The effects of onion (*Allium Cepa L*) and ginger (*Zingiber officinale*) supplementation on growth performance, carcass characteristics, hematological and serum biochemical parameters of Potchefstroom Koekoek.

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DECLARATION

I, **Thapelo Lucky Mamonong**, declare that this dissertation has not been submitted to any University and that it is my original work conducted under the supervision of Dr C.K. Lebopa, co-supervisors Prof K.H. Mokoboki and Dr N.A. Sebola. All assistance towards the production of this work and all the references contained herein have been properly accredited.

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DEDICATION

Special appreciation goes to my supportive family and friends for their encouragement throughout the period of my studies. I thank my siblings for believing in me and the support they gave me. Above all, I am thankful to the Almighty GOD, for this work was possible because of Him.

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ABBREVIATIONS

a*- Redness

ADF- acid detergent fibre

ADG- Average Daily Gain

ADL- acid detergent lignin

ALB- albumin

ANOVA- Analysis of Variance

AOAC - Association of Official Analytical Chemista

b*- Yellowness

BILIR- Bilirubin conjugated

CAL_CRD- calcium corrected

CAL_TOT- calcium total

CHOL- Cholesterol

CRD- Completely Randomized Design

CRE- Creatinine

DM- dry matter

EDTA- Ethylene Diamine Tetra Acetic Acid

EE- Ether extracts

FAO- Food and Agriculture Organization

FCR- Feed conversion ratio

FI- Feed intake

GLM- General Linear Model

GLU- Glucose

HbC- Haemoglobin concentration

K- Potassium

L- Lymphocyte

L*- Lightness

MAGN- Magnesium

MCH- Mean Corpuscular Haemoglobin

MCHC- Mean Corpuscular Haemoglobin Concentration

MCV- Mean Corpuscular Volume

N- Total Nitrogen

N- Neutrophil

Na –Sodium

NDF- neutral detergent fibre

NRC- National Research Council

OM- organic matter

PCV- Packed cell volume

PROT- Total Protein

s_Bili- Bilirubin

s-alt- Alanine Transaminase

SAS- Stastical Analysis System

s-ast- Aspartate aminotransferase

SE- Standard Error

TRTS- treatments

TRYGLY- Triglyceride

U- Urea

WBC- White blood cells

Abstract

The study was conducted to determine the effect of onion and ginger supplementation on growth performance, carcass characteristics, hematological and serum biochemical parameters of Potchefstroom Koekoek. A total of 160 day-old Potchefstroom Koekoek chickens were randomly assigned to five dietary treatments (TRT1 = basal diet (control), TRT2 = basal diet + 15g onion per kg feed, TRT3 = basal diet + 20g onion per kg feed, TRT4 = basal diet + 15g ginger per kg diet, TRT5 = basal diet + 20g of ginger per kg feed). Growth performance, carcass characteristics, haematological and serum biochemical parameters were determined. There were non-significant effect of ginger and onion on total feed intake, average daily gain, feed conversion ratio and final weight gain. The study did not establish any significant variation in terms of carcass yield, organ weights, initial pH, ultimate pH and meat colour of Potchefstroom Koekoek chickens supplemented with varying levels of onion and ginger. Haematological parameters were not significantly ($P>0.05$) influenced by treatment Serum biochemical parameters were also not significantly influenced ($P>0.05$) by addition of ginger or onion to rations fed Potchefstroom Koekoek chickens. The lack of response on all parameters measured in the current study to the effect of onion and ginger supplementation may be because indigenous chickens have for years managed to survive under stressful scavenging conditions without proper nutrition and vaccination. Therefore the inability of Potchefstroom Koekoek to respond to the inclusion levels used in the current study may suggest that the levels used were too low for the bioactive ingredients in these herbs to show any positive effect on the parameters measures.

Key words; Potchefstroom Koekoek, ginger, onion, carcass yield, haematological parameters and serum biochemical parameters

CHAPTER 1

INTRODUCTION

According to Elagib *et al.* (2013) feed stuff constitutes about 80% of the total lost in poultry production. Indigenous chicken production is said to be limited by factors such as quality and quantity of feed materials available, resulting in poor growth rates and low egg production, thus creating a need to improve production (Gadzirayi, 2014). Growth promoters or feed additives are commonly added in poultry rations at a low rate to improve production (Herawati & Marjuki, 2011). Some growth promoters act as pro-nutrients because of the role they play in enhancing the physiology and microbiology of the animals (Mohammed *et al.*, 2014). Among the growth promoters, antibiotics are the most commonly used in poultry diets for promoting intestinal microflora composition, feed intake, feed utilization efficiency, promoting growth rates, layer performance and taking control of health and well-being of the animal (Engberg *et al.*, 2000; Zomrawi *et al.*, 2012; Mohammed *et al.*, 2014). Growth promoters aid in the digestion of food thereby enabling poultry to derive maximum benefit from the feed ensuring that they grow well (Aji *et al.*, 2011). However, the use of antibiotic growth promoters in poultry feeds can cause development of antibiotic resistant bacteria, antibiotic residue effects in final product with potential harmful effects to human health and evidence of resistant strains that become zoonotic (Rahmafnejad *et al*, 2009; Herawati, 2010; Goodarzi *et al*, 2013; Dhama *et al.*, 2015; Oleforuh-Okoleh *et al.*, 2015). There is therefore an increasing trend towards using alternative natural growth promoters (Mohamed *et al.*, 2014, Dhama *et al.*, 2015; Oleforuh-Okoleh *et al.*, 2015). The new generation of growth promoters include botanical additives like herbs or plant extracts as they have antimicrobial, coccidiostatic or anthelmintic and antioxidant activities (Gopi *et al.*, 2014; Mohamed *et al.*, 2014; Sridhar *et al.*, 2014; Dhama *et al.*, 2015)

Medicinal plants are widely used because of their low cost, their effectiveness, the frequently inadequate provision of modern medicine, and cultural and religious preferences (Sheldon *et al.*, 1997; Dhama *et al.,* 2015). Herbs such as onion, ginger, garlic and other herbaceous plants, as well as extracts from such plant are now being used as natural feed additives. Herbs also improve the gizzard and gastrointestinal function, act on appetite and intestinal flora. They also stimulate the pancreatic secretions to increase endogenous enzyme activity, enhance growth efficiency, meat yield in birds and the immune system (Toress-Rodriguis *et al.*, 2005; Dhama *et al*, 2015). Much of the work carried out to date has been on the use of onion or ginger as non-antibiotic growth promoters in exotic broiler breeds (Elagib *et al.,* 2013; Zomrawi *et al.*, 2013; Goodarzi & Landy, 2014). Information on the effect of onion or ginger supplementation on performance of indigenous chickens is lacking. There is therefore a need to investigate onion and ginger as alternative non-antibiotic growth promoters in improving growth performance, carcass characteristics, hematological and serum biochemical parameters of Potchefstroom Koekock.

1.1. Problem statement

Indigenous chicken production is said to be limited by the factors such as quality and quantity of feed materials available, resulting in poor growth rates and low egg production thus creating a need to improve production (Goodarzi & Landy, 2014). The usage of dietary antibiotics have resulted in controversial problems such as the development of antibiotic resistant bacteria, and drug residue in the final products which can be harmful to consumers (Goodarzi *et al*, 2013; Dhama *et al.*, 2015; Oleforuh-Okoleh *et al.,* 2015). This situation has put tremendous pressure on the poultry industry to withdraw or limit antibiotics usage in animal feeds and to look for viable alternatives Dhama *et al.,* (2015). The herbs and plant extracts such as onion, ginger, garlic and other herbaceous plants supplement in feed of indigenous chicken might improve their health and production performance.

1.2. Justification

Small-scale farmers in urban and rural areas can better utilize their land through sustainable agricultural methods which are at low cost, practical, and can contribute to their daily food needs. One of the best opportunities for small-scale farmers can be through indigenous poultry production as they are well adapted and are resistant to local pests, parasites and diseases. Indigenous poultry production ensures food security, self-employment and self-reliance. Antibiotic growth promoters have for many years been used in intensive poultry production systems to improve production of exotic breeds. However due to the development of antibiotic resistant bacteria, and drug residue in the final product, there is a need for an alternative with no such effects. In order to improve production of indigenous chickens, we may need to come up with a semi or intensive production system where alternative less expensive natural growth promoters will be used to increase production. There has been growing interest in the use of natural herbs and medicinal plants as feed additives in poultry diets to maximise their potential output (Khan *et al.*, 2012; Mohamed *et al.*, 2014, Dhama *et al.*, 2015; Oleforuh-Okoleh *et al.*, 2015). Improvement in meat production of indigenous chickens using natural growth promoters has not been well researched as there is limited documented information. Aim of the present study is therefore to investigate the effects of onion (*Allium Cepa L*) and ginger (*Zingiber officinale*) supplementation on the growth performance, serum biochemical parameters and intestinal microflora composition of Potchefstroom Koekoek.

1.3. Research aim and objectives

1.3.1. Broad objective

The objective of the experiment was to determine the effect of onion (*Allium Cepa L*) and ginger (*Zingiber Officinale*) supplementation as natural feed additives on the growth performance, carcass characteristics, hematological and serum biochemical parameters of indigenous chickens (Potchefstroom Koekoek).

1.3.2. Specific objectives

The specific objectives of the study were:

1. To determine the effects of onion and ginger supplements on feed intake, feed conversion ratio and live body weight gain of Potchefstroom Koekoek
2. To determine the effects of onion and ginger supplementation on carcass and organ characteristics in Potchefstroom Koekoek
3. To determine the effect of onion and ginger supplementation on haematological and serum biochemical parameters of the Potchefstroom Koekoek

1.3.3. Hypothesis tested were:

1. Dietary inclusion of different levels of onion or ginger on ration will have an effect on feed intake, feed conversion ratio and live body weight gain of Potchefstroom Koekoek
2. Inclusions of onion and ginger at different levels in ration fed to Potchefstroom Koekoek will have an effect on carcass and organ characteristics
3. Dietary inclusion of different levels of onion and ginger will have an effect on haematological and serum biochemical parameters of the Potchefstroom Koekoek

1.3.4. The research questions:

1. Does supplementing broiler ration with onion or ginger influences feed intake, feed conversion ratio and live body weight gain of Potchefstroom Koekoek?
2. Does supplementing broiler ration with onion or ginger influences carcass and organ characteristics of Potchefstroom Koekoek?
3. Does supplementing broilers ration with onion or ginger influences haematological and serum biochemical parameters of the Potchefstroom Koekoek?

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CHAPTER 2

LITERATURE REVIEW

Several studies have shown that antibiotics have been extensively used as a feed additives in animal husbandry (Edens, 2003; Diarra *et al.*, 2011; Oleforuh-Okoleh *et al.*, 2015). During the past 50 years, antibiotics have been used in poultry production as therapeutic agents to treat bacterial infections that cause diseases and decrease performance (Edens, 2003). Antibiotics growth promoters have been used to promote growth and improve feed efficiency in intensive animal farming (Ogle, 2013). Shortly after the initiation of widespread use of antibiotics in the animal industries, they were placed under increased scrutiny because of concern over development of bacterial resistance towards the drug and evidence of resistant strains that become zoonotic (Wegener *et al.*, 1999; Edens, 2003). Ever since their first usage in animals, there has been a cause for concern about the use of antibiotics in poultry and livestock production. The use of some growth promoting antibiotics in poultry feeds was forbidden in 1999 by the European Union (EU). This ban was due to very disturbing observations that are potentially human pathogens, frequently found on processed poultry and swine carcasses, were increasingly resistant to certain antibiotics (Donoghue, 2003). However, therapeutic uses of appropriate antibiotics were allowed but only via prescription through a veterinarian. Around the world, controversy has surrounded this report, but the impact of the work has been extremely influential as it has caused unprecedented changes in the way animal production is being conducted today (Bager, 1998; Donoghue, 2003 and Edens, 2003). Natural medicinal products originating from herbs and spices such as (ginger, onion and garlic) have been used as feed additives for farm animals (Guo, 2003). The efficacy and importance of a feedstuff in a poultry production is evaluated from its impact on performance of the birds. Antibiotics were routinely used in broiler diets at low than therapeutic doses as to improve bird's performance (Oleforuh-

Okoleh *et al.*, 2015). This practice derives from observations made since 1946, that incorporation of antimicrobial growth promoters improved feed efficiency in intensive poultry production (Peterolli *et al.*, 2012). Growth performance, carcass yield, haematological, serum biochemical parameters, nutritional value of onion and ginger and description of Potchefstroom Koekoek were reviewed below.

2.1. Growth performance and carcass yield

Poultry meat is an important source of nutrients as it contains all the essential amino acid, fatty acids, vitamins, minerals especially selenium, iodine, phosphorus, potassium, iron and zinc. Vitamins and minerals present in poultry meat help to boost the immune system, digestion and metabolism, strengthen bones, skin, build, maintain and repair body tissues (Atteh, 2002). In the past, growth-promoting antibiotics were used as feed additives. However, the use of antibiotics in poultry feed as growth promoters and for health maintenance can cause drug resistant bacteria and antibiotic residue effects in meat and eggs (Wray & Davies, 2000; Diarra *et al.*, 2011). As a result, natural alternatives to antibiotics, such as herbs and medicinal plants have attracted attention due to their wide range of potential beneficial effects to animal husbandry (Manesh *et al.*, 2012). Natural products of plant origin like spices, herbs and many plant extract can be considered as alternative to antibiotic growth promoters in improving broiler performance (Hernandez *et al.*, 2004). This will result in maximum returns and carcass quality. Abdulmanan (2012) concluded that herbs are valuable substitutes for health and nutrition in poultry industry.

2.2. Haematological and serum biochemical parameters

The ability of an animal to physically respond to its internal and external environment is generally reflected in its haematological constituents (Esonu *et al.*, 2001; Khan & Zapper 2005: Maidala *et al.*, 2014). The effects of environmental and nutritional stresses can be detected through the changes in the haematological parameters (George *et al.*, 2015). Ajagbonna *et al.*, (1999) states that ingestion of plant constituents like ginger can alter normal ranges of haematological parameters. Blood serum and haematological parameters have in the past been used in diagnosing pathogenic and metabolic disorders. Thus, they are considered as vital tools in assessing health status of an individual flock (Elagib & Ahmed 2011; George *et al.*, 2015). Haematological and serum biochemical parameters have been reported to provide valuable information on the immune status of animals (Kral & Suchy, 2000). This information apart from being useful for diagnostic and management purposes, can also be incorporated in the breeding programmes for the genetic improvements of indigenous chickens (Ladokun *et al.,* 2008).

2.3. Onion (*Allium Cepa L*)

Onion (*Allium Cepa L*) is a bulbous plant widely cultivated in almost every country in the world (Ebesunum *et al.*, 2007). Onion is been used as a feed additive in poultry diets to enhance growth performance and control diseases. Many researchers states that onion possess of nutrients such as proteins, carbohydrates, sodium, potassium and phosphorus (Bello *et al.*, 2013; Bhattacharjee *et al.*, 2013). Onion bulbs possess numerous organic sulphur compounds including trans-s-(1-propenyl) cystein sulfoxide, S-methyl-systein, sulfoxide, S-propyl cystein sulfoxides and cycloallicin, flavinoids, phenolic acids, sterols including cholesterol, stigma sterol, b-sitosterol, saponing, sugars and trace of volatile oil compounds mainly of sulphur compounds

(Melvin *et al.*, 2009; Abdul *et al.*, 2010). Onion has been reported to contain compounds with proven antibacterial, antiviral, antiparasitic, antifungal properties and has antihypertensive, hypoglycaemic, antithrombiotic, antihyperlipidemic, anti-inflammatory and antioxidant activity (Goodarzi *et al.,* 2014). Onion stimulates blood circulation, improve immune response and antibacterial effects due to its contents of pungent substances that lead to higher production of saliva and gastric juices (Ibraheim *et al.*, 2004). Administration of onion has been shown to reduce serum, liver and aorta triglycerides and liver proteins (Ibraheim *et al.*, 2004; Ghalehkandi *et al.*, 2012). Onion stimulates growth by increasing the inflow of glucose into the tissues thus stimulating thyroid like activity (Goodarzi *et al.*, 2013). The ability of onion to perform these functions is attributed to the presence of bioactive components such as diakyl polysulfide which possess antimicrobial activity (Aji *et al.,* 2011).

2.4. Ginger (*Zingiber Officinale*)

Ginger (*Zingiber Officinale*) is a perennial herbaceous plant that is part of the Zingiberaceae family (Najafi & Taherpour, 2014). It is a rhizome widely used as a spice or condiment and for medical treatment of animal diseases (Tapsell *et al.*, 2006). The main important compounds in ginger are gingerol, gingerdiol and gingerdione which can stimulate digestive enzymes, affect the microbial activity and antioxidative activities (Mohammed *et al.,* 2014). Ginger contains several volatile oils like borneol, camphene, citral, eucalyptol, linalool, phenllandrene, zingiberine, zingiberol (gingerol and shogaol) and resin which possess strong antioxidant activity more powerful than vitamin C (Herbs Hands Healing, 2011). Mohammed & Yusuf (2011) states that nutrients found in ginger include carbohydrates, lipids, proteins, minerals and vitamins. Ginger is reported to exert a lot of useful effects on human and animal's health such as anti-dyspepsia, anti-bloating, anti-vomiting, diarrhoea and spasm. Studies have shown that ginger is a carminative, diuretic, tonic and disinfectant compound that has antibacterial and anti-inflammatory actions and also contains glucosinolete sterols and triterpenes Zomrawi *et al.*, (2012).

Ginger can improve digestion and cure gastric problem as well as destroy parasites and their eggs (Mohammed & Yusuf, 2011). Ginger speeds up digestion and enhances protein digestion due to enzyme (zingibaine) found in the plant. The use of ginger extracts has been reported to reduce blood fats (low density lipoprotein (LDL), cholesterol and serum triglycerides) levels in animals (Palvik *et al.*, 2007; Galib *et al.*, 2010; Najafi & Taherpour, 2014). Chickens fed ginger have hypertriglyceridemia which lead to a decrease in the activity of lipogenic enzymes, thereby reducing the re-synthesis of fatty acids in the liver (Ciftci *et al.*, 2010). Maximum levels of crude fibre content in ginger has also been reported to increase the excretion of bile, resulting in decreased blood cholesterol and triglycerides (Ciftci *et al.*, 2010; Najafi & Taherpour, 2014). Herawati and Marjuki (2011) concluded that feeding ginger phytobiotic as feed additive increases productive performance, carcass and meat quality of broilers.

2.5. Potchefstroom Koekoek

Potchefstroom Koekoek is a composite of White Leghorn, Black Australorp and Bared Plymouth Rock. The name Koekoek refers to the barred colour pattern of the birds. Potchefstroom Koekoek was bred for the hens to lay brown shelled eggs while the carcass should be attractive with deep yellow skin colour. It was bred at Potchefstroom Agricultural College in 1950 (Fourie & Grobbelaar, 2003). The meat of Potchefstroom Koekoek is popular among the local communities and is preferred to that of other commercial breeds for meat purposes (Grobbelaar *et al.*, 2010). Potchefstroom koekoek males can reach a mature body weight of 3.5-4.5 kg and females 2.5-3 kg. This breed is very popular among the rural farmers in South Africa and neighbouring countries for egg and meat production (Grobbelaar, 2008). They are the most important avian species reared for generating income by farmers around the country. Avian species plays important socio-economic roles in developing countries by production and its products (Melesse *et al.*, 2013). Grobbelaar *et al.*, (2010) state that village chickens are among the most adaptable domestic animals that can survive cold and heat, wet and drought conditions, sheltered in cages, unsheltered outside or roosting in trees.

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CHAPTER 3

THE EFFECT OF ONION OR GINGER SUPPLEMENTATION ON FEED INTAKE, FEED CONVERSION RATIO AND LIVE BODY WEIGHT GAIN OF POTCHEFSTROOM KOEKOEK

Abstract

The study was conducted to determine the impact of onion and ginger supplementation on feed intake, feed conversion ratio and body weight gain of Potchefstroom Koekoek chickens. A total of 160 day-old Potchefstroom Koekoek chickens were purchased from Grootfontein Fisheries in Zeerust. Chicks were randomly assigned to five dietary treatments formulated to be iso-nitrogenous and iso-caloric. The dietary treatments consisted of TRT1 = basal diet (control), TRT2 = basal diet +15g onion per kg feed, TRT3 = basal diet +20g onion per kg feed, TRT4 = basal diet +15g ginger per kg diet, TRT5 = basal diet +20g of ginger per kg feed. Each treatment had four (4) replicate pens holding 8 chickens in a Completely Randomised Design (CRD). The 31- day was used as initial weight and the chickens were weighed weekly for 13 weeks. The total FI per bird (g/bird) for the experimental period ranged from 47.23 ± 2.53 in TRT4 to 52.25 ± 2.53 in TRT3. The average daily gain ranged from 9.50 ± 0.59 in TRT1 to 10.69 ± 0.59 in TRT4. FCR ranged from 4.65 in TRT1 to 5.50 in TRT3. The average final weight ranged from 1.08 ± 0.04 in TRT1 to 1.18 ± 0.04 in TRT4. However, the results indicate that there were no significant differences (P>0.05) across all treatments in terms of feed intake, feed conversion ratio and body weight gain of Potchefstroom Koekoek chickens.

Key words: feed intake, feed conversion ratio, average daily gain,

3.1. Introduction

Natural products of plant origin can be considered as alternatives to antibiotics and used as growth promoters in improving broiler performance (Guo, 2003; Hernandez *et al.*, 2004; Manesh *et al.*, 2012; Safa, Eltazi & Mohamed., 2014). Herbaceous plants are widely used because of their low cost, their effectiveness, the frequently inadequate provision of modern medicine, and cultural and religious preferences (Sheldon *et al.*, 1997; Dhama *et al.*, 2015). The new generation of growth promoters include botanical additives like herbs, spices and plant extracts. The herbaceous plants, as well as extracts from such plants can be used as natural feed additives as they have antimicrobial, coccidiostatic or anthelmintic and antioxidant activities (Gopi *et al.*, 2014; Mohammed *et al.*, 2014; Sridhar *et al.*, 2014; Dhama *et al.*, 2015). They have been shown to improve the gizzard and gastrointestinal function, act on appetite, intestinal flora, stimulate the pancreatic secretions to increase endogenous enzyme activity, enhance growth efficiency, meat yield in birds and the immune system (Toress-Rodriguis *et al.*, 2005; Dhama *et al*, 2015). Spice and herbs of various plant extracts have been shown to have appetizing, digestion stimulating properties and antimicrobial properties (Engberg *et al.*, 2000; Zomrawi *et al.*, 2012; Mohammed *et al.,* 2014). Feedstuffs used in poultry feeding are evaluated based on how they affect production performance of these birds. Herbal formulations used as feed additives have been shown to boost animal performance by increasing their growth rate, feed conversion efficiency and lowered mortality (Onu, 2010). The objective of this study was therefore to determine the effects of onion and ginger supplementation on feed intake, feed conversion ratio and live body weight gain of Potchefstroom Koekoek.

3.2. Materials and Methods

3.2.1. Study site description

Research trial was conducted at North-West University Experimental Farm located in Mahikeng, South Africa (25.85° S, 25.63° E) at an altitude of 1012m above sea level. The vegetation is semi-arid Savannah with an average annual rainfall of 500 mm. All procedures used in experiments received prior approval from the Faculty of Agriculture, Science and Technology Research Committee.

3.2.2. Experimental Animals and dietary treatments

Chicks were randomly assigned to the 20 pens each consisting of 8 chicks. Stresspack was administered in drinking water of birds to reduce stress for a period of 3 days after arrival. All chicks were fed on a similar starter diet containing 20% CP and (2842 Kcal/kg ME) formulated by Opti feeds company to meet minimum nutrient requirements established by NRC (1994). Starter ration was fed until the commencement of the experimental diet feeding at 4 weeks of age. On day 31, chicks in each pen were weighed for initial weight and pens stratified by weight before allocation of experimental diets. Each treatment had four (4) replicate pens holding 8 chickens in a completely randomised design (CRD). On day 31, the five treatment diets were randomly assigned to pens within each weight strata. Five dietary treatments consisted of basal diet (control), basal diet +15g onion per kg feed, basal diet +20g onion per kg feed, basal diet +15g ginger per kg diet, basal diet +20g of ginger per kg feed. The five experimental diets were iso-nitrogenous (18% CP) and iso-caloric (2770 Kcal/ kg ME). First four weeks of the experiment were used as the adaptation period with chicks fed the same starter diet under the same management procedures. Feed and water were provided *ad-libitum*. Birds were kept on floor pens with sunflower husks as bedding material in a clean disinfected broiler house. The infrared lamps were used to provide initial heating and lighting for brooding. Birds were vaccinated for Newcastle at day 1, 12 and 22 and for Gumboro at day 1 and 14. Birds were then fed experimental diets from day 31 of age until finishing on day 90 of age.

3.2.3. Determination of nutrient composition of ginger and onion

Fresh onion (*Allium Cepa L*) and ginger (*Zingiber Officinale*) were purchased from Fruit and Vegetable Super Market at the Crossing Mall in Mafikeng. Onions were peeled and grated into smaller pieces and air dried for a period of six weeks. Ginger was sliced and air dried. The air dried onion and ginger were then separately milled to pass through a 1mm sieve to get onion and ginger powder which were then be placed separately in brown paper bags. Milled samples from onion and ginger were analysed for proximate analysis to determine the chemical composition of milled onion (*Allium Cepa L*) and ginger (*Zingiber Officinale*). Milled samples from onion and ginger were analysed for laboratory dry matter (DM) and Organic Matter (OM) according to AOAC (1990) procedure, Nitrogen (N) content was determined in a 1g of air dried sample using the Kjeldahl method (AOAC, 1990) on a Buchi system and converted to Crude Protein (CP), Neutral Detergent Fibre (NDF) determined using ANKOM^{2000} Fibre Analyser (ANKOM Technology, New York) according to van Soest *et al.*, (1991), and Acid Detergent Fibre (ADF).The ingredients and composition of basal diet is shown in a table 3.1.

Table 3.1. Ingredients and composition of basal diet

Description	Kilograms (kg)
Yellow maize	686.72
Soyabean meal (local)	148
Sunflower oilcake	80
Chubby poultry bypro	30
Wheat bran/ pollard	20
Limestone powder-fine	14.18
Mcp/moco calk k	6.85
Lysine	4.11
Salt-fine	2.53
Koeksoda	2.52
Methionine	1.72
Px p2 Br Grower with	1.67
Choline powder	0.75
Coxistac	0.5
L-Threonine	0.47
Total:	1000

3.2.4. Determination of growth performance traits of Potchefstroom Koekoek supplemented with onion and ginger

Growth performance was determined using the following traits: feed intake, feed conversion ratio and live body weight. Feed intake was determined by weighing the amount of feed given daily and subtracting the weight of that left the next morning to determine daily feed intake. The total feed intake per week and/or over the experimental period was calculated by adding the daily feeding intake. Mortalities and health status were visually observed and recorded daily throughout the entire experimental period. Mortality was used to adjust the total number of birds to determine total feed intake and Feed Conversion Ratio (FCR) using the method of Contreras Castillo *et al*., (2008) as follows:

$$FCR = \frac{\text{Feed intake(g)}}{\text{Weight gain (g)}}$$

Live body weights of the chickens were recorded on a weekly basis starting at 4 weeks of age until the end of the experimental period at 13 weeks of age to determine average daily gain.

3.3. Statistical analysis

Weekly feed intake, growth rate, and feed conversion efficiency data were analysed using the repeated measures procedure of (SAS, 2010). Overall feed intake, weight gain, growth rate, and feed conversion efficiency data were analysed using the General Linear Models (GLM) procedure for a Completely Randomized Design (CRD). For traits measured once during the experimental period, the data was subjected to Analysis Of Variance (ANOVA) using the following model;

$Y_{ij} = \mu + T_j + E_{ij}$

Where Y_{ij} = dependent variable (parameters analysed), μ = overall mean, T_J = treatment effects and E_{ij} = random experimental errors.

The significance was tested at P>0.05. The Turkey procedure was used to separate means among levels within a significant factor. Traits measured repeatedly during the experimental period, such as body weight and feed intake, were subjected to a repeated measured analysis of variance for CRD in SAS.

3.4. Results

3.4.1. Chemical composition of ginger and onion

There were significant effects (P<0.05) of ginger and onion on dry matter, ash, neutral and acid detergent fibre content (Table 3.2). Ginger had the highest content of dry matter, ash, neutral and acid detergent fibre content as compared to onion (Table 3.2). Several studies have also obtained shown moisture content of ginger and onion in these ranges (Odebunmi *et al.*, 2010; Bello *et al.*, 2013). The CP content of ginger and onion ranged from 25.9 to 43.3 g/kg respectively. The ranges are comparable to those obtained in several studies (Bhattacharje *et al.*, 2013; Eleazu *et al.*, 2012; Yalcin & Kavuncuoglu, 2014). To the contrary, higher values on crude protein were obtained for ginger or onion in several studies (Odebunmi *et al.*, 2010; Otunol *et al*, 2010; Eleazu *et al.*, 2012; Nwinuke *et al.*, 2005). The NDF content of ginger and onion were 571.6 and 336.2 g/kg respectively. Based on the chemical analysis results, a basal diet was formulated for the grower phase as seen in Table 3.1. Onion and ginger were then each added at a rate of both 15g/kg and 20g/kg resulting in four iso-nitrogenous and iso-energetic diets containing 15g/kg onion, 20g/kg onion, 15g/kg ginger, 20g/kg ginger and also control as basal diet.

Table 3.2. Chemical composition onion (*Allium Cepa L*) and ginger (*Zingiber Officinale*)

Nutrient	*Ginger (Zingiber Officinale)*	*Onion (Allium Cepa L)*	*SE*
DM g/kg	879.0^a	859.7^b	0.08
OM g/kg DM	821.1	826.2	0.25
Ash g/kg DM	57.9^a	33.5^b	0.17
CP g/kg DM	25.9	43.3	0.59
NDF g/kg DM	571.6^a	336.2^b	0.23
ADF g/kg DM	397.1^a	145.6^b	0.00

[a,b]Means of the same row with different superscripts differ significantly (P<0.05)

DM-dry matter, OM- organic matter, CP-crude protein, ADF-acid detergent fibre, NDF-neutral detergent fibre,

3.4.2. The effect of treatment on final weight gain, feed intake (FI), feed conversion ratio (FCR) and Average Daily Gain (ADG) of Potchefstroom Koekoek chickens

The results indicate that there was no significant difference among the diet treatments on mean final weight as shown in Table 3.3. The average final weight ranged from 1.08 ± 0.04 in treatment1 to 1.18 ± 0.04 in treatment 4.The results on growth performance traits (FI, FCR & ADG) showed no significant difference (P> 0.05) among the diet treatments as shown in Table 3.3. The total FI per bird (g/bird) for the experimental period ranged from 47.23 ± 2.53 in treatment 4 to 52.25 ± 2.53 in treatment 3. FCR ranged from 4.65 in treatment 1 to 5.50 in treatment 3. The Average Daily Gain ranged from 9.50 ± 0.59 in treatment1 to 10.69 ± 0.59 in treatment 4.

Table 3.3. Effects of onion and ginger supplementation on initial weight, final weight gain, feed intake, feed conversion ratio and average daily gain of Potchefstroom Koekoek

	Growth performance				
Treatments	**Initial Weight gain (g/bird)**	**Final Weight gain (g/bird)**	**FI (g/bird)**	**FCR (g/g)**	**ADG**
1. Control	0.26	1080	50.15	4.65	9.50
2. Basal diet +15g onion/kg feed	0.26	1160	52.15	5.48	10.52
3. Basal diet +20g onion/kg feed	0.25	1140	52.25	5.50	10.22
4. Basal diet +15g ginger/kg feed	0.26	1180	47.23	5.05	10.69
5. Basal diet +20g ginger/kg feed	0.25	1180	50.90	4.73	10.42
SE	0.006	0.04	2.53	0.32	0.59

3.4.3 The effect of onion and ginger supplementation on mortality of the chickens

There was no significant difference among the diet treatments on mean mortality. The average mortality of birds ranged from 15.6±20.4 (diet 1 and 5) to 25.0±21.4 (diet 2) (Table 3.5).

Table 3.4. Mean percent mortality and SE of birds on different experimental diets

Treatment	Means	SE
1. Control	15.6	20.4
2. Basal diet +15g onion/kg feed	25.0	21.4
3. Basal diet +20g onion/kg feed	15.6	20.4
4. Basal diet +15g ginger/kg feed	18.8	20.9
5. Basal diet +20g ginger/kg feed	15.6	20.4

3.5. Discussion

The current study was aimed at determining the effects of onion and ginger supplementation on feed intake, feed conversion ratio and live body weight gain of Potchefstroom Koekoek. Across all treatments onion and ginger supplementation did not significantly (P>0.05) influence feed intake, feed conversion ratio, average daily gain, final live body weight gain and mortality of the birds when compared to the control group. These results are in agreement with those reported by Aji *et al.*, (2011), An *et al.*, (2015) and Ademoyo *et al.*, (2016), where onion did not show any significant effect on feed intake and feed conversion ratio on diets fed to broilers. Similarly, studies carried out by Karangiya *et al.*, (2016) and Aditya *et al.*, (2017) using broilers also showed ginger to have no significant effect on the feed conversion ratio or mortality of broilers (Zomrawi *et al.*, 2012),. However, studies carried out by George *et al.* (2013), Karangiya *et al.*, (2016) and Aditya *et al.*, (2017), showed feed intake to be significantly higher in diets supplemented with ginger compared to the control.

The results of the current study indicate that live body weight gain of the chickens was not significantly influenced by addition of onion or ginger at different inclusion levels of 15g/kg and 20g/kg. These results are in agreement with those obtained in a study carried out by Ademoyo *et al.* (2016) using broilers where inclusion level of 1, 1.5 and 2%, ginger did not result in any significant difference in feed intake, body weight gain and feed conversion efficiency of chickens compared to the control group. Similarly studies carried out by Zomrawi *et al.* (2012) and An *et al.* (2015) using broilers where inclusion levels of 0.3% or 0.5% onion extracts were used, did not result in any significant difference in feed intake, body weight gain and feed conversion efficiency of broilers compared to the control group. Studies carried out by several researchers (Horton *et al.*, 1991; Ademola *et al.*, 2004 and Omage *et al.*, 2007; Dieumou *et al.*, 2009; Aji *et al.*, 2011) also showed that ginger supplementation in broiler diets did not improve live weight gain.

However, these results are in contrast to those obtained by a number of researchers who found ginger or onion supplementation to influence live body weight or feed conversion ratio in broilers (Onimisi *et al.*, 2005; Ademola *et al.*, 2009; Thayalini *et al.*, 2011; Mohammed *et al.*, 2012; George *et al.*, 2013; Adeyemo *et al.*, 2016; Karangiya *et al.*, 2016). Ibrahim *et al.* (2004) found 1.5% and 2% inclusion levels in broiler diets to improve live body weight gain. A study carried out by Zhang *et al.* (2009) on broilers supplemented with ginger powder showed higher average daily gain compared to the control. Similarly, significant differences between body weights and body weight gains of broilers supplemented varying levels of ginger were obtained in a study carried out by George *et al.*, (2015).

Conclusion

The study did not establish any significant variation in all growth performance traits of Potchefstroom Koekoek chickens supplemented with varying levels of onion and ginger.

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CHAPTER 4

THE EFFECT OF ONION OR GINGER SUPPLEMENTATION ON CARCASS AND ORGAN CHARACTERISTICS OF POTCHEFSTROOM KOEKOEK

Abstract

A study was conducted to determine the impact of onion and ginger supplementation on carcass and organ characteristics of Potchefstroom Koekoek. At day 90 of the research trial, 60 birds in all five treatments (TRT1 = basal diet (control); TRT2 = basal diet +15g onion per kg feed; TRT3 = basal diet +20g onion per kg feed; TRT4 = basal diet +15g ginger per kg diet; TRT5 = basal diet +20g of ginger per kg feed) were slaughtered. Carcass yield, organ weights (liver, spleen, heart and gizzard), pH and meat colour were not significantly ($P>0.05$) influenced by treatment. The hot carcass weight ranged from 820g to 920g while the cold carcass weight ranged from 810-890g. The values for the initial pH ranged from 6.08 to 6.32 while the ultimate pH ranged from 5.68 to 5.78. Weight of edible parts such as the breast, drumstick, thigh and wing were also not significantly ($P>0.05$) affected by treatment. The average final weight of breasts ranged from 11.12 ± 0.83 in TRT1 (control) to 14.46 ± 0.83 in treatment TRT4 (Basal diet +15g ginger/kg feed). Weight of the drumsticks ranged from 58.75±2.51 in TRT1 (control) to 61.67±2.51 in TRT3 (basal diet + 20g onion/kg feed). Thigh weights ranged from 66.17±2.74 to (73.92±2.74) in TRT3. The average final weight of wings ranged from 54.92±1.63 in TRT3 (basal diet + 20g onion/kg feed) to 58.25 ±1.63 in TRT1 (control). The colour score values for lightness (L*), redness (a*), and yellowness (b*) did not differ significantly between treatments. The meat colour values ranged from 57.40 to 67.29 for lightness (L*), -2.28 to -3.11 for redness (a*) and 11.12 to 14.45 for yellowness (b*). The values for the initial pH ranged from 6.08 to 6.32 while the ultimate pH ranged from 5.68 to 5.78. The study did not establish any significant

variation in terms of carcass yield, organ weights, initial pH, ultimate pH and meat colour of Potchefstroom Koekoek chickens supplemented with varying levels of onion and ginger.

4.1. Introduction

Poultry products are good sources of protein and can contribute greatly in boosting the consumption level of animal protein (Hertano *et al.*, 2018). Poultry meat is an alternative source of protein for health-conscious consumers as it contains low cholesterol and fat (Jaturasitha *et al.*, 2004.) Consumers of chicken meat prefer to purchase indigenous chicken meat because it is chewier and tastier (Jaturasitha *et al.*, 2002; Wattanachant *et al.*, 2005; Jaturasitha *et al.*, 2008). However indigenous chickens have low feed conversion efficiency and poor growth rates that make them reach market weight of 1.5kg at around 4 months (Leotaragul *et al.*, 2002). Yang & Jiang, (2005) state that native chicken breeds are generally slow-growing and have poor feed efficiency.

Jaturasitha *et al.*, (2008) state that a leaner poultry carcass with portion of retail cuts is desirable. Studies have shown that poultry carcass composition is mainly affected by breed and feeding systems which in turn influence the meat quality (Shahin & Elazeem, 2005; Jaturasitha *et al.*, 2008). Eating quality poultry meat is the most important aspect of meat acceptability which can be defined in physiochemical terms (pH and meat colour) as well as direct meat traits (sensory evaluation, water holding capacity and chemical composition). The texture of the meat and its visual appearance are the main attributes that attract consumers to purchase quality poultry meat (Yang & Jiang, 2005). Meat colour plays an important role in the type of meat products that are highly valued by consumers (Fletcher *et al.*, 2000; Chen *et al.*, 2013). Several researchers (Fletcher, 1999; Petracci, 2004; Surendranath & Poulson, 2013) state that the colour of the meat influences the consumer's initial selection of raw meat product in the market and the consumer's final evaluation and ultimate acceptance of the cooked product upon consumption. Baeza *et al*., (2008) highlights that pale, soft and exudative meat (PSE) is an increasing problem in the poultry industry. Choo *et al*., (2014) stated that meat colour is generally influenced by animal related factors, mainly the genotype and the age of animals. Environmental factors such as feed and housing conditions may also affect colour (Livingston & Brown, 1981; Ahn, 2002; 0'Grady & Kerry, 2009). The objective of the current study was to determine the effects of onion and ginger as alternative natural growth promoters on carcass and organ characteristics of Potchefstroom Koekoek chickens.

4.2. Materials and methods

At the end of the growth trial as described in Chapter 3 above, all birds were kept in crates for slaughter at Rooigrond abattoir in North West Province. Birds were slaughtered by cutting the throat and the jugular vein at the first vertibrum. Slaughter weights were recorded after complete bleeding. Birds were defeathered, eviscerated and dressed. The eviscerated weights were obtained after removal of the head, neck, viscera, shanks, spleen, gizzard, liver, heart and the reproductive organs. Dressed weight was taken and compared with live weight and their difference was used to calculate their dressing percentage as follows:

$$\text{Dressing percentage} = \frac{\text{Carcass Weightx 100}}{\text{Live weight}}$$

The carcasses were cut to determine the weights of the breast, wing, upper thigh and lower thigh. Breast fillet pH was directly measured using a pH meter with 0.01 precision (Sentron, model 1001) coupled to a probe (Sentron, type Lance FET, model 1074001) with a thin penetrating needle inserted in the center of the Pectoralis major muscle, 0.5 to 1.0cm below the muscle surface. Measurements were carried out immediately after deboning. The colour measurements were carried out using a tristimulus colorimeter (Minolta Chroma Meter Measuring Head CR-200, Minolta, Osaka, Japan) and this was used to objectively measure CIE Lab values (L-lightness, a-redness and b-yellowness). Before each measurement, the apparatus was standardized against a white tile. Breast fillets colour was classified in the deboning line and evaluated using a portable colorimeter (Minolta model, CR-400). Readings were carried out immediately after deboning. Samples were considered pale when their L value was equal or higher than 49 in the first reading. Out of the breast fillets classified as PSE and normal fillets were selected for the evaluation of meat colour and pH. The lymphoid organ weight indexes were calculated for liver and spleen according to the method described by Montgomery *et al.* (1995) as follows:

$$\text{Lymphoid organ weight index} = \frac{\text{OrganWeightx 100}}{\text{Bodyweight}}$$

And the small intestine length were calculated according to Statuz *et al.* (1983) as follows:

$$\text{Small intestine length} = \frac{\text{Small intestine fresh weight(g)x 100}}{\text{Smallintestinelength (cm)}}$$

4.3. Statistical analysis

Data was subjected to Analysis Of Variance (ANOVA) for a Completely Randomized Design (CRD) using the General Linear Model (GLM) procedure of SAS (2010) using the following model:

$$Y_{ijk} = \mu + D_{j(j=5)} + E_{ijk}$$

Where Yijk = dependent variable (parameters analysed), μ = overall mean, Dj = effect of experimental diet level and Eijk = random error. The significance was tested at P>0.05. The Turkey procedure was used to separate means among levels within a significant factor.

4.4. Results

4.4.1. The effect of onion and ginger supplementation on hot and cold carcass weight

Treatment did not significantly (P>0.05) influence the hot or cold carcass weights as shown in Table 4.1. The hot carcass weight ranged from as low as 820g in the control group (TRT1) to as high as 920g in dietary treatment TRT5 (basal diet + 20g ginger/kg feed). The trend was maintained in the cold carcass weights were the control group had the lowest weight (810g) compared to the other treatments.

Table 4.1. Hot and cold carcass weights (least square means ± SE) as influenced by treatment

Treatment	**Carcass Weight (g)**	
	Hot	**Cold**
1. Control	820	810
2. Basal diet +15g onion/kg feed	910	880
3. Basal diet +20g onion/kg feed	890	870
4. Basal diet +15g ginger/kg feed	870	860
5. Basal diet +20g ginger/kg feed	920	890
SE	0.03	0.03

4.4.2. The effect of onion and ginger supplementation on the initial and ultimate pH

The results on the initial and ultimate pH are shown in table 4.2. Initial pH ranged from 6.08 ± 0.12 in TRT3 to 6.32 ± 0.12 in TRT5. Ultimate pH was lower compared to the initial ones ranging from 5.68 ± 0.05 in the TRT 1 (control) to 5.68 ± 0.05 in both treatments TRT4 (basal diet +15g ginger/kg feed) and TRT5 (basal diet +20g ginger/kg feed).

Table 4.2. Effect of treatment on initial and ultimate pH ± SE

Treatment	pH	
	$pH_{(i)}$	$pH_{(u)}$
1. Control	6.28 ± 0.12	5.68± 0.05
2. Basal diet +15g onion/kg feed	6.23 ± 0.12	5.76 ± 0.05
3. Basal diet + 20g onion/kg feed	6.08 ± 0.12	5.74 ± 0.05
4. Basal diet +15g ginger/kg feed	6.11 ± 0.12	5.78 ± 0.05
5. Basal diet + 20g ginger/kg feed	6.32 ± 0.12	5.78 ± 0.05

4.4.3. The effect of onion and ginger supplementation on the carcass characteristics

The results on carcass characteristics indicate no significant difference (P>0.05) among the diet treatments as shown in Table 4.3. The average final weight of breasts ranged from 11.12 ± 0.83 in TRT1 (control) to 14.46 ± 0.83 in treatment TRT4 (Basal diet +15g ginger/kg feed). Weight of the drumsticks ranged from 58.75±2.51i n TRT1 (control) to 61.67±2.51 in TRT3 (basal diet + 20g onion/kg feed). Thigh weights ranged from 66.17±2.74 in TRT2 (Basal diet + 15g onion/kg feed) to 73.92±2.74 in TRT3. The average final weight of wings ranged from 54.92±1.63 in TRT3 (basal diet + 20g onion/kg feed) to 58.25 ±1.63 in TRT1 (control).

Table 4.3. Effect of onion and ginger supplementation on carcass characteristics

Treatment	Carcass yield (g)			
	Breast	Drumstick	Thigh	Wing
Control	11.83±0.83	58.75±2.51	67.50±2.74	58.25±1.63
Basal diet + 15g onion/kg feed	12.62±0.83	60.75±2.51	66.17±2.74	55.34±!.63
Basal diet + 20g onion/kg feed	14.46±0.83	61.67±2.51	73.92±2.74	54.92±1.63
Basal diet +15g ginger/kg feed	13.74±0.83	61.59±2.51	69.42±2.74	55.75±1.63
Basal diet +20g ginger/kg feed	11.12±0.83	60.42±2.51	68.92±2.74	55.59±1.63

4.4.4. The effect of onion and ginger supplementation on the organs

There were no significant differences among the treatments with regard to the weights of the different organs as shown in table 4.4. On average the liver weight ranged from 20.42±0.88 in the control to 20.97±0.88 in TRT3 (basal diet + 20g onion/kg feed). The range in the spleen weight was 2.67±2.83 in TRT4 (basal diet +15g ginger/kg feed) to 3.00 ±2.83 in TRT3 (basal diet + 20g onion/kg feed). The average weight of the heart ranged from as low as 4.58±0.27 in the control to as high as 5.42±0.27 in TRT5 (basal diet +20g ginger/kg feed). Although there were some differences in gizzards weights between the control and treatment 5, the differences were however not significant.

Table 4.4. Effect of onion and ginger on the organs relative to final weight

Treatment	Organs(g)					
	Final Weight (g)	Dressing %	Liver	Spleen	Heart	Gizzard
1. TRT1	1080	75	20.42	2.75	4.58	32.17
2. TRT2	1160	75	20.83	2.99	5.17	33.17
3. TRT3	1140	76	20.97	3.00	5.08	36.00
4. TRT4	1180	73	20.84	2.67	5.17	34.17
5. TRT5	1180	78	20.50	2.75	5.42	36.84
SE	0.04		0.88	2.83	0.27	0.71

4.4.5 The effect of onion and ginger supplementation on the colour score of meat

The results on the meat colour score showed no significant differences between the treatments as shown in Table 4.5. Meat colour lightness (L*) ranged from 57.40±2.27 in TRT5 (basal diet +20g ginger/kg feed) to 67.29±2.27 in TRT3 (Basal diet +20g onion/kg feed). The meat redness ranged from -2.28±0.39 in TRT2 (basal diet +15g onion/kg feed) to -3.11±0.39 in treatment 4 (basal diet +15g ginger/kg feed). The yellowness of the meat ranged from 11.12±0.83 in TRT5 (basal diet +20g ginger/kg feed) to 14.45±0.83 in TRT3 (Basal diet +20g onion/kg feed).

Table 4.5. Effect of onion and ginger on colour score of meat

Treatment	Meat colour		
	L*(lightness)	**a*(redness)**	**b* (yellowness)**
1. Control	62.49	-2.88	11.83
2. Basal diet +15g onion/kg feed	60.09	-2.28	12.62
3. Basal diet +20g onion/kg feed	67.29	-2.86	14.45
4. Basal diet +15g ginger/kg feed	66.95	-3.11	13.74
5. Basal diet +20g ginger/kg feed	57.40	-2.55	11.12
SE	2.27	0.39	0.83

4.5. Discussion

The present study investigated the effect of onion or ginger supplementation on carcass and organ characteristics of Potchefstroom Koekoek. The results indicate that carcass yield and organ weights were not significantly (P>0.05) influenced by dietary treatment. These results are in agreement with those obtained in studies carried out by several researchers (Aji *et al.*, 2011; Goodarzi *et al.*, 2013; Goodarzi *et al.*, 2014) where no significant difference were found in carcass yield of broilers supplemented with onion compared to the control. A study carried out by An *et al.*, (2015) on the effects of onion extracts on growth performance, carcass characteristics and blood profiles of white mini broilers also showed no significant difference in carcass yield. Dieumou (2009) also found no significant difference in carcass characteristics of chickens supplemented with ginger in their diet.

The results from the current study showed that the weights of the organs such as, the liver, spleen, heart and gizzard were not significantly influenced by treatment. Herbs like ginger and onion are known to have lipid reducing effect (Agarwal, 1996; Sharma *et al.*, 1996). However to the contrary, a study carried out by Ibrahiem *et al.*, (2004) showed that liver weights of broilers were decreased by feeding onion supplemented rations. Other studies carried out by Tekeli *et al.*, (2011) and Karangiva *et al.*, (2016), showed supplemental feeding of ginger to have a significant effect on weight gain of visceral organs.

Weight of edible parts such as the breast, drumstick, thigh and wing were not significantly affected by treatment. These results are in agreement with those obtained in studies carried out by Aji *et al.*, (2011) and An *et al.*, (2015) where no significant difference was found between treatments. The current study also showed onion and ginger to have no significant effect ($P<0.05$) on the initial pH, ultimate pH and the meat colour. The values for the initial pH ranged from 6.08 to 6.32 while the ultimate pH ranged from 5.68 to 5.78. The pH ranges obtained in the current study are within the ranges obtained by several researchers (Hertano *et al.*, 2018; Heinz & Hautzinger, 2007; Doungnapa Promket *et al.*, 2016). The results on pH and meat colour are also in agreement with those obtained in another study by Jang *et al.*, (2011), who found that the supplementation of onion extracts did not influence the pH and meat colour of chicken after slaughter. Under normal conditions, the fresh chicken meat has a pH is about 7 and roughly neutral (Heinz & Hautzinger, 2007). However, as the muscle is broken down, the pH falls to an ultimate value of between 5.3 and 6.5 post-slaughter (Soeparno, 2009). The glycolytic enzyme has been shown to be responsible for a drop in post-mortem muscle pH. Ultimate pH has been found to be dependent on the glycogen reserves in the muscle after slaughter (Fanatico *et al.*, 2007). After slaughter glycogen is catabolised to lactic acid through a pathway which reduces muscle pH (Nissan & Young, 2006). Meat products with low pH values are associated with poor holding capacity and meat colour (Chen *et al.*, 2013). Husak *et al.* (2008) reported that higher meat pH is more effective for retaining desirable colour and moisture absorption properties. Measurement of meat colour uses the CIELAB/CIE L*a*b* system where L* describes lightness, a* the redness (-a* greenness), and b* the yellowness. The meat colour values ranged from 57.40 to 67.29 for lightness (L*), -2.28 to -3.11 for redness (a*) and 11.12 to 14.45 for yellowness (b*) and were significantly influenced by treatment. The magnitude of the range of L*, a* and b* values obtained in the current study are comparable to those of other researchers (Barbut, 1997, Woelfet *et al.*, 2002; Gaobart & Moran, 2004; Petracci *et al.*, 2004; Doungnapa Promket *et al*, 2016). Using Qizo *et al.*, (2001) colour groupings of lighter than normal (L* > 53), normal (48<L*53) and darker (L* < 46), categorises meat samples of the current study as lighter than normal or pale. The reason for the meat in the current study being lighter than normal may be because of the slow growth of indigenous chickens.

The redness (a*) values (-2.28 to -3.11) showed meat to be less red and more yellow (b* 11.12 to 14.45). Studies have shown that higher b* values are observed mainly in meat of slow growing chickens (Kügükyilamaz *et al.*, 2012). The L* value is regarded as the main parameter that determines meat colour (Garcia *et al.*, 2010). The L* value indicate the degree of paleness. The lower L* value is associated with poor meat quality which is darker in colour. Some researchers have observed lower meat L* values in slow growing birds (Castellini *et al.*, 2002b; Fanatico *et al.*, 2006). The optimal lightness range of chicken fillets is around 49-50 (Barbut *et al.*, 1997). Higher values of meat L*, indicate lighter colour, indicating that the fillet has low pH (pH <5.6) while values below this range indicate meat darker in colour with a high pH above 5.9 (Garcia *et al.*, 2010). A study carried out by Castellini *et al.*, (2002) showed that a lower ultimate pH reduces the importance of myoglobin in selectively absorbing green light, resulting in meat that appears less red. Myoglobin concentration of the muscle have been found to vary with species, age, exercise, diet and environmental factors (Livingston & Brown, 1981; Miller, 2002).

Conclusion

The study did not establish any significant variation in terms of carcass yield, organ weights, initial pH, ultimate pH and meat colour of Potchefstroom Koekoek chickens supplemented with varying levels of onion and ginger.

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CHAPTER 5

THE EFFECT OF ONION OR GINGER SUPPLEMENTATION ON HAEMATOLOGICAL AND SERUM BIOCHEMICAL PARAMETERS OF POTCHEFSTROOM KOEKOEK

Abstract

The study was conducted to determine the effect of onion and ginger supplementation on haematological and serum biochemical parameters of Potchefstroom Koekoek. At day 90 of the research trail, twelve (12) birds from each treatment (TRT1 = basal diet (control); TRT2 = basal diet +15g onion per kg feed; TRT3 = basal diet +20g onion per kg feed; TRT4 = basal diet +15g ginger per kg diet; TRT5 = basal diet +20g of ginger per kg feed) were randomly selected for collection of blood. Blood samples were analysed for haematological and serum biochemical parameters. Haematological parameters (erythrocyte, haemoglobin, haematocrit, leucocyte, neutrophil, lymphocytes, monocytes, eosinophils and normoblasts) were not significantly ($P>0.05$) influenced by treatment. Serum biochemical parameters (bilirubin, alanine transaminase, Aspartate aminotransferase, total protein, sodium, potassium, albumin, urea, creatinine, glucose, calcium, cholesterol, magnesium and triglyceride) were also not significantly influenced ($P>0.05$) by addition of ginger or onion to rations fed Potchefstroom Koekoek chickens.

5.1. Introduction

Feed additives have over the years been used in poultry nutrition to maximise carcass weight, quality and thus the net return. Herbs such as onion and ginger have in the past been used to stimulate appetite, increase palatability, gastric secretions, nutrient utilization and thus higher productivity (Owen & Anwkiri, 2012; George *et al.*, 2015). Esonu *et al.*, (2001) state that the ability of an animal to physically respond to its internal and external environment, is generally reflected in its haematological constituents. The effects of environmental and nutritional stresses can be detected through the changes in the haematological parameters (George *et al.*, 2015). Ajagbonna *et al.* (1999) state that ingestion of plant constituents like ginger can alter normal ranges of haematological parameters. Blood serum and haematological parameters have in the past been used in diagnosing pathogenic and metabolic disorders. Thus, they are considered as vital tools in assessing health status of an individual flock (Elagib & Ahmed 2011; George *et al.*, 2015). Haematological and serum biochemical parameters have been reported to provide valuable information on the immune status of animals (Kral & Suchy, 2000). Furthermore, apart from being useful for diagnostic and management purposes, can also be incorporated in the breeding programmes for the genetic improvements of indigenous chickens (Ladokun *et al.*, 2008). The objective of this study was therefore to determine the effects of onion and ginger supplementation on serum and haematological parameters of Potchefstroom Koekoek chickens.

5.2. Materials and Methods

At day 90 of age, all birds that were used in the growth trial were fasted for 12 hours prior to being weighed A total of fifteen (15) birds per replicate were randomly selected and blood samples collected. The blood samples were collected via the wing veins using sterile needles and syringes into (5ml) non-heparinized tubes. Blood samples for haematological parameters were collected into well-labelled and sterilized bottles containing Ethylene Diamine Tetra Acetic Acid (EDTA) as an anti-coagulant, while the other set of bottles were without (EDTA). The blood was centrifuged at 3000rpm for five minutes to collect plasma in sterile Eppendorf tubes and stored at -20 ^{0}C for biochemical parameters analysis. Blood samples were immediately taken to LANCET laboratories for serum and haematological analysis. The samples were analysed for the following haematological parameters; erythrocytes, haemoglobin, haematocrit (HCT), leucocytes, neutrophils, lymphocytes, monocytes, eosinophils and normoblasts. Serum biochemical parameters analysed included; s-bilirubin (total), s-alt, s-ast, s-total protein, s-sodium, s-potassium, s-albumin, s-urea, s-creatinine, p-glucose random, s-calcium total, s-calcium corrected, s-cholesterol, s-magnesium, s-triglyceride and s-bilirubin conjugated.

5.3. Statistical analysis

For the traits measured once during the experimental period, the data were subjected to Analysis Of Variance (ANOVA) for a Completely Randomized Design (CRD) using the General Linear Model (GLM) procedure of SAS (2010) using the following model:

$Y_{ij} = \mu + T_j + E_{ij}$

Where Y_{ij} = dependent variable (parameters analysed), μ = overall mean, T_j = treatment effects and E_{ij} = random experimental errors.

The significance were tested at P>0.05. The Turkey procedure was used to separate means among levels within a significant factor.

5.4. Results

The results on haematological parameters showed that erythrocyte (Ery), haemoglobin (heam), hematocrit (hem), leucocyte (leu), lymphocyte (lym), monocytes (mono), neutrophil (neu), eosinophils (eos), normoblast (norm)were not significantly influenced (P>0.05) by treatment as shown in table 5.1.

Table 5.1. The effects of onion and ginger on Haematological parameters of Potchefstroom Koekoek chickens

Parameter	Treatments					
	TRT1	TRT2	TRT3	TRT4	TRT5	SE
Ery (x10^12/l)	2.6	2.7	2.7	2.6	2.8	0.09
Haem (g/dl)	8.7	9.5	9.1	9.1	9.8	0.33
Hem (l/l)	0.3	0.3	0.3	0.3	0.4	0.01
Leu (x10^12/l)	42.9	36.4	38.7	46.1	41.2	4.50
Lym (x10^9/l)	37.8	29.9	34.9	43.6	35.5	4.50
Mono (x10^9/l)	0.8	1.3	0.5	0.3	1.0	0.34
Neu (x10^9/l)	4.3	5.0	3.3	1.9	4.0	1.27
Eos (x10^9/l)	0	0.2	0	0.3	0.8	0.28
Norm(/100WBC)	1737	1997	1859	1633	1495	209.9

TRT1 (basal diet control); TRT2 (basal diet +15g onion per kg feed); TRT3 (basal diet +20g onion per kg feed); TRT4 (basal diet +15g ginger per kg diet); TRT5 basal diet +20g of ginger per kg feed.

The ranges of the levels of erythrocytes, leucocytes and monocytes were (2.61-2.77 x10^12/l), (36.36-46.05 x10^12/l) and (0.27-1.28x10^9/l) respectively. Haemoglobin and haematocrit ranges were (8.65 - 9.80g/dl) and (0.32- 0.35 l/l) respectively. Neutrophils, eosinophils and normoblast value ranges were (1.89 - 4.96 x10^9/l), (0-0.78 x10^9/l) and (1495 -1996/100WBC) respectively.

The results on serum biochemical parameters showed no significant difference (P>0.05) among the diet treatments as shown in table 5.2.

Table 5.2. Effect of onion and ginger on serum biochemical parameters

Parameter	Treatment					
	TRT1	TRT2	TRT3	TRT4	TRT5	SE
BILI (umol/l)	0.4	0.6	0.4	0.2	0.2	0.09
ALT (IU/L)	0.4	0.13	0.5	0.0	0.3	0.23
AST (IU/L)	165.0	167.4	164.8	166.9	169.0	5.80
PROT (G/l)	43.6	43.5	44.3	43.6	45.6	1.60
Na (mmol/l)	148.3	150.8	150.2	150.4	151.0	0.97
K (mmol/l)	4.5	4.2	4.8	4.6	4.1	0.29
ALB (g/l)	13.3	14.5	13.9	14.5	15.6	0.61
U (mmol/l)	0.2	0.2	0.2	0.3	0.3	0.04
CREA (umol/l)	18.0	16.9	18.5	18.6	18.0	1.32
GLU(mmol/l)	13.8	12.8	12.6	13.5	12.7	0.33
CAL_TOT(umol/l)	2.7	2.8	2.7	3.0	2.8	0.13
CAL_CRD(umol/l)	3.2	3.3	3.2	3.5	3.2	0.12
CHOL(mmol/l)	2.4	2.6	2.4	2.7	2.9	0.16
MAGN(mmol/l),	0.9	1.0	1.0	1.0	1.0	0.03
TRYGLY(mmol/l),	0.8	1.0	1.0	1.9	1.4	0.50

BILIR (umol/l)	1.2	1.2	1.2	1.2	1.2	0.00

TRT1 (basal diet control); TRT2 (basal diet +15g onion per kg feed); TRT3 (basal diet +20g onion per kg feed); TRT4 (basal diet +15g ginger per kg diet); TRT5 basal diet +20g of ginger per kg feed.

The levels of bilirubin ranged from 0.21 umol/l in TRT5 (basal diet + 20g ginger/kg feed), to 0.56 umol/l in TRT2 (basal diet + 15g onion/kg feed). Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST) value ranges were (0.00-0.30 IU/L) and (164.75-169 IU/L) respectively. Sodium, potassium and magnesium ranges were (148-151 mmol/l), (4.09-4.84 mmol/l) and (0.94-1.00 mmol/l) respectively. Cholesterol levels ranged from 2.36 in the control to 2.88 in TRT5. Creatinine levels ranged from 16.88 in TRT2 (basal diet + 15g onion/kg feed) to 18.63 in TRT 4 (basal diet + 15g ginger/kg feed).

5.5. Discussion

The results indicate that addition of ginger and onion at different inclusion levels did not significantly influence ($P>0.05$) the haematological parameters of Potchefstroom Koekoek chickens. These results are in agreement with those obtained in a study carried out by Al-Khalifa *et al.* (2018), where the inclusion of ginger in broiler diets did not significantly influence haematological parameters. This is in contrast with Oleforuh-Okoleh *et al.* (2015) who observed significant increases in the concentration of haemoglobin, packed cell volume, white blood cells and red blood cells of ginger treated birds. Dietary inclusions of herbal plants in broiler rations have been extensively evaluated and were proved in many cases to show positive results in terms of haematological parameters (Amera *et al.*, 2013). George *et al.* (2015) state that the ingestion of plant constituents such as natural plant materials can alter the normal ranges of haematological parameters. Several studies have shown that haematological profile of chickens are correlated with a number of factors such as age, gender, nutrition, rearing temperature, stocking density and stress conditions (Pampori & Iqbal, 2007; Kececi & Col, 2010; El-Gendy *et al.*, 2011; Elagib & Ahmed, 2011). Haematological constituents have been shown to reflect on the physiological responsiveness of an animal to its internal and external environment which includes feed and feeding Esonu *et al.*, (2001). Haematological parameters have often been suggested as useful indicators of stress or diseases.

Serum biochemical parameters were also not significantly influenced (P>0.05) by addition of onion and ginger to diets fed to Potchefstroom Koekoek chickens. These findings are similar to those of Onu, (2010) who reported that supplementation of ginger (0.25%) in the basal diet of broiler chicks did not result in any significant difference in terms of total protein, globulin, urea and createnine. George *et al.*, (2015) also found no significant difference in serum components (total protein, albumin, creatinine, urea, alkaline phosphate, total cholesterol, alanine and aspartate) except for albumin which was significantly influenced by ginger supplementation. Farinu *et al.*, (2004) reported that supplementation of ginger at the rate of 5, 10 and 15g/kg did not affect total protein and albumin in the serum of broilers. However to the contrary, several studies have shown cholesterol and glucose to be significantly reduced by supplementation of ginger (Bhandari *et al.*, 1998; Akhani *et al.*, 2004, Saeid, *et al.*, 2010; Oleforuh-Okoleh *et al.* (2015), Mansoub, 2011; Wafaa *et al.*, 2012). Suresh and Srinivasan (1997) found that 3% onion powder reduced blood lipids, lipid peroxides and cholesterol. Al-homidan (2005) also observed the reduced serum cholesterol in their experiments by using of onion. In contrast, Sklan *et al* (1992) did not observe any effect of onion on hepatic cholesterol. The effects of onion have been ascribed to its sulfur containing principles which oxidize thiol compounds either present free or combined with a protein and NADPH which are necessary for lipid synthesis.

Alikwe *et al.* (2010) state that serum protein may be used to indirectly measure the protein quality of the diet. In general the high levels of bilirubin are caused by problems with the red blood cells, the liver or bile ducts. Hyperbilirubinemia is the accumulation of bilirubin, a brownish-yellow compound that is formed when old or damaged red blood cells are broken down. Normally, bilirubin is chemically altered by the liver so that it can be safely excreted in urine. However, red blood cells are being broken down at an abnormally high rate or liver is not functioning as it should, hyperbilirubinemia can occur. Bilirubin is a waste product produced by normal breakdown of heme which is a component of haemoglobin. Thus it is used to evaluate the livers function or held diagnose anaemia caused by destruction of the red blood cells. In the current study serum bilirubin levels were not affected by supplementation of onion and ginger. This means that there were no abnormalities in liver functions after ginger and onion were used. Serum levels of aspartate aminotransferase (AST), alanine aminotransferase (ALT), creatine, and uric acid were not affected by addition of ginger and onion as they were all similar to those of the control indicating none of the dosages was toxic. Aspartate aminotransferase (AST) is an enzyme found throughout the body but mostly in the heart and liver and to a lesser extent in the kidneys and muscle. In healthy individuals AST levels are low. When the liver muscle cells are injured, they release AST into the blood. This makes AST a useful parameter for detecting and monitoring liver damage. Alanine aminotransferase (ALT) is also an enzyme found in the liver and kidneys with smaller amounts found in the heart and muscle. The function of ALT is to convert alanine into pyruvate, an important intermediate in cellular energy production. In healthy birds ALT levels in the blood is low (range below 6.1 IU/L) (De Marco *et al.*, 2015). When the liver is damaged, ALT is released into the blood and therefore is a useful test to detect liver damage (De Marco *et al.*, 2015).

Farinu *et al.* (2004) also reported that supplementation of ginger at the rate of 5, 10 and 15 g/kg did not affect total protein and albumin in the serum of broiler chickens. The reduction in cholesterol level can be traced to the presence of gingerols and shagols components in ginger which inhibits lipid peroxidation (Verma *et al.*, 2004; Ashani & Verma, 2009).

Conclusion

Results from this study revealed that ginger and onion supplementation in rations fed to Potchefstroom Koekoek chickens did not significantly influence their haematological and serum biochemical parameters.

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CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

Addition of onion and ginger to the rations fed Potchefstroom Koekoek chickens did not affect their ability to convert feed to muscle and be able to gain weight in a similar manner to chickens not supplemented with these herbs. Carcass yield, organ weights, pH and meat colour were also not significantly (P>0.05) influenced by treatment. Weight of edible parts (breast, drumstick, thigh and wing) and organs (liver, spleen, heart and gizzard) did not vary between the control and the treatments. The colour score values for lightness (L*), redness (a*), and yellowness (b*) did not differ significantly between treatments. Haematological parameters (erythrocyte, haemoglobin, haematocrit, leucocyte, neutrophil, lymphocytes, monocytes, eosinophils and normoblasts) were not significantly influenced by treatment. Serum biochemical parameters (bilirubin, alanine transaminase, Aspartate aminotransferase, total protein, sodium, potassium, albumin, urea, creatinine, glucose, calcium, cholesterol, magnesium and triglyceride) were also not significantly influenced by addition of ginger or onion to rations fed Potchefstroom Koekoek chickens.

The lack of response on all parameters measured in the current study to the effect of onion and ginger supplementation may be because indigenous chickens have for years managed to survive under stressful scavenging conditions without proper nutrition and vaccination. Years of natural selection under scavenging conditions have made them robust and resistant to various diseases. The hardiness of indigenous chickens has however been shown to be at the expense of higher level of productivity as they are less able to exploit the advantages of improved management and nutrition. Therefore the inability of Potchefstroom Koekoek to respond to the inclusion levels used in the current study may suggest that the levels used were too low for the bioactive ingredients in these herbs to show any positive effect on the parameters measures. Another reason may be that the higher natural antibodies may be enabling these indigenous chickens to survive without the support of natural herbs. For further study, optimum levels of below 15g/kg and above 20g/kg of both ginger and onion should be determined on growth performance, carcass and haematological characteristics of Potchefstroom Koekoek.