Consumers' knowledge and utilisation practices regarding plastic food and beverage packaging and containers

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DECLARATION

I, Magdi Susan van den Berg, hereby declare that:

Consumers' knowledge and utilisation practices regarding plastic food and beverage packaging and containers

is my own work and that this dissertation submitted for degree purposes at the North-West University has not previously been submitted for degree purposes to any other higher education institution and that, except for sources acknowledged, the work is entirely that of the researcher.

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"Education is the passport to the future, for tomorrow belongs to those who prepare for today" – Malcolm X.

SUMMARY

Plastic packaging and containers play an important role in the food industry. They provide product information, aid in preventing food spoilage, and offer protection during transport and storage. However, these packaging materials or containers may leach harmful chemical substances and compounds into food and beverages. The leaching process may be accelerated during the misuse and reuse of these plastic products.

Consumers are mostly familiar with the chemical substance Bisphenol A (BPA), “an endocrine-disrupting chemical (EDC)”, which has attracted attention worldwide. BPA and EDCs are associated with different diseases and health problems, since they alter and interfere with natural hormones. Research has indicated that the accumulation of BPA and other EDCs from a variety of sources pose threats to human development and health. In addition, substitute chemicals performing similar functions to that of BPA in plastics occur in “BPA-free” plastic products.

Research was therefore done to determine consumers’ knowledge and utilisation practices regarding plastic as food and beverage packaging and containers. The aim of this study was to investigate and describe consumers’ subjective and objective knowledge and their utilisation practices regarding plastic food and beverage packaging and containers in order to assess if consumers utilise these plastics safely. The information sources that consumers consult regarding the correct use of plastic packaging and containers as well as BPA and other harmful chemicals were also determined. The Social Cognitive Theory (SCT) was used as theoretical perspective in order to frame the objectives of this study, and aided in the understanding of consumer knowledge, their learning processes, and their behaviour and how to alter it.

A quantitative, cross-sectional, descriptive survey was used for this study. Information was obtained from consumers between the ages of 18 to 35 years, from different backgrounds. Non-probability, purposive sampling was used and 293 respondents completed the online questionnaire.

The results indicated that although most respondents had a fair subjective knowledge, they lacked objective knowledge regarding plastic food and beverage packaging and containers. Moreover, while some respondents had adequate to good knowledge of some of the identified factors, their utilisation practices did not reflect this knowledge since most types of packaging and containers were used incorrectly. A total lack of knowledge regarding plastic identification codes was

identified. Respondents indicated that they obtained product-related information from formal and informal information sources, but trusted formal sources more. In a developing country such as South Africa, informal sources are more easily accessible, and respondents may therefore use them more.

In contrast to previous research conducted in South Africa regarding consumer knowledge in other food contexts, no practically significant associations were indicated between subjective and objective knowledge. Additionally, only slight differences/tendencies were observed between respondents of different ages, genders and ethnicities.

In conclusion, results confirmed that consumers are ill-informed regarding the correct utilisation practices of plastic products in a food context, and that they are unaware of the harmful chemicals in plastics and their associated health effects. These findings highlight the need for consumer education regarding the correct utilisation practices of plastic food and beverage packaging and containers and education regarding plastic identification codes, paving the way for follow-up intervention research. Legislation and policy makers are also recommended to take action regarding harmful chemicals found in food packaging and containers, since doing so may lead to an overall improvement of consumer health.

OPSOMMING

Plastiekverpakking en houers speel ’n belangrike rol in die voedselbedryf. Dit verskaf produkinligting, dra by tot die voorkoming van voedselbederf en verleen beskerming tydens vervoer en opberging. Hierdie voedselverpakkingsmateriale en -houers kan egter skadelike chemiese stowwe en komponente in die voedsel en dranke uitloog. Hierdie uitlogingsproses kan deur die wangebruik en hergebruik van hierdie plastiese produkte versnel word.

Verbruikers is meestal met die chemiese stof Bisfenol A (BFA), ’n endokriene-ontwrigtende chemikalie (EOC) wat wêreldwyd aandag trek, bekend. BFA en EOCs word met verskillende siektes en gesondheidsprobleme geassosieer, aangesien hierdie chemikalieë natuurlike hormone verander of daarmee inmeng. Navorsing het aangedui dat die akkumulering van BFA en ander EOCs vanaf ’n verskeidenheid bronne ’n bedreiging vir menslike ontwikkeling en gesondheid inhou. Daarbenewens kom plaasvervangende chemikalieë, wat soortgelyke funksies as BFA in plastiek verrig, in “BFA-vrye” produkte voor.

Navorsing is dus gedoen om verbruikers se kennis en gebruikspratyke van plastiek wat as voedsel- en drankverpakking en houers gebruik word, te bepaal. Die doel van hierdie studie was om verbruikers se subjektiewe en objektiewe kennis en hulle gebruikspraktyke ten opsigte van plastiek voedsel- en drankverpakking en houers te ondersoek en te beskryf, ten einde te bepaal of verbruikers hierdie plastiek veilig gebruik. Die inligtingsbronne wat verbruikers aangaande die korrekte gebruikspraktyke van plastiekverpakking en houers raadpleeg, sowel as BFA en ander skadelike chemikalieë, is ook bepaal. Die sosiale kognitiewe teorie (SKT) is as teoretiese perspektief gebruik om die doelstellings van hierdie studie te omsluit, en het tot die begrip van verbruikers se kennis, leerprosesse en gedrag oor hoe om dit te verander bygedra.

’n Kwantitatiewe, deursnit, beskrywende opname is vir hierdie studie gebruik. Inligting is vanaf verbruikers tussen die ouderdomme van 18 tot 35 jaar, vanuit verskillende agtergronde bekom. Nie-waarskynlikheids, doelgerigte steekproefneming is gebruik, en 293 respondente het die aanlynvraelys voltooi.

Die resultate het aangedui dat alhoewel die meeste respondente redelike subjektiewe kennis gehad het, hulle aan objektiewe kennis rakende voedsel- en drankverpakking en houers ontbreek het. Verder, terwyl sommige respondente voldoende kennis ten opsigte van sommige van die geïdentifiseerde faktore gehad het, het hulle gebruikspraktyke nie hierdie kennis weerspieël nie,

aangesien die meeste soorte verpakkings en houers verkeerd gebruik is. ’n Algehele tekort aan kennis rakende plastiek-identifiseringskodes is geïdentifiseer. Respondente het aangedui dat hulle produkverwante inligting van formele en informele inligtingsbronne verkry, maar dat hulle formele bronne meer vertrou. In ’n ontwikkelende land soos Suid-Afrika, is informele inligtingsbronne makliker verkrygbaar as formele bronne, en respondente mag dit daarom meer gebruik.

In teenstelling met vorige navorsing wat in Suid-Afrika aangaande verbruikerskennis in ander voedselkontekste uitgevoer is, is geen praktiese betekenisvolle verwantskappe tussen subjektiewe en objektiewe kennis aangedui nie. Daarbenewens is slegs effense verskille/tendense tussen respondente van verskillende ouderdomme, geslagte en etnisiteite waargeneem.

Ter afsluiting het die resultate bevestig dat verbruikers waningelig is oor die korrekte gebruikspraktyke rakende plastiek produkte in ’n voedselkonteks, en dat hulle onbewus is van die skadelike chemikalieë in plastiek en die verbandhoudende gesondheidseffekte daarvan. Hierdie bevindinge lig die behoefte aan verbruikersopleiding rakende die korrekte gebruikspraktyke van plastiek voedsel- en drankverpakking en -houers en plastiek identifiseringskodes uit, wat die weg vir opvolg intervensie-navorsing baan. Wetgewing en beleidmakers word ook aanbeveel om op te tree met betrekking tot skadelike chemikalieë wat in voedselverpakkings en -houers voorkom, aangesien dit tot ’n algehele verbetering van verbruikersgesondheid kan aanleiding gee.

CONCEPT CLARIFICATION

1. **Bisphenol A (BPA) –** A chemical utilised on an industrial scale in producing consumer products. These products include polycarbonate plastic, plastic packaging, dental sealants and water pipes (Cooper *et al.*, 2011:943).
2. **Beverages –** Any drink intended for human consumption (The Free Dictionary, 2003; Bosman *et al.,* 1984:719).
3. **Consumer –** An individual who purchase goods and services for personal use (Schiffman & Kanuk, 2010:23).
4. **Endocrine-disrupting chemicals (EDCs) –** Chemicals that mimic or antagonise the actions of natural occurring hormones in the body, such as oestrogen (Yang *et al.*, 2011:989).
5. **Food containers –** Any containers consumers use to store their food in.
6. **Food packaging –** A system used for the preparation of consumer products for transportation, storage, distribution, retailing and end use. Packaging is intended to assure the delivery of products, in safe and good condition, at the least possible cost (Paine & Paine, 1992:3).
7. **Objective knowledge –** The actual measure of how much a person knows about something (House *et al*., 2004:113).
8. **Plastic –** Polymers consisting of either an aromatic unit containing the benzene ring, or as nonaromatic units. More than one monomer can be cross-linked, and side branches may exist, resulting in added structural rigidity of plastic packaging (Murano, 2003:388).
9. **Resin –** A polymer in the form of a small, individual pallet that is manufactured through the melting and extrusion into plastic packaging sheets (Murano, 2003:G-16).
10. **Subjective knowledge –** Consumers' subjective perceptions and self-beliefs regarding their own knowledge; an individual's own idea of how much he or she knows about something (Carlson *et al.,* 2008:864; House *et al.,* 2004:114; Pieniak *et al.,* 2010:581-588).

(References included in Chapter 1)

KEY WORDS

- Bisphenol A (BPA)
- Consumer knowledge
- Food containers
- Food packaging
- Health risks
- Information sources
- Objective knowledge
- Plastic
- Subjective knowledge
- Utilisation practices

LIST OF ACRONYMS

ADHD - Attention Deficit Hyperactivity Disorder

BPA – Bisphenol A

BPF – Bisphenol F

BPS – Bisphenol S

CPA – Consumer Protection Act

DBP – Dibutyl phthalate

EDCs – Endocrine-disrupting chemicals

EFA - Exploratory Factor Analysis

EPA – Environmental Protection Agency

EFSA – European Food Safety Agency

DEHP – di-(2ethylhexyl) phthalate

FAO – Food and Agriculture Organisation

FDA – Food and Drug Administration

HDPE – High-density polyethylene

HREC – Health Research Ethics Committee

ITRI – Industrial Technology Research Institute

KMO – Keiser-Meyer-Olkin

LDPE – Low-density polyethylene

NGOs – Non-government organisations

NWU – North-West University

OK – Objective knowledge

PAEs – Phthalate esters

PE – polyethylene

PCOS – Polycystic Ovary Syndrome

PVC – Polyvinyl chloride

PP – Polypropylene

PET – Polyethylene terephthalate

PS – Polystyrene

PC – Polycarbonate

SCT – Social cognitive theory

SK – Subjective knowledge

SKT – Sosiale Kognitiewe Teorie

SPI – Society of the Plastics Industry

SPSS - Statistical Package for Social Sciences

TCS – Triclosan

USEPA – United States Environmental Protection Agency

WHO – World Health Organisation

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Chapter 1
Introduction

1.1. BACKGROUND AND MOTIVATION

Food packaging is a rapidly evolving field (Bhunia *et al.,* 2013:523). The use of plastic in particular has been growing steadily, and the variety of food and beverage packaging applications have increased with new plastic materials and polymer modifications being developed (Hoppe *et al.,* 2016:118). The purpose of food packaging includes the physical protection of food and beverages during the production, transport and storing processes of food, protecting food from spoilage, as well as providing product information (Seltenrich & Tart, 2015: A175).

In terms of its practical use, the convenience of packaging is non-negotiable (Lorenzi, 2014:66). Reseal-ability, flexibility, reuse and recycling are additional features of plastic packaging that are important to consumers (Bhunia *et al.,* 2013:523; Stephen & Abdul, 2007:13). Plastic packaging also allows beverage companies to reduce their bottle weight and to move into markets where resistance to breakage is a key element (Stephen & Abdul, 2007:15). Prerequisites for plastic packaging and containers are that packaging must be lightweight, durable and extend shelf-life (Lorenzi, 2014:66).

Synthetic plastic and plastic resins are used in various aspects of human life (Bang *et al.,* 2012:453), not only for food and beverage packaging and containers. Plastic is used in children's toys, bicycle helmets, floatation devices and sport protective gear (Plastics|SA, 2014a), as well as personal care products, including cosmetic containers, hair care product containers, and lotion bottles (Weiss & Ruderman, 2011:16). Even though certain plastic materials are banned in some countries owing to health and environmental risks, questionable plastic bags and packaging are still used since they are relatively inexpensive (Jayaraman *et al.,* 2011:1528).

Controversy regarding the safety of plastic packaging has been reported, as chemicals with estrogenic properties leach from the packaging into the product it contains (Leman, 2009:64; Yang *et al.*, 2011:989). These chemicals include Bisphenol A (BPA) and BPA alternatives, which have not yet been studied intensively and which implications on human health are still unknown (Scherer *et al.,* 2014:649). In fact, most plastic products, including packaging, release or leach different chemicals in different amounts (Yang *et al.,* 2011:995). The influence of chemicals and materials leaching from packaging may be 100 times more than the influence of pesticides and environmental pollutants (Gallart-Ayala *et al.*, 2013:99), on consumer health.

Of these chemicals, consumers worldwide are most familiar with BPA (Seltenrich & Tart, 2015: A175).

BPA is an industrial chemical used in the production of consumer products including polycarbonate (PC) plastic, polyvinyl chloride (PVC) plastic, plastic packaging, dental sealants and water pipes (Cooper *et al.*, 2011:943; Geens *et al.,* 2011:340; Mahamuni & Shrinithivihahshini, 2017:861). It is said that nearly all canned food and beverage product-linings contain BPA (Stone *et al.,* 2010:3). Additionally, BPA is used in plastic and non-plastic, food and non-food related consumer products as stabilisers, plasticisers and additives (Cooper *et al.*, 2011:944). BPA is an endocrine-disrupting chemical (EDC) which has estrogenic characteristics and show endocrine-disrupting activities in animals and humans (Kang *et al.,* 2006:80; Kubwabo *et al.,* 2009:928). Studies show that it may be associated with different diseases and health problems, such as cardiovascular and metabolic diseases (Kang *et al.,* 2006:80; Kubwabo *et al.,* 2009:928). EDCs are chemical compounds that alter homeostatic and hormonal systems and influence the development process of humans (Sifakis *et al*., 2017:57). These chemical compounds alter and interfere with the synthesis, secretion, metabolism, transport and binding actions of natural hormones as well as homeostasis, reproduction and developmental processes (Diamanti-Kandarakis *et al.* 2009:294). Multiple EDCs, their effects, and their sources have not been identified, and are still poorly understood (Mani *et al*., 2017:40).

From this background, it becomes evident that although plastic is a popular material in the food and beverage industry (Wong & Durrani, 2017:107), the negative aspects of plastic components should be taken into consideration.

1.1.1. Consumers' exposure to leaching chemicals from plastic packaging and containers

Research has found that plastic food and beverage packaging and containers interact with the food it contains, and the process of diffusion is mainly responsible for this type of interaction (Arvanitoyannis & Kotsanopoulos, 2014:22). Diffusion is the transfer of substances from a higher concentration (food and beverage packaging and containers) to a lower concentration (food products) (Bhunia *et al.,* 2013:523). Evidence exists that this process is influenced by different factors, including time of storage, exposure to different temperatures, and the different types of products (Bhunia *et al.,* 2013:523; Kubwabo *et al.,* 2009:936; Pinto & Reali, 2009:229). This interaction or diffusion process is also referred to as leaching or migration.

BPA has been found to leach or migrate into food and beverages from BPA-containing packaging, PC plastic containers and reusable drinking bottles (Cooper *et al.*, 2011:947; Kubwabo *et al.,* 2009:929). However, BPA is still used in the production of plastic packaging and containers worldwide (Mirzajani *et al*., 2017:1059). Moreover, BPA is used in the production of paper, resulting in the expected presence of BPA in food-contact paper (Vandenberg *et al.*, 2007:150). Epoxy resins used in the coating of canned food and drinks cans (FDA, 2014; Huang *et al.,* 2012:93) may also leach BPA, as BPA residues have been detected in canned pet food, vegetables, fish, and baby formula (Vandenberg *et al.*, 2007:150).

Exposure to sunlight and high temperatures and the duration of storage and exposure adds to the leaching of chemicals from, for example, water bottles into the water (Kubwabo *et al.,* 2009:936; Pinto & Reali, 2009:229). Research has proven that BPA leaches from new and used PC water bottles at room temperature (24ºC), in the refrigerator (4ºC), and at higher temperatures (40ºC, 100ºC) (Kubwabo *et al.,* 2009:931; Le *et al.,* 2008:153; Li *et al.,* 2010:559). In addition, high temperatures have an increasing effect on the leaching from baby bottles (Li *et al.,* 2010:557). Microwave cooking and heating and moist heat from boiling and dishwashing may accelerate this leaching or migration process (Yang *et al.,* 2011:989). Therefore, it can be stated that the utilisation practices of consumers contribute to the natural migration of BPA and other EDCs from food packaging into foodstuffs.

The leaching process may lead to chemical changes in the packaging, the food with which it comes in contact, or both. This process causes food contamination, the loss of integrity of the packaging, and a decrease in the quality of the packaging and its contents (Jayaraman *et al.,* 2011:1529). To avoid BPA exposure, it is recommended that consumers use unlined stainless-steel drinking bottles (Cooper *et al.,* 2011:947). These steps can be taken by consumers in order to protect themselves from BPA exposure, as the first legislation regarding BPA in South Africa only intervenes to protect infants and babies (the Minister of Health signed regulations to ban the import and export as well as the manufacturing and selling of baby bottles that contain BPA) (ITRI, 2011). However, this legislation only applies to baby bottles, and not to other plastic food and beverage packaging and containers. Within South Africa, these BPA regulations are included in the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (ITRI, 2011).

Notwithstanding such regulation, research has shown that infants consume ten times the amount of BPA that adults consume on a daily basis (Li *et al.,* 2010:562; Muncke, 2011:120). The amount of BPA-exposed food per kilogram bodyweight that infants and children consume (Muncke, 2011:120) and the smaller packaging used result in a higher surface-to-volume-ratio migration (Grob *et al.,* 2007:202), leaving infants and children more vulnerable to BPA and

EDC exposure. These findings resulted in the banning of BPA from baby bottles in Canada in 2008 and in nine of the US states in 2011 (Lofstedt, 2013:195). In South Africa, BPA legislation was signed on 21 October 2011. During 2012, the Food and Drug Administration (FDA) issued a ban of using BPA in baby bottles and the drinking cups of children in the USA (Tavernise, 2012). However, BPA-free water bottles and baby bottles may contain BPA substitutes that have not yet been researched and analysed sufficiently (Scherer *et al.,* 2014:651, 652).

Indeed, Scherer *et al.* (2014:652) state that consumers are unaware that BPA-free products contain similar chemical substitutes, as BPA is evaluated separately. Research has found that BPA-free products still leached other chemicals or BPA alternatives that showed estrogenic activity (Royte & Greer, 2015:130; Wong & Durrani, 2017:110; Yang *et al.,* 2011:995). This finding emphasises the fact that the plastic exposure problem is greater than just BPA exposure, as the number of chemicals possessing estrogenic activity are unknown (Yang *et al.,* 2011:995). Moreover, these EDCs are present in plastic packaging and containers and leach into food products. Therefore, consumer research within this field is of utmost importance, especially since, as previously mentioned, BPA contributes to different diseases and health problems (Kang *et al.,* 2006:80; Kubwabo *et al.,* 2009:928). Furthermore, the known estrogenic activity of BPA alters and interferes with homeostatic and hormonal systems (Diamanti-Kandarakis *et al.* 2009:294). Evidently the leaching of chemical substances will have an effect on human health.

1.1.2. Alternative routes of exposure and products

Although the main sources of BPA consumption for humans are through food and water, environmental sources (water, soil, air) can provide additional routes of BPA contamination (Kang *et al.*, 2006:86; Li *et al.,* 2010:557; Sifakis *et al*., 2017:57). The main source of BPA in soil is human waste (Kang *et al.*, 2006:81). Studies also indicate that BPA exposure can occur through alternative sources, such as thermal receipts (till slips) and through smoking (Chen *et al.,* 2016:145). Other uses of BPA that contribute to exposure are the lids of metal jars, coating of PVC pipes, adhesives, automobile parts and aerospace applications (Kang *et al.*, 2006:80). Additionally, PC plastics are used in the production of compact discs (CDs), household appliances and automotive lenses (Kang *et al.*, 2006:80). These applications can provide a route of exposure to BPA and thus an increase of exposure to humans.

Researchers are concerned that the number of sources of human exposure to BPA is insufficiently clarified, which raises concern that researchers underestimate the total exposure of humans to BPA (Geens *et al.,* 2011:339; Vom Saal & Welshons, 2014:109; Zhou *et al.,*

2017: 41). The combination of numerous exposure routes and long-term exposure also results in concerns regarding specific populations and human health in the future (Chen *et al.,* 2016:145). The possible risks associated with long-term exposure through environmental sources have also been suggested as needing further investigation (Zhou *et al.,* 2017:41). It has already been found that at the current levels of human exposure to BPA, cell and organ functions are impacted (Vandenberg *et al.*, 2007:170). However, controversy regarding low-level exposure and health effects still exist (Huang *et al.*, 2017:151).

1.1.3. Health effects of chemical substances in plastic packaging and containers

Even though literature suggests that BPA levels and consumption do not reach concentrations associated with health effects, the accumulated exposure resulting from the ingestion of multiple food sources with elevated BPA levels as well as other contributing routes of exposure to BPA must be considered and be monitored (Gallart-Ayala *et al.*, 2013:109). Several studies show that a number of different health problems may be associated with BPA intake (Kubwabo *et al.,* 2009:928). Mahamuni and Shrinithivihahshini (2017:861, 862) report that results regarding BPA toxicity vary, and that even the World Health Organisation (WHO) and the United States Environmental Protection Agency (USEPA) are uncertain regarding the toxicity of BPA. It was scientifically proven that BPA can be detected and measured in humans in blood, serum, urine, follicular fluid, amniotic fluid, placental tissue, umbilical cord blood, semen and breast milk (Vandenberg *et al.*, 2007:140-143).

Animal testing has raised the most concerns about the effects of BPA on hormonal activity, since it may potentially affect neurological, physical and behavioural development (WHO & FAO, 2009:2). A variety of potential health effects of BPA have been reported by research. These include:

- **Hormonal effects in males**: BPA affects the male reproductive tract/prostate, and is associated with prostate cancer and decline in semen quality in males (Kubwabo *et al.,* 2009:928; Sifakis *et al*., 2017:57; WHO & FAO, 2009:2).
- **Hormonal effects in females:** Obesity, Polycystic Ovarian Syndrome (PCOS), endometrial hyperplasia, abnormal karyotypes, breast cancer, and the early onset of puberty in girls (Kubwabo *et al.,* 2009:928; Riskind & Lohr, 2016; Sifakis *et al*., 2017:57; Vandenberg *et al.,* 2007:147) have all been linked with BPA exposure.
- **Hormonal effects in both males and females**: BPA may contribute to delays in the onset of puberty in males and females, obesity, and alterations in brain development and behaviour, while concerns about the possible carcinogenicity of BPA have also

been expressed (Kubwabo *et al.,* 2009:928; Vandenberg *et al.,* 2007:147; WHO & FAO, 2009:2).

- **Pregnancy:** BPA can be found in the placenta, and recurrent miscarriages are associated with BPA (Kang *et al.,* 2006:85; Vandenberg *et al.,* 2007:147).
- **Neurological, neurodevelopmental effects and behavioural changes** (EFSA, 2015:17; Kirchnawy *et al.,* 2013:467; Kubwabo *et al.,* 2009:928; Leman, 2009:66; Rochester, 2013:144).
- **Immune effects:** BPA has a negative effect on immune function in general (EFSA, 2015:18; Rochester, 2013:148).
- **Cardiovascular effects:** There is an increased risk for cardiovascular diseases and atherosclerosis due to chemical exposure (EFSA, 2015:18; Kubwabo *et al.*, 2009:928; Lin *et al.,* 2015:658; Rochester, 2013:146-8).
- **Metabolic effects:** BPA and EDCs affect body weight, insulin regulation, and thyroid function, and may contribute to liver dysfunctions (Bang *et al.,* 2012:465; EFSA, 2015:18; Kabir *et al.,* 2015:252; Rubin & Soto 2009:58; Vafeiadi *et al.,* 2016:383, 384; Vandenberg *et al.,* 2007:147).
- **Genotoxicity**: Effects on chromosomal abnormalities and alignment as well as gene expression alterations have been associated with BPA and EDC exposure (EFSA, 2015:19; Machtinger *et al.,* 2013:8; Rochester, 2013:148; Vandenberg *et al.,* 2007:147).
- **Carcinogenicity:** Associations between EDC exposure and an increased prevalence of breast, prostate and testis cancer have been observed (EFSA, 2015:19; Kabir *et al.,* 2015:252; Seachrist *et al.*, 2016:178; Wuttke, 2010:9)
- **Organ failure:** Higher doses of BPA exposure could cause organ failure in humans (Baluka & Rumbeiha, 2016:59).

It is evident that there is little consensus in research regarding the effects of BPA on the reproductive systems of males and females. However, the serious potential health risks associated with BPA are a cause for concern regarding the safety of consumers that are exposed to BPA and other chemicals found in food packaging and containers.

1.1.4. Consumer knowledge of plastic containing food packaging and containers

It is evident at this point in the discussion that consumers' exposure and the associated health risks of BPA and other, less researched chemical substances found in plastic food and

beverage packaging and containers provide reasons for concern. Indeed, since plastic is a popular packaging material as a result of the advertised benefits to which consumers are constantly exposed through the food and beverage industries, BPA should be an increasingly important cause of concern. Yet consumer research in this context is still limited.

International research shows that when asked about food contaminants, only a few consumers mentioned food-packaging materials (Gallart-Ayala *et al.*, 2013:99). Research confirms a total lack of knowledge regarding the exposure information and the hazards for most of the high-level chemicals (Vom Saal & Welshons, 2014:110). High-level chemicals include those to which consumers are exposed. Moreover, Scherer *et al.* (2014:652) confirm that consumers are unaware that BPA-free products contain similar chemical substitutes, as BPA is evaluated in isolation. Additionally, consumers may even be unaware of the types of plastic used in packaging (Jayaraman *et al.,* 2011:1528). Therefore, although consumer research regarding plastic and BPA is limited, it seems that consumer knowledge in this regard is inadequate.

Furthermore, Pouokam *et al.* (2014:297) state that there is no information regarding the exposure of BPA available in African countries – neither regarding adults nor infants. However, BPA and other EDCs were found in South African drinking water (Van Zijl *et al.,* 2017:306), confirming that South Africans are exposed. In addition, South Africa is the only African country that has taken action regarding the BPA exposure of infants (ITRI, 2011; Pouokam *et al.,* 2014:297). However, despite the banning of manufacturing, imports, exports and sales of baby bottles containing PC plastic and BPA (Green Times, 2012), no research regarding the knowledge of South African consumers regarding BPA could be found.

Consumer knowledge has been found to be an important subject to consumer researchers, and has been investigated across many different fields, including products and services (Carlson *et al.,* 2008:864). Researchers distinguish between **objective** and **subjective knowledge.** Objective knowledge can be defined as the accurate information regarding a specific product, stored in the long-term memory of a consumer (Pieniak *et al.,* 2010:581-588), i.e. knowledge based on facts. Subjective knowledge is defined as consumers' subjective perceptions and self-beliefs regarding their own knowledge (Carlson *et al.,* 2008:864; Pieniak *et al.,* 2010:581-588), i.e. what they think they know.

Previous studies regarding knowledge in the Consumer Sciences and food context have been conducted in South Africa, including on knowledge regarding food labels and nutrition (Oldewage-Theron *et al.,* 2014:858; Van der Merwe *et al.,* 2011:407), as well as differentiating between subjective and objective knowledge (Donoghue *et al.,* 2016:386). Consumers must have access to correct information in order to educate themselves (Donoghue *et al.,* 2016:397). Thus, it is suspected that the different levels of subjective and objective knowledge

and a lack of knowledge regarding label reading, nutrition, and consumer protection revealed by previous research in a South African context may result in the misuse of different products and packaging. Furthermore, the lack of available information in developing countries may contribute to sub-optimal consumer choices, as well as behavioural and misuse practices.

1.1.5. Consumer use practices of plastic in food packaging and containers

Research has shown that the use of plastic products has increasingly grown since its discovery (Hoppe *et al.,* 2016:118). Consumers' knowledge of plastic will also affect their utilisation practices, and a lack of knowledge may result in the misuse of plastic products.

The Society of the Plastics Industry (SPI) developed recycling codes in 1988 in order to identify different polymer types. These codes serve as a guide to aid consumers in determining how plastic products should be used safely, and how safe they are for human health (Leman, 2009:65). Plastic recycling and identification codes can be found on most plastic packaging and containers; however, the use of these codes is voluntary and omission of the codes on plastic products is often as a result of ignorance (Plastics|SA, 2012).

With regard to the use of plastic in the microwave oven, some products make use of the term "microwave safe", while others contain an imprinted microwave symbol, or the specific product packaging label will provide information for proper use and microwave use (Plastics|SA, 2014b). However, the recycling symbol found on plastic packaging and containers does not mean that the product is microwave safe (Harvard Women's Health, 2006:7). Only products that have been tested and found to be safe will show "microwave-safe" or display the microwave-safe logo (Harvard Women's Health, 2006:7).

Moreover, PC plastic containing harmful chemicals is used in the production of reusable beverage containers, frozen and prepared food oven trays, microwaveable cookware as well as in "boiling-in-the-bag" packs (Bhunia *et al.,* 2013:528; Hoppe *et al.,* 2016:122). Consumers are roasting and microwaving food in plastic "boiling-in-the-bag" packing when in fact this the process is believed to accelerate the leaching of chemicals (Hoppe *et al.,* 2016:122). Single-use plastic products, such as beverage and water bottles, are found to be refilled and reused by consumers (Muncke, 2011:120). However, these bottles have not been designed for or assessed in this respect (Muncke, 2011:120). Consumers may not be aware that these products leach harmful chemicals, therefore their utilisation practices may not take this leaching into consideration. In order to improve the utilisation practices of consumers, it is necessary to determine the information sources they consult regarding the correct use of plastic packaging and containers, as well as BPA and other harmful chemicals.

1.1.6. Information sources of plastic-containing food packaging and containers

Consumer attitudes regarding BPA are formed by their exposure to news and trust in both the manufacturing companies and the FDA (Scherer *et al.*, 2014:649). In order to inform consumers regarding the risks associated with EDCs including BPA, Mustieles *et al.* (2015:182) recommend that physicians, gynaecologists and paediatricians should be educated regarding the hazards of EDC exposure. Other healthcare providers (e.g. nurses) should also be advised and educated regarding this subject (Enneking, 2006:96), which would allow them to make recommendations regarding reducing exposure and precautions or preventions to be taken by consumers of high risk populations (Mustieles *et al.,* 2015:182). High risk populations or consumers are individuals with pre-existing illnesses or diseases, which may also be linked to BPA and EDCs. Within developing countries, such as South Africa, nurses may be of utmost importance in this instance, since many consumers in rural areas only have access to clinics.

Public health information is also provided to consumers through popular sources and local media, such as newspapers, radio stations (Pouokam *et al.,* 2014:297) and press releases (Endocrine Society, 2016). In turn, such information available at the community level is provided through vendors, mothers and women associations, pharmacies (Pouokam *et al.,* 2014:297, 301), and local authorities (Jayaraman *et al.,* 2011:1532). Plastic recycling and identification codes can be found on most plastic packaging and containers and serve as a guide to aid consumers in determining if products are safe for use, and how safe they are (Leman, 2009:65). However, in sub-Saharan Africa, the lack of available public health information is made more problematic as a result of a shortage of trained manpower to communicate these risks and issues (Pouokam *et al.,* 2014:301).

The ineffective transfer of public health information in sub-Saharan African countries, such as South Africa, is a cause for concern when the limited international studies regarding consumers and chemical substances found in plastic indicate a high degree of consumer unawareness. The problem should therefore also be addressed in a South African context, through determining consumers' knowledge, information sources, and utilisation practices of plastic food and beverage packaging and containers.

In order to frame the design and objectives of this study, the Social Cognitive Theory (SCT) will be used as a theoretical perspective. The need for the use of a theoretical perspective arose because African consumers differ from consumers where the previous research has been conducted (mostly in developed countries). The ways in which consumers use products and search for information as well as their levels of knowledge differ. The SCT will aid in providing a clearer perspective on how environmental elements (information sources),

behavioural elements (utilisation practices), and the consumer (knowledge, personal factors) are interdependent elements that influence one another. The SCT in the context of plastic food and beverage packaging and containers is discussed in Chapter 3.

1.2. PROBLEM STATEMENT

Plastic packaging and containers are used for a variety of purposes for food, including providing product information, preventing spoilage, and protecting food while transported and stored. However, these valuable packaging or containers may leach harmful chemical substances and compounds into food and beverages. The substance with which more consumers are familiar, and which has attracted attention worldwide, is BPA, as it is proven to leach from different products and has been banned from baby bottles.

Products containing BPA include PC and other types of plastic, plastic packaging, water pipes, resins used for the lining of food and beverage containers, plastic film, and microwaveable packaging. Environmental sources, such as water, soil, and air can provide pathways of BPA contamination. However, the primary pathway of contamination for humans is through BPA-contaminated foods.

BPA has further been found to be an EDC, and studies show that it may be associated with different diseases and health problems. EDCs are compounds that alter and interfere with the synthesis, secretion, metabolism, transport, binding actions and elimination of natural hormones present in blood. These hormones are responsible for homeostasis, reproduction, and developmental processes.

Yet much confusion still exists regarding BPA, a chemical consumed on a daily basis, and the risks it poses to human health. Consumers seem unaware that concerns regarding BPA may exist, confirming international research that knowledge of BPA has been found to be limited. In addition, a lack of information regarding the BPA issue was found in literature. Consumers appear to be uninformed about the necessary practices to reduce or avoid BPA consumption.

Such knowledge is important, as BPA has been found to leach from PC plastic, such as water bottles or baby bottles, into water and food. Further research also shows that leaching rates increase when BPA-containing products are heated to high temperatures and with longer exposure times. Previous studies have found release of BPA from baby bottles at 4 ºC, 24ºC, 40ºC and 100ºC. As BPA was found in room-temperature water, there is concern about other plastic bottles, containers and packaging. It was also stated that the pH of the food can influence the migration of BPA. However, research has stated that the amount of BPA found

in water is not the main problem, but rather the accumulation from different sources poses threats to human development and health.

Although legislation was amended to protect babies and infants, research shows that consumers' utilisation practices have not changed, indicating that they are uninformed regarding the correct use of plastic food and beverage packaging and containers. PC bottles are still re-used, plastic containers are heated in microwaves, and plastic packaging is still exposed to extreme temperatures. Microwave cooking or heating and moist heat from boiling and dishwashing further accelerates leaching of BPA. Therefore, it can be stated that the utilisation practices of consumers contribute to the natural leaching of BPA and other EDCs.

A total lack of knowledge regarding exposure information and hazards associated of high volume chemicals, such as BPA, was already pointed out during 1997, and the situation has not changed since. Literature thus suggests that consumers obtain information with regard to plastic from unreliable or uninformed sources, such as local media, newspapers and radio stations. Furthermore, healthcare workers are still uninformed and therefore provide unreliable information. The education of physicians, paediatricians and chemists in this regard is thus encouraged. Moreover, although substitute chemicals that perform similar functions to that of BPA are found in BPA-free products, these products have not received as much attention as BPA, and it may be possible that these chemicals and their reactions might be worse than those of BPA.

Therefore, research is necessary to determine consumers' knowledge of plastic as food and beverage packaging and containers, their information sources regarding plastic, and their utilisation practices of plastic food and beverage packaging and containers. International consumer research in this context is inadequate, and information in a South African context is even more limited. Such research is essential as a baseline for determining the nature and the extent of plastic misuse among consumers, to allow for appropriate actions to be taken in follow-up research and interventions in addressing the possible problem.

1.3. AIM AND OBJECTIVES

1.3.1. Aim

The aim of this study was to investigate and describe consumers' knowledge regarding the correct use of plastic food and beverage packaging and containers, as well as their actual practices employed in such use, in light of the information sources consulted for information regarding plastic and its possible associated health effects/dangers.

1.3.2. Objectives

In order to achieve the aim of this study, the following objectives have been identified:

- To identify and investigate consumers' utilisation practices of plastic food and beverage packaging and containers;
- To determine consumers' subjective knowledge of plastic food and beverage packaging and containers;
- To determine consumers' objective knowledge of plastic food and beverage packaging and containers;
- To identify information sources that consumers consult to obtain information regarding the proper use of plastic food and beverage packaging and containers; and
- To determine associations between consumers' objective and subjective knowledge, demographic variables, utilisation practices, and information sources.

1.4. RESEARCH QUESTION

What knowledge do consumers have regarding the correct utilisation practices of plastic food and beverage packaging and containers from a health perspective, and what are their utilisation practices of these products?

1.5. OUTLINE OF DISSERTATION

A short discussion on each chapter is provided below. References are provided after each chapter according to NWU practice, as a research article is included among the Chapters of the dissertation.

Chapter 1 serves as introduction and provides an overview and background of the study. A general introduction, motivation and problem statement is provided. The aims and objectives for this study are then explained.

Chapter 2 provides an in-depth literature review of plastic food and beverage packaging and containers. Knowledge regarding plastic, information sources consulted for information regarding plastic and plastic-related chemicals, and the associated health effects are reviewed. Consumers' utilisation practices regarding plastic food and beverage packaging and containers are also discussed.

Chapter 3 comprises an application the SCT in the context of this study. This theoretical perspective is used to frame the design and objectives of this study.

Chapter 4 provides the full methodology used in this study. The explanation and reason for choosing the specific methods used in this study is described. Reliability and validity of the study as well as the ethical considerations are discussed.

Chapter 5 presented as a research article, serves as the results and discussion chapter, where the collected data is described and analysed. The analysed data is linked to literature and the research article is written for submission to an accredited journal for publication upon completion. To be more comprehensive for the sake of examination, the included article is presented in a slightly longer format than expected by the journal. The research article was conducted according to the specifications of the *Family and Consumer Sciences Research Journal.* (Addendum G: Authors' guidelines).

Chapter 6 concludes this dissertation, and includes a conclusion as well as recommendations for implementing the results of this study and for further research.

Addenda A (questionnaire), B (Informed consent form), C (Ethical approval of study), D (Invitation to participate), E (Ethical approval of invitation), F (Additional tables for results), G (Research article guidelines - *Family and Consumer Sciences Research Journal*), H (Language editing letter), and I (Turnitin reports) are attached for comprehensiveness and as additional information.

1.6. AUTHORS' CONTRIBUTIONS

The aims and objectives of this study were accomplished by a team of academic researchers. Each researcher played a definite part throughout the study. Table 1.1 provides a summary of these contributions.

Table 1.1. Summary of authors' contribution to this study

Name	Contribution
Miss M.S. van den Berg	First author, responsible for obtaining ethical approval, the literature research, questionnaire design and adaption, gathering of data, statistical analysis and interpretation of the data, and preparation of this dissertation and research article.
Prof M. van der Merwe	Supervisor, study leader and co-author, supervised the ethical approval process, literature research, questionnaire development, interpretation of results, and the completion of this dissertation and the research article. Provided funding for this study and statistical analysis.
Mrs. L. Wyma	Co-supervisor and co-author, supervised the ethical approval process, literature research, questionnaire development, interpretation of results, and the completion of this dissertation and research article.
Prof S.M. Ellis	Co-author of the research article. Responsible for statistical analyses and providing assistance with the interpretation of data and results. Assisted with study design and questionnaire development.

DECLARATION OF AUTHORS' CONTRIBUTIONS

I declare that I have approved the above-mentioned article, that my role in the study as indicated above is representative of my actual contribution and that I hereby give my consent that this article may be published as part of the M dissertation of Ms MS van den Berg.

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Prof M. van der Merwe **Prof S. Ellis**

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Ms L. Wyma

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Chapter 2

Literature review

2.1. INTRODUCTION TO PLASTIC FOOD AND BEVERAGE PACKAGING AND CONTAINERS

Packaging is an important component of consumer products, especially food products (Schafer, 2013:54) and the majority of products make use of some type of packaging (Arvanitoyannis & Kotsanopoulos, 2014:21) that serves more than one purpose. Packaging is defined as a coordinated system of preparing and protecting consumer goods for safe transport, storage, distribution, retailing, and end use (Paine & Paine, 1992:3; Seltenrich & Tart, 2015:A175). Other reasons for the use of packaging include the increase of product shelf-life, in-store merchandising, and safeguarding the contents from bacteria and contaminants (Schafer, 2013:54).

A major force driving packaging manufacturers and material suppliers is consumer convenience (Schafer, 2013:56). As a result of the development of new plastic materials, an increase in the variety of food and beverage packaging has become increasingly noticeable over the last 50 years (Hoppe *et al.,* 2016:118). More than 30 different types of plastic are currently used as materials in the packaging industry (Lau & Wong, 2000:256), as trays and their lids, pouches, films, and bottles amongst other products (Bhunia *et al.,* 2013:525). There is a wide variety of plastics that show toughness and strength (Coles *et al.,* 2003:174), and different types of plastics have different applications. Table 2.1 presents the different plastics and their abbreviations used in the food packaging industry (Coles *et al.,* 2003:177).

Among these plastics, polyethylene (PE) contributes to almost 56% of the total usage, and the remaining 46% mostly consists of polypropylene (PP), polyethylene terephthalate (PET), polystyrene (PS) and PVC (Coles *et al.,* 2003:177). This high usage of certain plastics has been confirmed by Andrady and Neal (2009:1977), who state that low-density polyethylene (LDPE), high-density polyethylene (HDPE), PP, PVC, PS and PET collectively account for 90% of the global demand for plastics. However, the concern regarding plastic safety and its possible effects on humans seems to be rising with the increase in plastic production (Bang *et al.,* 2012:453). Previous research has found that a total lack of knowledge exists among consumers regarding exposure and the hazards related to most of the high-level chemicals found in plastic (Vom Saal & Welshons, 2014:110). The different types of plastic (that may contain dangerous chemicals) used in the packaging industry are indicated in Table 2.1. It can be argued that an increase in plastic production and use will increase consumer exposure to these products and their related chemicals.

Table 2.1. Plastics used in the food packaging industry

Type of plastic	Abbreviation
Polyethylene	PE
Polypropylene	PP
Polyesters	PET/PETE, PEN, PC
Polyvinyl acetate	PVA
Ethylene vinyl acetate	EVA
Polyamides	PA
Polyvinyl chloride	PVC
Polyvinylidene chloride	PVdC
Polystyrene	PS
Styrene butadiene	SB
Acrylonitrile butadiene styrene	ABS
Ethylene vinyl alcohol	EVOH
Polymethyl pentene	TPX
High nitrile polymers	HNP
Fluoropolymers	PCTFE, PTFE
Cellulose based materials	No abbreviations available
Ionomers	

Adapted from: Andrady& Neal 2009:1977; Bang *et al.,* 2012:453; Coles *et al.,* 2003:177.

Consumers are taking a closer look at food packaging as they are becoming more aware of the environment and active in terms of sustainability and recycling (Schafer, 2013:59). The search for alternative plastic monomers produced from plant materials, where biodegradability aspects are taken into account, have also begun (Hoppe *et al., 2*016:118). Continuous developments in the food packaging industry are required in order to address specific needs and problems that arise (Arvanitoyannis & Kotsanopoulos, 2014:22). However, when considering the possible harmful effects of plastic, consumers are usually concerned with pollution and the environment. Yet the use and misuse of plastic food and beverage packaging and containers by the food industry and consumers may affect human health.

Indeed, a variety of additives, including anti-static and anti-blocking agents, lubricants, stabilisers, and antioxidants, are used to improve the performance of polymeric packaging materials (Lau & Wong, 2000:256). The use of these additives in plastic raises concerns regarding the safety of packaging and packaged food and beverages (Lau & Wong, 2000:256; Leman, 2009:64; Yang *et al.*, 2011:989). As a result of these consumer concerns, there has been a demand for safer product packaging, which has resulted in further studies regarding

packaging-related food additives that are accidentally found inside food products owing to unsuitable packaging materials (Arvanitoyannis & Kotsanopoulos, 2014:22), thus affecting the quality and safety of the foodstuffs.

Figure 2.1 indicates the market shares of different types of packaging materials. It is evident that rigid (27%) and flexible (10%) plastics cover a large sector of the packaging market share. According to Muncke (2012), the layer of packaging that comes into direct contact with the food or beverage is referred to as the "food contact material". With regard to beverage cartons or boxes, the food contact material is laminated plastic, and not carton itself (Muncke, 2012), contributing to an even higher plastic market-share percentage globally. One problem associated with food packaging is that the food contact material acts as a source of elements and chemicals that contaminate food products (Arvanitoyannis & Kotsanopoulos, 2014:22), and is therefore a cause for concern (Mahamuni & Shrinithivihahshini, 2017:863).

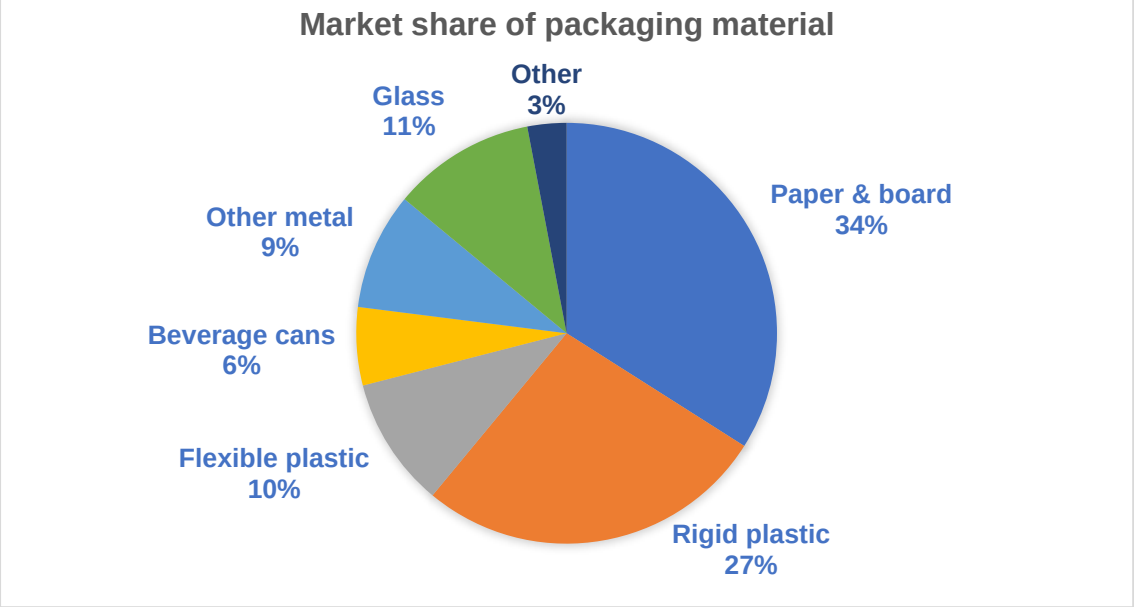


Figure 2.1. Market share of packaging material. (Image adapted from: Muncke, 2012).

Controversy regarding the safety of plastic packaging has been reported after chemicals with estrogenic properties and estrogenic activities were found to leach from the packaging into food products (Leman, 2009:64; Yang *et al.*, 2011:989). Thus, even though plastics have a wide range of uses and applications, some chemicals and additives found in plastic may have adverse effects on the environment and human health (Bang *et al.,* 2012:453). In order to address the problem regarding chemicals found in plastic packaging and containers and their possible health effects, knowledge regarding the possible "threat compounds" is crucial (Celinski & Sankowska, 2016:127). Since plastic identification codes can be confusing for

consumers who are unfamiliar with the variety of available plastics, manufacturers use additional labelling (such as BPA-free) to inform consumers about the contents of plastic products (Tooley, 2017).

In South Africa, plastic label information includes information on the different types of plastic used for production, distinguishing between, for example, the cap, the label itself, and the bottle (Figure 2.2). In addition, health claims such as “BPA-free” and some care instructions may be provided on plastic packaging (Figures 2.3 to 2.5). Some statements such as “freezer safe”, “microwave safe”, “not suitable for microwave heating”, and “do not heat in packaging” are also visible on some plastic food and beverage packaging materials and containers. However, consumers’ knowledge and understanding of this information, identification codes, and health claims are questionable.

Figure 2.2. Plastic identification codes on product labels (Image source: Photo taken).

Figure 2.3. BPA Free claims (Image source: WeCraveCoffee.com).

Figure 2.4. Information on plastic products (Image source: Photo taken).

Figure 2.5. Care and use instructions on plastic consumer products (Source: Sistema®, 2016).

2.2. CONSUMERS' SUBJECTIVE AND OBJECTIVE KNOWLEDGE OF PLASTIC PACKAGING AND CONTAINERS

Objective knowledge can be defined as the accurate factual information on a specific topic that is stored in the long-term memory of a consumer, as is the actual measure of how much a person knows (House *et al*., 2004:113; Pieniak *et al.,* 2010:581-588). Subjective knowledge, however, or self-assessed knowledge (Park *et al.,* 1994:71) is defined as consumers' perceived familiarity and self-beliefs regarding their own knowledge, i.e. an individual's own idea of how much he or she knows about something (Carlson *et al.,* 2008:864; House *et al.,* 2004:114). Subjective knowledge is said to be a strong driver of consumer behaviour (Ahmad & Nordin, 2014:66). Essentially, objective knowledge is what consumers really know regarding a topic, and subjective knowledge is what they think they know.

Carlson *et al.* (2008:864) indicate that significant variations in the relationship between subjective and objective knowledge have been reported. Differences between consumers' subjective and objective knowledge occur when consumers inaccurately distinguish how much they really know (House *et al.,* 2004:114). A weak correlation between subjective and objective knowledge may also result from pre-existing factors, such as product-related experiences and stored product-category information (Park *et al.,* 1994:79). Product category or product class refers to a group of similar products, with some variations and some identical characteristics, or a set of products used for specific functions (All Business, 2017), such as packaging. Stored product-category information does not fully represent objective knowledge, and inconsistencies between this information and objective knowledge exist since category information underrepresents or misrepresents consumers' true knowledge (Park *et al.,* 1994:79) regarding a specific product.

The present study focusses on consumers' subjective and objective knowledge as well as utilisation practices of plastic food and beverage packaging and containers. Previous international research has shown that only a small number of consumers mention food-packaging materials when asked about food contaminants (Gallart-Ayala *et al.*, 2013:99). It is expected that consumers may be unaware of or do not possess knowledge regarding plastic and packaging in this regard. Previous research also found that consumers have a total lack of knowledge of exposure information regarding plastic-related chemicals and the hazards associated with most of the high levels of certain chemicals found in plastic (Vom Saal & Welshons, 2014:110). This lack includes knowledge regarding endocrine disrupting chemicals (EDCs) (found in plastic), how they work and the related health effects (Beronius *et al.,* 2010:132).

Research indicated that knowledge regarding exposure to EDCs and their possible health effects is vital, as it could motivate consumers to protect themselves (Park & Chung, 2017:2). In order to acquire better knowledge and educate themselves regarding plastic food and beverage packaging and containers, consumers must engage in an efficient information search process during the decision-making process of buying and using food and beverage packaging and containers.

2.3. CONSUMER KNOWLEDGE, THE INFORMATION SEARCH PROCESS, AND INFORMATION SOURCES CONSULTED REGARDING PLASTIC FOOD AND BEVERAGE PACKAGING AND CONTAINERS

2.3.1. Consumer knowledge defined

Consumer knowledge is an important subject to consumer researchers, and has been investigated across several different fields, including knowledge regarding various products and services (Carlson *et al.,* 2008:864). In such research, there is agreement that knowledge plays a crucial part in the process of information processing (Verbeke, 2008:284) and decision-making (Raju *et al.,* 1995:153). Additionally, the literature has shown that knowledge impacts consumer behaviour (Ahmad & Nordin, 2014:66). Knowledge is the range of consumers' acquired information, understanding, or the skills that they obtain from education, experience, or association, which affect their behaviour (Hunt, 2003:100, 102; Merriam Webster, 2015). Knowledge is also described as true and justified beliefs (Hunt, 2003:102). Alba and Hutchinson (2000:123) indicate that consumers are overconfident with regard to their knowledge, thinking that they know more than they do. They add that consumer knowledge is almost never errorless and hardly ever complete.

Knowledge can be obtained by the experience gained through the continuous use of products, and different amounts of knowledge may be obtained by similar use experiences (Raju *et al.,* 1995:154). Less experienced and less knowledgeable consumers may experience more difficulty in evaluating products and services as well as products' performances than experienced consumers (Donoghue *et al.,* 2016:388). In the context of plastic food and beverage packaging and containers this implies that information provided on packaging may be of no use to consumers that are not informed about such practices or that they may make wrong conclusions when selecting certain products. A lack of knowledge may also result in incorrect utilisation of certain food packaging products, which may increase the consumers' exposure to harmful compounds.

Researchers thus distinguish between different types of knowledge (De Jong & Ferguson-Hessler, 1996:106), such as procedural, declarative, subjective, and objective knowledge (Brucks, 1985:1; Sternberg, 2006:229). For the purpose of the study, only objective and subjective knowledge will be discussed. It has been suggested that subjective knowledge should be explored alongside objective knowledge in order to provide a better understanding of the role of knowledge in consumer behaviour (Flynn & Goldsmith, 1999:58).

2.3.2. Consumer knowledge and the information search process

Consumer knowledge comprises information, facts, beliefs, existing behavioural patterns, relationships, and heuristics (Boriani, 1995:142). Once a problem or need – for example, a need to know more about the utilisation practices applicable to the plastic packaging of foodstuffs – has been recognised, the information search can begin, where consumers set out to obtain information regarding a certain topic or identified problem (Cant *et al.,* 2009:197). Figure 2.6. provides a theoretical framework constructed by the researcher for consumer knowledge and the process of information search in the context of the present study.

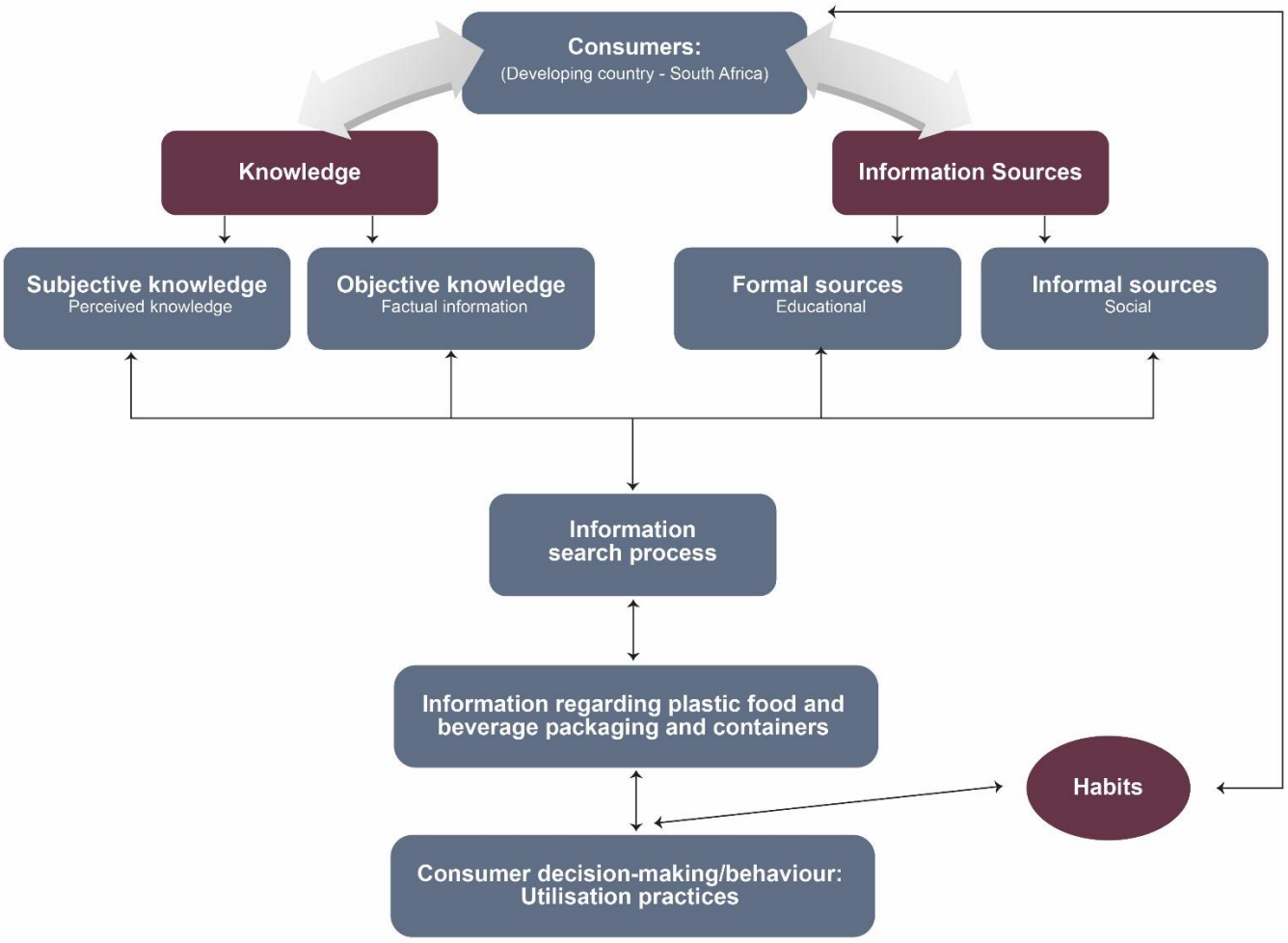


Figure 2.6. Theoretical framework outlying the concept of knowledge and the information search in the context of consumers' utilisation practices of food and beverage plastic packaging and containers.

According to Park *et al.* (1994:71), an information search may narrow the gap between subjective and objective knowledge, as subjective knowledge mainly influences consumers' motivation to learn, while objective knowledge mainly influences their ability to encode and recall the information. Although the exact relationship between the information search and knowledge is poorly understood, Raju *et al*. (1995:154) highlight that both subjective and objective knowledge may influence the process of searching for information (Figure 2.6). In addition, the ways in which consumers search for, process, and recall information during problem-solving and decision-making differ (Psychology Glossary, 2016), owing to their individual memory, perception, and previously obtained knowledge (Stajkovic & Luthans, 2002:127). Moreover, Benn *et al.* (2015:271) report that consumers often make choices out of habit (Figure 2.6) without conducting further information searches. Product or brand loyalty also influence consumer choice, and these habitual choices can be transferred from generation to generation (Schiffman & Kanuk, 2010:326).

The process of information search and attainment is described as the cognitive component within the decision-making process (Fallon *et al.,* 2014:24). Literature shows that consumers in general tend to search for and be satisfied with limited information, and that some consumers show more interest and are more active in the searching process than others (Jun & Park, 2016:99). Furthermore, consumers may consult different information sources for different situations or products (Boundless, 2016), indicated in Figure 2.6 as formal and informal sources. An information search is influenced by the level of uncertainty regarding product attributes and how important the consumer regard particular attributes of the product (Chorus & Timmermans, 2008:8). For example, the more uncertain consumers are about plastic food and beverage packaging and containers as well as EDCs, the more they will search for information regarding this topic.

A smaller probability to undertake an information search regarding familiar products, or products with which consumers have experience (for example, plastic packaging and containers), exists among consumers with a higher level of subjective knowledge (House *et al.,* 2004:114). These consumers will most likely base decisions on what they perceive they know about the product based on their experience. However, consumers' stored product information is more strongly related to their objective knowledge (House *et al.,* 2004:114), since objective knowledge (factual knowledge) is the recollection of past knowledge obtained through attention and information

processing (Ladwig *et al.,* 2012:12). The type of consumer product will also determine the degree of the information search (Fallon *et al.,* 2014:24).

Donoghue *et al.* (2016:397) propose that consumers must become more active in their search for information and it is their responsibility to search for factual information. However, consumers may be frustrated or confused when they are exposed to too much information in a short period (Schiffman & Kanuk, 2010:227). In turn, too much information may lead to a cognitive overload and poor decisions. For consumers to benefit from the information search process, all consumers should be able to access and understand the information that is necessary to inform and educate themselves. It is suggested that the obtained information should be added to already existing knowledge in order to make knowledge meaningful to consumers and for them to consider possible changes in their health-related behaviour (Whitehead, 2001:420; Yilmaz, 2011:205). A review by Karimi *et al.* (2015:139) confirms that knowledge regarding a product will have a definite effect on consumer purchase behaviour. For the present study, behavioural changes include the alteration of habits and utilisation practices regarding plastic packaging and containers (Figure 2.6).

2.3.3. Information sources consulted regarding plastic food and beverage packaging and containers

Jun and Park (2016:99) point out that consumers have four primary sources of information: personal sources such as family and friends; commercial sources such as advertisements and websites; public sources including mass media; and experience sources, where experience is gained from using or conducting research regarding products. In addition, information sources can be divided into formal (educational, e.g. school and classes) and informal sources (Jun & Park, 2016) (Figure 2.6). Of these sources, the internet (websites) is considered as the main source of information, which consumers can use to search for a range of information (such as price and product attributes) before they make a final decision or purchase (Dutta & Das, 2017:36).

Although information searches in developing countries may pose certain difficulties, the rapid development of the internet and digital technology in many of these countries is contributing to successful information searches being conducted by consumers. Within developing countries such as South Africa, consumers living in rural areas without electricity are also now enabled to

make use of battery-operated products such as cell phones and tablets to access information sources and gain knowledge to empower themselves (Karlsson *et al.,* 2012:577; Trujillo *et al.,* 2010:538). In turn, the acquired information regarding EDCs may contribute to consumers' health behaviour (Park & Chung, 2017:2). However, it has been proposed that South African consumers' different levels of education, literacy and knowledge influence their ability to make informed decisions (Donoghue *et al.,* 2016:386).

Indeed, consumers must be literate in order to obtain and understand the information and knowledge provided by the internet, therefore the internet cannot be the only source providing information in developing countries. Consequently, consumers make use of informal information sources, such as communication between friends and family, to search for information that may aid them during the decision-making process (Hoyer & MacInnis, 2010:390; Schiffman & Kanuk, 2010:281). In some instances, information can be gained through the behaviour and observation of others (Bandura, 1989:21; Hurst, 2016), which is referred to as observational learning and is considered to be an informal source of information.

Apart from the internet, other sources providing consumers with public health information include popular sources and local media, such as newspapers and radio stations (Pouokam *et al.,* 2014:297; Browning, 2011), while press releases by regulatory authorities also serve as a source of information (Endocrine Society, 2016) regarding health and possible concerns (informal sources, Figure 2.6). On a community level, vendors, mothers and women's associations, shopkeepers, and pharmacies provide information (Pouokam *et al.,* 2014:297, 300), while local authorities or non-government organisations (NGOs) may provide further information regarding the use of plastic packaging and containers (Jayaraman *et al.,* 2011:1532). Formal school education should also not be disregarded as information source, as consumers are educated regarding possible environmental pollutants (Park & Chung, 2017:2) at a young age.

Yet reliable information regarding chemicals found in plastic packaging can only be provided once improved information on different exposure routes is available (Rudel *et al.,* 2011:914). Consumers' attitude towards plastic packaging and BPA is shaped mainly through their trust in regulatory authorities and businesses, and by news exposure that provides information regarding this chemical (Scherer *et al.,* 2014:649). Moreover, various consumers who are aware of the possible dangers pertaining to some plastics search for guidance in order to try and avoid exposure to chemicals found in plastic packaging and containers (Rudel *et al.,* 2011:914).

However, shopkeepers, including pharmacists, are unable to assist consumers with information when they make purchases, since they are unaware of the existing concerns themselves (Pouokam *et al.,* 2014:300).

In order to provide better information regarding the hazards and health effects of chemicals found in plastic packaging and containers and to be able to make recommendations to reduce or prevent exposure to consumers in high-risk populations, physicians, gynaecologists, paediatricians, and other healthcare providers should be educated on this subject (Mani *et al.,* 2017:40; Mustieles *et al.,* 2015:182). Furthermore, Enneking (2006:96) suggests that nurses should advise consumers to check all plastic packaging labels and follow the provided recommendations regarding utilisation and storage practices. Doing so is important since healthcare workers are considered to be an important resource group in terms of information sources (Mani *et al.,* 2017:40).

Consumer scientists may also be of utmost importance in advising consumers of proper utilisation, preparation, and storage practices with regard to plastic food and beverage packaging and containers. However, further education of consumer scientists on this subject may be needed, as research have found that Home Economics and Consumer Studies students' food safety knowledge and behaviour are inadequate (Lange *et al.,* 2016:71). Within the context of this study, local authorities, healthcare workers, home economists and consumer scientists can be classified as formal information sources (Figure 2.6). Therefore, it may be of importance to improve the education of consumer scientists, healthcare workers and Consumer Protection Act (CPA) (South Africa, 2011:3) implementers in order to improve the communication of consumer information and education regarding plastic and its possible negative effects on human health.

2.3.4. Deficiencies in consumers' informedness regarding plastic food and beverage packaging and containers

Although it is often expected that an increase in consumer education will lead to an increase in overall objective knowledge, various variables such as demographics may also influence education (House *et al.,* 2004:121), or the process of obtaining information. According to Darley and Johnson (1993:50), the way in which consumers conduct information searches in developed and developing countries differ, as more countries are moving into the "information age". However, developed and developing countries experience similar problems with regard to suitable information, consumer empowerment, and consumer protection (Lysonski *&* Durvasula.

2012:534). Consumers should thus be provided with sufficient information and education by manufacturers and consumer protection organisations, since consumers have the right to information and education (Donoghue & De Klerk, 2009:465) as stipulated in the Consumer Protection Act (CPA) (68/2008), which came into effect on 1 April 2011 (South Africa, 2011:3).

Of relevance to this study is the CPA's aim to assist disadvantaged consumers such as illiterate consumers and consumers living in remote areas in improving their awareness and knowledge to help them to make informed decisions (South Africa, 2011:30). It was proposed that businesses and governments take part in providing consumer information, education, and protection (Darley & Johnson, 1993:50), in that order. However, in South Africa, consumers are firstly protected, then informed and educated (Darley & Johnson, 1993:37). Consumers may therefore rely on the CPA for protection since they are not adequately socialised and informed to make educated decisions, or to fully understand the CPA (Darley & Johnson, 1993:37; Erasmus, 2013:357). As a result of disadvantages pertaining to access to or lack of information, consumers have been found to be uninformed regarding some characteristics associated with low quality products, such as the possible negative health effects of small particles found in a wide range of consumer products (Li *et al.,* 2016:209).

While some consumers may think that they are informed regarding a certain topic, they may in fact be misinformed, which is worse than being uninformed, as misinformation may lead to errors in consumer decision-making, and therefore in product performance (Hunt, 2003:105). Park *et al.* (1994:79) report that inaccurately stored information or misinformation may be owing to factors such as the expertise of the information source, the quality of the recipients' or consumers' mode of information attainment, the consumers' information processing prejudices, and their personal abilities. With regard to issues such as BPA, research has revealed a total lack of information, showing that consumers were unaware and uninformed of different plastic materials (Pouokam *et al.,* 2014:300).

Consumers are also unaware of and uncertain regarding chemical substances (Li *et al.,* 2016:210) and the types of plastic used in packaging (Jayaraman *et al.,* 2011:1528). Previous research reported that some consumers were aware of chemical substances, such as BPA, but they were uncertain regarding the quantities present in the products and the risks it poses to human health (Li *et al.,* 2016:210; Scherer *et al.*, 2014:652). Other consumers were found to be unaware of the existence and presence of any plastic-related substances in consumer products

(Li *et al.,* 2016:210). The omission of EDCs and BPA from chemical compound lists contributes to the low levels of consumer awareness regarding these harmful chemicals (Kabir *et al.,* 2015:241).

Research states that consumers will always benefit from more information, including information regarding chemical substances, their possible health effects, and amounts present in products (Li *et al.,* 2016:222) such as plastic packaging and containers. Although information regarding health and nutrition can be used in consumers' evaluation of product substitutes and in their formation of quality expectations (Verbeke, 2008:281), consumers may not be aware that substitutes exist. Therefore, it can be speculated that consumers may also be uninformed or misinformed regarding the possible health effects of the use and misuse of plastic food and beverage packaging and containers.

2.3.5. Plastic identification codes as a source of information

The Society of the Plastics Industry (SPI), an international society, developed recycling codes during 1988 in order to identify different polymer types and to provide information regarding the type of plastic used. Although plastic recycling and identification codes can be found on most plastic packaging and containers, the use of these identification codes in South Africa is voluntary, and omission of the codes on plastic products is often a result of ignorance (Plastics|SA, 2012). Moreover, the numbering code system refers only to the type of packaging material and not to the different polymers used in engineering applications (Plastics|SA, 2012). Table 2.2 provides a summary of the seven identification codes found on plastic food and beverage packaging and containers globally.

Table 2.2. Plastic identification codes

Identification code	Material used	Characteristics/properties	Applications
	Polyethylene terephthalate	• Clear • Fair to good moisture barrier • Good oxygen barrier • Maximum temperature: 48.8˚C • Moderate to high rigidity • Good to excellent resistance to impact • Poor to fair heat resistance • Good cold resistance • Good resistance to sunlight	• Soft drink and beverage bottles • Clear bottles used for dishwashing liquids and edible oils • Jars • Salad domes • Food packaging • Biscuit trays
	High-density polyethylene	• Translucent • Good to excellent moisture barrier • Poor oxygen barrier • Maximum temperature: 62.7˚C • Moderate rigidity • Good to excellent resistance to impact • Good heat resistance • Excellent cold resistance • Fair resistance to sunlight	• Milk and fruit juice bottles • Packaging films • Industrial wrapping and film • Plastic shopping bags • Tubs • Pallets • Cosmetic bottles • Bins
	Polyvinyl chloride	• Clear • Fair moisture barrier • Good oxygen barrier • Maximum temperature: 60˚C • Moderate to high rigidity • Fair to good resistance to impact • Poor to fair heat resistance • Fair cold resistance • Poor to good resistance to sunlight	• Bottles • Packaging film • Industrial cling film • Water containers • Water pipes • Food packaging • Inserts (chocolate trays)

Table 2.2. (continued) Plastic identification codes

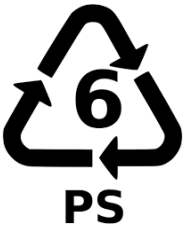
Identification code	Material used	Characteristics/properties	Applications
	Low-density polyethylene	• Translucent • Good moisture barrier • Poor oxygen barrier • Maximum temperature: 48.8˚C • Low rigidity • Excellent resistance to impact • Fair heat resistance • Excellent cold resistance • Fair resistance to sunlight	• Packaging films • Cling film or cling wrap • Plastic bags • Flexible food containers • Food wrap • Peel-able lids • Cosmetic tubes
	Polypropylene	• Translucent • Good to excellent moisture barrier • Poor oxygen barrier • Maximum temperature: 73.9˚C • Moderate to high rigidity • Poor to good resistance to impact • Good heat resistance • Poor to fair cold resistance • Fair resistance to sunlight	• Food packaging • Yogurt, ice cream and margarine containers • Sweets and snacks wrappers • Packaging films • Bottles and caps • Woven bags • Milk and beer crates
	Polystyrene	• Clear • Poor to fair moisture barrier • Fair oxygen barrier • Maximum temperature: 65.5˚C • Moderate to high rigidity • Poor to good resistance to impact • Fair heat resistance • Poor cold resistance • Poor to fair resistance to sunlight	• Disposable hot or cold drink cups and plates • Dairy product tubs • Fast food packaging • Meat and vegetable trays • Disposable boxes • Cake domes

Table 2.2. (continued) Plastic identification codes

Identification code	Material used	Characteristics/properties	Applications
	Polycarbonate (PC), Acrylonitrile butadiene styrene (ABS) OR All other resins and multi-materials not otherwise defined.	• Characteristics vary	• Food tubs • Portion packs for margarine and jam • Laminates

Adapted from: Joan (2015); Plastics|SA (2012); Packaging Graphics (2017).

According to Plastics|SA (2012), **PET** or **code 1** bottles can be re-used. However, a study by Pinto and Reali (2009:230) found that 90% of the tested PET mineral water bottles showed oestrogenic activity. Therefore, PET plastic is considered only to be safe for one-time use (Howard, 2008). Not all PET materials have the same chemical qualities, since they are produced from a variety of polymers, and storage conditions, exposure to sunlight, extreme temperatures, and duration of storage contribute to chemical migration (Pinto & Reali, 2009:230). Only a small number of PET plastic products may be recycled for food contact materials (Plastics|SA, 2012).

HDPE plastics, or **code 2** plastics, have the lowest risk of leaching chemicals and is the "least toxic" type of plastic (Howard, 2008; Leman, 2009:66). This assertion has been confirmed by information provided by Plastics|SA (2012), which states that HDPE food packaging and containers do not easily react with the foodstuffs it contains.

Plastics|SA (2012) have reported that **PVC** or **code 3** plastics consist of a variety of additives, and that these additives are never used individually. These types of plastic products contain chlorine and may release dangerous chemicals, such as BPA and phthalates (Howard, 2008; Nilsen-Kupsch, 2011:25). Furthermore, PVC plastics, especially those containing phthalates, are suspected to be carcinogenic, and should therefore be phased out of use (Plastics|SA, 2012). PVC plastic is usually used for medical devices, construction profiles, credit cards, water pipes and children's toys (Plastics|SA, 2012), and should not be present in food packaging or other plastic that comes into contact with food.

LDPE or **code 4** plastics is the type of plastic that has the highest impact strength and water and chemical resistance (Plastics|SA, 2012; 2016). LDPE is the most commonly and easily recyclable plastic, with over 100 000 tons recycled annually (Plastics|SA, 2012). Howard (2008) reports that LDPE plastics pose the least health risks to consumers, and compared to other types of plastic, it is safer for use in food packaging and containers.

The plastic utilised for the widest range of applications is **PP** or **code 5** plastics (Plastics|SA, 2012). Although these polymer plastics are not supposed to leach chemicals, oestrogen activity has been reported in a single case (1 out of 7) during a study by Kirchnawy *et al.* (2013:475). According to Howard (2008), PP plastics do not show adverse health effects or pose hazards to human health. However, PP plastics are not resistant to acids (Plastics|SA, 2012) and incorrect utilisation and cleaning practices may therefore result in a low level of chemical leaching. The use of code 5 plastics for the specified cold-storage packaging and containers (Table 2.2) are also cause for concern, since this type of plastic only shows poor to fair cold resistance.

PS or **code 6** plastics are cost-effective materials used for a variety of purposes (Plastics|SA, 2012). Still, these plastics may leach chemicals into foodstuffs (Howard, 2008), especially at high temperatures (Plastics|SA, 2012). Therefore, foodstuffs should never be microwaved, heated, or reheated in any way while inside PS packaging material or containers (Plastics|SA, 2014). However, warm food and beverages are often sold in these plastic PS products. PS have been tested positive for oestrogen activity (Kirchnawy *et al.*, 2013:476) and is therefore classified as a plastic that should be avoided (Schellack, 2010:35) in manufacturing or use of food and beverage materials.

Code 7 plastic products include **ABS** and polycarbonate **(PC)** plastics. The code 7 is used for all plastics that are not included within the other six categories. Therefore, in this category, it is required that the material names be included with the code (Plastics|SA, 2012). **ABS** plastics derived from PS contain BPA (Howard, 2008) and are frequently used for packaging (Plastics|SA, 2012). In contrast to ABS, **PC** plastics are not used for packaging (Plastics|SA, 2012). However, the Food and Drug Administration (FDA) has reported that PC plastic is used in the production of plastic containers in which consumers store food and beverages, as well as some water bottles (FDA, 2012). It has been emphasised that consumers should refrain from heating code 7 products, especially PC plastics, in the microwave (Nilsen-Kupsch, 2011:25), since BPA may leach or migrate from these products during extreme temperatures (Plastics|SA, 2012).

The identification codes described above do not provide all the necessary information that consumers need to obtain sufficient knowledge regarding plastic packaging and containers. Therefore, these codes only serve as a guide for consumers (Leman, 2009:65), informing them on how to use different types of plastic. However, if consumers do not know what these codes are and what they mean, they cannot serve their purpose. Furthermore, Andrady and Neal (2009:1979) emphasise that the major issue with additives used in plastic products is the deficiency in customers' understanding of the available evidence provided by studies on these additives. Although critical evidence regarding the use of BPA-containing plastic in food related products exists, but it seems to be ignored by plastic manufacturers and regulatory authorities (Mercola, 2015).

2.4. HARMFUL CHEMICALS FOUND IN FOOD AND NON-FOOD RELATED PACKAGING

A multitude of chemicals intentionally or unintentionally find their way into food and beverages throughout different stages of food production, preparation, and storage (de Fatima Pocas & Hogg, 2007:219). Food contact material is an underestimated source of exposure to chemicals such as EDCs (Muncke, 2011:118), and most plastic products are reported to release or leach different chemicals in different amounts (Yang *et al.,* 2011:995). The influence and contribution of chemicals and materials leaching from packaging into food and beverages on human health and the environment may be 100 times more than the influence of pesticides and environmental pollutants (Gallart-Ayala *et al.*, 2013:99). Moreover, chemical exposure in African countries occurs on top of already existing distressing environmental circumstances, and the exposure of EDCs may in turn increase these problems (Bornman *et al.,* 2017:5).

It is suggested that a paradigm shift is needed in the testing of chemicals in order to assess the overall impact of chemicals and EDCs on human health. Furthermore, traditional toxicity tests are needed to evaluate these chemicals in an attempt to contribute to the protection of human health (Gore *et al.,* 2014:2).

2.4.1. Endocrine-disrupting chemicals

EDCs are natural or synthetic chemical compounds or mixtures that alter homeostatic and hormonal systems and interfere with the synthesis, secretion, metabolism, transport, and binding

actions of hormones as well homeostasis, reproduction, and developmental processes (Diamanti-Kandarakis *et al.,* 2009:294, Kabir *et al.,* 2015:242, 251; Olujimi *et al.,* 2010:671). Additionally, EDCs are described as chemicals that show estrogenic activity or that mimic the actions of natural oestrogens (Bittner *et al.,* 2014:2) through the binding of the EDC to hormone receptors (Sifakis *et al*., 2017:58). Any changes in the endocrine system may lead to illnesses and may even cause death (Gore *et al.,* 2014:1). The action of endocrine disruption can be seen in Figure 2.7.

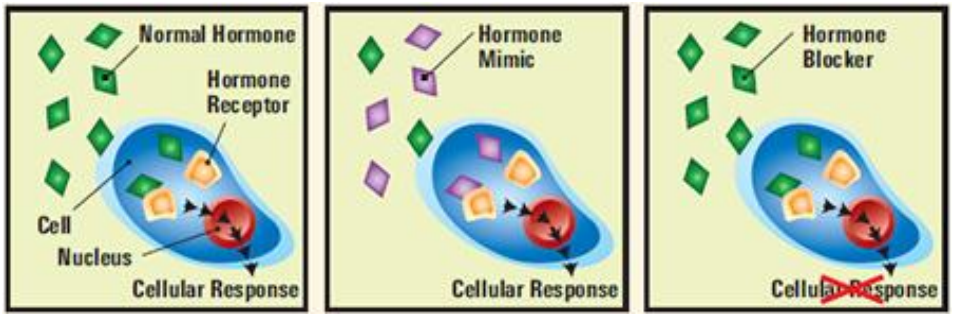


Figure 2.7. Endocrine disruption (Source: NIH, 2017).

When EDCs are absorbed in the body (Figure 2.7), they can increase or decrease hormone levels (left), mimic the action of hormones by blocking the hormone-binding process (middle), or alter the natural hormone production process, or their metabolism in the liver (right) (NIH, 2017).

Kabir *et al.* (2015:247) state that both natural and/or synthetically produced chemicals are important in sustaining life, and that contact with these chemicals cannot be avoided, as they are used in a wide variety of products, from insecticides, insulations, and flame retardants to the production of modern materials, including plastic. EDCs are also used in the production of personal care and household cleaning products (Wong & Durrani, 2017:107). Yet recent research has confirmed the pressing problem of pesticides and their classification as EDCs (Bornman *et al.,* 2017:). Moreover, according to Gore *et al.* (2014:1, 2), about a 1000 of the hundreds of thousands of man-made chemicals show endocrine activity, and chemicals that have not been tested previously are also suspected to be EDCs. As a result of the multiple uses of EDCs, they occur in all places in the environment, including water, soil, air, and sediments (Kabir *et al.,* 2015:247). The presence of EDCs in air and water pollution has been reported to be a concern across African countries (Bornman *et al.,* 2017:2). Additionally, plastic food packaging materials

and wastes are often dumped in aquatic systems (Parker, 2015), contributing to the accumulation of these chemicals from different sources and posing threats to human development and health.

Even though research by EFSA (2008:8-10) has suggested that the current human exposure levels of EDCs are safe, Gore *et al.* (2014:3) state that EDCs influence bodily functions even at very low levels. Previous research has reported that there is evidence proving that EDCs pose a risk to human and environmental health (Muncke, 2009:4556), and that EDCs may cause adverse effects (Van Zijl *et al.,* 2017:306). According to Olujimi *et al.* (2010:679), EDCs transport occurs across the earth, since it can be transported through water and the atmosphere. The EDCs and additives posing the greatest concern are phthalates, anti-microbial agents, brominated flame retardants and BPA (Thompson *et al.,* 2009:2154).

Of all the EDCs or additives in plastics, consumers worldwide are most familiar with BPA (Seltenrich & Tart, 2015:A175), the most important man-made chemical among the synthetic xeno-oestrgens (Michalowicz, 2014:739). BPA is used in the foodstuffs industry in the production of plastic packaging and containers and for nearly all canned food and beverage product-linings (Cooper *et al.*, 2011:944; Stone *et al.,* 2010:3). Research indicates an increase in interest regarding the exposure routes and toxicity of BPA over the past few years (Lakind & Naiman, 2011:272) since it was declared as a “chemical of concern” by the United States Environmental Protection Agency (USEPA) during 2010 (Huang *et al.,* 2012:97).

2.4.2. Bisphenol A

BPA is an industrial, man-made chemical that was developed during 1891 and is used in the production of consumer products, PC and PVC plastic, plastic packaging, dental sealants, and water pipes (Cooper *et al.*, 2011:943; Geens *et al.,* 2011:340: Lofstedt, 2013:194). According to Vandenberg *et al.* (2007:149), BPA is used in the paper production process as well, resulting in probable BPA presence in food-contact paper. As the result of recycling of thermal printing paper, it is suggested that BPA may be present in recycled paper products too (Geens *et al.,* 2011:344).

The annual production of BPA thus exceeds 3.8 million tons (Michalowicz, 2014:739), and 95% of BPA is used for the production of PC plastic and epoxy resins, with the remaining 5% being used in a variety of consumer and non-consumer products (Huang *et al.,* 2012:92) such as non-food applications, toys, and pacifiers (EFSA, 2015:6). PC plastic is used in the manufacture of a variety of food and beverage packaging and containers, including microwave ovenware,

cookware, and water dispensers (EFSA, 2015:6). Epoxy resins are used as a lining to protect food and beverages from direct contact with metal-based cans (FDA, 2014) and as coating on water storage reservoirs and supply structures (EFSA, 2015:6). Furthermore, BPA is used in plastic and non-plastic consumer products as stabilisers, plasticisers, and additives (Cooper *et al.*, 2011:944).

BPA is described as an EDC that has estrogenic characteristics and activities, and studies show that it may be associated with different diseases and health problems (Kubwabo *et al.,* 2009:928; Kang *et al.,* 2006:80), such as hormonal and metabolic abnormalities, glucose intolerance, and certain types of cancers. Although BPA levels in human fluids have been measured and detected in many developed countries worldwide, tests for BPA levels in populations of less-developed countries are still lacking (Baluka & Rumbeiha, 2016:59; Vandenberg *et al.*, 2007:141).

Ironically, BPA was originally described as a weak environmental chemical (Michalowicz, 2014:743). However, Huang *et al.* (2012:93) describe BPA as a chemical with high production levels, raising concern. In the USA, during 2007, the following amounts of BPA were released into the environment (USEPA, 2010):

- 271 138 kg into air;
- 13 772 kg directly into water;
- 33 013 kg released on-site onto land; and
- 1 509 627 kg transferred off-site onto land.

Gore *et al.* (2014:54) report that BPA pollution is even worse in developing countries such as South Africa. The urbanisation of developing countries has led to an increase in the release of contaminants into the environment (Bornman *et al*., 2017:2). A study conducted by Van Zijl *et al.* (2017:306) has found that BPA and other EDCs were present in South African drinking water. The prevalence of these EDCs is a concern, since South African consumers rely on water for consumption and agricultural use (Olujimi *et al.,* 2010:679). There is, however, no information available regarding the overall exposure of adults or infants to BPA in African countries (Pouokam *et al.,* 2014:297), and according to Mahamuni and Shrinithivihahshini (2017:863), African countries are unaware of BPA and its possible health effects and have not set restrictions regarding its use in other consumer products. As yet, South Africa is the only African country to have taken action regarding the BPA exposure of infants (Pouokam *et al.,* 2014:297).

According to ITRI (2011), South Africa was the first African country to ban the use of BPA in PC baby bottles, as well as the import, export, and manufacturing of BPA-containing baby bottles. The BPA regulations regarding baby bottles are included in the "Foodstuffs, Cosmetics and Disinfectants Act, 1972" of South Africa (ITRI, 2011). However, this legislation only applies to BPA in baby bottles, and not to all plastic food and beverage packaging and containers or other EDCs. Previous research indicates that infants still consume up to ten times more BPA than the amount adolescents and adults consume, and are therefore more vulnerable to BPA and EDC exposure (Li *et al.,* 2010:562; Muncke, 2011:120). The vulnerability of infants is concerning since bottle-fed babies receive all their food from the plastic bottle before starting solids.

Moreover, even though consumers show interest in BPA and its safety (FDA, 2014), it is evident that they are unaware or lack knowledge regarding plastic and packaging. Only a small number of consumers mentioned food packaging materials when asked about food contaminants in a previous study (Gallart-Ayala *et al.*, 2013:99). Other studies show that consumers are unaware that "BPA-free" products contain alternatives or substitutes, and that "BPA-free" does not mean that the product is EDC-free (Scherer *et al.*, 2014:661; Yang *et al.,* 2011:995). It is said that BPA is replaced by Bisphenol S (BPS) in these products, which is potentially just as harmful (Royte & Greer, 2015:130). BPA alternatives are often used in water bottles, can linings, and a variety of plastic containers (Wong & Durrani, 2017:110). However, when faced with an alternative, potentially regrettable substitute to BPA, consumers choose to persist with the current in-use item, particularly when the risks and benefits of the alternative is uncertain (Scherer *et al.*, 2014:651).

When substitute chemicals are introduced into the market, they should ideally have less toxic effects than the original chemical, such as BPA. However, these chemicals are not scrutinised enough through testing before they are introduced (Rochester & Bolden, 2015:643), and the presence of BPS and BPF in plastic products may therefore still be a cause for concern. Research reported that little is known regarding the behaviour of these BPA-alternatives (Choi & Lee, 2017:3731). Moreover, some of the unfortunate or regrettable substitute chemicals, such as BPS and Bisphenol F (BPF), are proxies to BPA, therefore their effect on the physiological systems may be comparable (Rochester & Bolden, 2015:643; Wong & Durrani, 2017:107). BPS and BPF are generally used in "BPA-free" products (Mahamuni & Shrinithivihahshini, 2017:862), and the similarities in the chemical structures of BPA, BPS and BPF can be seen in Figure 2.8.

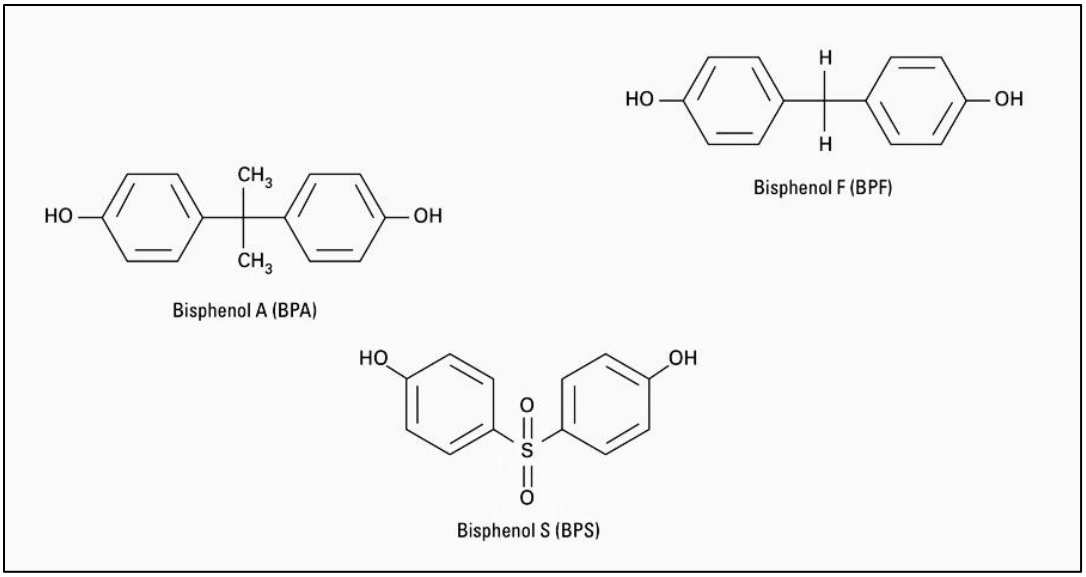


Figure 2.8. Chemical structures of Bisphenol A, Bisphenol F and Bisphenol S (Source: Rochester & Bolden, 2015:644).

A systematic review by Rochester and Bolden (2015:646) indicates that BPS and BPF are as dangerous as or even more dangerous than BPA, and these compounds may show more disruptive effects that are not observable in BPA. For this reason, Mercola (2015) indicates that BPA-free plastic is not the solution to the chemical exposure problem. Moreover, an increase in environmental concentrations of BPA alternatives are visible in sediments and wastewaters (Choi & Lee, 2017:3731), confirming that the chemical exposure problem may be higher than expected, and not limited to BPA alone.

Research also indicates that consumers are exposed to more chemicals that have estrogenic activity than just BPA, and these chemicals are not taken into account when the exposure levels of chemicals are evaluated (Vandenberg *et al.*, 2007:155). Researchers have further reported that EDCs migrate from “BPA-free” products that have not been exposed to a stress condition such as heating or freezing, and that the migration increases when stress is applied to these products (Bittner *et al.,* 2014:2). In addition, it is suggested that the migration of chemicals into dry food products is underestimated, and that chemical migration from food contact materials is only assessed for repeated-use products (Grob, 2008:264; Muncke, 2011:119, 120).

Manufactures have therefore simply traded one EDC for another (Mercola, 2015). Although BPA, as an endocrine disrupter, is still being studied with regard to public health, since the potential of

low-level exposure has not been adequately addressed and possible health effects are still unknown (Lin *et al.,* 2015:658), continuous low-dose exposure of EDCs is said to be the main threat to humans (Muncke, 2009:4556). Literature suggest that previous studies focused on only one product or aspect, and did not consider overall exposure and accumulation (Muncke, 2009:4552). The conclusion can be drawn that the accumulative effect of BPA and other EDCs from a variety of sources should be the main concern regarding human health.

2.4.3. Other endocrine-disrupting chemicals found in plastic products

Apart from BPA and is derivatives, other endocrine-disrupting chemicals are found in plastic packaging and containers, and other consumer products. A few of these chemicals are discussed below.

2.4.3.1. Phthalates

Phthalates are defined as phthalate esters (PAEs) and occurs in a wide range of industrial chemicals (Giulivo *et al.,* 2016:251). According to Martinéz *et al.* (2017:567), phthalates are contributing to environmental contamination. The phthalates raising most concern in terms of human health are dibutyl phthalate (DBP) and di-(2ethylhexyl) phthalate (DEHP), since these are also classified as EDCs (Petersen & Jensen, 2010:1608). These chemicals are primarily used to soften PVC-based consumer products (Giulivo *et al.,* 2016:251; Van Zijl *et al.,* 2017:306) in order to transform unmodified PVC into a rubbery, soft material (Petersen & Jensen, 2010:1608) with high flexibility (Wong & Durrani, 2017:108). However, in order to obtain this result, up to 20-50% phthalates are required, resulting in high migration rates of these chemicals into foodstuffs (Petersen & Jensen, 2010:1608).

The estimated production of phthalates during 2010 was approximately 4.9 million tons, contributing to 84% of the total plasticiser production in the world (Giulivo *et al.,* 2016:252). While phthalates are commonly used in the production of food containers and packaging and the gaskets of lids (Petersen & Jensen, 2010:1608), they also have non-food applications (such as vinyl flooring, lubricant oils, detergents, and personal-care products such as soaps, shampoos, nail polish, and plastic raincoats) (CDC, 2009). Consumers are exposed to phthalates through direct contact with these products and through the migration of phthalates into the surrounding

environment (Giulivo *et al.,* 2016:252; Singh & Li, 2012:85), such as food products as well as air and soil.

Indeed, reports confirm leaching of phthalates into food and beverages from plastic packaging and containers (Bang *et al.,* 2012:457). BPA and phthalates exhibit similar effects with regard to human health, since 89 proteins in BPA and phthalates commonly interact with human proteins or genes (Singh & Li, 2012:85). Thus, even though DEHP and DBP have been banned from use in the production of children's toys in the European Union, a variety of other phthalates are still used in the production of these toys as well as other consumer products (Giulivo *et al.,* 2016:252). Yet health-risk assessments regarding the collective effects of phthalate exposure via multiple sources have only recently been considered (Bang *et al.,* 2012:454). As far as could be ascertained, no information exists and no studies have been conducted regarding DEHP and DBP in plastic products in South Africa. These products are still widely used in manufacturing of plastic products in South Africa, despite their ban in the European Union.

2.4.3.2. Parabens

Owing to their anti-microbial and anti-fungal properties, parabens have been used for centuries (Giulivo *et al.,* 2016:252). Human exposure to parabens takes place through ingestion, inhalation, and skin absorption (Giulivo *et al.,* 2016:255). Parabens are alleged EDCs, with mounting evidence of their endocrine-disrupting effects (Gabaleiro *et al.,* 2014:35; Giulivo *et al.,* 2016:252). However, studies to determine these effects are still being conducted (Wong & Durrani, 2017:111). As yet, parabens are used in everyday consumer products, including moisturisers, shaving products, hair products, toothpaste, toiletries, industrial products, and food packaging and containers (Giulivo *et al.,* 2016:252).

Questions regarding the association between parabens and the incidence of breast cancer have been raised, as these chemicals were found and isolated in cancer tumours (Best Health, 2008). Since questions regarding their impact on male breast cancer, testicular cancer, and declining sperm counts are still unanswered, more research is needed regarding this chemical and its impact on human health (Best Health, 2008). Because of the possible effects of parabens, consumers are advised to take precautionary measures when using paraben-containing products (Wong & Durrani, 2017:111).

2.4.3.3. Triclosan

Consumer interest towards Triclosan (TCS) and the pathways through which consumers are exposed are on the increase (Teitelbaum *et al.,* 2016:39). TCS is used as additive in a wide range of consumer products in order to lessen or prevent bacterial contamination, and it is regarded a weak oestrogen (FDA, 2016a; Li *et al.,* 2010:557). In addition, TCS is used as a high-volume chemical in a variety of personal-care products, such as toothpaste, cosmetics, and body washes, contributing to human exposure (FDA, 2016a; Li *et al.,* 2010:557; Wong & Durrani, 2017:108). Consumers are further exposed to TCS through clothing, toys, kitchenware, and furniture (FDA, 2016a), as well as food and water consumption (Li *et al.,* 2010:557). The migration of TCS from packaging into dry foodstuffs (flour and rice) was also reported by Silva *et al.* (2008:668).

Animal studies show that TCS exposure may contribute to the evolution of antibiotic-resistant bacteria, and that exposure may affect thyroid hormones (FDA, 2016a). The exposure of TCS may also increase hyper-responsiveness to allergens (Wong & Durrani, 2017:110). No information is available on the daily intake of TCS, but studies on determining the estimated intake, the effect of TCS on skin cancer, as well as TCS exposure and ultraviolet rays are being conducted (FDA, 2016a; Teitelbaum *et al.,* 2016:42). Even though the effects of TCS on human health are still uncertain (FDA, 2016a), the FDA has recently banned its use in a variety of consumer products such as cosmetics (MacLellan, 2016). Although the FDA does not have jurisdiction in South Africa, they collaborate and share their expertise with counterpart regulatory authorities in order to improve regulatory infrastructures and, in turn, global health (FDA, 2016b). The FDA may therefore influence products produced and used in South Africa.

2.5. CONSUMER EXPOSURE TO EDCs AND BPA

Consumers are exposed to BPA and other EDCs through a multiple of sources and pathways. This includes food and beverage packaging and containers, environmental sources and other consumer products.

2.5.1. Consumer exposure to EDCs and BPA through food and beverage packaging and containers

Bittner *et al.* (2014:9) report that EDCs can migrate or leach from outer surfaces of packaging when consumers handle it, or from the inner surface, which exposes the contents of the packaging. The process of migration refers to the transfer of chemical substances from a higher concentration (food and beverage packaging and containers) to a lower concentration (food products) (Bhunia *et al.,* 2013:523). This migration process is influenced by a variety of factors, such as storage time, temperature exposure, and the type of product (Bhunia *et al.,* 2013:523; Pinto & Reali, 2009:229; Kubwabo *et al.,* 2009:936). Research indicates that consumer exposure to BPA happens through a wide range of sources, resulting in elevated BPA levels in humans (Huang *et al.,* 2012:92). Moreover, sunlight may increase the amount of BPA migration (Gore *et al.,* 2014:53). Other factors affecting the rate of this migration of chemicals, described as a process of high complexity, include the nature of the food and packaging material, the type of contact (direct or indirect), the characteristics of the specific migrant, and the amount of migrant found in the packaging material (Arvanitoyannis & Kotsanopoulos, 2014:22, 23).

It has been reported that any residual or unreacted BPA can migrate into foodstuffs from PC products as well as epoxy resins (Huang *et al.,* 2012:93). However, human exposure to BPA is not only a result of dietary exposure, and the total number of sources that leach BPA or sources that may expose humans to BPA has not yet been determined (Geens *et al.,* 2011:339). A study conducted by Martinéz *et al.* (2017:569, 570) found that fruit and vegetables (49%) and meat and meat products (26%) had the highest contribution rates of BPA. This finding may be due to the frequent consumption of these food products. Of the 4 million tons of phthalates produced annually (Lin *et al*., 2003:2100), milk and dairy products (56%) and ready-to-eat meals (30%) had the highest dietary contributions (Martinéz *et al.,* 2017:570). In addition to food and beverages and their packaging and containers, BPA are also found in a range of other consumer products (Gore *et al.,* 2014:53). It was also reported that the utilisation and disposal of consumer products containing EDCs are responsible for human and environmental contamination, and not the production of these products (Bornman *et al.,* 2017:2).

2.5.2. Consumer exposure to EDCs and BPA through other plastic products and packaging

Consumers are exposed to a multitude of chemicals that are used for packaging of foodstuffs and other consumer products and goods (Muncke, 2009:4555). The long-term exposure and accumulation (Gallart-Ayala *et al.*, 2013:109) of these harmful chemicals, from a wide range of sources, may increase the negative effects on human health. Moreover, the uncertain and unknown risks regarding these harmful chemicals cause for even greater concern (de Fatima Pocas & Hogg, 2007:227). It is therefore important to determine consumers' knowledge regarding different plastic products with which they come into contact with, as sources of EDC and BPA exposure.

A study by Huygh *et al.* (2015:64) found that medical appliances, specifically those used for critical care medicine, contain BPA and that it may leach from these products. This finding was supported by Thompson *et al.* (2009:2164), who reported that medical devices may expose consumers to BPA. These devises include blood bags, tubing used for transfusions and infusions, nutritional tubing, cardiopulmonary bypass apparatuses and tubing used in oxygenation and haemodialysis systems, and organ and tissue transplants (Huygh *et al.,* 2015:68; Thompson *et al.,* 2009:2164).

Other consumer products containing BPA include PC eyeglasses, plastic water pipes, and thermal receipt paper (EFSA, 2015:6; Gore *et al.,* 2014:53). Plastic is also used in the production of children's toys (EFSA, 2015:6), bicycle helmets, floatation devices, and sport protective gear (Plastics|SA, 2014). Further uses include personal-care products such as cosmetic and hair-care product containers, and lotion bottles (Weiss & Ruderman, 2011:16). These different products may also serve as routes of human exposure to BPA. Apart from consumer products, BPA is also present in the natural environment (Michalowicz, 2014:740).

2.5.3. Consumer exposure to BPA and EDCs through environmental sources

Literature suggests that the main problem regarding BPA and EDCs is not the concentration levels within a certain product, but is rather the accumulation from a wide variety of products and sources that are affected by chemical migration (Gallart-Ayala *et al.*, 2013:123; Kang *et al.,* 2006:84). Although consumers' exposure to BPA through food and beverages can be reduced, alternative environmental exposure sources are still of major concern (Gore *et al.,* 2014:54).

Because BPA is not produced naturally, human activities are to blame for the presence of BPA in the environment (Huang *et al.,* 2012:93). Environmental exposure sources include the atmosphere, water and wastes, as well as dust (Michalowicz, 2014:741), making BPA a common environmental contaminant (Choi & Lee, 2017:3725). BPA is released directly from plastic manufacturing facilities into the environment (such as water and the atmosphere) during production processes (Huang *et al.,* 2012:93). Epoxy-based products contribute to environmental exposure of BPA as it is released from paint, adhesives, flooring, some electronic equipment, and printed circuit boards (EFSA, 2015:6). In addition, BPA can be released into the air via handling and processing of plastic products (Huang *et al.,* 2012:93).

In contaminated environments, EDCs and other chemicals leach or migrate into soil and drinking water, where microorganisms, plants, and algae absorb them (Gore *et al.,* 2014:32). EDCs were also found to migrate into previously treated drinking water from water pipes, and although available information regarding EDCs in South African drinking water is limited (Van Zijl *et al.,* 2017:306), existing evidence is cause for concern (Olujimi *et al.,* 2010:678). Moreover, some banned chemicals are present in the environment for prolonged periods, even decades, because of their tenacity (Gore *et al.,* 2014:32). Pesticides, algaecides, herbicides, and fungicides provide alternative exposure routes of EDCs to humans (Gore *et al.,* 2014:32).

BPA also poses risk to the environment. It was reported that the reproductive life and the development of aquatic life, reptiles, and amphibians are adversely affected after exposure to BPA (Nordqvist, 2014). It is stated that any residual BPA found in PC products as well as epoxy resins may cause leakage into the environment (Huang *et al.,* 2012:93). BPA was also found to pollute soil, as it interferes with nitrogen fixation at the roots of numerous plant species (Nordqvist, 2014). Moreover, on account of BPA in water and soil, humans are further exposed to this EDC through ingestion of water, plant materials, and the meat of fish.

As a result of the increase in the demand for BPA-containing materials, such as PC plastic and epoxy resins, environmental BPA pollution will undoubtedly worsen in the future (Huang *et al.,* 2012:97). According to Lin *et al.* (2015:662), a reduction in environmental exposure of BPA will be necessary in order to minimise or prevent the risk of health problems.

2.6. HEALTH EFFECTS RELATED TO EDCs AND BPA

Even though the FDA has indicated that low level exposure to BPA pose no threat to human health (FDA, 2012), concerns have been raised about the migration of chemicals into foodstuffs and the possible effects posed to human health (Bhunia *et al.,* 2013:523). Consumers are exposed to low levels of chemical substances from food contact materials throughout their lives (Muncke, 2011:121). In comparing various sources contributing to food contamination with regard to chemicals, it has been suggested that the public as well as experts have a distorted perception of the risks involved (Gallart-Ayala *et al.*, 2013:99).

zFurther research indicates that the risk assessment regarding global BPA exposure have increased from “no risk” to “risk” at the current exposure levels (Beronius *et al.,* 2010:142, 144). Moreover, consumers living in African countries are exposed to different environmental risks through water, poor sanitation and hygiene, and overall poorer living conditions than consumers of developed countries (Bornman *et al.,* 2017:2). These conditions may exacerbate the health effects of BPA and EDCs on already vulnerable consumers.

A number of studies have found evidence that relates BPA and EDCs to adverse health effects and illnesses in humans (Chen *et al.,* 2016:141; Kirchnawy *et al.,* 2013:467; Vom Saal & Welshons, 2014:102). Although studies regarding health effects of these contaminants have mainly been conducted in the US, Europe and Asia, BPA and EDC exposure is a global problem (Bornman *et al.,* 2017:2). These findings somewhat discredit the FDA, although it is still conducting research to monitor studies and uncertainties regarding BPA (FDA, 2012). Although South African consumers may not be aware of the FDA as an institution, it is one of only a few institutions that studies and regulates the use of chemical compounds, such as BPA plastics, and monitors their presence in the human health environment. USEPA is a similar organisation dealing with similar aspects regarding chemical products in the natural environment (FDA, 2018). FDA and USEPA documentation are therefore important sources of information regarding the presence of these compounds in the environment and their effect on human health.

Research further indicates that exposure to BPA has definite but different effects on males and females, as they respond differently to oestrogens (Beronius *et al.,* 2010:143; Gore *et al.,* 2014:54). Moreover, BPA may accumulate in humans over time, and its effects may only become evident during late childhood or adulthood (Vafeiadi *et al.,* 2016:385). According to Bornman *et al.* (2017:5), scientists and policy makers from African countries should change their approach

towards EDC exposure from treating to preventing illnesses/diseases associated with EDCs and BPA. Moreover, it is suggested that prevention of exposure to harmful chemicals is the most effective method (Mani *et al*., 2017:40). EDCs and BPA exposure have been associated with various aspects of human health, which are discussed below.

2.6.1. Neurological and neurodevelopmental effects and behavioural changes

Recent prospective human studies indicate a causal link between prenatal and childhood BPA exposure and neurodevelopmental effects (EFSA, 2015:17) and altered child behaviour, with the effects on girls being greater (Rochester, 2013:144). Kirchnawy *et al.* (2013:467) report developmental and neurological effects as the result of human exposure to EDCs. These findings support the suspected effects of BPA exposure on the nervous system (Kubwabo *et al.,* 2009:928). EDCs and BPA may cause behavioural changes in humans and BPA exposure can be linked to behavioural problems and attention deficit hyperactivity disorder (Kubwabo *et al.,* 2009:928; Leman, 2009:66).

EDCs are also suspected to interfere with consumers' ability to deal with internal or external stress (Wuttke *et al.*, 2010:9). This suspicion was confirmed through studies that indicated a change in anxiety-like behaviour, learning or memory abilities, sensory motor function, and social behaviour after BPA exposure (EFSA, 2015:17). Significant associations between elevated maternal BPA and an increase in hyperactivity and aggression in girls were reported (Rochester, 2013:144). The effects in boys were non-significant.

2.6.2. Hormonal effects

Research has indicated that BPA levels in blood can be associated with a wide range of human health conditions (Vandenberg *et al.,* 2007:147). Different hormonal effects regarding EDC exposure have been reported in males and females, and these effects are still debatable (Sifakis *et al*., 2017:67).

2.6.2.1. Hormonal effects in females

Research has found that women with PCOS may be more vulnerable to BPA exposure, since this syndrome is associated with elevated male hormones in the blood of sufferers compared with non-sufferers (Riskind & Lohr, 2016; Rochester, 2013:142). Furthermore, BPA levels were found to be approximately three times higher in women who have had repeated miscarriages (Bang *et al.,* 2012:465; Riskind & Lohr, 2016), endometrial hyperplasia, and abnormal karyotypes (Vandenberg *et al.,* 2007:147). Further evidence shows an association between endometrial disorders and BPA exposure in adult women (Rochester, 2013:142).

Chemicals produced within the plastic industry and factories have a slight effect on women's infertility (Bang *et al.,* 2012:465). A study by Ehrlich *et al.* (2012:981) on *in vitro* fertilisation reported that increased implantation failure was associated with higher BPA levels in women. Additionally, BPA exposure can be linked to shorter gestation periods and premature delivery (Rochester, 2013:143), as well as vitamin D deficiencies in pregnant women (Johns *et al.,* 2017:8). Contradictory results have been found regarding the effect of BPA and EDCs on the onset of puberty, since studies have showed that BPA and EDC exposure is being associated with premature breast development (Bang *et al.,* 2012:465) on the one hand, and with a delay in the onset of puberty in females (Kubwabo *et al.,* 2009:928) on the other.

2.6.2.2. Hormonal effects in males

Hormonal effects as a result of BPA and EDC exposure within males can be related to testicular dysgenesis (Bang *et al.,* 2012:465), male genital abnormalities (shorter anogenital distance) (Rochester, 2013:143), and an effect on the male reproductive tract (WHO & FAO (2009). Furthermore, associations between BPA, prostate cancer, testicular cancer, and a decrease in semen quality and sperm count in males have been reported (Kubwabo *et al.,* 2009:928; Sifakis *et al*., 2017:57; Vandenberg *et al.,* 2007:171; WHO & FAO, 2009:2). BPA and EDCs are also suspected to delay the onset of puberty in males (Kubwabo *et al.,* 2009:928).

2.6.3. Immune effects

Recent studies indicate immunological outcomes in humans as a result of BPA exposure, and animal studies support these findings (EFSA, 2015:18). According to Rochester (2013:148), the prolonged exposure to BPA may negatively affect the immune system in general and as well as different antibodies.

2.6.4. Cardiovascular effects

According to EFSA (2015:18), insufficient data exist to support cardiotoxicity and an effect of cardio function as the result of BPA exposure. However, numerous published studies confirm an association between human exposure to BPA and higher risks for cardiovascular diseases as well as atherosclerosis in adults (Kubwabo *et al.*, 2009:928; Lin *et al.,* 2015:658; Rochester, 2013:146). Furthermore, Rochester (2013:146) states that BPA exposure during adulthood can be related with adverse cardiovascular diseases in a variety of populations.

2.6.5. Metabolic effects

According to Rubin and Soto (2009:58), the role that oestrogen plays in body weight regulation is still not fully understood but indications are that BPA may alter mechanisms that influence body weight and its regulation (Rubin & Soto, 2009:60). A variety of animal studies indicate that BPA exposure may affect metabolic functions such as insulin or glucose regulation, body-weight gain, and lipogenesis (EFSA, 2015:18). With regard to humans, an increase in the prevalence of obesity and diabetes as the result of EDC exposure has been reported (Bang *et al.,* 2012:465; Kabir *et al.,* 2015:252; Sifakis *et al*., 2017:57; Vandenberg *et al.,* 2007:147).

In children specifically, an increase in urinary BPA concentrations can be associated with higher BMI scores, waist circumference, and fat mass (Vafeiadi *et al.,* 2016:383, 384). Moreover, data indicate that BPA and EDC exposure during adulthood may disrupt glucose homeostasis and may therefore contribute to the development of type-2 diabetes (Rubin & Soto, 2009:59).

Other metabolic disorders associated with BPA and EDC exposure include altered liver function due to altered liver enzymes and disrupted thyroid function as the result of a decrease in the release of thyroid stimulation hormone (Rochester, 2013:146, 147). In terms of thyroid function,

some hormones increase and others decrease when exposed to BPA, resulting in complicated outcomes (Rochester, 2013:148).

2.6.6. Genotoxicity

According to EFSA (2015:19), it is unlikely that BPA will cause genotoxicity or act as a mutagenic. However, research indicates that chromosomal abnormalities can be linked to higher levels of BPA exposure (Vandenberg *et al.,* 2007:147). The effect of BPA exposure on gene expression and DNA sequence alterations is also confirmed by Rochester (2013:148) and Sifakis *et al*. (2017:59). Furthermore, meiotic maturation and chromosomal alignment was found to be affected by BPA exposure – for example, the percentage of oocytes progressing to the stage of meiosis-II decreased, and an increase in the percentage of oocytes becoming degenerated was observed (Machtinger *et al.,* 2013:8).

2.6.7. Carcinogenicity

A variety of studies have been done regarding BPA and cancer. Epidemiological data has illustrated associations between EDC exposure and an increase in breast, prostate, and testis cancer in humans (Kabir *et al.,* 2015:252). Furthermore, research shows that EDCs may alter organ functions and cause malignancies (Wuttke *et al.*, 2010:9). Although a conclusion can still not conclusively be drawn regarding carcinogenicity of BPA in humans (EFSA, 2015:19), a more recent study by Seachrist *et al.* (2016:178) shows that BPA may increase the risk of cancer, as a result of lifelong exposure.

2.6.8. Organ failure

According to Baluka and Rumbeiha (2016:59), higher doses of BPA exposure could cause organ failure in humans. However, further research regarding BPA and EDC exposure and possible organ failure is necessary.

From the above discussion of the health effects of BPA and EDCs, it is evident that even low doses of BPA and EDCs found in food and beverage packaging and containers are of concern to

human health. Therefore, Muncke (2009:4555-4556) suggests that the legal use of EDCs within packaging needs to be extensively reassessed, as a variety of chemicals are present within these products. Moreover, in order for identification codes to be successful in altering the utilisation practices of consumers, consumers must be aware of and understand the identification codes as well as the possible effects associated with the misuse of plastic products. If, however, sub-optimal or incorrect utilisation practices are not changed, consumer behaviour and choices may further contribute to an already existing health problem.

2.7. CONSUMER UTILISATION PRACTICES OF PLASTIC FOOD AND BEVERAGE PACKAGING AND CONTAINERS

Although plastic identification codes aid in guiding consumers to determine if products are safe for use, and how safe they are (Leman, 2009:65), the utilisation practices of consumers are not always influenced by these codes, as some single-use items are used repeatedly. For example, consumers reuse plastic water bottles made from PET, which are not designed to be reused. Even though this is common practice among consumers, the effect of reuse on human health has not been assessed (Muncke, 2011:120). The effect of the repeated use of plastic water bottles by individual consumers may be exacerbated by the sale and reuse of large plastic water containers that are refilled and sold at commercial outlets that sell bottled water in large volumes.

Consumer utilisation practices such as using plastic containers or plastic plates for reheating food in microwave ovens was also found to increase the amount of BPA migration (Gore *et al.,* 2014:53). Moreover, literature states that plastic products should not be used in a microwave, washed in a dishwasher, or cleaned with harsh cleaning products (Nordqvist, 2014). Leaving plastic bottles inside motor vehicles where they are exposed to heat and sunlight also contributes to the BPA migration process (Gore *et al.,* 2014:53).

Although Tupperware is a trusted brand in South Africa, not all of their products are microwave safe, and only products manufactured after 2010 are BPA free (Tupperware SA, 20106). Only products marked with the “microwave reheatable” or “microwave cooking” symbols are safe for microwave use. However, it seems that consumers are to a great extent not aware of this since a wide variety of plastic products are still used for these purposes.

Sanlier (2009:541) thus points out that consumers' personal perceptions of food safety risks are "low", which may result in incorrect and improper storing, preparing, thawing, and reheating practices used in food preparation. However, research shows that women are more informed regarding food handling and storage practices than men, which may be owing to the fact that grocery shopping is mainly done by the woman of a household (Tshuma *et al.*, 2010: 465). Additionally, knowledge of foodstuffs and food-related practices is better in adults than younger consumers (Sanlier, 2009:541). Still, literature regarding the specific ways in which consumers use plastic food and beverage packaging and containers is limited, and further research is therefore necessary in this regard.

Although substantial evidence regarding the benefits of plastics exist, the existing approach to plastic production as well as consumers' utilisation and disposal practices pose considerable risks to human health and the environment (Jayaraman *et al.,* 2011:1528; Thompson *et al.,* 2009:2164; Zhou *et al.,* 2017:41). Resolutions to the various plastic-related problems will only be possible through individual and combined actions (e.g. policy makers, manufacturers) (Thompson *et al.,* 2009:2164). On the one hand, resourceful formal, informal, and mass-media education regarding food safety should take place from childhood to adulthood in order to enable consumers to obtain information regarding the appropriate utilisation, disposal, and food preparation practices and to change misguided consumer habits (Sanlier, 2009:541, 2164). On the other hand, manufacturing companies should aim to design plastic food and beverage packaging and containers for re-use, while policy makers should enforce appropriate plastic product labelling laws to better inform consumers regarding correct utilisation practices (Thompson *et al.,* 2009:2164). Research suggests that training and education programmes should be improved to decrease and aim to prevent EDC exposure, and guidelines for the utilisation of BPA alternatives should be provided (Bornman *et al.,* 2017:5; Mahamuni & Shrinithivihahshini, 2017:866). Doing so may, in turn, contribute to improved human health.

2.8. METHODS TO REDUCE EXPOSURE TO BPA AND EDCS

A review by Mani *et al*. (2017:41) shows that a variety of strategies should be implemented to control the exposure of consumers to EDCs. These strategies include the following:

- To strengthen consumer knowledge regarding EDCs through school education, local representatives, and mass media (Mani *et al*., 2017:41; Bergman *et al.,* 2012:xv).

- To enable a research environment and to improve the testing of EDCs, as well as evaluate their evidence and health effects and to identify exposed communities (Mani *et al*., 2017:41; Bergman *et al,* 2012:xvi).
- To reduce exposure and, in turn, consumers' vulnerability to diseases associated with EDCs. Here, strict regulatory measures, community, parent, and teacher education regarding EDCs are necessary (Mani *et al*., 2017:41; Bergman *et al,* 2012:xvi).
- To obtain commitment from policy-makers and to enforce the banning of EDCs and the increase in the use of substitute chemicals, empower communities affected by poverty, and provide guidelines for consumers to protect themselves (Mani *et al*., 2017:41).
- To inform and educate all healthcare professionals (e.g. doctors, nurses, community workers) as well as home economists and consumer scientists of the risks associated with chemical exposure through foodstuffs. In addition, these professionals should advise consumers of plastic identification codes and labels to help them follow the provided recommendations and storage practices provided on plastic packaging (Enneking, 2006:96; Mani *et al.,* 2017:40; Mustieles *et al.,* 2015:182).

Although consumers cannot avoid all harmful chemicals, certain measures can be taken to minimise exposure to these chemicals (Mercola, 2015). The following measures can be taken in a food and beverage context:

- Eat more fresh food and avoid packaged food (including canned foods and food in plastic wrap) (Mercola, 2015; Wong & Durrani, 2017:113).
- Buy glass and use glass baby bottles rather than plastic products (Mercola, 2015), or breastfeed, and avoid plastic packaging and containers marked with a code "3", "6" or "7" (FDA, 2012; Wong & Durrani, 2017:113). It is important to check the labels provided on plastic food and beverage packaging and containers (FDA, 2010).
- Use glass, ceramic, wood, or stainless-steel containers to store food (Wong & Durrani, 2017:113).
- Discard all plastic products with scratches since these may leach more BPA or EDCs (FDA, 2012).
- Store and heat food and beverages in glass or ceramic containers (Leman, 2009:65, Mercola, 2015).

- Avoid plastic wrap (Glad-Wrap) and beware of plastic wraps marked “microwave safe” (Leman, 2009:65, Mercola, 2015), as they may contain BPA alternatives or EDCs that are not yet sufficiently researched. Rather make use of wax-paper.
- Avoid using plastic containers for hot or boiling liquids, especially those containing BPA (FDA, 2012).
- Never use plastic containers to reheat food (Wong & Durrani, 2017:113), unless it is clearly marked that it is “microwave safe”; however, these products are rare (Leman, 2009:65).
- Use alternative water pipes to PVC pipes. Furthermore, all drinking water should be filtered and never drink from a watering hose (Mercola, 2015).

While consumers’ exposure to BPA found in food and beverages may be reduced through changes in use patterns, alternative environmental exposure sources are still of major concern (Gore *et al.,* 2014:54). More studies evaluating the accumulative effects of BPA and EDC exposure through food and beverage packaging and containers as well as through the environment are necessary.

2.9. CONCLUSION

From this literature review, it is evident that plastic as a packaging material is convenient and is used for a multitude of products within the food, industrial, and cosmetic industries. Plastic packaging serves a variety of purposes, such as to provide information, protect foodstuffs while transported and stored, and to prevent spoilage. However, consumers are becoming more health and environmentally conscious, and concerns regarding chemicals found in plastic and the possible health effects of plastic packaging and containers have thus been raised.

Literature suggests that consumers think they know more than they do, and that consumers are sometime misinformed regarding plastic packaging and containers. It may therefore be suggested that consumers have a sense of false knowledge regarding a specific topic, due to this misinformation. It is thus suggested that consumers need to engage more in an information search processes, consulting a variety of sources before they make decisions or purchases. Additionally, consumers need to be informed regarding plastic identification codes, and how they should be used in order to determine the type of plastic used, how the product may be used, and the possible harmful chemicals that may be found in the plastic product. Within the present study, consumers may think that they are informed regarding plastic packaging and containers, the way

in which they should be used, and EDCs and BPA. However, they may not be informed about BPA substitutes and the specific ways in which “BPA-free” products should be used. As a result, consumers may buy and use “BPA-free” products, only to be exposed to BPA alternatives and other EDCs.

With regard to harmful chemicals found in plastic packaging and containers, some studies report that BPA and EDC exposure poses no risk to human health, but it is proposed that these researchers may underestimate the overall exposure to these chemicals. However, although direct exposure to plastic products, especially those associated with food processing, manufacturing, and packaging, may have adverse effects on human health, these risks can be managed. Information indicates that it is not necessarily direct contact with such products that may result in adverse effects, but that the continued wrongful use of these products increases human exposure to these harmful products. The widespread sources of exposure, including the environment, contribute to the increase and accumulation of human exposure to harmful chemicals.

It can be confirmed that researchers are not fully informed of consumer behaviour and utilisation practices when considering plastic food and beverage packaging and containers. The health effects related to the exposure of harmful chemicals from a wide variety of sources emphasise the need to further examine consumers’ knowledge, habits, information sources, and utilisation practices with regard to plastics in a food context.

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Chapter 3

The Social Cognitive Theory in the Context of Plastic Food and Beverage Packaging and Containers

3.1. INTRODUCTION

Theoretical perspectives are valuable in order to visualise the outcomes of research projects (Erasmus, 2014:2). A variety of psychological perspectives exist that provide diverse explanations for consumer behaviour (Bell, 2015). For the purpose of this study, the SCT will be discussed. In cognitive theories, the importance of what consumers know and how they obtain this knowledge is more important than consumer behaviour (Yilmaz, 2011:205). Therefore, when using a cognitive approach, such as the SCT, the focus is on organising and relating new information to already existing knowledge in order to make knowledge meaningful to consumers and for them to consider possible changes in their health-related behaviour (Whitehead, 2001:420; Yilmaz, 2011:205). Once knowledge becomes meaningful, consumer behaviour can be influenced or changed.

The purpose of this chapter is to introduce and describe the potential value of using an integrated theoretical perspective. The use of the SCT will contribute towards enclosing the objectives and design of this study. Although care has been taken to include the most recent literature on the SCT, several older references from the work of seminal authors regarding the SCT are included.

3.2. THE SOCIAL COGNITIVE THEORY

The SCT is a psychological behavioural model, described as being broader than just a learning theory (Van Lange *et al.,* 2012:350) and more inclusive than behavioural approaches to action and social learning (Stajkovic & Luthans, 2002:127). For this study, Albert Bandura's viewpoint and development of the SCT, focussing on a health perspective, will be discussed and used as a framework. This theory refers to consumers' conscious intellectual activities during which they use cognitive processes such as cognitive schemata (cognitive structures), scripts, expectations and objectives to improve their understanding of the world and the behaviour of others (Erasmus, 2014:23). The cognitive part of the theory further refers to how different consumers process, store, and retrieve information in order to utilise it when solving problems and making decisions

(Psychology Glossary, 2016). When consumers do not have all the information they need, they use heuristics as intellectual shortcuts to facilitate decision-making and to make sense of the world (Schiffman & Kanuk, 2010:481). Heuristics within the present study may include learned behaviour from parents (I do because they do), brand names of plastic products associated with quality, BPA-free claims, price of the products and trusted stores where plastic products are sold. Within the SCT model, consumer behaviour, personal factors (such as cognition) and environmental influences are all elements that affect one another (Bandura, 1989:2). The interdependent influences of consumers, the environment and consumer behaviour are represented in Figure 3.1 below.

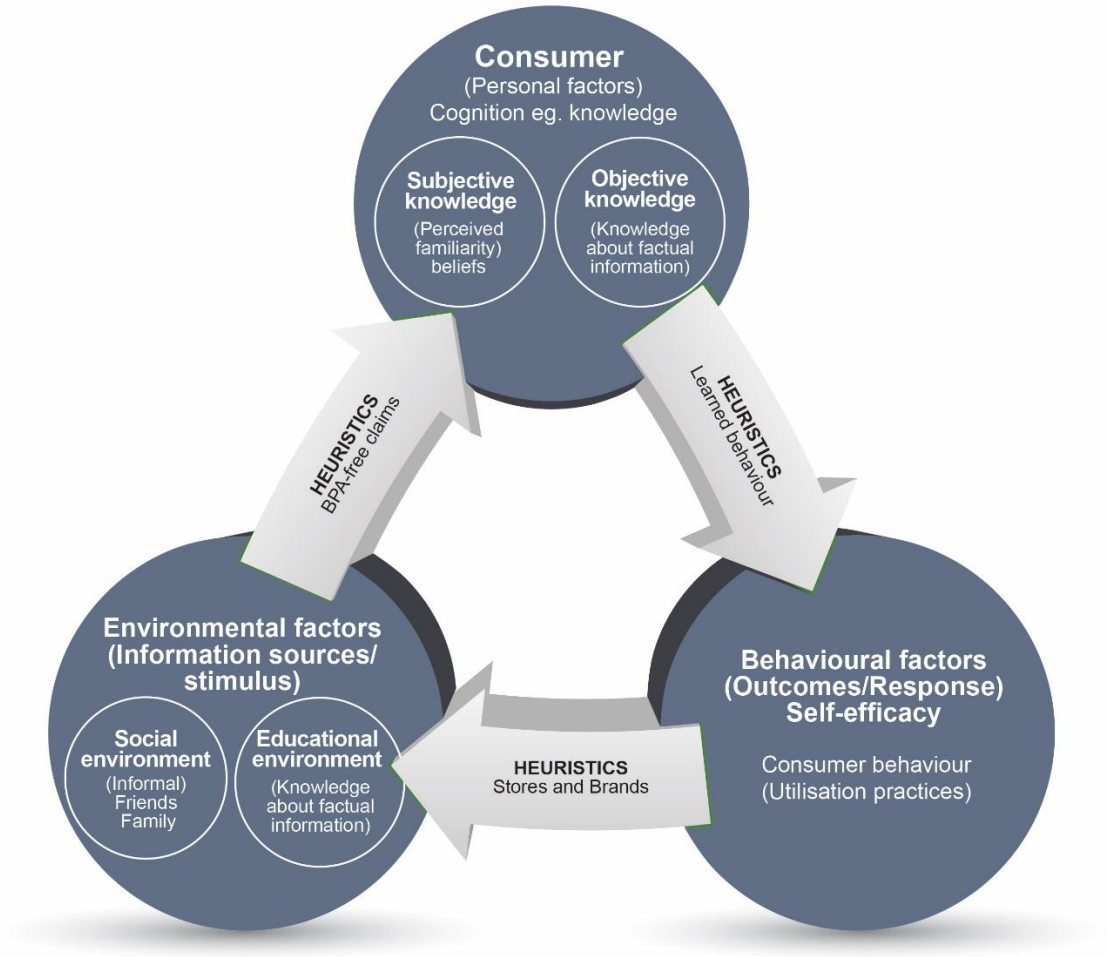

Figure 3.1. The interdependent influences of the social cognitive theory (Adapted form: Bandura, 1986; Oppong, 2014).

Within the SCT, learning is defined as the gaining of psychological processes used during decision-making, and comprises consumers' memory, perception and knowledge through cognitive information processes (Stajkovic & Luthans, 2002:127). Cognition is the knowledge and attention that represents one's beliefs regarding certain topics (Cant *et al*., 2006:191; Knipe, 2007:96). According to Bandura (1989:10; 2001a:4), thoughts are not isolated cognitive entities, but are rather defined as brain processes. Thoughts also have a definite influence on consumers and their behaviour (Figure 3.1), which is rooted in social systems (e.g. from the social and educational environment) (Bandura, 2001a:4; Van Lange *et al.,* 2012:349). Consumers may obtain information regarding the use and storage of plastic packaging and containers from a variety of sources from their environment, such as local media, newspapers, radio stations, their social systems, such as friends and family (Figure 3.1), and their educational environment, such as school and classes. These sources contribute to personal factors, i.e. the consumers' subjective and objective knowledge, rooted in cognition. As a result, the obtained knowledge may affect the ways in which consumers behave, namely their purchasing, use and storage of plastic food and beverage packaging and containers (Figure 3.1). Heuristics are in turn simplifying strategies or cognitive shortcuts that facilitate the decision-making process (Schiffman & Kanuk, 2010:481; Ungerer, 2014:409).

Moreover, the SCT includes developing interactive activity and focuses on learning through the behaviour and observation of others (Bandura, 1989:21; Hurst, 2016). However, consumers cannot be influenced by observations if information retention is not involved, confirming that behaviour is a result of personal cognition or knowledge (Figure 3.1) (Bandura, 2001a:23). Knowledge regarding health risks, as applicable to the present study, is needed to create change (Bandura, 2004:144). If consumers lack knowledge regarding their health, they will not go through the effort of changing their practices. It is suggested that behavioural change is possible through consumers' personal sense of control (Luszczynska & Schwarzer, 2005:128).

The SCT is based on several assumptions or concepts, including the following five that are particularly relevant to the present study, namely: observational learning, outcome expectations, perceived self-efficacy, goal-setting and self-regulation. These assumptions are closely related to the objectives of this study, which are presented in Chapter 1, and are applied below in the context of the present study.

3.2.1. Observational learning

Observational learning is the process by which consumers observe, try to remember and attempt to imitate the behaviour of other consumers, or adjust their behaviour accordingly (Cant *et al.,* 2006:126; Schiffman & Kanuk, 2010:570). Literature suggests that observational learning enables consumers to expand their skills and knowledge (Bandura, 1989:21). Additionally, the degree of observational learning may be influenced by the route, intensity and the frequency of observations (Bandura *et al.,* 1966:500). For the purpose of this study, the observed consumers will be referred to as model consumers (I do because they do), as these consumers voice their thoughts and participate in problem-solving activities (Bandura, 1989:25). Observational learning consists of four interconnected processes: attention, representation, production and motivation (Bandura, 1989:27-29).

3.2.1.1. Attention

Attention refers to the ability to acquire new information and to learn by observing others and their behaviour (Hurst, 2016). Applied to the context of this study, consumers' attention can be gained through both labelling on plastic food and beverage packaging and containers as well as previously consulted information sources in order to increase, adapt and shape their knowledge, buying behaviour and utilisation practices. Additionally, model consumers may serve as alternative information sources for consumers (Schiffman & Kanuk, 2010:224).

3.2.1.2. Representation

Representation refers to an active process in which consumers transform and restructure information that will enable them to recall and use the stored information in a later stage of production (Bandura, 1989:24, 28). Importantly, knowledge is only useful when a consumer can retain or remember it (Hunt, 2003:102). Within the context of this study, information recollection regarding the safety and utilisation practices of plastic food and beverage packaging and containers is necessary. For example, when consumers are faced with purchasing decisions or utilising plastic products, they must be able to recollect the previously obtained information from model consumers, product labels and other information sources that contributed to their knowledge attention. The aim of information representation is to **produce** a change in behaviour.

3.2.1.3. Production

Production is the process of recalling stored information of previous observations in order to guide behaviour or to take action (Bandura, 1989:29). Consumers' purchasing decisions and utilisation practices may therefore be affected when recalling the information regarding the safety of plastic packaging and containers in combination with BPA and EDCs. The **production** process may result in the evaluation of alternatives, such as glass containers or BPA-free plastic products.

3.2.1.4. Motivation

Lastly, **motivation** is instrumental in terms of consumers' effort to repeat the relevant, observed behaviour. The expected outcomes, risks and benefits of observed behaviour serve as further motivation (Bandura, 1989:29; 2001a:7). It is proposed that the motivation for behaviour changes will differ between consumers. For example, if consumers are aware of the risks regarding plastics BPA and EDCs, some may be motivated by the improvement of their own health, whereas others may be more concerned for future generations (for example, their children). Such concern may include the utilisation practices of future generations as well as health concerns that may increase over time if the misuse of plastic food and beverage packaging and containers is continued.

3.2.2. Outcome expectations

Outcome expectations are consumers' beliefs regarding the consequences of their actions (Luszczynska & Schwarzer, 2005:128). Consumer behaviour is shaped through these outcome expectations, as well as beliefs, intentions, self-perceptions and goals, thus these factors are important (Bandura, 1989:3). Researchers distinguish between physical, social and self-evaluative outcomes (Luszczynska & Schwarzer, 2005:128). Consumers' decisions are likely to result in positive outcomes, since actions that produce unsatisfactory outcomes are rejected (Bandura, 2001a:7). Consumer behaviour is specifically directed to achieve a specific goal, such as making an informed decision to produce the maximum positive outcome (Schiffman & Kanuk, 2010:481, Young *et al.,* 2005:273-274). Outcome expectations, in combination with **self-efficacy**, will influence the **goal-setting** and pursuit of consumers (Luszczynska & Schwarzer, 2005:128).

Consumers tend to assess numerous decision outcomes subjectively after decisions are made or a product is used (Raju *et al.,* 1995:158). This assessment can be interpreted as feedback from

behaviour (Ryckman, 1997:612), which is measured against initial expectations and may include the perceived need for more information regarding the specified topic and feelings associated with satisfaction (Raju *et al.,* 1995:158). Hence, self-perceived decision outcomes are expected to be influenced by the type and amount of knowledge that consumers have (Raju *et al.,* 1995:158) and the ways in which consumers think (Ryckman, 1997:612).

When applied to the context of this study, consumers may become aware of the gaps within their knowledge about the appropriate utilisation practices of plastic and products containing BPA. This realisation may result in indirect education regarding the health risks and possible health effects associated with the misuse of plastic food and beverage packaging and containers. Consumers may thus be motivated to change their behaviour (utilisation practices) to better meet their outcome expectations and avoid possible unfavourable outcomes such as health problems.

For some consumers, the protection of their health and the health of their children may serve as motivation to change their utilisation practices of plastic products. For others, fitting into a new trend and making a social statement may serve as motivations to purchase BPA-free products. If model consumers and label information are successful in informing consumers regarding the risks of misuse of plastic containing BPA and other EDCs, these informed consumers may be willing to change their old lifestyle habits and utilisation practices of plastic packaging products to provide a better, more favourable outcome.

3.2.3. Perceived self-efficacy

Self-efficacy is defined as consumers' confidence or beliefs regarding their own capabilities to complete a specific task within a specified context (Stajkovic & Luthans, 2002:130). Perceived self-efficacy is a cognitive factor that plays a part in consumer behaviour, and it contributes significantly to the implementation of personal motivation (Bandura, 1989:47; Young *et al.,* 2005:273). According to Bandura (1989:59), self-efficacy influences how consumers think, feel and act, and is the result of consumers' personal performances, previous experiences, observation of other consumers as well as a consumer's current physiological state. Self-efficacy will further determine if consumers will consider changing their behaviour, and how they will maintain these possible changes (Bandura, 2001b:288). A low sense of self-efficacy can be associated with anxiety, depression and helplessness, while a higher sense of self-efficacy can be correlated with improved social integration (Luszczynska & Schwarzer, 2005:128). Therefore,

self-efficacy and self-belief will contribute to whether consumers succeed in reaching the **goals** that they set.

Within the context of this study, consumers may be uninformed or unaware of the gap between their subjective and objective knowledge regarding plastic food and beverage packaging and containers, BPA and EDCs. If, however, consumers are informed and confident in their knowledge and capabilities, they may think, feel and act differently towards plastic products. Owing to their self-efficacy, consumers may aim to alter their behaviour and improve their utilisation practices of plastic products. Upon the self-evaluation of their current practices, consumers must be convinced that their behavioural changes in utilisation practices of plastic food and beverage packaging and containers may contribute to the maintenance or improvement of their health. This belief may in turn have a positive effect on their self-efficacy.

3.2.4. Goal-setting

Goals are defined as the desired results of consumers' motivated behaviour (Schiffman & Kanuk, 2010:107). With regard to the SCT, goal-setting reflects cognitive demonstrations of expected, anticipated and preferred outcomes (Bandura, 2001a:7). Literature indicates that consumer knowledge has a direct effect on the safety, comfort, efficiency and satisfaction of consumer goals and how they are formulated and reached (Hunt, 2003:101). Furthermore, knowledge allows consumers to conceptualise their goals (Hunt, 2003:101).

According to Hurst (2016), goal-setting will lead to goal-directed behaviour. It is suggested that goals based on identifiable values result in consumer investment in purposeful actions. Goals further motivate consumers by enlisting self-evaluative involvement in activities and serve as influential promoters of consumer action. Moreover, the satisfaction consumers obtain from achieving their goals creates further interest in improving their behaviour (Bandura,1989:48; Bandura, 2001a:8). After a certain goal has been reached, consumers with a strong sense of self-efficacy will most likely set higher goals for the future (Bandura, 2001b:268).

Applied to the context of this study, the risks pertaining to the misuse of plastic packaging and containers and the benefits of the desired utilisation practices may serve as motives for consumers on which to base their **goals** regarding knowledge and utilisation of plastic products. This goal-setting may result in the change of old habits and utilisation practices regarding plastic

food and beverage packaging and containers, as consumers may set a goal to maintain and improve their health and lifestyle activities. If consumers achieve their goals regarding change towards plastic utilisation, they may then act as model consumers themselves.

3.2.5. Self-regulation

Self-regulation refers to the ability of consumers to control and monitor their personal behaviour, as well as change their behaviour according to the specific demands of the situation, regardless of whether learning was through observation, past experiences, thoughts and/or emotions, (Cook & Cook, 2014). According to Bandura (2001b:267), consumers are not only knowers and behaviourists, but also have the ability for self-reaction. Literature indicates that consumer behaviour depends on knowledge obtained through learning, experience and practice, as well as on the sensory receptors in the human body (Hunt, 2003:101). Bandura's SCT states that self-regulation is dependent on goal-setting, cognitive preparation and the continued evaluation of goal-directed activities to reach specific outcomes (Bandura, 1997). Moreover, self-regulation regarding health incorporates a wide variety of cognitions and behaviours (Luszczynska & Schwarzer, 2005:159). Within the SCT, three sub-processes relating to self-regulation are highlighted, namely self-observation, self-judgement and self-reaction (Bandura, 2001a:8).

3.2.5.1. Self-observation

Self-observation is described as introspection – or the examination of one's thoughts and emotions and the recognition that personal actions are part of oneself – needed to set realistic goals and to evaluate the progress made towards them (Bandura, 1989:61; 1998:633; Merriam-Webster, 2015; The Free Dictionary, 2016). The first step needed in order to affect consumer behaviour is consumers' observation of their own behaviour, known as self-judgement (Bandura, 1998:634).

3.2.5.2. Self-judgement

Self-judgement is defined as how consumers view themselves in the most critical ways, where personal values and standards are applied to judge the consumer's behaviour. This self-analysis involves an individual's qualities and faults (NLP-Motivational, 2014; Tougas *et al.,* 2015:5). It can

therefore be concluded that self-judgement refers to a process during which consumers estimate whether their actions are effective and if they enable them to progress towards their set goals.

3.2.5.3. Self-reaction

Self-reaction is the consumer's individual reaction to assessment of modified behaviour, and has been found to provide cognitive and motivational regulators of moral conduct (Bandura, 2001a:9). Literature suggests that self-reaction may take place as the result of self-judgement, therefore all three components (self-observation, self-judgement and self-reaction) contribute to behavioural changes (Tougas *et al.,* 2015:5).

Regarding this study, respondents may realise though **self-observation** that their behaviour in terms of purchase and utilisation practices of plastic food and beverage packaging and containers needs to change. As a result, they may choose glass or paper products, or realise that plastic must be used in the correct manner, as described on labels and by the plastic identification codes. Respondents may judge their own actions in order to set goals and make progress towards those goals (for example, a goal may be to maintain or improve their current health status). Therefore, **self-judgement** must take place for consumers to reach these goals.

Upon self-judgement, consumers' **self-reaction** will be either satisfied or disappointed with their newly acquired knowledge and utilisation practices of plastic food and beverage packaging and containers. If consumers are satisfied with their knowledge and utilisation practices, they will continue with their newly learned behavioural practices. However, if they are disappointed, they will discontinue or discard the use of their newly learned behaviour patterns and practices, and may return to their previous behaviour, in which the appropriate use of plastic is not a concern.

3.3. CONCLUSION

The SCT provides a framework for understanding, predicting and changing human behaviour. This theory is based on five main assumptions, including observational learning, outcome expectations, perceived self-efficacy, goal-setting and self-regulation. These assumptions closely relate to the objectives of this study (presented in Chapter 1) and were theoretically applied within the context of this research.

With regard to the present study, consumers may become aware of their lack of knowledge regarding plastic and utilisation practices by observing model consumers. The attained information can then be stored, recalled at a later stage and used to initiate an action to increase, change or shape their knowledge, buying behaviour and utilisation practices of plastic food and beverage packaging and containers. The expected outcomes of changed behaviour or utilisation practice, may in turn motivate consumers to learn more and to increase their knowledge regarding the topic.

Outcome expectations in the present study may be that consumers become aware of their lack of knowledge regarding the appropriate utilisation practices of plastic and food and beverage packaging and containers containing BPA and EDCs. Consumers may be willing to participate in information searches and education of the possible health effects and risks associated with the misuse of these plastics. They may therefore be motivated to change their behaviour (utilisation practices) to improve their outcome expectations.

Through self-efficacy, consumers may in turn aim to change their behaviour and improve their utilisation practice to improve their health. The risks related to the misuse of plastic packaging and containers and the benefits of the correct utilisation practices may serve as motives for consumers on which to base the goals they would like to set for themselves. Possible goals include the knowledge they want to obtain and the implementation of improved and safer utilisation of plastic products.

Self-regulation and its three sub-processes, self-observation, self-judgement and self-reaction, in the context of this study means that consumers may realise the need to alter their behaviour in terms of purchase and utilisation practices of plastic food and beverage packaging and containers. Furthermore, consumers may judge their own actions, set goals and be either satisfied or disappointed with their newly acquired knowledge and utilisation practices of plastics.

The use of the SCT as theoretical perspective therefore successfully contributed towards enclosing the objectives and design (Chapter 1) of this study.

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Chapter 4
Methodology

4.1. RESEARCH DESIGN

A quantitative, cross-sectional, descriptive survey was used for this study. In order to investigate and describe different topics, researchers make use of surveys to obtain quantitative information (Maree & Pietersen, 2007:152), and describe the sample in terms of percentages and proportions (Punch, 2005:75). A descriptive design was used for this study as little is known about the topic (Botma *et al.,* 2010:110). Furthermore, the descriptive survey design is usually included in cross-sectional studies, which make use of questionnaires for data collection (Creswell, 2014:13). A cross-sectional design was suited to this study, since it is associated with descriptive studies that examine numerous groups of people at a certain point in time (Fouché *et al.*, 2011:156). This approach was taken in order to determine if a particular problem existed within a group of consumers and, if so, to determine the extent of the problem.

4.2. SAMPLING

The following section explains the different aspects of the sampling process.

4.2.1. Population and study location

For the purpose of this study, the study location or research setting was across South Africa. The aim was to obtain information from a wide set of consumers in the age group 18 to 35 years with different backgrounds for the purpose of identifying the nature and extent of the problem. Statistics South Africa (2015:7) shows that the population of South Africans is an estimated 55 million. The age groups of 15-19 years, 20-24 years, 25-29 years, and 30-34 years constitute an estimated 5.1 million, 5.3 million, 5.2 million, and 4.3 million of the population respectively. When combined, these age groups contribute over 19.9 million, almost 35% of the total consumer population. Within these age groups, the percentage of male and female is almost equal (Statistics South Africa, 2015:7). The targeted consumers for this study (18-35 years) were within these age group divisions.

It was expected that younger consumers (18-35 years) who had to start taking care of themselves recently would be exposed to more complex food-related decisions (e.g. the type of packaged food to be purchased) than more experienced consumers. For these younger consumers, purchasing decisions may be high involvement decisions, specifically when buying a product for the first time (Peters-Texeira & Badrie, 2005:511; Silayoi & Speece, 2004:619). Furthermore, the targeted age group may already have children, or may plan to have children in the future. Therefore, it was necessary to determine their knowledge and, if necessary, to educate these consumers regarding plastic bottles as well as packaging and containers so that they can implement it in an early stage of their lives, and transfer this knowledge to the next generation.

The **inclusion criteria** for this study were:

- Consumers who are male or female, 18 to 35 years old and made use of plastic food or beverage packaging or containers. This specific age group was chosen as it represents a third of the population. These consumers still have to use plastic for a long period of time, and will have to transfer their knowledge and educate their children regarding the use of plastic food and beverage containers. Furthermore, consumers are marrying at a later age (IOL, 2008), and once they have children, they may be more aware and attentive to health risks.
- Consumers who do not live at their parents' home, and must buy, prepare or store their own food. This requirement is necessary as the younger consumers' knowledge and use practices must be determined, not the knowledge and use practices of their parents.
- Consumers who are willing to complete the questionnaire.

The **exclusion criteria** for this study were:

- Consumers who live with their parents. These consumers were excluded as their parents may mostly buy, prepare and store their food.
- Consumers working or studying in the food or packaging industry, as well as chemical engineers, as they may be more educated or informed about the risks regarding the misuse of plastic.

4.2.2. Respondents

Non-probability, purposive sampling was used. Purposive sampling aims at identifying a population that exhibits characteristics, or attributes that suit the purpose of the study (Grinnell & Unrau, 2008). This type of sampling refers to the means that the inclusion of consumers who adhere to the criteria stipulated in 4.2.1.

The sampling of respondents was done by Consulta Research Company, which has databases of consumers nationwide. This company was used because it is a trusted research company with a good reputation. For the purpose of this study, Consulta panellists in combination with social media crowd sourcing (Facebook) were used. This approach was taken to obtain opinions regarding a new or unfamiliar product/problem (EDCs and BPA in plastic products, and misuse of plastics) from a wide set of consumers with different backgrounds. Consulta Research Company is one of the top three market research companies in South Africa, with a highly qualified research team (ConsultaPanel, 2016a). ConsultaPanel, Consulta Research's own community, provides an easy, quick and cost-effective way to gather information regarding consumers (ConsultaPanel, 2016a). ConsultaPanel has conducted 10 101 surveys and consists of 228 569 panellists (ConsultaPanel, 2016b).

Consulta Research (2015a) states that ConsultaPanel members represent the whole of South Africa: a multi-cultural nation, with people from different backgrounds, ethnicities, income levels and age groups. Researchers can make use of the ConsultaPanel member database, or community members, who are dedicated volunteers helping to contribute to South Africa's consumer market (ConsultaPanel, 2016a; ConsultaPanel, 2016c). Consumers' confidentiality is ensured; thus, no personal information will be made public or provided to third parties (ConsultaPanel, 2016c).

Regarding data collection, ConsultaPanel has the needed resources and expertise to send out surveys, capture data and provide the findings. Furthermore, ConsultaPanel makes use of online communities and platforms to send out explanatory information to the identified target group (ConsultaPanel, 2016d). Data integrity is ensured through a strict quality control process, which makes sure that the reliability and validity requirements of the specific research or study are met (Consulta Research, 2015b).

ConsultaPanel has developed a unique method of executing online panel research in South Africa, since consumer preferences have changed from paper and telephone surveys to online

research platforms and online surveys (ConsultaPanel, 2016e). ConsultaPanel (2016e) explains that online or electronic research has improved the quality and quantity of the collected data, and consumers are also more likely to respond to online surveys, since they can be completed in their own time and at their convenience.

4.2.3. Sample size

A power calculation was not applicable for this study, as it was not a random sample. However, to be suitable for factor analysis, 300 respondents are usually necessary. For the purpose of this study, 200-300 respondents were targeted. A total of 293 respondents participated in the survey, which is sufficient for factor analysis in this study. The number of respondents was recommended by Professor Suria Ellis, a statistical analyst at the North-West University. The link to the electronic questionnaire was active for about three months (from April-June 2017). Consulta Panel shared the link within their personal networks until the desired number was reached.

4.3. DATA COLLECTION

4.3.1. Measuring instrument

Electronic questionnaires were used for this study. With electronic questionnaires, data are entered directly into a computerised database, and paper questionnaires with data that need to be transferred into a database are eliminated, which results in minimising any mistakes (Delport & Roestenburg, 2011:189). By using electronic questionnaires, interviewer bias was avoided, since all respondents received a standardised questionnaire, and the computer is impersonal and all questions were stated the same (Phellas *et al.*, 2012:188; Walliman, 2011:197). The use of consumers across South Africa as a sample pool improved the possibility of including a diverse consumer population.

As to limitations regarding these methods, the researchers acknowledge that respondents, as in the case of all questionnaires, might have guessed answers, rather than selecting the “I do not know” or “unsure” option. Only literate consumers could sign up for the online surveys. Furthermore, only computer-literate consumers could participate in this study – a bias that the researchers acknowledge. However, this method was still suitable for this study, since the selected age group (18-35-year olds) often makes use of computers and the internet. With the

use of electronic questionnaires, a wider population could be reached, and electronic questionnaires have been indicated to improve the response rate of consumers (Diaz de Rada, 2015:168).

It can also be argued that should a literate and probably more affluent consumer group (indicated by access to a computer and the internet), as used in the present study, fail to utilise plastic food and beverage packaging and containers correctly or have insufficient knowledge in this regard, these findings may be exacerbated among less affluent and computer illiterate consumer groups, living in, for instance, more rural areas. The use of the targeted consumer group could therefore provide valuable insights into the extent of the problem – if any – regarding plastic food and beverage packaging and containers.

There was no advertising of the study beforehand and an invitation was sent to potential respondents. Consulta Research Company together with ConsultaPanel sent out the invitation to participate in this study as well as informed consent forms (Addendum B), drawn up by the researchers, to the targeted population via their e-mail database as well as through social media crowd sourcing. The respondents had sufficient time to decide if they wanted to participate in the study. When ConsultaPanel members sign in or join the panel to voluntarily participate in online surveys, they automatically give consent to receive all surveys sent out by Consulta. For the purpose of this study, the consent form was programmed into the online questionnaire, and all willing respondents could read it and tick the “I agree” button (Addendum B). The consent forms and questionnaires were administered in English, as it is the official computer language, and one with which consumers on these databases are comfortable.

A link was provided on the online questionnaire, which directed respondents to read the consent form and agree to participate in the study. Upon their agreement, they were directed to the questionnaire. The first set of questions ensured that the potential respondents adhered to the inclusion criteria. If they did not adhere to these criteria, they were thanked and the survey ended.

The questionnaire (Addendum A) was compiled by the researchers by conducting a thorough literature review on the topic and relevant variables, as well as by adapting previous questionnaires measuring these variables in other consumer research contexts. Specific questions regarding BPA, packaging, knowledge and utilisation practices were compiled from literature (which will be discussed in more detail below). The questions were kept short and subjective terms were avoided.

SECTION A of the questionnaire (Addendum A) comprised questions regarding the inclusion criteria for the study. Question 13, regarding potential diagnoses, was used to determine if consumers with health problems were aware of the type of packaging that they use, and if their doctors were informed regarding the risks regarding the use of plastic. All of the mentioned illnesses or diseases in this question have in some way been linked or associated with BPA or EDCs in the literature.

SECTION B (Addendum A) included questions regarding each respondent's utilisation practices of plastic food and beverage packaging and containers. The frequency of use and the way in which the consumer uses these different products were measured (Addendum A). These questions were adapted from Nomura *et al.* (2015) and Havenga (2014:133-147).

SECTION C measured subjective knowledge. Respondents were asked if they know how to evaluate the possible health effects of the use of plastic food and beverage packaging and containers. These questions were adapted from Malindi (2010:66-69) and Steyn (2014:42-51). The correct answers to these questions were determined from an in-depth literature review. Correct answers were awarded a "1" and incorrect answers a "2", and statistical analyses were conducted according to this data.

SECTION D of the questionnaire addressed consumers' objective knowledge of plastic food and beverage packaging and containers. These questions were adapted from the Mongolia Baseline (2005), Steyn, (2014:42-51) and Havenga (2014:133-147). Data analyses were conducted according to the same criteria as mentioned in SECTION C of the questionnaire.

SECTION E aimed to identify consumers' information sources regarding plastic food and beverage packaging, and to establish if they trusted these sources. These questions were adapted from Havenga (2014:133-147), Wyma (2018) and European Commission Special Eurobarometer (2010), and included a variety of possible formal and informal information sources.

SECTION F, the final section of the questionnaire, served as the demographic and general information section. Because this study used Consulta Research Company, this company's set of demographic questions were included in the questionnaire, but only those questions relevant to the study as well as compulsory questions from Consulta were selected. To address the objectives of this study, questions pertaining to age, gender, level of education, the province in which respondents reside and ethnicity were asked. It was necessary to determine respondents'

ethnicity, as previous studies have shown differences between ethnicities and label use, consumer knowledge and eating behaviour (Grunert *et al.,* 2010:268; Jasti & Kovacs, 2010:312).

Incentives to participate were provided by Consulta Research Company, as doing so is part of its practice for all surveys. Incentives are generally provided to motivate consumers to take part in studies, as well as to generate a higher number of respondents. ConsultaPanel offers rewards on a lucky draw basis only, as its philosophy is that it provides benefits greater than financial awards (Consulta Panel, 2016c). The use of incentives was approved by the HREC in advance (Addendum C).

4.3.2. Resources assisting in data collection

Resources assisting data collection for the present study included Consulta Research Company, ConsultaPanel and its member database. Furthermore, the Vovici Workbench program, used for sending out questionnaires, as well as the data capturing program, Microsoft Excel, where used to assist in data collection. The researcher received the raw, anonymised spread sheet with data as a password-protected Microsoft Excel file. The file could only be downloaded for 15 days, after which the link expired.

4.3.3. Recruitment of respondents

The ConsultaPanel member database or community members voluntarily participate in order to contribute to South Africa's consumer market (ConsultaPanel, 2016a; ConsultaPanel, 2016c). Consumers can sign up for participation, thus indicating their willingness to be recruited for future studies. When signing up, consumers must provide personal information to ConsultaPanel, in order to allow the company to categorise consumers according to the necessary criteria specified by researchers. However, social media crowd sourcing (Facebook) was used to recruit other respondents not signed up as ConsultaPanel members. These respondents also voluntarily chose to participate.

4.3.4. Role of researcher during data collection

The role of the researcher, with supervision and input from the study supervisors, included writing a letter of consent and compiling, developing and ensuring valid and reliable questionnaires in order to gather and analyse data. These documents were provided to Consulta Research Company. The data collection process and the monitoring of the data collected by Consulta Research Company also formed part of the researcher's role. Consulta Research Company in combination with ConsultaPanel was used to improve the quality control process. The final role of the researcher was to analyse quantitative data, and come to a conclusion that is beneficial for other researchers and consumers.

4.4. DATA ANALYSIS

Because Consulta Research Company, ConsultaPanel and electronic questionnaires were used, data entry was not necessary, as such information was provided in an electronic format. Data received in Microsoft Excel were analysed using the Statistical Package for Social Sciences (SPSS, Version 22) and the Statistical Consultation Services of the NWU. Descriptive statistics were determined, including frequencies, mean scores and standard deviations. Two-sided independent t-tests, one-way analysis of variance (ANOVA), Exploratory Factor Analysis, in combination with Kaiser-Meyer-Olkin values, and Spearman's rank order correlations were also conducted. Spearman's rank order correlations determined the association and differences between the variables, where large correlations (r=0.5) are reported. For differences in means of demographical groups, only Cohen's d-values as effect sizes for practical significance (d=0.8=large) and tendencies (d=0.5=medium) are reported (Walker, 2008). Cronbach Alpha's were used to determine reliability of all statistical analyses.

The results were carefully interpreted in the context of the study population and are seen as relevant only to the study population. The researcher did not attempt to generalise the findings to a larger population, due to the non-probable nature of the sample.

Table 4.1 provides the different objectives of the study, the sections of the questionnaire addressing these objectives, the constructs measured, as well as the applicable statistical analyses.

Table 4.1. Operationalisation table

OBJECTIVE	QUESTIONNAIRE	CONSTRUCT	STATISTICAL ANALYSIS
Demographics and general information	Section A Section F	Age Gender Education Employment Ethnicity	Descriptives - frequencies and means
To identify and investigate consumers' utilisation practices of plastic food and beverage packaging and containers	Section B	Utilisation practices	Descriptives - frequencies and means Factor analysis Reliability/Cronbach's alpha Calculation of factor scores
To determine consumers' subjective knowledge of plastic food and beverage packaging and containers	Section C	Subjective knowledge	Descriptives - frequencies and means Factor analysis Reliability/Cronbach's alpha Calculation of factor scores
To determine consumers' objective knowledge of plastic food and beverage packaging and containers	Section D	Objective knowledge	Descriptives - frequencies and means Factor analysis Reliability/ Cronbach's alpha Calculation of factor scores
To identify information sources that consumers consult to obtain information regarding the proper use of plastic food and beverage packaging and containers	Section E	Information sources	Descriptives - frequencies and means Factor analysis Reliability/ Cronbach's alpha Calculation of factor scores
To determine associations between objective and subjective knowledge, demographic variables, utilisation practices and information sources.	Sections A to F	Age Gender Education Employment Ethnicity Utilisation practices Subjective knowledge Objective knowledge Information sources	T-tests ANOVA tests Spearman's rank order correlations Descriptives - frequencies and means

4.5. VALIDITY AND RELIABLITY

4.5.1. Validity

Validity is obtained when a measuring instrument measures what it is intended to measure (Maree & Pietersen 2007:147). Face validity, content validity and construct validity were used to measure validity in this study.

4.5.1.1. Face validity

Face validity can be seen as the extent to which the measuring instrument looks valid, and if it measures what it is supposed to (Pietersen & Maree, 2007:217). Previously evaluated and tested questionnaires were adapted from literature on the current topic to increase validity. For high levels of face validity, it is important that experts in the field examine and evaluate the questionnaire. For the purpose of this study, the following experts were consulted:

- Consumer Sciences experts (Professor M. van der Merwe; Ms L. Wyma);
- Statistical consultant (Professor S. Ellis);
- Researcher familiar with the literature on BPA and EDCs (Ms L. Wyma); and
- Researchers with experience in quantitative research and questionnaire development (Professor M. van der Merwe; Ms L. Wyma and Professor S. Ellis).

4.5.1.2. Content validity

In this study, it was important that the electronic questionnaire measured all aspects regarding knowledge and utilisation practices regarding plastic, and no component was left out. To ensure content validity, the questionnaire was revised by experts in the field, and their comments taken into account when finalising the measuring instrument (Pietersen & Maree, 2007:217). The same experts evaluating face validity were also responsible for ensuring content validity.

4.5.1.3. Construct validity

Construct validity refers to how well the intended constructs are measured by different and related groups and questions within the questionnaires. To measure construct validity, factor analysis

was used (Pietersen & Maree, 2007:217). Factor analysis is defined as a multivariate technique used to identify whether the correlations between a set of observed variables stem from their relationship to one or multiple latent variables within the data (Field, 2009:782). Factor analysis is used when measuring constructs that cannot be measured directly (Field, 2009:628), such as consumer behaviour constructs. The constructs within this study included knowledge (subjective and objective), utilisation practices and information sources.

Factor analysis was done using the SPSS (Version 22). Exploratory factor analysis (EFA) with principle component factoring was used as the extraction method, and Oblimin rotation was used for all scales in the different sections of the questionnaire. Detail on the results of EFA are provided in Chapter 5.

4.5.2. Reliability

Reliability refers to the consistency and repeatability of measuring instruments (Maree & Pietersen, 2007:147) – i.e. the electronic questionnaires. High levels of reliability are obtained when the instruments provide the same results when repeated on the same or a similar sample. Within this study, reliability of the electronic questionnaire was ensured by the cautious construction of questions, the pretesting of the questionnaires (conducted by the researchers and by Consulta Research Company), and by determining internal reliability.

The researcher determined internal reliability to measure similarities between different items regarding the knowledge and utilisation practices of food and beverage packaging and containers. Cronbach's alpha coefficient was used to determine consistency between items of the same construct (Pietersen & Maree, 2007:216) defined in the factor analysis. According to Malhotra (2010:319), a Cronbach's alpha value of 0.6 is indicative of satisfactory internal reliability.

4.6. ETHICAL CONSIDERATIONS

Ethical approval was gained from the Health Research Ethics Committee (HREC) of the Faculty of Health Sciences of the North-West University (Reference number: NWU-00338-16-A1). The researcher also had the following ethical obligations towards the respondents in this study:

4.6.1. Respect

Since the well-being and best interests of respondents are more important that the research goal, these participants were treated with respect (Strydom, 2011:115) and dignity. Respect towards privacy and confidentiality was shown, and it was made clear that withdrawal from the study was possible without penalty, and respondents were told that they would be informed of the results of the study (Moodley & Naidoo, 2011:330, 332). Although it is important to consider the participants' language, culture, beliefs and perceptions, for this study, questionnaires were sent out in English only, as all consumers who signed up as ConsultaPanel members are English literate. Because the questionnaire was sent out to consumers across South Africa, respect for the respondents was maintained by ensuring that the questions did not offend in any way. Care was taken to only include those questions that were relevant to the aim and objectives of the study, and to keep the questionnaire as short as possible (approximately 15 minutes) to respect respondents' time.

4.6.2. Relevance and value

It is important that all questions are relevant to the study in question, and that all data collected is published and contributes to further education and scientific knowledge (Strydom, 2011:116), which results in the enhancement of health and wellbeing of consumers (Moodley & Naidoo, 2011:329). These factors were taken into account when carefully compiling the questionnaire, ensuring that all the data collected were relevant and valuable to this study. As such, only questions regarding subjective and objective knowledge, utilisation practices and information sources regarding plastic packaging and containers were included. Biographical questions were included to accurately describe the context of the study (Addendum A).

4.6.3. Scientific integrity

Scientific integrity is a fundamental aspect when ethics are considered. It was of utmost importance that the aim of the study is clear, and that the research adds knowledge about consumer's knowledge and utilisation practices to ultimately better inform and contribute to improved health-related practices among consumers.

4.6.4. Recruitment of respondents

As stated in section 4.2.2, the recruitment of respondents was done by Consulta Research Company and Consulta Panel. The following section explains how the process took place:

1. Research project was launched on Consulta's web page and social media by providing an invitation for participation (Addendum D).
2. Social media crowd sourcing took place on Consulta's social channels (Facebook).
3. A link to the consent form and questionnaire was provided.
4. Respondents had time to decide if they wanted to participate before agreeing to do so.
5. If respondents provided informed consent, the link directed them to the questionnaire.
6. The first section of questions determined if the respondents met the inclusion criteria.
7. If they did adhere to the criteria, they were guided through the questionnaire. If they did not, they were thanked and the questionnaire ended.

The role of the researcher during this process was to aid in the development of an ethical invitation for the proposed study (Addendum D). Thereafter, the researcher had no influence in the recruitment process, as ConsultaPanel does not provide any further information to the researchers.

4.6.5. Risks and benefits analysis

It was important that the benefits the study holds for all respondents outweigh all anticipated risks (Moodley & Naidoo, 2011:330). Furthermore, all consumers adhering to the inclusion criteria had an equal possibility of inclusion within the study, and all respondents received the same benefits of inclusion.

- **Risks for respondents**

Physical risks included the following:

  - **Boredom**: This risk was minimised by keeping the questionnaire short. The questionnaire was tested on consumers who did not participate in the study, and the testing proved that it took approximately 15 minutes to complete.

- **Time**: This risk was minimised by allowing the respondents to complete the questionnaire in their own time and space, and by telling the respondents that it would take approximately 15 minutes to complete the questionnaire. Data could thus be provided from the comfort of the respondents' homes or offices. It was not necessary to walk or travel to participate in this study.

Therefore, it can be stated that **limited physical risks** were anticipated for respondents in this study.

Psychological risks included the following:

- **Discomfort:** Respondents may have felt uncomfortable if they were unable to answer certain questions. Furthermore, language barriers may have contributed to miscommunication in the questionnaires. However, all consumers that signed up at ConsultaPanel or those that were recruited through social media crowd sourcing were capable of reading and understanding English.
- **Emotional:** Respondents may have felt emotional if they did not understand the questions. In order to minimise this risk, questions were stated in an easy, understandable way that allowed for ease of reading and answering.

Psychological risks to respondents were therefore limited.

- **Benefits for the respondents include the following:**
  - There were no direct benefits to the respondents within this study.
  - Indirect benefits include the following:
    - respondents may have become more informed about the topic during the research process and upon feedback;
    - this study provided an opportunity for respondents to think about their utilisation practices while they were completing the questionnaire;
    - the wider consumer population may benefit from a resultant education intervention regarding the topic that may lead to the improvement of consumer health; and

- policy makers will be informed of the possible risks regarding the use of plastic, EDCs and BPA.

- **Risks for the researcher included the following:**
    - No physical risk was anticipated for the researcher, as the researcher did not actively take part in the data collection process.
    - There was a psychological risk of stress if the researcher did not find enough respondents to participate in the study, or if the questionnaires were answered incorrectly or were incomplete.

- **Benefits for the researcher include the following:**
    - The targeted population (18-35 years) provided information from a variety of backgrounds and cultures in South Africa.
    - Knowledge and skills regarding research were gained.
    - Resultant academic publications may be of benefit to the researcher and the NWU.

An indirect benefit to respondents included informing policy makers of BPA and other EDCs. If the policy is changed, the wider consumer population will be better protected. Furthermore, this study contributes to this field of knowledge, especially within South Africa. No social risks, economic risks, legal risks or dignity risks towards the respondents or the researcher were anticipated or experienced. Therefore, it can be stated that this was a minimal risk study, since the respondents did not endure more risk than they would in their everyday lives, and any risk was outweighed by the benefits.

4.6.6. Vulnerability

It was important that decisions regarding the inclusion and exclusion criteria as well as recruitment and enrolment in the study were based on the stated aims and objectives (Moodley & Naidoo, 2011:329). A fundamental rule in ethics of social research is that participants must not be harmed by the research (Babbie, 2007:27). Researchers should provide respondents with the freedom to participate and not be discriminated against if they choose not to participate or to withdraw from the study. The respondents that participated in this study are not from a vulnerable population, as

no power relations with the researchers existed, no communication issues were suspected, no payment arrangements were necessary and no decisional issues or excessive motivation for the study were needed. Furthermore, this study did not focus on consumers with a cognitive or communicative vulnerability, institutional vulnerability, differential vulnerability, economic vulnerability, medical vulnerability or social vulnerability.

4.6.7. Informed consent

All respondents must be able to make a voluntary decision without being convinced to participate (Moodley & Naidoo, 2011:331). As such, before the data collection process began, written consent (Addendum B) was obtained from all respondents, and was confirmed by the researcher. Sufficient time was provided to the respondents to allow to decide if they wanted to participate before they were required to sign the written consent form. In this study, signing the consent form means ticking the "I agree" button on the survey. Respondents therefore decided at their own pace upon receiving the invitation whether they wanted to "agree" to the consent form and proceed to the questionnaire.

The informed consent forms must contain sufficient and truthful information for respondents in order to enable them to make an informed decision. Respondents should be informed of the aim of the study, even though it might lead biased answers, as individuals often aim to provide the "correct answer" (Walliman, 2011:197). Therefore, only a short description of the study was added in the consent form in which the purpose of the study and the method of data collection were explained. After the questionnaire was tested, it was suggested that specific information be withheld from respondents in order to minimise bias within the study. It was therefore not stated in the informed consent form that knowledge will be determined, as it may have led respondents to do research before completing the questionnaire. The HREC approved this strategy since it was necessary to ensure research integrity. However, after the questionnaire was completed, information regarding the correct utilisation practices of plastic food and beverage packaging and containers was provided to the respondents, to improve their knowledge regarding the topic.

The following aspects were included in the consent form (Addendum B):

- personal detail of the researcher as well as the Human Research Ethics Committee, Faculty of Health Sciences, NWU;

- the purpose of the study;
- the total time needed to complete the questionnaire;
- voluntary participation and right to withdraw from the study;
- confidentiality, anonymity and privacy, with a guarantee that no personal details would be provided to the researcher;
- the inclusion and exclusion criteria;
- what was expected of the respondent;
- risks and benefits of the study;
- future storage of the obtained data;
- information regarding feedback or the results; and
- relevant incentives.

4.6.8. Voluntary participation

It is important that no respondent is forced to participate within a study, and that participation is always voluntary (Rubin & Babbie, 2005:71). With the use of electronic questionnaires, this problem was easily resolved, as the consumers unwilling to participate could decline to answer or submit the questionnaire. With the use of Consulta Research Company as a third party, possible undue influence from the researcher was eliminated and voluntary participation was ensured, as all ConsultaPanel members participate voluntarily (ConsultaPanel, 2016c). Furthermore, the respondents had the right to withdraw at any stage of the study by merely exiting the questionnaire and not completing it.

4.6.9. Confidentiality and privacy

The anonymity of respondents must be respected (Maree & Van der Westhuizen, 2007:42). Anonymity refers to the fact that even the researchers do not know to whom the collected data belong, as no identifiable data is provided to the researcher (Botma *et al.,* 2010:17). Within this study, information regarding the respondents was not discussed with individuals outside of the study, and the researcher did not have the personal information of respondents, since data was received from Consulta Research Company in the form of an anonymised spreadsheet.

Confidentiality refers to how personal information is managed (Botma *et al.,* 2010:17). For this study, information was kept confidential by Consulta Research Company, and was not provided

to any third party, or even to the researchers. If follow-up information was needed, Consulta Research Company would have contacted the respondents. Therefore, the data were anonymised before it reached the researcher, and Consulta Research Company entered into a confidentiality agreement with the respondents.

4.6.10. Data management

In this study, the researchers received the raw, anonymised data in the form of a password-protected Microsoft Excel spreadsheet, which was kept on the office computer of the principle researcher. The data will be destroyed after a storage period of five years. Only the researcher, supervisor, co-supervisor and statistician had access to the spreadsheet, and no data were available to outside parties or researchers. Furthermore, the data set will be removed from the researcher's computer after completion of the study, in accordance with the regulations of the NWU.

Consulta Research Company also keeps a set of data and stores the obtained data on a sequel database. This system has its own security system, and only Consulta has access to this data. No data will be shared with outside parties or used for other research.

4.6.11. Competence of the researchers

The researcher completed a B.Sc. Honours degree in Consumer Sciences, in which a mini-dissertation was submitted. In this dissertation, a complete methodology was established, a literature review was conducted and results were analysed with SPSS. These results were then interpreted and discussed, and used to draw conclusions. Furthermore, the researcher gained knowledge of and experience using quantitative data, and attended a research methodology workshop presented by the Africa Unit for Transdisciplinary Health Research (AUTHeR), and The Basics of Health Research Ethics training in 2016.

The researcher acts under supervision of Professor M. Van der Merwe (Consumer Sciences) and Ms L. Wyma (Consumer Sciences). Professor S. Ellis (Statistical consultation services of the NWU) aided in the statistical procedures and analysis.

4.6.12. Feedback to respondents

After completion of the study, the combined results will be revealed to the respondents via an electronic report sent out by Consulta Research Company. It is important that respondents are informed about the results of this study and the proper use of plastic food packaging and containers in their daily lives in order for them to benefit from this research.

4.6.13. Reimbursement

For the purpose of this study, respondents were not payed to participate. However, Consulta Panel offers incentives or rewards on a lucky draw basis. For this survey, five R500 Takealot.com vouchers were offered. All respondents had an equal chance of being selected in this lucky draw.

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Chapter 5

Research article

Manuscript to be submitted for publication in the *Family and Consumer Sciences Research Journal.*

This article was written according to the author guidelines for this journal (Addendum G) except for the length, which is slightly longer for the purpose of comprehensiveness for the dissertation.

For this dissertation, and due to the limited amount of words available for the specified journal, additional data tables are included in the form of addendums (Addendum F). If more information is needed, the authors can be contacted.

Title:

Consumers' knowledge and utilization practices regarding plastic food packaging

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ABSTRACT

Problem: Chemicals associated with health problems and diseases leaches from packaging materials into foodstuffs. It is therefore important to assess consumer knowledge and utilization practices regarding plastic as a food packaging material.

Participants: Participants (N=293) from South Africa aged 18 – 35 years participated in this study.

Methods: A quantitative, cross-sectional, descriptive survey design was employed, making use of online questionnaires.

Results: Respondents' objective knowledge of plastic food and beverage packaging and containers varied between lacking and being adequate depending on the different aspects addressed. However, their utilization practices did not reflect this knowledge, as most packaging and containers were used incorrectly.

KEY WORDS: Consumer knowledge; Food packaging; Information sources; Plastic packaging; Utilisation practices

INTRODUCTION

Food packaging is a rapidly evolving field (Bhunia *et al.*, 2013:523), and the use of plastic as packaging material has increased, with a variety of food and beverage packaging applications and polymer modifications being developed (Hoppe *et al.,* 2016). Food packaging serves several purposes, including the physical protection of food and beverages during the production, transport and storing processes, safeguarding food from spoilage, and providing product information (Seltenrich & Tart, 2015).

However, controversy regarding the safety of plastic packaging has been reported, since plastic food and beverage packaging and containers – in this article referred to as plastic food packaging – interact with the food they contain (Arvanitoyannis & Kotsanopoulos, 2014). Different types and amounts of chemicals with estrogenic properties leach from packaging into the products contained

(Leman, 2009; Yang *et al.*, 2011). These chemicals include Bisphenol A (BPA) and BPA alternatives that have not yet been intensively studied despite their adverse health effects (Scherer *et al.*, 2014).

Consumers worldwide are most familiar with BPA (Seltenrich & Tart, 2015), an endocrine-disrupting chemical (EDC) that alters homeostatic and hormonal systems (Diamanti-Kandarakis *et al.*, 2009). Studies show that EDCs may be associated with different diseases and health problems (Michalowicz, 2014; Riskind & Lohr, 2016; WHO & FAO, 2009).

Despite substantial evidence regarding the benefits of plastics, the existing approach to plastic production as well as consumers' utilization and disposal practices pose risks to human health and the environment (Thompson *et al.*, 2009). Although consumers show interest in BPA and its safety (FDA, 2014), research reveals that consumers are unaware and uninformed regarding different plastic materials (Pouokam *et al.*, 2014), types of plastic used in packaging (Jayaraman *et al.*, 2011) and chemical substances found in plastic (Li *et al.*, 2016). Therefore, consumers may not be aware that plastic products leach harmful chemicals, and consequently their incorrect utilization practices may remain unaffected by this phenomenon, which may result in adverse health effects.

Yet while international consumer research regarding plastic in food packaging is inadequate, this lack is even more apparent in South Africa, which may serve as an indicator of the situation in other developing countries. It is proposed that consumers' lack of knowledge regarding label reading, nutrition, and consumer protection highlighted by previous research in a South African context (Oldewage-Theron *et al.*, 2014; Van der Merwe *et al.*, 2011) may be indicative of a possible lack of knowledge regarding and possible misuse of plastic food packaging. Furthermore, the general lack of sufficiently available information in developing countries (Donoghue *et al.*, 2016; Pouokam *et al.*, 2014) may possibly contribute to sub-optimal consumer choices and misuse practices of plastic food packaging.

The present study is therefore essential in providing a baseline on the nature and extent of misuse of plastic among South African consumers, and, should there prove to be a problem, allow for appropriate actions to be taken. Our study therefore aims to determine consumers' knowledge and utilization practices of plastic food packaging to assess whether consumers can utilize these

plastics in a safe manner. It is, however, also necessary to determine the information sources consumers consult regarding the correct use of plastic food packaging, as well as those pertaining to BPA and other harmful chemicals.

Albert Bandura's view on the Social Cognitive Theory (SCT) was used as a theoretical framework within which to situate the objectives and design of this study. Within the SCT model, consumer behavior, personal factors (e.g. cognition), and environmental influences are elements that affect one another (Bandura, 1989). The interdependent nature of these elements is presented below in Figure 1.

Figure 1. **The interdependent influences of the social cognitive theory** (Adapted from: Bandura, 1986; Oppong, 2014).

Chemicals in plastic food packaging

Consumers are exposed to various chemicals used in food packaging materials and other consumer products (Muncke, 2009). Most plastic products are reported to release or leach different chemicals in different amounts (Yang *et al.*, 2011), with BPA posing a major concern. BPA, used in the production of paper, is also expected to be present in food-contact paper (Vandenberg *et al.*, 2007). Epoxy resins used in the coating of canned food and drinks may also leach BPA (Vandenberg *et al.*, 2007; Kubwabo *et al.,* 2009; Pinto & Reali, 2009), contributing to the accumulation of BPA and EDCs in humans.

The long-term exposure (de Fatima Pocas & Hogg, 2007) and accumulation of these harmful chemicals may increase the negative effects on human health. Moreover, the risks regarding these harmful chemicals remain uncertain, and even unknown (de Fatima Pocas & Hogg, 2007). Although research by EFSA (2008) suggests that the current human exposure levels to EDCs pose no cause for concern, Gore *et al.* (2014) state that the very low levels of EDCs influence bodily functions at, thereby putting consumers' future health at risk.

Nevertheless, research reveals that only a small number of consumers mentioned food-packaging materials when asked about food contaminants (Gallart-Ayala *et al.*, 2013). Consumers are also unaware that BPA-free products contain alternatives or substitutes, potentially equally as harmful as BPA (Royte & Greer, 2015), and that "BPA-free" does not mean EDC-free (Scherer *et al.*, 2014; Yang *et al.*, 2011). Some consumers are reported to be aware of chemical substances, but uncertain about the quantities present in the products and the risks they pose to human health (Li *et al.*, 2016). Better availability of information and improved knowledge among consumers regarding plastic-related chemicals are therefore needed. In terms of the SCT, such information can be provided to consumers through social and educational environments (Figure 1).

Consumer knowledge regarding plastic food packaging

Knowledge is the range of consumers' acquired information, understanding, or skills obtained from education, experience, or association, which affects their behavior (Hunt, 2003; Merriam-

Webster, 2015). This process is illustrated in Figure 1. Objective knowledge (OK) is the accurate information on a specific topic that is stored in the long-term memory of consumers and is the actual measure of how much a person knows (House *et al*., 2004; Pieniak *et al.*, 2010). Subjective knowledge (SK) or self-assessed knowledge (Park *et al.*, 1994) is consumers' subjective perceptions and self-beliefs regarding their own knowledge – i.e. an individual's own idea of how much he/she knows (Carlson *et al.*, 2008; House *et al.*, 2004; Pieniak *et al.*, 2010). Alba and Hutchinson (2000) suggest that consumers are overconfident regarding their knowledge, thinking that they know more than they do.

An information search may, however, narrow the gap between SK and OK, as SK mainly influences consumers' motivation to learn, while OK influences their ability to encode and recall the information (Park *et al.*, 1994). Although the exact relationship between information search and knowledge is poorly understood, knowledge may influence the process of searching for information (Raju *et al*., 1995), thereby play a crucial part in information processing (Verbeke, 2008) and decision-making (Raju *et al.*, 1995). To the best of our knowledge, no published research regarding consumers' knowledge of plastic in a food context, BPA, or EDCs is available internationally or in South Africa.

Information search and sources regarding chemicals in plastic food packaging

An information search is influenced by the level of uncertainty and how important the consumers regard attributes of the product involved (Chorus & Timmermans, 2008). The type of consumer product will also determine the degree of the information search (Fallon *et al.*, 2014). Consumers have four primary sources of information: personal sources (family and friends), commercial sources (advertisements and websites), public sources (including mass media), and experience sources (gained from using or researching products) (Jun & Park, 2016). Of these sources, the internet (i.e. websites) is considered the main source of a range of information (for example, price and product attributes) consumers use before making a final decision or purchase (Dutta & Das, 2017). Consumers also make use of informal information sources such as communication between friends and family to search for the information that may aid them during the decision-making

process (Hoyer & MacInnis, 2010; Schiffman & Kanuk, 2010). Other sources providing consumers with public health information include popular sources and local media, such as newspapers, radio (Pouokam *et al.*, 2014; Browning, 2011), and press releases by regulatory authorities (Endocrine Society, 2016). On a community level, vendors, mothers and women's associations, shopkeepers and pharmacists provide information (Pouokam *et al.*, 2014), while local authorities or non-government organisations (NGOs) may provide further information regarding the use of plastic food packaging (Jayaraman *et al.*, 2011). However, reliable information regarding chemicals found in plastic packaging can only be provided once improved information on different exposure routes is available (Rudel *et al.*, 2011). Within the SCT framework, information sources form part of the environmental factors, and the decision/purchase is associated with the behavioral factors of this model (Figure 1).

Information searches in developing countries, such as South Africa, may pose difficulties owing to a lack of available information and consumers' inability to search for and understand such information. However, the rapid development of the internet and digital technology in many of these countries has facilitated consumers' information searches. Consumers living in rural areas without electricity are able to use battery-operated products such as cell phones to access information sources and gain knowledge to empower themselves (Karlsson *et al.*, 2012; Trujillo *et al.*, 2010). However, consumers must have access to correct information to educate themselves, and South African consumers' different levels of education, literacy, and knowledge may impact their ability to make informed decisions (Donoghue *et al.*, 2016). Consumers should therefore be provided with sufficient information and education by manufacturers and consumer protection organisations to ensure their right to information and education (Donoghue & De Klerk, 2009), as stipulated in the Consumer Protection Act (CPA) (68/2008) (South Africa, 2011).

Utilization practices of plastic food packaging

The type of plastic food packaging with which consumers are confronted may contribute to their utilization practices and other behavioral factors or responses, and the outcome of the SCT (Figure 1). Plastic containing harmful chemicals is used in the production of reusable beverage containers,

frozen and prepared food oven trays, microwaveable cookware, and "boiling-in-the-bag" packs (Bhunia *et al.*, 2013; Hoppe *et al.*, 2016). Furthermore, consumers often roast and microwave food in plastic "boiling-in-the-bag" containers, which accelerates the leaching of chemicals (Hoppe *et al.*, 2016) that may affect human health. Other common consumer utilization practices include using single-use plastic products, such as beverage and water bottles, for refill and reuse that have not been designed for, or assessed regarding, the common reuse practices employed by consumers (Muncke, 2011).

For instance, although Tupperware® is a trusted plastic food container brand in South Africa, only products marked with the "microwave reheatable" or "microwave cooking" symbols are safe for microwave use. Furthermore, only products manufactured after 2010 are BPA-free (Tupperware SA, 2016), but products manufactured earlier are still used by consumers today. It is also possible that consumers tend to trust popular brands (such as Tupperware®) when they do not have the relevant knowledge to make educated decisions. The trusting of brands or specific stores serves as heuristics in terms of learned behavior in assisting in decision-making (Figure 1). It is however questionable whether consumers are aware of the potential adverse effects posed by the reuse or misuse of a wide variety of everyday plastic products, even those of trusted brands. Sanlier (2009) emphasizes that consumers' personal perceptions of food safety risks are "low", which may result in incorrect and improper storing, preparing, thawing, and reheating practices used in food preparation. It can therefore be proposed that consumers' knowledge of plastic will affect their utilization practices and a lack of knowledge may result in the misuse of plastic products, as suggested in the SCT framework (Figure 1).

METHODOLOGY

Research design

This study employed a quantitative, cross-sectional, descriptive survey design (Maree & Pietersen, 2007) to identify potential problems or shortcomings regarding consumers' knowledge and utilization practices of plastic food packaging, as well as the extent of any identified problems.

This study was approved by the Health Research Ethics Committee of the North-West University, South Africa (NWU-00338-16-A1).

Sampling

This research was conducted throughout South Africa in order to obtain information from a wide range of respondents from different backgrounds. Non-probability, purposive sampling was used to include South African citizens, between the ages of 18 and 35 years, who are not living with their parents, who make use of plastic food and beverage packaging or containers, and who buy, prepare, or store their own food. Respondents working or studying in the food or packaging industries or who are chemical engineers were excluded from the study, since they may be informed about the risks regarding the misuse of plastic. Non-probability, purposive sampling comprises features containing the most suitable characteristics or attributes of a certain population according to the purpose of the study (Grinnell & Unrau, 2008). Sampling was done through Consulta Research Company to gain access to a wider range of consumers who meet the inclusion criteria nationwide.

A total of 293 respondents participated in this study, adhering to the 200-300 respondents needed for factor analysis. This study focused on a younger-aged group (18 – 35 years), since they have recently started to take care of themselves, make independent food decisions, and may find it more challenging than older, more experienced consumers. Furthermore, the targeted age group may already have children, or may plan to have children soon. Therefore, it is necessary to determine their knowledge and, if necessary, to educate consumers regarding plastic food packaging to transfer relevant knowledge to the next generation.

Measuring instrument

An online electronic questionnaire was employed by Consulta Research Company to allow respondents to enter data directly into the software program and thus into a computerized database, minimizing possible human error. Interviewer bias was therefore avoided since all respondents received exactly the same, standardized questionnaire (Delport & Roestenburg, 2011). The

questionnaire was compiled according to the objectives of the study after conducting a thorough literature review on the topic and other relevant variables. Questionnaires from previous similar surveys in which some of these variables were measured in other consumer contexts were also consulted. Specific questions regarding BPA, packaging, knowledge, and utilization practices were compiled from the literature, and cognitive interviews were then conducted with consumers in the study field to test the questionnaire. Cognitive interviews were conducted to establish if possible respondents understand the questions as intended by the researcher.

SECTION A of the questionnaire included questions regarding the inclusion criteria for the proposed study. SECTION B addressed utilization practices of plastic food packaging and the frequency of use (Likert scale: 1: Never; 2: Rarely; 3: Monthly; 4: Weekly; 5: Daily), and the way in which consumers use these different products (freeze, microwave, wash in dishwasher) were measured. These questions were adapted from Nomura *et al.* (2015) and Havenga (2014). SECTION C measured SK, where respondents were asked if they knew how to evaluate the possible health effects associated with the use of plastic food packaging (Likert scale: 1: Strongly disagree; 2: Disagree; 3: Neither agree nor disagree; 4: Agree; 5: Strongly agree). These questions were adapted from Malindi (2010) and Steyn (2014). SECTION D measured consumers' OK of plastic food packaging (Yes, No, Don't know options) through questions adapted from Mongolia Baseline (2005), Steyn (2014) and Havenga (2014). The percentage correct responses of respondents were calculated according to set correct answers indicated in a pre-determined memorandum for SECTION D based on the literature. SECTION E addressed where respondents obtain information regarding plastic food and beverage packaging and their trust in these sources (internet, books, scientists). These questions were adapted from Havenga (2014), Wyma (2018) and the European Commission Special Eurobarometer (2010). The final section of the questionnaire served as the demographic and general information section (SECTION F).

Statistical analysis

The Statistical Package for Social Sciences (SPSS – IBM Statistics version 22) was used for data analysis. Descriptive statistics such as frequencies, mean scores, and standard deviations were determined for all sections of the questionnaire. Exploratory factor analyses (EFA) were conducted

on the following sections: B, C, D and E. Cronbach alpha values were used to determine internal reliability of all factors yielded by EFA. Two-sided independent t-tests, one-way analysis of variance (ANOVA), and Spearman's rank order correlations were also conducted for all sections of the questionnaire. Spearman's rank order correlations determine the association and differences between the variables, where large correlations (r=0.5) are reported. For differences in means of demographical groups, only Cohen's d-values as effect sizes for practical significance (d=0.8=large) and tendencies (d=0.5=medium) are reported (Walker, 2008).

Validity and Reliability

Exploratory factor analysis using principal axis factoring with Oblimin rotation was conducted for sections B, C, D and E in the questionnaire respectively and explained between 33.4% and 71.2% of the variance. In all instances, the factors extracted yielded acceptable KMO values greater than 0.5 (KMO=0.61-0.92) (Table 1), indicating significant correlations and an adequate sample size (Field, 2009). The extracted factors in all cases theoretically made sense and confirmed construct validity. All factors showed acceptable internal reliability (Cronbach's alpha=0.60-0.95). According to Malhotra (2010), a Cronbach's alpha value of 0.60 is indicative of satisfactory internal reliability. Furthermore, inter-item correlations of most factors were within the recommended range of 0.15 – 0.55 (Clark & Watson, 1995). Only "utilization practices of plastic identification codes" and "SK of utilization practices" had inter-item correlations higher than 0.6, indicating that the items within these factors had a higher level of similarity (Table 1).

Table 1. Summary of the different factors extracted with exploratory factor analysis.

Section on questionnaire	Factors extracted from factor analysis	Inter item correlation[#]	Cronbach's Alpha (α)[##]	Mean factor score[###]	Standard deviation
	Utilization practices				
Section B: Utilization practices	Utilization of plastic identification codes	0.63	0.90	1.58	0.72
	Frequency of food consumption from plastic food packaging	0.31	0.78	3.19	0.62
	Subjective knowledge (SK)				
Section C: SK	SK of utilization practices	0.63	0.95	3.63	0.82
	SK of informed decision-making	0.52	0.84	2.69	0.82
	Objective knowledge (OK)				
Section D: OK	**Freezing of various plastics**	**0.23**	**0.60**	**39%**	**0.30**
	Freezing of cans and boxes	0.38	0.71	81%	0.28
	Plastic products not often used in the microwave	0.46	0.77	92%	0.21
	Plastic products most often used in the microwave	0.25	0.70	**42%**	0.26
	The use of plastic products in the dishwasher	0.35	0.81	65%	0.28
	Reuse practices of various plastic food packaging	0.31	0.80	67%	0.27
	Plastic products and exposure to extreme temperatures	0.36	0.86	72%	0.27
	Utilization of plastic and products containing plastic after exposure to sunlight	0.49	0.91	66%	0.34
	Release of chemicals from plastic products into foodstuffs	0.50	0.92	53%	0.36
	Illnesses/diseases and the use of plastic products	0.55	0.91	**17%**	0.28
	Plastic identification codes – reuse and recycle	0.42	0.59	**12%**	0.23
	Plastic identification codes – specific utilization practices	0.31	0.64	**48%**	0.42
	BPA characteristics	0.38	0.85	**43%**	0.31

[#]Inter item correlations 0.15 – 0.55 (Clark & Watson, 1995)

[##]Cronbach's Alpha ≥ 0.60 (Malhotra, 2010)

Numbers presented in bold indicate a lack of sufficient knowledge from a large number of respondents.

[###]Utilization practice mean: Identification codes: 1: Never; 2: Rarely; 3: Sometimes; 4: Always.

Frequency of consumption mean: 1: Never; 2: Rarely; 3: Monthly; 4: Weekly; 5: Daily.

SK mean = 1: Strongly disagree; 2: Disagree; 3: Neither agree nor disagree; 4: Agree; 5: Strongly agree.

OK mean = % correct responses

Table 1. (continued) Summary of the different factors extracted with exploratory factor analysis.

Section on questionnaire	Factors extracted from factor analysis	Inter item correlation[#]	Cronbach's Alpha (α)[##]	Mean factor score[###]	Standard deviation
	Information sources				
Section E: Information sources	Formal information sources	0.24	0.69	12%	0.19
	Informal information sources	0.41	0.73	42%	0.36
	Trust in formal information sources	0.43	0.81	3.76	0.58
	Trust in informal information sources	0.44	0.80	3.15	0.64

[#]Inter item correlations 0.15 – 0.55 (Clark & Watson, 1995)
[##]Cronbach's Alpha ≥ 0.60 (Malhotra, 2010)
Numbers presented in bold indicate a lack of sufficient knowledge from a large number of respondents.
[###]Utilization practice mean: Identification codes: 1: Never; 2: Rarely; 3: Sometimes; 4: Always.
Frequency of consumption mean: 1: Never; 2: Rarely; 3: Monthly; 4: Weekly; 5: Daily.
SK mean = 1: Strongly disagree; 2: Disagree; 3: Neither agree nor disagree; 4: Agree; 5: Strongly agree.
OK mean = % correct responses

RESULTS AND DISCUSSION

Frequencies and distribution of respondents' demographics

The demographic profile of the study sample (N=293; Table 2) indicates that more women participated in the study than men. More than 90% of the respondents were between the ages of 26 and 35 years, with the majority being white or African. The overall education level of respondents was high, and only one respondent did not complete secondary schooling (Grade 12). Most respondents were graduates with either a degree or diploma, and were employed full-time. Only a few were employed part-time or were unemployed.

Table 2. Frequencies and distributions of respondents' self-reported health and demographics

Demographic characteristics		Frequency (n)	Percentage (%)
Gender	Female	175	59.7
	Male	118	40.3
Age	Between 18 and 25 years	18	6.1
	Between 26 and 35 years	275	93.9
Ethnicity	African	94	32.1
	Asian	3	1.0
	Colored (descending from mixed origin)	32	10.9
	Indian (descending from India)	23	7.8
	White	133	45.4
	Other	1	0.3
	Prefer not to say	7	2.4
Education	No education – some secondary schooling	1	0.3
	Complete secondary schooling (passed grade 12/standard 10)	47	16.0
	Undergraduate (currently busy with after school studies)	45	15.4
	Graduate (degree or diploma)	111	37.9
	Post-graduate degree	84	28.7
	Unclassified	5	1.7
Employment status	Employed (full-time)	269	91.8
	Employed (part-time)	12	4.1
	Unemployed	7	2.4
	Not applicable	5	1.7
Self-reported health	Poor	8	2.7
	Fair	47	16.0
	Good	172	58.7
	Excellent	66	22.0
Known illnesses or diseases of respondents	Cardiovascular diseases,	4	1.4
	Metabolic disorders (including diabetes type 2),	3	1.0
	Attention deficit hyperactivity disorder, (ADHD)	5	1.7
	Urogenital abnormalities (urinary track defects)	1	0.3
	Infertility	6	2.0
	Other	23	7.2
	None	233	79.5

Respondents' self-reported health profile

More than half of the respondents reported that their overall health was "good" followed by "excellent" and "fair" health (Table 2). Only a small number indicated that their health was "poor" (Table 2). These results were confirmed by the low prevalence of illnesses/diseases reported by the respondents (0.3 – 2.0%). This can be expected due to the young age of the sample group. Poor utilisation practices might be an indication of possible future health problems, if the misuse is not addressed.

Only 6.4% of the respondents indicated that they suffered from any of the illnesses or diseases listed in the questionnaire (Table 2). The other illnesses/diseases listed in the questionnaire to which none of the respondents indicated they suffered from included liver enzyme abnormalities, prostate cancer, and breast cancer. Furthermore, 7.2% of respondents did not know if they suffered from these illnesses/diseases, and 79.5% did not suffer from any of the illnesses/diseases listed. All the listed illnesses/diseases have been linked or associated with BPA or EDCs by research in some way (Kubwabo *et al.*, 2009:928; Leman, 2009:66; Vafeiadi *et al.*, 2016:383, 384). However, the low prevalence of these illnesses/diseases is not an indication of the levels of EDCs and BPA to which respondents are exposed, nor do these results indicate or confirm that BPA and/or EDCs were the cause of the illnesses or poor health reported by these respondents. Owing to the young age of the respondents in this study, it is possible that they may be at risk for these diseases later in life.

Respondents' utilization practices of plastic food packaging

The frequency of food consumption from plastic food packaging was high, and most respondents indicated using it "daily" (58.1%) or "more than once a week" (23.0%) (data not shown in a table). These results confirm that plastic is a popular food packaging material among respondents.

The different utilization practices of plastic food packaging included in this study are provided in Table 3. It is evident that a large number of respondents misuse plastics (probably without even realizing it) since nearly all the packaging and/or containers mentioned in Table 3 must not be frozen, microwaved, washed in the dishwasher, or exposed to sunlight for a long period to maintain

their different properties and quality. All these utilization practices have been associated with the leaching of EDCs and BPA (Kubwabo *et al.*, 2009; Pinto & Reali, 2009). Plastic bags (e.g. Ziploc/Glad), cling wrap, take-away containers, and lunch boxes were misused by a considerable number of respondents through one or more incorrect utilization practice(s) (Table 3).

Table 3. Frequencies of respondents engaging in different utilization practices of plastic food packaging (N= 293).

	None (do not use in any of these ways)		Store in the fridge		Freeze		Microwave		Wash in dish-washer		Expose to sunlight for a long time	
	%	N	%	N	%	N	%	N	%	N	%	N
Plastic shopping bags (e.g. Pick n Pay, Shoprite, Spar, Woolworths)	66.2	194	19.8	58	15.4	45	6.5	19	0.3	1	10.6	31
Food cans (e.g. vegetables, fish, meat, sauces)	56.3	165	33.8	99	6.5	19	5.5	16	0.7	2	3.8	11
Boxed meals/meal in a box (e.g. microwave chips, curry and rice)	43.0	126	32.1	94	**28.0**	82	**34.1**	100	1.4	4	1.0	3
Cling wrap (e.g. Glad Wrap)	38.2	112	**55.6**	163	**19.1**	56	**14.7**	43	0	0	1.4	4
Pre-packed microwave meals/ convenience food (e.g. microwave spinach, pasta)	34.5	101	37.2	109	**42.0**	123	**41.6**	122	0.7	2	0.7	2
Plastic bags (e.g. Ziploc, Glad Wrap)	31.4	92	**57.3**	168	**49.1**	144	**11.6**	34	0.7	2	2.0	6

Table sorted from highest to lowest, according to the "none" option.

Numbers in bold print indicate the products misused by several respondents in different utilization practices

Table 3. (continued) Frequencies of respondents engaging in different utilization practices of plastic food packaging (N= 293).

	None (do not use in any of these ways)		Store in the fridge		Freeze		Microwave		Wash in dish-washer		Expose to sunlight for a long time	
	%	N	%	N	%	N	%	N	%	N	%	N
Polystyrene or plastic take-away packaging	30.4	89	62.1	182	6.5	19	**24.2**	71	1.0	3	2.7	8
Plastic lunch boxes	13.7	40	**72.0**	211	**33.4**	98	**43.7**	128	**32.8**	96	8.2	24
Beverage cans (e.g. soft drinks, ice tea, juice, beer)	12.3	36	85.0	249	6.8	20	1.0	3	0.3	1	5.5	16
Frozen foods in plastic packaging (e.g. vegetables, chips)	5.8	17	35.2	103	**79.5**	233	**21.8**	64	0.3	1	1.0	3
Plastic beverage bottles (e.g. water, soft drinks, ice tea, juice)	3.8	11	93.2	273	**33.8**	99	7.8	23	**8.9**	26	**12.6**	37

Table sorted from highest to lowest, according to the "none" option.
Numbers in bold print indicate the products misused by several respondents in different utilization practices.

A large proportion of respondents (19.8-93.2%) indicated that it was a common practice for them to put all the mentioned packaging and containers inside **fridges**. Controversy exists regarding the storage of plastics in this way since it was reported that some new and used packaging materials may leach chemicals at 4 °C (Kubwabo *et al.*, 2009; Le *et al.*, 2008; Li *et al.*, 2010). Respondents' common freezing practices included the **freezing** of plastic bags, plastic beverage bottles, plastic lunch boxes, and cling wrap. These products are not generally intended to be frozen. Boxed meals, pre-packed microwave meals, and frozen foods are manufactured with the intention to be stored in the freezer. However, the common freezing practices employed with these packaged products (both those intended and not intended to be frozen) may lead to leaching of BPA and other EDCs

(Bhunia *et al.*, 2013; Kubwabo *et al.*, 2009; Pinto & Reali, 2009). It is therefore possible that consumers may be misled by the ignorance of plastic manufacturers.

Microwaving of lunch boxes, pre-packed microwave meals, boxed meals, plastic and polystyrene take-away containers, frozen foods in plastic packaging, cling wrap, and plastic bags was indicated as a common practice amongst respondents. The use of convenience-related plastic food packaging in the microwave (a practice that several respondents engaged in) may once again be attributed to ignorance of plastic manufacturers and the misleading information found on packaging, since only certain types of plastic may be frozen and microwaved, and these plastics are often expensive and their availability is limited. Actual misleading information that the researchers noticed on packaging include pictures instructing the user to pierce the protective film before microwaving, or to cut a corner of the bag, but the small print indicates that the food must be removed from the packaging or container completely. The plastic identification codes provided on packaging may also be of little support in this regard, since consumers do not understand what the codes mean (identification codes data presented in Table 1).

Some plastic food packaging that may be dangerous to human health are specifically designed for use by children (e.g. cartoon lunch boxes), and may not be stored in the fridge, frozen, or heated. Infants and children are more vulnerable to BPA and EDC exposure due to the amount of BPA- and EDC-exposed food per kilogram bodyweight (Muncke, 2011), and the smaller packaging used, the higher surface-to-volume-ration of chemical migration (Grob *et al.*, 2007). The above-mentioned practices may therefore magnify the misuse problem.

Utilization practices of plastics involving exposure to high or low temperatures may be harmful to human health since the leaching or migration of BPA and EDCs from plastic in extreme temperatures has also been reported. For example, leaching has been reported to occur at 24 ºC (room temperature) and at higher temperatures, such as 40ºC and 100ºC (heating and cooking temperatures) (Kubwabo *et al.*, 2009; Le *et al.*, 2008; Li *et al.*, 2010). Another practice among more than 10% of respondents that may lead to increased leaching of chemicals from plastics is the **prolonged exposure of plastic beverage bottles to sunlight** (Table 3). Even though plastic shopping bags are also exposed to sunlight for prolonged periods, this practice will most likely not contribute substantially to consumer exposure of EDCs since they are seldom used to store

unprotected food. Other misuse practices by respondents regarding lunch boxes and beverage bottles include **washing them in dishwashers,** once again exposing the plastic to extreme temperatures.

The age group that participated in this survey are mostly students or young working adults. Owing to their fast and changing lifestyles, an increase in the consumption and utilization of pre-packed meals, microwave meals, frozen foods, and take-away meals may be a reality. It can therefore be concluded that even though plastic products have limited safe uses, it is still widely used by consumers and the food packaging industry. The wide use of plastic products may contribute to consumers being misinformed and confused regarding the appropriate utilization practices of these products.

Respondents' subjective knowledge regarding plastic food packaging

When considering the question regarding respondents' SK of plastic food packaging (rate their own knowledge), the mean value (1= Poor; 4= Excellent) indicates that respondents had fair (mean=1.76; standard deviation=0.75) SK regarding plastic food packaging (results not shown in a table). Moreover, when respondents were asked to compare their SK of informed decision-making to that of other consumers, (1=Strongly disagree; 5=Strongly agree), the mean factor score indicated that they tended to be neutral regarding their agreement (mean=2.69) about their "SK of informed decision-making" regarding plastic food packaging (Table 1). However, respondents' "SK of utilization practices" (1=Strongly disagree; 5=Strongly agree) shows that they had more confidence in their knowledge, in agreeing (mean=3.63) that they know how to use plastic food packaging (Table 1). Viewed from the SCT, respondents therefore had better confidence in their knowledge regarding their utilization practices of plastic food packaging (i.e. the self-efficacy of their behavior) than their knowledge regarding these packaging as such and their knowledge of informed decision-making regarding plastic food packaging (Figure 1). This discrepancy may possibly stem from consumer's reliance on their learned behavior as being heuristic, resulting in particular utilization practices in which they have more confidence than they have about their knowledge of plastic food packaging itself or making decisions regarding plastics.

Respondents' objective knowledge regarding plastic food packaging

Respondents' OK (% correct) regarding plastic food packaging is indicated in Table 1. According to the mean factor scores, respondents lacked OK (<50% correct) regarding the following factors: "plastic identification codes – reuse and recycle", "illnesses/diseases and the use of plastic products", "freezing of various plastics", "plastic products most often used in the microwave", "BPA characteristics", and "plastic identification codes – specific utilization practices". The following individual questions not within one of the factors also revealed poor knowledge among respondents: "cling wrap (e.g. Glad Wrap) may be used in the microwave, if you poke holes into it" (38%) and "some food and beverage cans contains plastic" (39%).

A total of 53 – 68% of the respondents could correctly answer questions regarding the factors "release of chemicals from plastic products into foodstuffs", "reuse practices of plastic bags (e.g. Ziploc, Glad)", "food or beverage cans may be used to bake bread or pudding in", "the use of plastic products in the dishwasher", "utilization of plastic and products containing plastic after exposure to sunlight", and "reuse practices of various plastic food packaging". Knowledge regarding these practices still need improvement, because the lack thereof may result in health consequences for the consumer. More than 70% correct responses from respondents were reported for the six remaining factors, probably since these factors involved aspects that may be regarded as more common knowledge within the wider consumer community. In general, it does not seem that respondents in our study, and according to the SCT framework, have sufficient knowledge to allow them to alter their utilization (behavioral) practices in a way that will positively affect their health (Figure 1).

The factor "SK of utilization practices" of plastic food packaging correlated with the factor "OK regarding plastic products not often used in the microwave" (r= 0.28), and the factor "SK of informed decision-making" correlated with both the factors "BPA characteristics" (r= 0.28), and "plastic identification codes – specific utilization practices" (r=0.29). However, these medium-effect size correlations (tendencies) are limited, and do not indicate a strong relationship between SK and OK. In contrast, significant variations regarding SK and OK (regarding products and services) have been indicated in some previous studies (Carlson *et al.*, 2008; Robson *et al.*, 2014).

Although respondents' OK regarding the different factors varied between 12% and 92%, showing an acceptable to high level of OK among respondents, their actual utilization practices of plastic food packaging did not fully reflect this knowledge, since most of the packaging and containers were to some degree incorrectly used. Furthermore, with respect to most of the OK factors in Table 1, the lack of knowledge amongst most respondents was proven to be a concern.

Information sources consulted about plastic food packaging and chemicals

Respondents indicated that they obtained information from both formal sources in the education environment (e.g. scientists, health professionals, books, classes, and courses) (12%) and informal sources form their social environment (e.g. friends, family, media, and internet) (42%) (data not shown in a table). Informal information sources may be consulted more often as these sources are easily accessible, and many information searches are conducted on electronic devices and cell phones (Jun & Park, 2016; Ordun, 2015). These findings correspond to those in Kende (2014), who reports that consumers in developing countries conduct more internet searches than those in developed countries.

Moreover, respondents agreed that they had more trust (1=Strongly disagree; 5=Strongly agree) in formal sources (mean=3.76), and were more neutral in their agreement to trust informal sources (mean= 3.15) (data not shown). Although consumers show more trust in formal information sources, they may make use of informal information sources more often, since access to formal sources may be limited or more restricted.

Associations between respondents' utilization practices, knowledge and information sources

Correlations were determined between all extracted factors and single questions regarding consumers' knowledge (SK and OK), utilisation practices and information sources. Only correlations with practical significance (interpreted as $r \geq 0.41$) are reported. Practically significant correlations indicated that the more often respondents consumed food from plastic lunch boxes, the more often they made use of other plastic food packaging (r=0.45) overall. The factor regarding respondents' "SK of informed decision-making" showed a correlation (r=0.58) with the question

regarding "SK of plastic food packaging". This correlation implies that respondents who thought they had more knowledge than others to make informed decisions about plastic packaging also thought that they have more knowledge regarding plastic food packaging.

Correlations were also observed in terms of OK, where respondents' OK regarding "reuse practices of various plastic food packaging" correlated with their OK regarding "freezing of cans and boxes" (r=0.43), "use of plastic products in the dishwasher" (r=0.50), and "plastic products and exposure to extreme temperatures" (r=0.42) respectively. Respondents with good OK regarding reuse of plastics thus also had good OK regarding practices of freezing, dishwashing and exposure to extreme temperatures. However, the factor regarding OK of "plastic products and exposure to extreme temperatures" correlated with "utilization of plastic and products containing plastic after exposure to sunlight" (r=0.41). Respondents' OK in this instance correlated with factors that related to the effects of temperature abuse of plastics. This correlation may be owing to learned behavior based on experience regarding specific temperature abuse and its effect on plastic products (e.g. some plastics melt in the microwave).

Furthermore, correlations indicated that an increase in respondents' obtainment of information from informal sources led to an increase in search for information from formal information sources (r = 0.42), and trust of informal information sources (r = 0.51). This finding may indicate both that respondents make more use of informal sources based on the trust they have in these sources, and that an informal information search process may lead to a need for a more formal search process.

Differences in respondents' knowledge and utilization practices of plastic food packaging

A few practically significant differences (Cohen's $d \geq 0.7$) were found between the demographic and general information provided by respondents and their knowledge and utilization practices of plastic food packaging. T-tests indicated that respondents that thought that they knew what plastic identification codes mean made practically significantly (d=1.20) more use (mean=2.33; rarely) of these identification codes than those who indicated that they did not understand what they mean (mean=1.39; never). Furthermore, those who indicated they knew what plastic identification codes mean had, on average, practically significantly higher (d=0.73) levels of "SK of informed decision-

making" (mean=3.18; neither agree nor disagree) than those who did not know (mean=2.57; neither agree nor disagree), and more "SK regarding plastic food packaging" (*d* =1.02; mean=2.33; fair), than those who claimed not to know (mean=1.61; poor; fair). These results may indicate that the respondents who thought they understood plastic identification codes had more confidence in their knowledge to make informed decisions and their knowledge regarding plastics than those who did not know the meaning of plastic identification codes. Respondents who indicated that they know the meaning of plastic identification codes also had practically significantly more OK regarding BPA characteristics (*d*=0.73; 61% correct) compared to those who did not know (mean=38% correct), indicating that respondents who thought they knew more regarding plastic identification codes actually also knew more regarding BPA and its characteristics.

Despite the findings of other studies (Grunert *et al.,* 2010:268; Jasti & Kovacs, 2010:312), no practically significant differences were found between the knowledge, utilization practices, and information sources of respondents from different ethnicities. Moreover, no practical significant differences for gender and level of education were found, contradicting previous research regarding knowledge and food label use (Ali & Kapoor, 2009; Van der Merwe *et al*., 2012:407). However, medium effect sizes (*d*=0.45-0.69) indicating tendencies regarding demographic differences were found. Female respondents tended to know more than males regarding the exposure of plastics to different extreme temperatures (72% vs 58% respectively; *d*=0.40) and freezing practices (cans and boxes) (86% vs 74% respectively; *d*=0.38). This discrepancy may be owing to learned behavior from experience, since females are mainly responsible for the purchase (Tshuma *et al.*, 2010: 465) and preparation of food.

Regarding age groups, 18- to 25-year-old respondents tended to have more knowledge regarding the appropriate freezing (96% vs 80%; *d*=0.54) and reuse practices (77% vs 66% respectively; *d*=0.40) of plastic products than 26- to 35-year-old respondents. They also tended to consume food from lunch boxes more frequently (mean=4.17 vs 3.42 respectively; *d*=0.68). This finding may reflect the lifestyle habits of younger consumers, who depend more on convenient foods or ready-to-eat meals, whereas older consumers may already prepare food for the entire household making less use of lunch boxes. The younger group's better knowledge of appropriate freezing and reusing practices may stem from experienced gained from the above-mentioned lifestyle habits.

With regard to plastic identification codes, respondents who indicated to know (SK) what the codes mean tended to have better OK regarding these codes than those who indicated not to know when considering the factors "identification codes – reuse and recycle" (23% vs 9% respectively; *d*=0.50) and "identification codes – specific utilization practices" (63% vs 44% respectively; *d*=0.46). The respondents who indicated that they know what the identification codes mean also tended to obtain information from formal sources more often than those who did not know (20% vs 10% respectively; *d*=0.44) and consumed food from lunch boxes less often (mean=3.15; monthly; *d*=0.38) than those who did not know (mean=3.55; monthly-weekly). It seems that respondents who think they know (SK) the meaning of plastic identification codes may have already been exposed to them through formal information sources. This information, in combination with use experience, has possibly led to real knowledge (OK) and awareness of these codes.

One-way ANOVAs indicated slight differences/tendencies between respondents of different ethnicities. White and Indian respondents did not seem to differ, but showed differences from colored and African respondents with respect to some questions. For instance, white respondents (mean=3.30) tended to consume food from lunch boxes less often than African (mean=3.67; *d*=0.35) and colored (mean=3.75; *d*=0.40) respondents respectively, and had more OK (17%) regarding "plastic identification codes – reuse and recycle" (7%, *d*=0.38; and 6%; *d*=0.41 respectively). However, a complete lack of knowledge regarding identification codes is evident among all ethnicities. Other tendencies regarding ethnicities included the following:

White respondents tended to have more OK than African respondents regarding:

- Plastic products not often used in the microwave (96% vs 86% respectively; *d*=0.36)
- Plastic products most often used in the microwave (47% vs 36% respectively; *d*=0.38)
- The use of plastic products in the dishwasher (47% vs 36% respectively; *d*=0.43)

White and Indian respondents tended to have more OK than African respondents regarding:

- Reuse practices of various plastic food packaging (73% vs 57%; *d*=0.59; and 73% vs 57%; *d*=0.50 respectively)
- Plastic products and exposure to extreme temperatures (77% vs 66%; *d*=0.37; and 80% vs 66%; *d*=0.47; respectively)
- BPA characteristics (48% vs 32%; *d*=0.49; and 53% vs 32%; *d*=0.66; respectively)

From these results, it is evident that white and Indian respondents did not greatly differ regarding their OK and utilization practices, and were generally more knowledgeable than African respondents regarding plastic food packaging. Additionally, African and colored respondents showed similarities. However, it is possible that all ethnic groups were uninformed to some degree.

CONCLUSION

Plastic containers are frequently used for the packaging, storage, and preparation of foodstuffs. However, there is controversy regarding the safety of plastic food packaging, as chemicals associated with health problems have been reported to leach into foodstuffs. Since the inappropriate utilization of plastic food packaging contributes to the leaching of chemicals, the need arose to determine consumers' utilization practices and their knowledge regarding plastics.

Regarding consumers' cognition, this study on the one hand revealed that respondents have fair SK regarding plastic food packaging, and neutral feelings when comparing their SK of their ability to make informed decisions to that of other consumers. On the other hand, respondents' OK regarding plastic food packaging was largely lacking. Although some respondents had adequate to good knowledge on some of the identified factors, their utilization practices did not reflect this knowledge since most types of packaging and containers were used incorrectly. The plastic products most often misused, and therefore posing the greatest concern, were lunch boxes, plastic bags, cling wrap, and beverage bottles, probably due to incorrect learned behavior. Some packaging (e.g. frozen foods, microwave meals) were often misused according to the environmental factors in terms of misleading instructions found on packaging.

It was indicated that respondents consult informal information sources (e.g. friends, media) more often than formal sources (e.g. books, scientists), but showed higher levels of trust towards formal sources. Because informal information sources are more easily accessible from the social environment, specifically in developing countries, than formal sources from the educational environment, respondents may use them more.

Respondents who thought they had more knowledge (SK) than others regarding informed decision-making also thought that they had more knowledge regarding plastic food packaging. Additionally, respondents who thought they had knowledge regarding plastic packaging in general actually did have more OK regarding some aspects of packaging and containers. Respondents' OK correlated mostly with factors that related to the effects of temperature abuse of plastics. This may indicate that consumers whom assumed that they had more knowledge, did in practice know more regarding plastic food packaging, and could therefore utilize it in a safer manner. Respondents who thought they understood plastic identification codes had the confidence to use these codes more, and actually knew more regarding BPA and its characteristics. However, overall, respondents' knowledge regarding the identification codes was lacking. From these results, it can be concluded that plastic identification codes do not serve their intended purpose of informing and indirectly protecting consumers, since they are either ignored or misunderstood.

Even though some demographic subgroups (e.g. ethnicity, gender, age) knew more regarding plastic food packaging in some instances, an overall deficiency in respondents' knowledge was identified. From the literature and this study, it is evident that respondents had insufficient subjective and objective knowledge regarding the use of plastic food and beverage packaging and containers as well as BPA and EDCs associated with plastics. This lack of knowledge confirms that the use of plastic as a food packaging material should be evaluated and that education regarding this subject is necessary across most demographic subgroups.

IMPLICATIONS AND LIMITATIONS

Limitations to this study included the fact that the non-probability sample is not intended be generalized to the whole of South Africa, but rather to provide a baseline of the misuse practices

and lack of knowledge of consumers in developing countries. A more inclusive study regarding age groups, education levels, ethnicities, and gender is recommended.

Although some respondents were informed regarding specific factors or aspects of plastic food packaging, the need for an overall improvement in the correct utilization practices were evident. Education therefore needs to be applied to create awareness and increase knowledge regarding the health implications associated with misuse practices of plastic food packaging. Appropriate actions should be undertaken to inform and educate possible information sources (e.g. shopkeepers, medical workers) regarding this problem. The available information found on packaging and containers should also be portrayed as pictures or symbols, which are more understandable to a wider set of consumers.

This research may have valuable implications for the wider consumer population and may ultimately assist in informing policy makers regarding BPA and EDCs as well as the deficiencies in consumers' knowledge regarding the utilization practices of plastic food packaging. Should policies regarding the use of and communication about BPA and EDCs change, the wider consumer population may be better protected. In developing countries such as South Africa, policies may serve as protection for illiterate consumers with limited access to and understanding of the available information.

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Chapter 6
Concluding chapter

6.1. INTRODUCTION

This chapter serves as conclusion to this study. A summary of the main findings, conclusions, contributions of the research, recommendations and limitations will be discussed. For this study, a quantitative, cross-sectional, descriptive survey was employed, using online questionnaires.

The aim of this study was to investigate and describe consumers' subjective and objective knowledge and utilisation practices regarding plastic food and beverage packaging and containers. Consumers' information sources regarding plastic and its possible associated health effects/dangers were also considered. The SCT was used as theoretical perspective in order to frame the objectives of this study.

6.2. CONCLUSIONS

6.2.1. Conclusion pertaining to the literature

Literature indicates that plastic is a popular material used for packaging and containers in the food industry. Although plastic is used for a variety of foodstuffs, harmful chemical substances and compounds leach into food and beverages. Yet there is little clarity regarding chemical substances consumed daily, the risks they pose to human health, and the necessary practices needed to reduce or avoid chemical exposure and consumption. Moreover, although consumers are mostly exposed to chemicals through contaminated food and beverages, environmental sources also provide pathways of contamination.

The way in which consumers utilise food plastic packaging and containers also increases the leaching rates and amounts of BPA and EDC into the food contents. These utilisation practices include freezing, microwaving, dishwashing, and exposure of plastics to sunlight. Although human exposure to these chemicals from a single source is not indicated as being the main problem, the accumulation from a variety of these sources poses threats to human health. Research was therefore necessary to determine consumers' knowledge, information sources, and utilisation practices regarding plastic food and beverage packaging and containers.

6.2.2. Conclusion of findings of the present study

Most respondents that participated in this study used plastic on a daily or weekly basis, had generally high levels of education, and had overall good health. Only a small number of respondents suffered from the illnesses/diseases that may be associated with BPA and EDCs, according to the literature. However, owing to the young age of respondents, it is possible that these diseases may develop later in life.

Many of the packaging and containers mentioned in the questionnaire were misused by a considerable number of respondents in one or more incorrect utilisation practice(s). The plastic products most often misused, therefore posing the greatest concern, were lunch boxes, plastic bags, cling wrap, and beverage bottles. Some packaging (i.e. frozen foods, microwave meals) were often misused because of the misleading instructions found on these packaging and containers. The results showed that identification codes were also found to be uninformative, since consumers generally did not understand them.

Because of the fast and changing lifestyles of younger consumers, convenience foods, pre-packed meals, and microwave meals may be consumed more often. The increase in chemical exposure from the misuse practices regarding these products is therefore a cause for concern. In addition, the need for further education on the correct utilisation practices of plastics was shown to be necessary.

The subjective and objective knowledge of respondents revealed that respondents had fair subjective knowledge (e.g. utilization practices and informed decision-making) regarding plastic packaging and containers, but their objective knowledge (e.g. knowledge regarding freezing practices and illnesses associated with plastics) was largely lacking. Although some respondents had adequate to good knowledge on some of the identified objective knowledge factors (e.g. the use of plastic products in the dishwasher), this knowledge was not reflected in their utilisation practice, since most types of packaging and containers were still used incorrectly (e.g. washed in the dishwasher, used for microwave heating). Such packaging and containers (used correctly), can be associated with the more common utilisation practices (e.g. some packaging melts when microwaved, cans expand when frozen, and boxes disintegrate when washed). Additionally, respondents had better knowledge regarding the factors relating to temperature abuse of plastics. This knowledge may be owing to experience gained from misuse practices and visible effects on plastic products rather than knowledge about the negative health consequences of consuming

food susceptible to chemical exposure when used incorrectly. No practically significant associations between subjective and objective knowledge were reported – only a few tendencies. This finding indicated that respondents did not perceive to know more than they actually know regarding plastic packaging and their utilisation practices thereof.

In general, more respondents consulted informal information sources than formal sources, although formal sources were trusted by more respondents. Respondents may use informal sources more often because these sources are more easily accessible and understandable, specifically in developing countries such as South Africa. As such, the internet was the main information source utilised by respondents. However, the available information must be based on sound scientific evidence and be correctly understood and interpreted in order for knowledge to become meaningful.

Within the present study, plastic identification codes were also classified as a source of information. However, most respondents were unaware of what plastic identification codes mean, and therefore did not make use of these codes provided on the packaging. Although the few respondents who knew what these codes mean did make more use of them, overall, respondents' knowledge regarding the identification codes was lacking. From these results, it can be concluded that plastic identification codes do not serve their intended purpose of informing and indirectly protecting consumers, since they are either ignored or misunderstood.

The different demographic subgroups of the respondents also did not show practically significant differences pertaining to knowledge, the information sources, or utilisation practices. On average, white and Indian respondents did not differ in their responses, but in general tended to be more informed than coloured and African respondents in some respects regarding plastic packaging and containers. However, an overall deficiency in respondents' knowledge was shown, regardless of ethnicity, age, gender and education.

From the literature and this study, it is evident that respondents had insufficient subjective and objective knowledge regarding the use of plastic food and beverage packaging and containers as well as BPA and EDCs associated with plastics. By determining respondents' subjective and objective knowledge, where they obtained their information regarding plastic, BPA, and EDCs, and how they utilised plastic products, the present study has provided baseline information on the nature and extent of the lack of knowledge and misuse practices regarding plastics in a food context.

6.2.3. The Social Cognitive Theory in conclusion

The SCT was used to frame the objectives of this study, with emphasis on Bandura's viewpoint, focussing on the theory in a health perspective (Bandura, 1989:2). The SCT suggests that the consumer (cognition and other personal factors), behavioural factors (outcomes, self-efficacy and utilisation practices), and environmental factors (social and educational information sources) are all interdependent elements.

Consumers' subjective and objective knowledge, as examined in this study, contribute to the consumer element of the SCT. It is suggested that consumers must have knowledge of and understand the available information on plastic and chemical substances to enable them to make informed decisions. The knowledge of the respondents in the present study was insufficient, and therefore did not result in informed decisions regarding the correct utilisation practices of plastic packaging in a food context. The amount of consumer knowledge also affects their information search processes. For respondents from the present study, this implies that their lack of knowledge and awareness of the chemicals found in plastic contributed to an unsatisfactory information search process.

The information sources that consumers consult form part of the environmental elements of the SCT, where informal (social) and formal (educational) information sources influence consumers' knowledge and behaviour. Respondents were shown to obtain information mostly from informal sources. These sources are not necessarily informed regarding plastic packaging and chemicals, and may provide incorrect information, which in turn may have contributed to the respondents' lack of correct knowledge in this regard. Consumers' utilisation practices relate to the behavioural component of the SCT. Because respondents' information sources enable them to gain knowledge and make informed decisions, a link can therefore be drawn between their information sources/environmental factors and their utilisation practices of plastic packaging and containers, which was also found to be incorrect.

Within the context of this study, learning and the altering of consumer behaviour are the desired outcomes of this theory in order to improve consumers' health and help them avoid negative health consequences in the long term. However, consumers must obtain information and gain knowledge in order to change their behaviour. Thus, respondents from the present study must be educated regarding plastic food packaging in order to be able to alter the way in which they use (or misuse) these products. Experience gained through plastic utilisation also influences

knowledge, and so the interdependent process continues. This interdependence was illustrated by the respondents' utilisation practices being altered according to their actions (e.g. when plastic melt in the microwave) and not owing to an increase in knowledge and awareness of plastic-related chemicals and their associated health effects. It can therefore be concluded that the SCT provided a framework in which to understand, predict, and ultimately change consumer behaviour with regard to plastic packaging and containers as well as the associated chemicals and possible health effects.

6.3. IMPLICATIONS OF THIS STUDY

This research may have valuable implications for consumers, not only to respondents of the present study. Upon feedback (Consulta Research Company), respondents themselves gained knowledge and awareness regarding their own utilisation practices of plastic packaging and containers. However, this baseline research also provides the opportunity for further research in this underexplored field of research, which may contribute to informing legislation/policy makers of BPA and EDCs as well as the deficiencies in knowledge in terms the utilisation practices of plastic food and beverage packaging and containers, as well as plastic identification codes. Should policies regarding the use of and communication about BPA and EDCs change, the wider consumer population may be better protected.

Moreover, because this study shows that educated respondents are uninformed of but affected by their misuse of plastics, and their misunderstanding of plastic identification codes, it can be speculated that the problem will be even greater in more vulnerable populations. In developing countries such as South Africa, policies may serve as protection for illiterate and more vulnerable consumers with limited access to and understanding of the available information. Although policies cannot be the only form of protection, and consumer education and awareness are crucial, such policies may lead to further education interventions and changes in utilisation practices that may indirectly contribute to the improvement of consumers' health.

Finally, this study contributed to this field of knowledge, specifically within South Africa, and provided insight into the extent of consumers' misuse practices and lack of knowledge regarding plastic food and beverage packaging and containers.

6.4. LIMITATIONS

Limitations to this study included the fact the non-probability sample and sample size were not intended to be generalised to the whole of South Africa. A more inclusive study regarding age groups, education levels, ethnicities, living conditions, and gender is recommended for follow-up research. A different method of sampling (e.g. random sampling) is also recommended. Another limitation may also be that the researchers are aware of the plastic misuse problem amongst consumers, but are unaware of the origin of their behaviour. Although this was not the aim of the present study, a qualitative study can be undertaken to understand the origin of such behaviour before interventions are conducted.

In this study, difficulties regarding data collection in particular were experienced, in terms of reaching respondents that adhered to the inclusion and exclusion criteria of this study. A more inclusive study may not experience this same difficulty. Finally, only limited information and studies regarding consumer knowledge and EDCs/ BPA could be found, thus contributing to difficulties in tracing relevant literature.

6.5. RECOMMENDATIONS

6.5.1. Education and awareness

The online survey addressed several aspects regarding consumers' knowledge, utilisation practices, and information sources regarding plastic packaging and containers. Although some respondents were knowledgeable regarding some facets or aspects of plastic packaging and containers, the need for better utilisation practices was evident. Education interventions are therefore recommended to create awareness and increase knowledge regarding the general misuse practices of plastics in a food context, and the associated health implications.

6.5.2. Future research

It is recommended that future research includes a sample from a wider set of consumers, not only those with access to computers and the internet. The questionnaire could also be translated to increase the number of respondents reached, specifically in rural areas of South Africa and other developing countries. It can be argued that since the literate and more affluent consumer group

used in this study failed to utilise plastic food and beverage packaging correctly, these practices may be even more prevalent among less affluent and computer illiterate consumer groups. However, research focussing on consumers not included in this group is also recommended.

An in-depth study on more specific utilisation practices and the motivation behind the misuse practices regarding a specific product (e.g. water bottles, plastic bags) is also recommended. Doing so may aid in determining the impact of single items on the accumulation of EDC and BPA exposure. The use of focus groups is recommended to determine the reasons for misuse practices. In developing countries, less privileged consumers have limited options for preparation of food and may therefore misuse plastics more. Strategies should be developed to ensure that consumers in rural areas are informed about how to use what they have in the best possible way. Further research regarding the utilisation of plastic packaging and containers is recommended in the context of both developed and developing countries.

6.6. FINAL CONCLUSION

This study yielded valuable results that show that respondents' objective knowledge regarding plastic packaging and containers in a food context is lacking. It was also shown that many misuse practices of plastic food and beverage packaging and containers were employed by a large number of respondents. This finding is cause for concern, since the misuse of plastics is associated with multiple health effects and diseases. It can be concluded that it is necessary for consumers engaging in similar misuse practices to those of the respondents to change their habits and utilisation practises of plastic food and beverage packaging and containers, in order to reduce environmental and human exposure to chemicals. Although reduced exposure to chemicals may not directly lead to an improvement in human health, it may decrease the risk of users developing illnesses or diseases associated with BPA and EDCs.

ADDENDA:

Addendum A:

Questionnaire

A: INCLUSION CRITERIA

1. **Do you make use of plastic food and beverage packaging and containers?**
    a) Yes
    b) No

2. **Do you or your spouse work as one of the following**

	Yes	No
a. Consumer Scientist		
b. Chemical engineer		
c. Nutritionist		
d. Packaging industry		

3. **Are you between 18 – 35 years old?**
    a) Yes
    b) No

4. **Year of birth**_____

5. **Do you live with your parents?**
    a) Yes
    b) No

F: BIOGRAPHICAL AND GENERAL INFORMATION:

Please select the most appropriate option for each question:

6. **Please specify your highest level of education:**

    a) No education
    b) Some primary schooling
    c) Complete primary schooling (passed grade 7/standard 5)
    d) Some secondary schooling
    e) Complete secondary schooling (passed grade 12/standard 10)
    f) Undergraduate (currently busy with after school graduate studies)
    g) Graduate (Degree or Diploma)
    h) Honours Graduate
    i) Masters graduate
    j) Doctors graduate
    k) Unclassified

7. **What is your employment status?**

    a) Employed (paid full time)
    b) Employed (paid part time)
    c) Pensioner/ Retired
    d) Self- employed (full time)
    e) Unemployed
    f) Not applicable

8. **Please specify your ethnicity:**

    a) African
    b) Asian

c) Coloured
d) Indian
e) White
f) Other
g) Prefer not to say

9. Please specify your gender:

a) Female
b) Male

10. Please select the province in which your permanent residence is located:

a) Eastern Cape
b) Free State
c) Gauteng
d) Kwazulu Natal
e) Limpopo
f) Mpumalanga
g) North West
h) Northern Cape
i) Western Cape
j) Prefer not to say

11. For whom do you prepare food?

a) For the entire household
b) For yourself and children
c) Only for yourself
d) None of the above

12. How would you rate your overall health?

a) Poor
b) Fair
c) Good
d) Excellent

13. Do you suffer from any of the following illnesses? Select all the options that apply to you:

a) Cardiovascular diseases,
b) Liver enzyme abnormalities,
c) Metabolic disorders (including diabetes type 2),
d) Attention deficit hyperactivity disorder, (ADHD)
e) Urogenital abnormalities (urinary track defects)
f) Infertility
g) Prostate cancer
h) Breast cancer
i) None of the above
j) Don't know
k) Other. Please specify_____

14. Do you know what plastic identification codes mean?

a) Yes
b) No

B: USE PRACTICES

15. How often do you make use of plastic food and beverage packaging and containers?

a) Daily
b) Once a week
c) More than once a week
d) Monthly
e) Occasionally
f) Never

16. Please mark the most relevant option for the following questions:

		Never	Rarely	Sometimes	Always
16.1.	How often do you make use of the following codes on plastic food and beverage packaging and containers? (e.g)				
16.2	How often do these codes affect your decision to buy a product?				
16.3	How often do you use identification codes before you purchase a plastic product for the first time?				
16.4	How often do you read identification codes before reusing a plastic packaging or container?				
16.5	How often do identification codes affect the way you use the plastic packaging or container?				

17. How often do you eat foods, and consume drinks that are from the following containers?

		Never	Rarely	Monthly	Weekly	Daily
17.1	Plastic beverage bottles (e.g. water, soft drinks, ice tea, juice)					
17.2	Beverage cans (e.g. soft drinks, ice tea, juice, beer)					
17.3	Food cans: (e.g. vegetables, fish, meat, sauces)					
17.4	Prepacked microwave meals / convenience food (e.g. microwave spinach, pasta)					
17.5	Prepacked mixes: (e.g. muffins, cake, cupcakes, bread, pancakes)					
17.6	Boxed meals / meal in a box: (e.g. microwave chips, curry and rice)					
17.7	Plastic lunch boxes					
17.8	Frozen foods in plastic packaging: (e.g. vegetables, chips)					
17.9	Polystyrene or plastic take away packaging					

18. For each product type, select all the ways that you have used the product by ticking the relevant blocks

		Store in the fridge	Freeze	Micro-wave	Wash in dishwasher	Expose to sunlight for a long time	None
18.1	Plastic beverage bottles (e.g. water, soft drinks, ice tea, juice)						
18.2	Beverage cans (e.g. soft drinks, ice tea, juice, beer)						
18.3	Prepacked microwave meals / convenience food (e.g. microwave spinach, pasta)						
18.4	Boxed meals / meal in a box: (e.g. microwave chips, curry and rice)						
18.5	Plastic lunch boxes						
18.6	Polystyrene or plastic take away packaging						
18.7	Food cans: (e.g. vegetables, fish, meat, sauces)						
18.8	Frozen foods in plastic packaging: (e.g. vegetables, chips)						
18.9	Cling wrap (e.g. Glad wrap)						
18.10	Plastic bags (e.g. Ziplock, Glad)						
18.11	Plastic shopping bags (e.g. Pick ‘n Pay, Shoprite, Spar, Woolworths)						

C: SUBJECTIVE KNOWLEDGE

19. To which extent do you agree to the following for each type of packaging provided:

WHEN I LOOK AT THE PACKAGING, I KNOW HOW TO CORRECTLY USE THE FOLLOWING FOOD AND BEVERAGE PACKAGING AND CONTAINERS:

		1. Strongly disagree	2. Disagree	3. Neither agree nor disagree	4. Agree	5. Strongly agree
19.1	Plastic beverage bottles (e.g. water, soft drinks, ice tea, juice)					
19.2	Beverage cans (e.g. soft drinks, Ice tea, juice, beer)					
19.3	Prepacked microwave meals / convenience food (e.g. microwave spinach, pasta)					
19.4	Boxed meals/ meal in a box: (e.g. microwave chips, curry and rice)					
19.5	Plastic lunch boxes					
19.6	Polystyrene or plastic take away packaging					
19.7	Food cans: (e.g. vegetables, fish, meat, sauces)					
19.8	Frozen foods in plastic packaging: (e.g. vegetables, chips)					
19.9	Cling wrap (e.g. Glad wrap)					
19.10	Plastic bags (e.g. Zip lock bags, Glad)					
19.11	Plastic shopping bags (e.g. Pick ‘n Pay, Shoprite, Spar, Woolworths)					

20. Compared to an average person, I …

		1. Strongly disagree	2. Disagree	3. Neither agree nor disagree	4. Agree	5. strongly agree
20.1	…do not compromise on the quality of plastic that I buy and use					
20.2	…give myself enough time to buy plastic products, as its quality is important to my health					
20.3	…don't buy plastic food and beverage packaging and containers from unknown brands or suppliers					
20.4	…look for the plastic identification codes before I buy plastic food and beverage packaging and containers					
20.5	…evaluate different types of plastic food and beverage packaging and containers critically and regularly					

21. How would you rate your overall knowledge about food and beverage packaging and containers?

a) Poor
b) Fair
c) Good
d) Excellent

D: OBJECTIVE KNOWLEDGE

22. According to your knowledge, may the following food and beverage packaging and containers be frozen:

		Yes	No	Don't know
22.1	Plastic beverage bottles			
22.2	Beverage cans			
22.3	Food cans			
22.4	Plastic take away boxes			
22.5	Polystyrene take away boxes			
22.6	Lunch boxes			
22.7	Plastic bags (e.g. Ziplock, Glad) cook in bags, sandwich bags, freeze in bags			
22.8	Plastic shopping bags			
22.9	Cling wrap (e.g. Glad wrap)			

23. According to your knowledge, may the following food and beverage packaging and containers be heated in the microwave?

		Yes	No	Don't know
23.1	Plastic beverage bottles			
23.2	Beverage cans			
23.3	Food cans			
23.4	Plastic take away boxes			
23.5	Polystyrene take away boxes			
23.6	Lunch boxes			
23.7	Plastic bags (Ziplock, Glad) cook in bags, sandwich bags, freeze in bags			
23.8	Plastic shopping bags			
23.9	Cling wrap/ glad wrap			
23.10	Microwave meals			
23.11	Boxed meals			

24. According to your knowledge, may the following food and beverage packaging and containers be washed in a dishwasher:

		Yes	No	Don't know
24.1	Plastic beverage bottles			
24.2	Beverage cans			
24.3	Food cans			
24.4	Plastic take away boxes			
24.5	Polystyrene take away boxes			
24.6	Lunch boxes			
24.7	Microwave meal containers			
24.8	Boxed meal containers			

25. According to your knowledge, may the following food and beverage packaging and containers be used more than once:

		Yes	No	Don't know
25.1	Plastic beverage bottles			
25.2	Beverage cans			
25.3	Food cans			
25.4	Plastic take away boxes			
25.5	Polystyrene take away boxes			
25.6	Lunch boxes			
25.7	Plastic bags (e.g. Ziplock, Glad)			
25.8	Plastic shopping bags (To cook or heat food in)			
25.9	Cling wrap/ glad wrap			
25.10	Microwave meal containers			
25.11	Boxed meal containers			

26. According to your knowledge, may the following food and beverage packaging and containers be exposed to different extreme temperatures (e.g. to cook food in and to freeze leftovers in)

		Yes	No	Don't know
26.1	Plastic beverage bottles			
26.2	Beverage cans			
26.3	Food cans			
26.4	Plastic take away boxes			
26.5	Polystyrene take away boxes			
26.6	Lunch boxes			
26.7	Plastic bags (Ziplock, Glad, sandwich bags)			
26.8	Plastic shopping bags			
26.9	Cling wrap/ glad wrap			
26.10	Microwave meal containers			
26.11	Boxed meal containers			

27. According to your knowledge, may the following food and beverage packaging and containers be used after it was left in the car for a long time:

		Yes	No	Don't know
27.1	Plastic beverage bottles			
27.2	Beverage cans			
27.3	Food cans			
27.4	Plastic take away boxes			
27.5	Polystyrene take away boxes			
27.6	Lunch boxes			
27.7	Plastic bags (Ziplock, Glad)			
27.8	Plastic shopping bags			
27.9	Cling wrap/ glad wrap			
27.10	Microwave meal containers			
27.11	Boxed meal containers			

28. According to your knowledge, can chemicals move from the following food and beverage packaging and containers into food and beverages:

		Yes	No	Don't know
28.1	Plastic beverage bottles			
28.2	Beverage cans			
28.3	Food cans			
28.4	Plastic take away boxes			
28.5	Polystyrene take away boxes			
28.6	Lunch boxes			
28.7	Plastic bags (e.g. Ziplock, Glad)			
28.8	Plastic shopping bags			
28.9	Cling wrap (e.g. Glad wrap)			
28.10	Microwave meal containers			
28.11	Boxed meal containers			
28.12	All plastic packaging and containers			

29. According to your knowledge, the following illnesses/ diseases may be linked to the use of plastic food and beverage packaging and containers:

		True	False	Don't know
29.1	Cardiovascular diseases,			
29.2	Liver enzyme abnormalities,			
29.3	Metabolic disorders (including diabetes type 2),			
29.4	Attention deficit hyperactivity disorder, (ADHD)			
29.5	Urogenital abnormalities (urinary track defects)			
29.6	Infertility			
29.7	Prostate cancer			
29.8	Breast cancer			

30. Please state if the following statements regarding plastic food and beverage packaging and containers are true or false:

		True	False	Don't know
30.1	Plastic beverage bottles may be used for warm beverages			
30.2	Cling wrap (e.g. Glad wrap) may be used in the microwave, if you poke holes into it.			
30.3	Food or beverage cans may be used to bake bread or pudding in			
30.4	Some food and beverage cans contains plastic			
30.5	Food may be heated in the can			

31. The following questions relate to the codes found on plastic packaging and containers:

		True	False	Don't know
31.1	These codes show how many times a product may be used			
31.2	The codes show if a product is made out of recycled plastic			
31.3	The codes show that the product may be recycled			
31.4	The codes show what type of plastic is used in the product			
31.5	The codes show if a product may be heated			
31.6	The codes show if a product may be frozen			

SECTION E 3: BISPHENOL A (BPA)

32. The following questions relate to Bisphenol A (BPA)

		True	False	Don't know
32.1	BPA is a chemical substance			
32.2	BPA is a hormone			
32.3	BPA is a type of plastic			
32.4	BPA is found in plastic			
32.5	BPA is used in the production of certain types of plastics			
32.6	BPA is found in food and beverage cans			
32.7	BPA hardens plastic			
32.8	BPA makes plastic clear (see through)			
32.9	BPA is harmful to human health			

E: INFORMATION SOURCES

33. Select all the sources that have provided you with information regarding the use practices of plastic food and beverage packaging and containers, and BPA

		Yes	No
33.1	Scientists or academic researchers at universities		
33.2	Store assistants, supermarkets, retailers		
33.3	Health professions (e.g. doctors, nurses, dentists, chemists)		
33.4	Nutritionist / dietician		
33.5	Friends		
33.6	Family		
33.7	Classes / Course		
33.8	Media (e.g. Newspapers, Magazines, TV, Radio)		
33.9	Books		
33.10	Internet sources		
33.11	Government and legislation		
33.12	No one		
33.13	Other (pleases specify) _____		

34. I trust the information, regarding plastic and BPA, provided by these sources:

		1. Strongly disagree	2. Disagree	3. Neither agree nor disagree	4. Agree	5. Strongly agree
34.1	Scientists or academic researchers at universities					
34.2	Store assistants, supermarkets, retailers					
34.3	Health professions (e.g. doctors, nurses, dentists, chemists)					
34.4	Nutritionist / dietician					
34.5	Friends					
34.6	Family					
34.7	Classes / Course					
34.8	Media (e.g. Newspapers, Magazines, TV, Radio)					
34.9	Books					
34.10	Internet sources					
34.11	Government and legislation					
34.12	No one					
34.13	Other (please specify) _____					

You have reached the end of the questionnaire. Thank you for your participation.

Questionnaire Memorandum:

The ticked boxes indicate the correct answers to questions, as determined by literature. Data analysis were conducted according to these results.

35. According to your knowledge, may the following food and beverage packaging and containers be frozen:

		Yes	No	Don't know
22.1	Plastic beverage bottles		✓	
22.2	Beverage cans		✓	
22.3	Food cans		✓	
22.4	Plastic take away boxes		✓	
22.5	Polystyrene take away boxes		✓	
22.6	Lunch boxes		✓	
22.7	Plastic bags (e.g. Ziplock, Glad) cook in bags, sandwich bags, freeze in bags		✓	
22.8	Plastic shopping bags		✓	
22.9	Cling wrap (e.g. Glad wrap)		✓	

36. According to your knowledge, may the following food and beverage packaging and containers be heated in the microwave?

		Yes	No	Don't know
23.1	Plastic beverage bottles		✓	
23.2	Beverage cans		✓	
23.3	Food cans		✓	
23.4	Plastic take away boxes		✓	
23.5	Polystyrene take away boxes		✓	
23.6	Lunch boxes		✓	
23.7	Plastic bags (Ziplock, Glad) cook in bags, sandwich bags, freeze in bags		✓	
23.8	Plastic shopping bags		✓	
23.9	Cling wrap/ glad wrap		✓	
23.10	Microwave meals		✓	

23.11	Boxed meals		✓	

37. According to your knowledge, may the following food and beverage packaging and containers be washed in a dishwasher:

		Yes	No	Don't know
24.1	Plastic beverage bottles		✓	
24.2	Beverage cans		✓	
24.3	Food cans		✓	
24.4	Plastic take away boxes		✓	
24.5	Polystyrene take away boxes		✓	
24.6	Lunch boxes		✓	
24.7	Microwave meal containers		✓	
24.8	Boxed meal containers		✓	

38. According to your knowledge, may the following food and beverage packaging and containers be used more than once:

		Yes	No	Don't know
25.1	Plastic beverage bottles		✓	
25.2	Beverage cans		✓	
25.3	Food cans		✓	
25.4	Plastic take away boxes		✓	
25.5	Polystyrene take away boxes		✓	
25.6	Lunch boxes			
25.7	Plastic bags (e.g. Ziplock, Glad)	✓		
25.8	Plastic shopping bags (To cook or heat food in)	✓		
25.9	Cling wrap/ glad wrap		✓	
25.10	Microwave meal containers		✓	
25.11	Boxed meal containers		✓	

39. According to your knowledge, may the following food and beverage packaging and containers be exposed to different extreme temperatures (e.g. to cook food in and to freeze leftovers in)

		Yes	No	Don't know
26.1	Plastic beverage bottles		✓	
26.2	Beverage cans		✓	
26.3	Food cans		✓	
26.4	Plastic take away boxes		✓	
26.5	Polystyrene take away boxes		✓	
26.6	Lunch boxes		✓	
26.7	Plastic bags (Ziplock, Glad, sandwich bags)		✓	
26.8	Plastic shopping bags		✓	
26.9	Cling wrap/ glad wrap		✓	
26.10	Microwave meal containers		✓	
26.11	Boxed meal containers		✓	

40. According to your knowledge, may the following food and beverage packaging and containers be used after it was left in the car for a long time:

		Yes	No	Don't know
27.1	Plastic beverage bottles		✓	
27.2	Beverage cans		✓	
27.3	Food cans		✓	
27.4	Plastic take away boxes		✓	
27.5	Polystyrene take away boxes		✓	
27.6	Lunch boxes		✓	
27.7	Plastic bags (Ziplock, Glad)		✓	
27.8	Plastic shopping bags		✓	
27.9	Cling wrap/ glad wrap		✓	
27.10	Microwave meal containers		✓	
27.11	Boxed meal containers		✓	

41. According to your knowledge, can chemicals move from the following food and beverage packaging and containers into food and beverages:

		Yes	No	Don't know
28.1	Plastic beverage bottles	✓		
28.2	Beverage cans	✓		
28.3	Food cans	✓		
28.4	Plastic take away boxes	✓		
28.5	Polystyrene take away boxes	✓		
28.6	Lunch boxes	✓		
28.7	Plastic bags (e.g. Ziplock, Glad)	✓		
28.8	Plastic shopping bags	✓		
28.9	Cling wrap (e.g. Glad wrap)	✓		
28.10	Microwave meal containers	✓		
28.11	Boxed meal containers	✓		
28.12	All plastic packaging and containers	✓		

42. According to your knowledge, the following illnesses/ diseases may be linked to the use of plastic food and beverage packaging and containers:

		True	False	Don't know
29.1	Cardiovascular diseases,	✓		
29.2	Liver enzyme abnormalities,	✓		
29.3	Metabolic disorders (including diabetes type 2),	✓		
29.4	Attention deficit hyperactivity disorder, (ADHD)	✓		
29.5	Urogenital abnormalities (urinary track defects)	✓		
29.6	Infertility	✓		
29.7	Prostate cancer	✓		
29.8	Breast cancer	✓		

43. Please state if the following statements regarding plastic food and beverage packaging and containers are true or false:

		True	False	Don't know
30.1	Plastic beverage bottles may be used for warm beverages		✓	
30.2	Cling wrap (e.g. Glad wrap) may be used in the microwave, if you poke holes into it.		✓	
30.3	Food or beverage cans may be used to bake bread or pudding in		✓	
30.4	Some food and beverage cans contains plastic	✓		
30.5	Food may be heated in the can		✓	

44. The following questions relate to the codes found on plastic packaging and containers:

		True	False	Don't know
31.1	These codes show how many times a product may be used		✓	
31.2	The codes show if a product is made out of recycled plastic		✓	
31.3	The codes show that the product may be recycled		✓	
31.4	The codes show what type of plastic is used in the product	✓		
31.5	The codes show if a product may be heated	✓		

31.6	The codes show if a product may be frozen	✓		

SECTION E 3: BISPHENOL A (BPA)

45. The following questions relate to Bisphenol A (BPA)

		True	False	Don't know
32.1	BPA is a chemical substance	✓		
32.2	BPA is a hormone		✓	
32.3	BPA is a type of plastic		✓	
32.4	BPA is found in plastic	✓		
32.5	BPA is used in the production of certain types of plastics	✓		
32.6	BPA is found in food and beverage cans	✓		
32.7	BPA hardens plastic	✓		
32.8	BPA makes plastic clear (see through)	✓		
32.9	BPA is harmful to human health	✓		

Addendum B:

Informed consent form

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
POTCHEFSTROOM CAMPUS

HREC Stamp

INFORMED CONSENT DOCUMENTATION FOR CONSUMERS OF FOOD AND BEVERAGE PACKAGING MATERIAL.

TITLE OF THE RESEARCH STUDY: Consumers' knowledge and utilisation practices regarding plastic food and beverage packaging and containers.

ETHICS REFERENCE NUMBERS: NWU-00338-16-A1

PRINCIPAL INVESTIGATOR:
Prof. D. van der Merwe

POST GRADUATE STUDENT:
M.S. van den Berg

ADDRESS:
North-West University
Faculty of Health Sciences
Private bag X6001
Potchefstroom
2522

CONTACT NUMBER:
0836793842

You are being invited to take part in a **research study** that forms part of my Master's degree in Consumer Sciences. Please take some time to read the information presented here, which will explain the details of this study. Please ask the researcher or person explaining the research to you any questions about any part of this study that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research is about and how you might be involved. Also, your participation is **entirely voluntary** and you are free to say no to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part now.

This study has been approved by the **Health Research Ethics Committee of the Faculty of Health Sciences of the North-West University (**NWU-00338-16-A1) and will be conducted according to the ethical guidelines and principles of Ethics in Health Research: Principles, Processes and Structures (DoH, 2015) and other international ethical guidelines applicable to this study. It might be necessary for the research ethics committee members or other relevant people to inspect the research records.

What is this research study all about?

- This study will be conducted in all 9 provinces of South Africa and will involve an online questionnaire, compiled by experienced consumer science researchers, and distributed by Consulta Research Company. A total of 405 participants will be included in this study.
- We plan to: investigate consumers' use practices of plastic food and beverage packaging and containers; to identify information sources that consumers consult to obtain information regarding the proper use of plastic food and beverage packaging and containers; and to determine if there are any associations between what they know and think they know, their demographics (e.g. gender and age), their use practices and the information sources they use.

Why have you been invited to participate?

- You have been invited to be part of this research because you signed up at Consulta or ConsultaPanel, or opted to participate through social media sourcing.
- You also fit the research because you are a consumer between the ages of 18 and 35 years who make use of plastic food or beverage packaging or containers, who do not live

at your parents' home, and must prepare your own food; and you are a consumer willing to participate in this research project through giving your informed consent. Participation within this study is voluntary.

- You will not be able to take part in this research if you live with your parents. These consumers will be excluded as their parents may mostly prepare their food; if you work or study in the food or packaging industry, as well as well as chemical engineers since they may be more educated or informed about proper use practices of plastic food and beverage packaging and containers than a regular consumer.

What will be expected of you?

- You will be expected to complete a once off online questionnaire that will take about 15min to complete. The link to the questionnaire will be provided by e-mail. The questionnaire can be completed at any computer, at your own time. Once the questionnaire is completed, it must be submitted electronically. An internet link will be provided.

Will you gain anything from taking part in this research?

- There will be no direct benefit to you in participating, but, but you will have the opportunity to think about your own use practices of plastic and beverage packaging and containers and may become more informed regarding this topic upon feedback.
- Through your participation in the research; you will enable consumers in general to benefit by identifying needs for further education on the topic that may ultimately support consumers to optimise their use of food and beverage packaging.
- The other benefits of the study are for the targeted population (18-35 years), who will provide information from a variety of backgrounds and cultures, knowledge and skills that can be used by the researchers to inform policy makers of BPA. Furthermore, academic publications may be of benefit to the researchers and the NWU.

Are there risks involved in you taking part in this research and what will be done to prevent them?

- The risks to you in this study are: Limited **physical risks** is anticipated for you as a respondent, as the questionnaire can be completed at your own time and place and taking

into account that it wil take only about 15 minutes to complete. Data can be collected from the comfort of your own home; therefore it is not necessary to walk or travel to be able to participate in this study. Little boredom with the questionnaire is expected since it should only take 15 min of your time to fill out. **Psychological risks** to you as a respondent are limited. However, you may feel uncomfortable if you feel unable to answer certain questions. Please note that the researchers are interested in your own honest responses and that your answers will not be linked to you in any way.

- There are more gains for you in joining this study than there are risks It can be stated that this is a minimal risk study since you will not experience more discomfort while filling out the questionnaire than you would in your everyday life. The benefits of the study therefore outweigh the risks.

How will we protect your confidentiality and who will see your findings?

Your anonymity and confidentiality of your findings will be protected throughout this study, since Consulta Research Company will provide no personal information to the researcher. Your privacy will be respected by the researchers and Consulta Research Company as no personal information will be made public. Only the researchers and Consulta Research Company will be able to look at your findings which will not be linked to personal data that may identify you. Furthermore, all collected data will be collated and statistically processed, and therefore, no connections can be made between individuals and answers. Electronic data will be kept safe and secure. The received data, will be protected by a security password and kept on the computer of the the principle researcher and the data will be deleted after the storage period of five years have been completed. This adheres to the regulations of the NWU. Furthermore, only the researchers and statistician involved will have access to the anonymised data, and no data will be available to outsde parties or researchers.

What will happen with the findings?

- The findings of this study will only be used for this study and publications from this study, and the data will only be analysed in South Africa.

How will you know about the results of this research?

- We will give you the results of this research when the study is complete. The findings of the research will be shared with you by an electronic report, after the study has been

completed. The report will be sent out by Consulta Research Company, as the researcher will not have any of your personal information.

Will you be paid to take part in this study and are there any costs for you?

This study is funded by funding from the National Research Foundation and funding by the researchers

The only costs involved if you do take part in this study, is internet or data fees.

Furthermore, you will not be paid to take part in the study, but incentives will be provided by Consulta Research Company on a lucky draw basis.

Is there anything else that you should know or do?

- You can contact Magdi van den Berg at 018 299 02470 if you have any further questions or have any problems.
- You can also contact the Health Research Ethics Committee via Mrs Carolien van Zyl at 018 299 1206 or carolien.vanzyl@nwu.ac.za if you have any concerns that were not answered about the research or if you have complaints about the research.
- You will receive a copy of this information and consent form for your own purposes.

Declaration by participant

By clicking on the “I agree” box below, I ……..……. agree to take part in the research study titled: Consumers’ knowledge and utilisation practices regarding plastic food and beverage packaging and containers.

I declare that:

- I have read this information/ in a language with which I am fluent and comfortable.
- The research was clearly explained to me in the consent form.
- I have had a chance to phone the researcher or email Consulta to ask questions.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be handled in a negative way if I do so.
- I may be asked to leave the study before it has finished, if the researcher feels it is in the best interest, or if I do not follow the study plan, as agreed to.

I AGREE

Addendum C:

Ethics approval certificate:

NORTH-WEST UNIVERSITY
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NOORDWES-UNIVERSITEIT
POTCHEFSTROOM CAMPUS

Private Bag X6001, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222
Web: http://www.nwu.ac.za

Faculty of Health Sciences
Health Sciences Ethics Office for Research, Training and Support
Health Research Ethics Committee (HREC)

Tel: 018-285 2291
Email: Wayne.Towers@nwu.ac.za

10 November 2016

Prof D van der Merwe
Consumer Sciences

Dear Prof Van der Merwe

CONDITIONAL APPROVAL OF YOUR APPLICATION BY THE HEALTH RESEARCH ETHICS COMMITTEE (HREC) OF THE FACULTY OF HEALTH SCIENCES

Ethics number: NWU-00338-16-S1

Kindly use the ethics reference number provided above in all correspondence or documents submitted to the Health Research Ethics Committee (HREC) secretariat.

Study title: Consumers' knowledge and utilisation practices regarding plastic food and beverage packaging and containers

Study leader/supervisor: Prof D van der Merwe

Student: M van den Berg

Application type: Single study

Risk level: Minimal

You are kindly informed that your application was reviewed at the meeting held on 20/10/2016 of the HREC, Faculty of Health Sciences, and was conditionally approved (see conditions at end of letter) on 10/11/2016.

The commencement date for this study is dependent on fulfilling the conditions indicated below. Continuation of the study is dependent on receipt of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation up to a maximum period of three years when extension will be facilitated during the monitoring process.

After ethical review:

Translation of the informed consent document to the languages applicable to the study participants should be submitted to the HREC, Faculty of Health Sciences (if applicable).

The HREC, Faculty of Health Sciences requires immediate reporting of any aspects that warrants a change of ethical approval. Any amendments, extensions or other modifications to the proposal or other associated documentation must be submitted to the HREC, Faculty of Health Sciences prior to implementing these changes. Any adverse/unexpected/unforeseen events or incidents must be reported on either an adverse event report form or incident report form at Ethics-HRECIncident-SAE@nwu.ac.za.

A monitoring report should be submitted within one year of approval of this study (or as otherwise stipulated) and before the year has expired, to ensure timely renewal of the study. A final report must be provided at completion of the study or the HREC, Faculty of Health Sciences must be notified if the study is temporarily suspended or terminated. The monitoring report template is obtainable from the Faculty of Health Sciences Ethics Office for Research, Training and Support at Ethics-Monitoring@nwu.ac.za. Annually a number of studies may be randomly selected for an external audit.

Please note that the HREC, Faculty of Health Sciences has the prerogative and authority to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process.

Please note that for any research at governmental or private institutions, permission must still be obtained from relevant authorities and provided to the HREC, Faculty of Health Sciences. Ethics approval is required BEFORE approval can be obtained from these authorities.

The HREC, Faculty of Health Sciences complies with the South African National Health Act 61 (2003), the Regulations on Research with Human Participants (2014), the Ethics in Health Research: Principles, Structures and Processes (2015), the Belmont Report and the Declaration of Helsinki (2013).

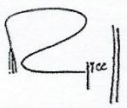
We wish you the best as you conduct your research. If you have any questions or need further assistance, please contact the Faculty of Health Sciences Ethics Office for Research, Training and Support at Ethics-HRECApply@nwu.ac.za.

Conditions of approval:

1. Please submit the advertisement once it becomes available to the HREC (Ethics-HRECApply@nwu.ac.za).

Yours sincerely

Dr Wayne Towers
HREC Chairperson



Prof Minrie Greeff
Ethics Office Head

Current details: (13210572) C:\Users\13210572\Documents\HREC\HREC - Applications\2016 Applications\Applications 09-20 October 2016\NWU-00338-16-S1(M van der Merwe-M van den Berg)\NWU-00338-16-S1(D van der Merwe-M van den Berg)-CAL\NWU-00338-16-S1(D van der Merwe-M van den Berg)-CAL.docm
15 November 2016

File reference: 9.1.5.3

Addendum D

Invitation to participate in study

Addendum E:

Ethical approval of invitation

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Faculty of Health Sciences
Health Sciences Ethics Office for Research, Training and Support
Health Research Ethics Committee (HREC)

Tel: 018-285 2291
Email: Wayne.Towers@nwu.ac.za

14 February 2017

Prof D van der Merwe
Consumer Sciences-AUTHeR

Dear Prof Van der Merwe

APPROVAL OF YOUR APPLICATION BY THE HEALTH RESEARCH ETHICS COMMITTEE (HREC) OF THE FACULTY OF HEALTH SCIENCES

Ethics number: NWU-00338-16-S1

Kindly use the ethics reference number provided above in all correspondence or documents submitted to the Health Research Ethics Committee (HREC) secretariat.

Study title: Consumers' knowledge and utilisation practices regarding plastic food and beverage packaging and containers

Study leader/supervisor: Prof D van der Merwe

Student: M van den Berg

The documentation submitted by the applicant in response to the approval with conditions provided by the Health Research Ethics Committee (HREC) for the single study entitled "Consumers' knowledge and utilisation practices regarding plastic food and beverage packaging and containers," has been reviewed by the HREC and the study has been approved. Please inform us immediately if there are any amendments required to your study. If there are any queries, please let us know at your earliest convenience.

Yours sincerely

Prof Wayne Towers
HREC Chairperson

Prof Minrie Greeff
Ethics Office Head

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15 February 2017

File reference: 9.1.5.3

Addendum F:

Additional tables

Summary of factor analysis

These tables were used in Chapter 5 – Results and findings written in article format.

Table 1. Summary of exploratory factor analysis of the 5-item utilisation of plastic identification codes scale (Factor loadings from Principle Components Analysis)

Item	**Factor loading** **Utilisation of plastic identification codes**
How often do you make use of the following codes on plastic food and beverage packaging and containers? e.g.	0.70
How often do these codes affect your decision to buy a product?	0.87
How often do you use identification codes before you purchase a plastic product for the first time?	0.89
How often do you read identification codes before reusing a plastic packaging or container?	0.88
How often do identification codes affect the way you use the plastic packaging or container?	0.88
Inter item correlation	0.63
Cronbach alpha coefficient	0.9
Mean factor score **Standard deviation**	1.58 0.72
Keiser-Meyer-Olkin value	0.83

(Likert scale: 1: Never, 2: Rarely, 3: Sometimes, 4: Always)

Table 2. Summary of exploratory factor analysis of the 8-item food consumption from plastic packaging and containers scale (Factor loadings from Principle Components Analysis)

Item	**Factor loading** **Frequency of food consumption from plastic food and beverage packaging and containers**
Plastic beverage bottles (e.g. water, soft drinks, ice tea, juice)	0.54
Beverage cans (e.g. soft drinks, ice tea, juice, beer)	0.71
Food cans: (e.g. vegetables, fish, meat, sauces)	0.59
Prepacked microwave meals / convenience food (e.g. microwave spinach, pasta)	0.75
Prepacked mixes: (e.g. muffins, cake, cupcakes, bread, pancakes)	0.62
Frozen foods in plastic packaging: (e.g. vegetables, chips)	0.31
Polystyrene or plastic take-away packaging	0.55
Boxed meals / meal in a box: (e.g. microwave chips, curry and rice)	0.72
Inter item correlation	0.31
Cronbach alpha coefficient	0.78
Mean factor score **Standard deviation**	3.19 0.62
Keiser-Meyer-Olkin value	0.76

(Likert scale: 1: Never, 2: Rarely, 3: Monthly, 4: Weekly, 5: Daily)

Table 3. Summary of exploratory factor analysis of the 11-item subjective knowledge of utilisation practices regarding plastic packaging and containers scale (Factor loadings from Principle Components Analysis)

Item	Factor loading Consumers' subjective knowledge of utilisation practices
Plastic beverage bottles (e.g. water, soft drinks, ice tea, juice)	0.71
Beverage cans (e.g. soft drinks, Ice tea, juice, beer)	0.80
Prepacked microwave meals / convenience food (e.g. microwave spinach, pasta)	0.78
Boxed meals/ meal in a box: (e.g. microwave chips, curry and rice)	0.77
Plastic lunch boxes	0.80
Polystyrene or plastic take-away packaging	0.79
Food cans: (e.g. vegetables, fish, meat, sauces)	0.85
Frozen foods in plastic packaging: (e.g. vegetables, chips)	0.87
Cling wrap (e.g. Glad Wrap)	0.86
Plastic bags (e.g. Zip lock bags, Glad)	0.88
Plastic shopping bags (e.g. Pick 'n Pay, Shoprite, Spar, Woolworths)	0.83
Inter item correlation	0.63
Cronbach alpha coefficient	0.95
Mean factor score **Standard deviation**	3.63 0.82
Keiser-Meyer-Olkin value	0.92

(Likert Scale: 1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly agree)

Table 4. Summary of exploratory factor analysis of the 5-item subjective knowledge regarding plastic food and beverage packaging and containers compared to others scale (Factor loadings from Principle Components Analysis)

Item	Factor loading Consumers' subjective knowledge compared to other consumers
…do not compromise on the quality of plastic that I buy and use	0.72
…give myself enough time to buy plastic products, as its quality is important to my health	0.80
…don't buy plastic food and beverage packaging and containers from unknown brands or suppliers	0.71
…look for the plastic identification codes before I buy plastic food and beverage packaging and containers	0.83
…evaluate different types of plastic food and beverage packaging and containers critically and regularly	0.85
Inter item correlation	0.52
Cronbach alpha coefficient	0.84
Mean factor score **Standard deviation**	2.69 0.82
Keiser-Meyer-Olkin value	0.77

(Likert Scale: 1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly agree)

Table 5. Summary of exploratory factor analysis of the 9-item objective knowledge regarding freezing practices of plastic food and beverage packaging and containers scale (Factor loadings from Principle Components Analysis)

Item	Factor loading	
	Freezing of various plastics	**Freezing of cans and boxes**
Plastic beverage bottles	0.39	
Lunch boxes	0.61	
Plastic bags (e.g. Ziploc, Glad) cook in bags, sandwich bags, freeze in bags	0.69	
Plastic shopping bags	0.63	
Cling wrap (e.g. Glad Wrap)	0.73	
Beverage cans		0.67
Food cans		0.76
Plastic take-away boxes		0.72
Polystyrene take-away boxes		0.72
Inter item correlation	0.23	0.38
Cronbach alpha coefficient	0.60	0.71
Mean factor score **Standard deviation**	0.81 0.28	0.39 0.30
Keiser-Meyer-Olkin value	0.69	

(Scale: 1: Yes, 2: No, 3: Don't know)

Table 7. Summary of exploratory factor analysis of the 11-item objective knowledge regarding microwaving practices of plastic food and beverage packaging and containers scale (Factor loadings from Principle Components Analysis)

Item	Factor loading	
	Knowledge regarding plastic products not often used in the microwave	**Knowledge regarding plastic products most often used in the microwave**
Plastic beverage bottles	0.69	
Beverage cans	0.87	
Food cans	0.82	
Plastic shopping bags	0.61	
Plastic take-away boxes		0.59
Polystyrene take-away boxes		0.54
Lunch boxes		0.70
Plastic bags (Ziploc, Glad) cook in bags, sandwich bags, freeze in bags		0.52
Cling wrap/ Glad Wrap		0.35
Microwave meals		0.58
Boxed meals		0.36
Inter item correlation	0.46	0.25
Cronbach alpha coefficient	0.77	0.70
Mean factor score **Standard deviation**	0.92 0.21	0.42 0.26
Keiser-Meyer-Olkin value	0.72	

(Scale: 1: Yes, 2: No, 3: Don't know)

Table 8. Summary of exploratory factor analysis of the 8-item objective knowledge regarding dishwashing practices of plastic food and beverage packaging and containers scale (Factor loadings from Principle Components Analysis)

Item	**Factor loading**
	Knowledge regarding the use of plastic products in the dishwasher
Plastic beverage bottles	0.56
Beverage cans	0.77
Food cans	0.75
Plastic take-away boxes	0.76
Polystyrene take-away boxes	0.75
Lunch boxes	0.32
Microwave meal containers	0.63
Boxed meal containers	0.72
Inter item correlation	0.35
Cronbach alpha coefficient	0.81
Mean factor score **Standard deviation**	0.65 0.28
Keiser-Meyer-Olkin value	0.78

(Scale: 1: Yes, 2: No, 3: Don't know)

Table 9. Summary of exploratory factor analysis of the 11-item objective knowledge regarding repeated utilisation practices of plastic food and beverage packaging and containers scale (Factor loadings from Principle Components Analysis)

Item	Factor loading Reuse practices of various food and beverage packaging and containers
Plastic beverage bottles	0.39
Beverage cans	0.57
Food cans	0.55
Plastic take-away boxes	0.68
Polystyrene take-away boxes	0.65
Plastic shopping bags (to cook or heat food in it)	0.64
Cling wrap/ Glad Wrap	0.67
Microwave meal containers	0.65
Boxed meal containers	0.74
Inter item correlation	0.31
Cronbach alpha coefficient	0.80
Mean factor score **Standard deviation**	0.67 0.27
Keiser-Meyer-Olkin value	0.77

(Scale: 1: Yes, 2: No, 3: Don't know)

Table 10. Summary of exploratory factor analysis of the 11-item objective knowledge regarding exposure of plastic food and beverage packaging and containers to different extreme temperatures scale (Factor loadings from Principle Components Analysis)

Item	Factor loading
	Plastic products and exposure to extreme temperatures
Plastic beverage bottles	0.65
Beverage cans	0.61
Food cans	0.63
Plastic take-away boxes	0.67
Polystyrene take-away boxes	0.69
Lunch boxes	0.53
Plastic bags (Ziploc, Glad, sandwich bags)	0.67
Plastic shopping bags	0.71
Cling wrap/ Glad Wrap	0.69
Microwave meal containers	0.59
Boxed meal containers	0.68
Inter item correlation	0.36
Cronbach alpha coefficient	0.86
Mean factor score **Standard deviation**	0.72 0.27
Keiser-Meyer-Olkin value	0.85

(Scale: 1: Yes, 2: No, 3: Don't know)

Table 11. Summary of exploratory factor analysis of the 11-item objective knowledge regarding utilisation practices of plastic food and beverage packaging and containers after exposure to sunlight scale (Factor loadings from Principle Components Analysis)

Item	**Factor loading**
	Utilisation of plastic and products containing plastic after exposure to sunlight
Plastic beverage bottles	0.64
Beverage cans	0.68
Food cans	0.65
Plastic take-away boxes	0.78
Polystyrene take-away boxes	0.77
Lunch boxes	0.61
Plastic bags (Ziploc, Glad)	0.81
Plastic shopping bags	0.77
Cling wrap/ Glad Wrap	0.77
Microwave meal containers	0.79
Boxed meal containers	0.79
Inter item correlation	0.49
Cronbach alpha coefficient	0.91
Mean factor score **Standard deviation**	0.66 0.34
Keiser-Meyer-Olkin value	0.89

(Scale: 1: Yes, 2: No, 3: Don't know)

Table 12. Summary of exploratory factor analysis of the 12-item objective knowledge regarding chemical substances migration from plastic food and beverage packaging and containers scale (Factor loadings from Principle Components Analysis)

Item	**Factor loading**
	The release of chemicals from plastic products into foodstuffs
Plastic beverage bottles	0.67
Beverage cans	0.66
Food cans	0.64
Plastic take-away boxes	0.78
Polystyrene take-away boxes	0.71
Lunch boxes	0.72
Plastic bags (e.g. Ziploc, Glad)	0.80
Plastic shopping bags	0.74
Cling wrap (e.g. Glad Wrap)	0.79
Microwave meal containers	0.79
Boxed meal containers	0.77
All plastic packaging and containers	0.77
Inter item correlation	0.50
Cronbach alpha coefficient	0.92
Mean factor score **Standard deviation**	0.53 0.36
Keiser-Meyer-Olkin value	0.90

(Scale: 1: Yes, 2: No, 3: Don’t know)

Table 13. Summary of exploratory factor analysis of the 8-item objective knowledge regarding health effects of plastic food and beverage packaging and containers scale (Factor loadings from Principle Components Analysis)

Item	**Factor loading**
	Illnesses/diseases and the use of plastic products
Cardiovascular diseases,	0.77
Liver enzyme abnormalities,	0.72
Metabolic disorders (including type 2 diabetes),	0.79
Attention-deficit hyperactivity disorder, (ADHD)	0.76
Urogenital abnormalities (urinary track defects)	0.74
Infertility	0.81
Prostate cancer	0.78
Breast cancer	0.83
Inter item correlation	0.55
Cronbach alpha coefficient	0.91
Mean factor score **Standard deviation**	0.17 0.28
Keiser-Meyer-Olkin value	0.89

(Scale: 1: True, 2: False, 3: Don’t know)

Table 14. Summary of exploratory factor analysis of the 6-item objective knowledge regarding plastic identification codes scale (Factor loadings from Principle Components Analysis)

Item	Factor loading	
	Plastic identification codes – reuse and recycling	**Plastic identification codes – specific utilisation practices**
These codes show how many times a product may be used.	0.76	
The codes show if a product is made of recycled plastic.	0.81	
The codes show that the product may be recycled.	0.65	
The codes show what type of plastic is used in the product.		0.65
The codes show whether a product may be heated.		0.95
The codes show whether a product may be frozen.		0.93
Inter item correlation	0.42	0.31
Cronbach alpha coefficient	0.59	0.64
Mean factor score **Standard deviation**	0.12 0.23	0.48 0.42
Keiser-Meyer-Olkin value	0.61	

(Scale: 1: True, 2: False, 3: Don't know)

Table 15. Summary of exploratory factor analysis of the 9-item objective knowledge regarding Bisphenol A (BPA) scale (Factor loadings from Principle Components Analysis)

Item	Factor loading
	BPA characteristics
BPA is a chemical substance.	0.79
BPA is a hormone.	0.62
BPA is a type of plastic.	0.38
BPA is found in plastic.	0.85
BPA is used in the production of certain types of plastics.	0.88
BPA is found in food and beverage cans.	0.55
BPA hardens plastic.	0.68
BPA makes plastic transparent (see-through).	0.55
BPA is harmful to human health.	0.70
Inter item correlation	0.38
Cronbach alpha coefficient	0.85
Mean factor score **Standard deviation**	0.42 0.31
Keiser-Meyer-Olkin value	0.84

(Scale: 1: True, 2: False, 3: Don't know)

(BPA=Bisphenol A)

Table 16. Summary of exploratory factor analysis of the 11-item sources of information regarding plastic packaging and containers as well as Bisphenol A (BPA) scale (Factor loadings from Principle Components Analysis)

Item	Factor loading	
	Formal information sources	**Informal information sources**
Scientists or academic researchers at universities	0.54	
Store assistants, supermarkets, retailers	0.54	
Health professions (e.g. doctors, nurses, dentists, chemists)	0.65	
Nutritionist / dietician	0.71	
Classes / Course	0.45	
Books	0.52	
Government and legislation	0.61	
Friends		-0.85
Family		-0.85
Media (e.g. Newspapers, Magazines, TV, Radio)		-0.64
Internet sources		-0.45
Inter item correlation	0.24	0.41
Cronbach alpha coefficient	0.69	0.73
Mean factor score **Standard deviation**	0.12 0.19	0.42 0.36
Keiser-Meyer-Olkin value	0.72	

(Scale: 1: Yes, 2: No)

Table 17. Summary of exploratory factor analysis of the 11-item trust in information sources regarding plastic packaging and containers as well as BPA scale (Factor loadings from Principle Components Analysis)

Item	Factor loading	
	Trust in formal information sources	**Trust in informal information sources**
Scientists or academic researchers at universities	0.59	
Health professions (e.g. doctors, nurses, dentists, chemists)	0.80	
Nutritionist / dietician	0.77	
Classes / Course	0.67	
Books	0.68	
Government and legislation	0.62	
Store assistants, supermarkets, retailers		-0.64
Friends		-0.88
Family		-0.86
Media (e.g. Newspapers, Magazines, TV, Radio)		-0.54
Internet sources		-0.34
Inter item correlation	0.43	0.44
Cronbach alpha coefficient	0.81	0.80
Mean factor score **Standard deviation**	3.76 0.58	3.15 0.64
Keiser-Meyer-Olkin value	0.83	

(Scale: 1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly agree)

Descriptive statistics

Table 18. Summary of descriptive statistics

Factor name	N	Minimum	Maximum	Mean	Standard deviation
Utilisation of plastic identification codes	293	1.0	4.0	1.58	0.72
Frequency of food consumption from plastic food and beverage packaging and containers	293	1.5	5.0	3.19	0.62
Frequency of food consumption from plastic lunch boxes	293	1.0	5.0	3.90	1.33
Consumers' subjective knowledge of utilisation practices	293	1.0	5.0	3.63	0.82
Consumers' subjective knowledge compared to other consumers	293	1.0	5.0	2.69	0.82
Subjective knowledge regarding food and beverage packaging and containers	293	1.0	3.0	1.76	0.75
Freezing of various plastics	293	0.0	1.0	0.39	0.30
Freezing of cans and boxes	293	0.0	1.0	0.81	0.28
Knowledge regarding plastic products not often used in the microwave	293	0.0	1.0	0.92	0.21
Knowledge regarding plastic products most often used in the microwave	293	0.0	1.0	0.42	0.26
Knowledge regarding the use of plastic products in the dishwasher	293	0.0	1.0	0.65	0.28
Reuse practices of various food and beverage packaging and containers	293	0.0	1.0	0.67	0.27
Reuse practices of lunch boxes	293	0.0	1.0	0.91	0.28
Reuse practices of plastic bags (e.g. Ziploc, glad)	293	0.0	1.0	0.62	0.49
Plastic products and exposure to extreme temperatures	293	0.0	1.0	0.72	0.27

Table 18 (Continue). Summary of descriptive statistics

Factor name	N	Minimum	Maximum	Mean	Standard deviation
Utilisation of plastic and products containing plastic after exposure to sunlight	293	0.0	1.0	0.66	0.34
The use of plastic and products containing plastic after exposure to sunlight	293	0.0	1.0	0.53	0.36
Illnesses/diseases and the use of plastic products	293	0.0	1.0	0.17	0.28
Plastic beverage bottles may be used for warm beverages	293	0.0	1.0	0.73	0.44
Cling wrap (e.g. Glad wrap) may be used in the microwave, if you poke holes into it.	293	0.0	1.0	0.38	0.49
Food or beverage cans may be used to bake bread or pudding in	293	0.0	1.0	0.62	0.49
Some food and beverage cans contains plastic	293	0.0	1.0	0.39	0.49
Food may be heated in the can	293	0.0	1.0	0.77	0.42
Plastic identification codes – reuse and recycling	293	0.0	1.0	0.12	0.23
Plastic identification codes – specific utilisation practices	293	0.0	1.0	0.48	0.42
BPA characteristics	293	0.0	1.0	0.43	0.31
Informal information sources	293	0.0	1.0	0.42	0.36
Formal information sources	293	0.0	1.0	0.12	0.19
Trust in informal information sources	293	1.0	5.0	3.15	0.64
Trust in formal information sources	293	1.0	5.0	3.76	0.58

Correlation table

***. Correlation is significant at the 0.05 level (2-tailed).**
**** . Correlation is significant at the 0.01 level (2-tailed).**

Addendum G:

Research article guidelines:

Family and Consumer Sciences Research Journal

Author Guidelines:

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Addendum H:

Language editing letter – Dissertation

18/11/2017

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This letter serves to confirm that the attached dissertation, "Consumers' knowledge and utilisation practices regarding plastic food and beverage packaging and containers", has been edited by a qualified language practitioner. For further verification, I may be contacted by email: kellygilbertson@gmail.com or by cellphone: 0616150292/ +447984529866.

Kind regards,

Kelly-Anne Gilbertson

1

Language editing letter – Article

18/11/2017

To whom it may concern,

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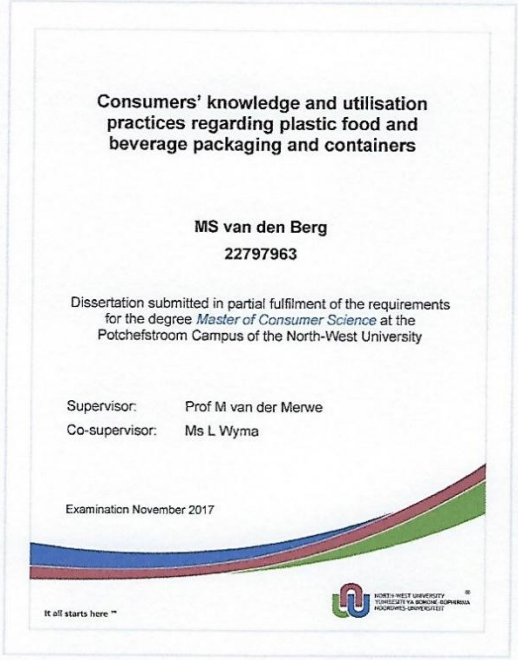

Consumers' knowledge and utilisation practices regarding plastic food and beverage packaging and containers

MS van den Berg

22797963

Dissertation submitted in partial fulfilment of the requirements for the degree *Master of Consumer Science* at the Potchefstroom Campus of the North-West University

Supervisor: Prof M van der Merwe

Co-supervisor: Ms L Wyma

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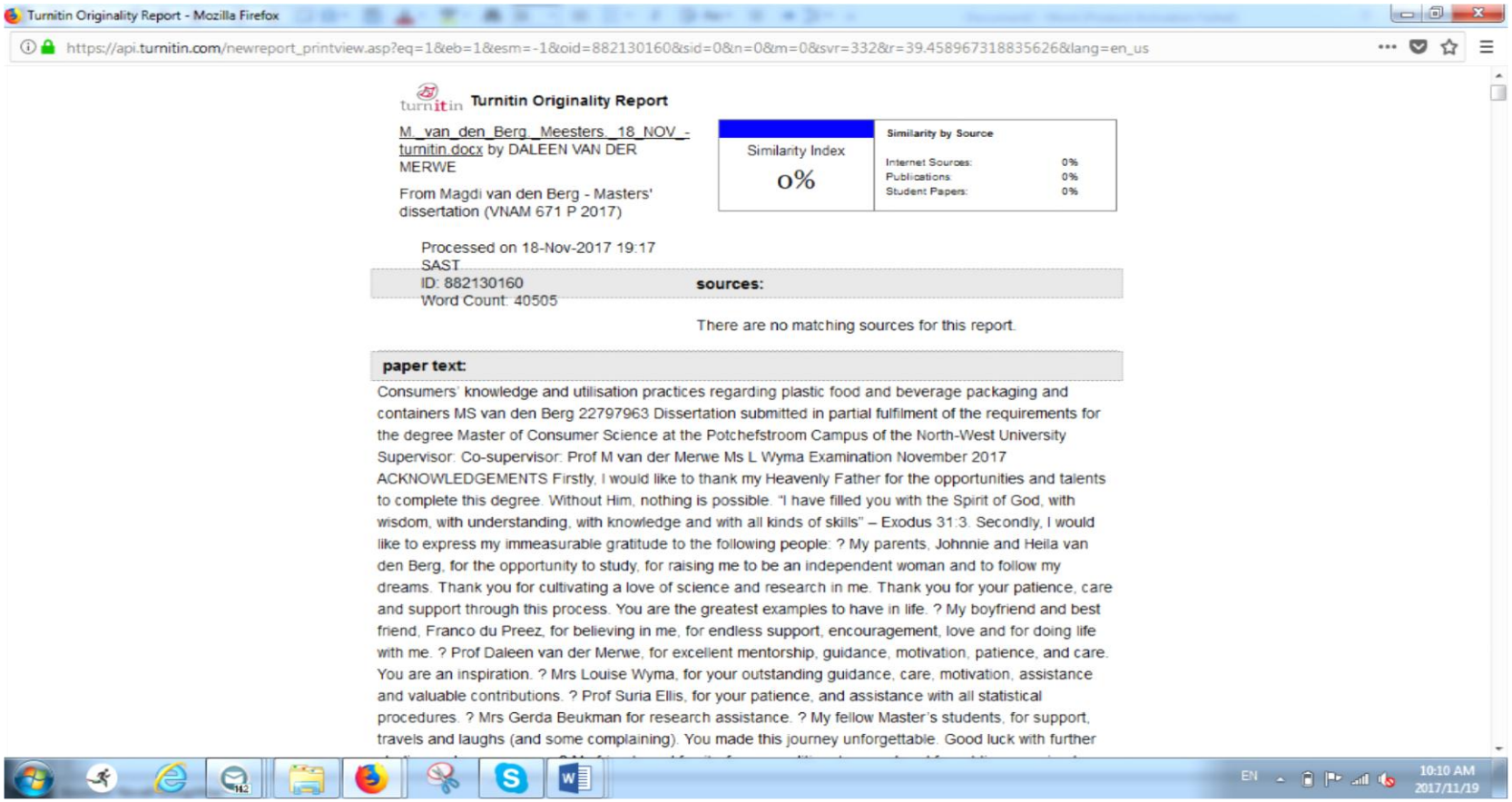
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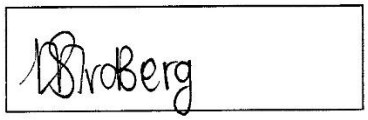
Signature of student  University number 22797963

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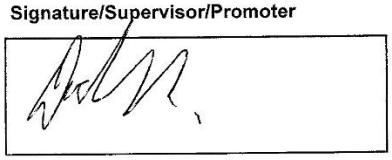
Signature/Supervisor/Promoter 

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