

**NUTRITIONAL CHARACTERISTICS OF VEAL**

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## PREFACE

This study formed part of a major project on the determination of the nutritional and quality characteristics of red meat (beef and veal) in South Africa, sponsored by the South African Meat Board. The study on veal was divided into two phases. Phase 1 included evaluation of the physical composition and proximate chemical analysis, total collagen and collagen solubility determinations, as well as the sensory evaluation of each veal cut, raw and prepared according to the most appropriate dry or moist heat cooking method. Phase 2 consisted of the determination of the nutrient content of both raw and cooked veal cuts of carcasses found in the South African Carcass Classification System. However, for the purpose of this dissertation, only the nutritional characteristics (phase 2) and the proximate chemical analyses (phase 1 and 2) will be reported and discussed. The data obtained from the physical analysis was used to determine the contribution of each cut to the carcass.

The researcher was responsible for:

- Definition of criteria for the selection of carcasses
- Supervision of physical dissection of carcasses, weighing and deboning of cuts as well as collection of data
- Preparation and packaging of samples for proximate, collagen and nutrient analyses
- Dispersion of samples to different laboratories for analyses
- Determination of a suitable cooking method for each of the eight cuts of veal
- Cooking and the sensory evaluation of all the veal cuts
- Determination of the shear force on each of the cooked veal cuts
- Recording of data
- Statistical analyses of results
- Interpretation of results

The project was monitored by the " Working Group on Nutritional Value Research of Red Meat", under the chairmanship of Dr. R.T. Naudé, presently Vice-president, Animal Production, of the Agricultural Research Council. They participated in the planning, execution, progression and regular reporting of the work.

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During the course of the study, the following work documents were prepared and presented to the working group of the project:

- DE BRUIN, F. M. 1991. Veal: Tables and statistics. p 15.
- DE BRUIN, F.M. 1992. Progress report on veal. p 20.
- DE BRUIN, F.M. 1993. Nutritional value of veal.

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## OPSOMMING

Die nutriëntsamesstelling van Suid-Afrikaanse kalfsvleis is onbekend. Die inligting wat in die Suid-Afrikaanse Voedseltabelle gegee word, is saamgestel uit gepubliseerde oorsese data. Teen die agtergrond van die potensiële belangrikheid van kalfsvleis in die menslike dieet, is die fisiese en chemiese eienskappe van kalfsvleissnitte, rou en voorberei op die mees geskikte gaarmaakmetode, ondersoek. Bykomend is die nutriëntsamesstelling van rou en gaar kalfvleissnitte van karkasse volgens die Suid-Afrikaanse karkassklassifikasie stelsel bepaal. Die moontlike bydrae van kalfsvleis tot 'n gesonde, gebalanseerde diet vir Suid-Afrikaners is teen die agtergrond van die nutriëntsamesstelling van kalfsvleis en die riglyne vir 'n omsigtige dieet bespreek.

Graad 1 en Super kalfsvleiskarkasse is in agt groothandelsnitte verdeel. Die bepaling van die fisiese samestelling het ontbening en verdere verdeling van elke snit in onderhuidse vet, maer vleis en been ingesluit. Verteenwoordigende monsters van elke snit is gebruik vir chemiese analises om die persentasie vog, vet, proteïen en as te bepaal. 'n Saamgestelde monster bestaande uit drie kalfkarkasse van elke graad is gebruik om die nutriëntinhoud van elke rou en gaar snit te bepaal. Analises van die volgende nutriënte is gedoen: proksimale analise (% vet, vog, proteïen en as), minerale (kalsium, fosfor, magnesium, kalium, natrium, koper, sink, mangaan en yster), wateroplosbare vitamien (tiamien, riboflavin, niasien, piridoksien, folasien, sianokobalamien, biotien en kalsiumpantonaat), vetsuurprofiel en totale cholesterolinhoud. Die voedselenergiewaarde is bereken uit die vet - en proteïenwaardes wat uit die chemiese analises verkry is.

Die koëffisiënte van variansie vir alle nutriënte behalwe folasien tussen die verskillende nitte van beide Graad 1 en Super rou en gaar kalfsvleis, was groter as die analitiese variansie vir hierdie nutriënte.

Die resultate van hierdie studie het aangetoon dat die nutriëntsamesstelling van Suid-Afrikaanse Graad 1 en Super kalfsvleis effens verskil, hoewel nie statisties betekenisvol nie, van Amerikaanse kalfsvleis, sowel as van die waardes wat in die Suid-

Afrikaanse Voedsel Tabele aangegee word. Analises in hierdie studie is gedoen op spier plus sigbare onderhuidse vet, in vergelyking met studies oor Amerikaanse kalfsvleis waar spier en onderhuidse vet apart geanaliseer is. Om die nutriëntsamestelling van Suid-Afrikaanse kalfsvleis soos in hierdie studie bevind met Amerikaanse data te vergelyk, is 'n karkaswaarde vir elke nutriënt bereken. Hierdie karkaswaarde is bereken volgens elk van die agt snitte se relatiewe bydrae tot die karkassamestelling en vir die kalfsvleis wat op die Suid-Afrikaanse mark beskikbaar is (93,3% Graad 1 en 6,7% Super) aangepas. Die gepaarde Mann-Whitney en die Kolmogorov-Smirnov tweemonster toetse is gebruik om die twee datastelle statisties met mekaar te vergelyk. Hoewel die resultate geen statisties betekenisvolle verskille tussen die Suid-Afrikaanse en Amerikaanse kalfsvleis aangetoon het nie, was Suid-Afrikaanse kalfsvleis egter effens laer in vet (9,82 g/100 g teenoor 10,09 g/100 g) maar hoër in versadigde vetsure (5,03 g/100 g teenoor 3,64 g/100 g) as Amerikaanse kalfsvleis.

Die nutriëntdigthede van Suid-Afrikaanse kalfsvleis was in dieselfde orde as dié van Amerikaanse en Australiese kalfsvleis. Daarvolgens is Suid-Afrikaanse kalfsvleis 'n uitstekende bron van proteïene (nutriëntdigtheid 5,47), kalium (1,39), sink (5,40), koper (6,76), riboflavin (1,72), niasien (3,9) en vitamien B<sub>6</sub> (1,57) en B<sub>12</sub> (10,36) onderskeidelik. Suid-Afrikaanse kalfsvleis is ook 'n goeie bron van yster, tiamien en folasien met nutriëntdigthede van 0,55, 0,99 en 0,51. Verskille in die samestelling tussen rou en gaar snitte is vasgestel. Dit blyk dat vogverliese gedurende die gaarmaakproses moontlik daarvoor verantwoordelik was. Die gaarmaakproses het egter nie die nutriëntwaarde (vitamien en minerale) nadelig beïnvloed nie.

Hierdie studie het nuwe inligting aangaande die nutriëntsamestelling van Suid-Afrikaanse kalfsvleis verskaf. Dit is duidelik dat kalfsvleis 'n waardevolle bron van proteïene, verskeie minerale en vitamien is. Daar is tot die gevolgtrekking gekom dat as gevolg van die relatiewe lae vetinhoud en die hoë nutriëntdigtheid, kalfsvleis op 'n gereelde basis in die omsigtige dieet, wat aanbeveel word om Westerse siektes te help voorkom, ingesluit kan word. Kalfsvleis het verder die ideale nutriëntsamestelling om diëte waar mielies as stapelvoedsel gebruik word en laag in proteïen en niasien is, te balanseer.

Uit hierdie studie kan die volgende algemene aanbevelings ten opsigte van die toekoms van kalfsvleis in Suid-Afrika gemaak word:

- Kalfsvleis kan op 'n gereelde basis in die omsigtige dieet ingesluit word en kan ook gebruik word om nutriënttekorte in diëte waar mielies as stapelvoedsel gebruik word aan te vul. Daarom behoort die nutriëntsamesstelling van kalfsvleis soos in hierdie studie bepaal, in die Suid-Afrikaanse Voedseltabelle opgeneem te word.
- Die publiek moet van korrekte en resente inligting voorsien word om sodoende die verbruik van kalfsvleis te verhoog.
- Die potensiaal om kalfsvleis in Suid-Afrika nie slegs as 'n lekkerny nie, maar ook as 'n gesonde voedsel te bemark, moet ontwikkel word.

## SUMMARY

The nutrient composition of South African veal is not known. The information given in the South African Food Composition Tables was compiled from published overseas data. Against the background of the potential importance of veal in the human diet, the physical and chemical characteristics of veal cuts (raw and prepared according to the most appropriate cooking method) were investigated. In addition, the nutrient content of raw and cooked veal cuts of carcasses classified according to the South African carcass classification system was also determined. The possible contribution of veal to a healthy and balanced diet for South Africans is discussed against the background of the nutrient composition of veal and the recommendations for a prudent diet.

Grade 1 and Super veal carcasses were divided into eight wholesale cuts. The determination of the physical composition involved deboning as well as further subdivision of each cut into subcutaneous fat and lean meat. Representative samples of each cut were used for proximate chemical analyses to determine the percentages of moisture, fat, protein and ash. A composite sample from three veal carcasses within each grade was used to determine the nutrient content of each raw and cooked cut. Analyses of the following nutrients were done: proximate analyses (% fat, moisture, protein and ash), minerals (calcium, phosphorus, magnesium, sodium, potassium, zinc, manganese, copper and iron), water-soluble vitamins (thiamin, riboflavin, niacin, pyridoxine, folic acid and biotin), fatty acid profiles and total cholesterol content. The food energy content was calculated from fat and protein values obtained from the proximate chemical analyses.

The coefficients of variance for all nutrients except folacin between cuts of both Grade 1 and Super raw and cooked veal were greater than the analytical variance for these nutrients.

The results of this study indicate that the nutrient composition of South African Grade 1 and Super veal differed slightly but not statistically significant from American veal, as well as from values given in the South African Food Composition Tables. Analyses in

this study were performed on muscle plus visible subcutaneous fat, whereas studies of American veal analysed lean and subcutaneous fat separately. To compare the nutrient composition of South African veal as determined in this study to American data, a carcass value for each nutrient was calculated. This carcass value was calculated according to the relative contribution of each of the eight cuts to the carcass composition and adjusted for veal available on the South African market (93,3% Grade 1 and 6,7% Super). The paired Mann-Whitney and Kolmogorov-Smirnov two sample tests were used to compare the two data sets statistically. Although the results indicate no statistically significant differences between the South African and American data, South African veal was slightly lower in fat (9,82 g/100 g compared to 10,09 g/100 g) but higher in saturated fatty acids (5,03 g/100 g compared to 3,64 g/100 g) than American veal.

The nutrient densities of South African veal were in the same order as those of American and Australian veal. Accordingly South African veal is an excellent source of protein (nutrient density 5,47), potassium (1,39), zinc (5,40), copper (6,76), riboflavin (1,72), niacin (3,9) and vitamins B<sub>6</sub> (1,57) and B<sub>12</sub> (10,36). South African veal is also a good source of iron, thiamin and folacin with nutrient densities of 0,55, 0,99 and 0,51. Differences in composition between raw and cooked cuts were established. Moisture loss during cooking is most probably responsible for these differences. The cooking process does not seem to adversely influence the nutrient content (including vitamins and minerals) of veal.

This study supplied new information concerning the nutritional composition of South African veal. Veal is clearly a valuable source of protein, several minerals and vitamins. The relative low fat content and high nutrient density of veal makes it suitable for regular inclusion in the prudent diet which is recommended to prevent Western diseases of affluence. Veal has the ideal nutrient composition to balance diets low in protein and niacin, furthermore typical of South Africans whose dietary staple is maize.

This study enables the following general recommendations regarding the future of veal in South Africa to be made:

- Veal can be included in the prudent diet on a regular basis, and can also be used to address nutritional deficiencies in diets where maize is the staple.
- The public should be supplied with reliable and current formation on veal in order to promote consumption. Therefore, the nutrient composition data as determined by this study should be incorporated in the South African Food Tables.
- The potential of marketing veal in South Africa, not only as a delicacy but also as a healthy food, should be developed.

## CHAPTER 1

### INTRODUCTION

#### 1.1 Background

The relationship between diet and health is no longer questioned. Knowledge of this relationship has led to the formulation of the Recommended Dietary Allowances (RDA: Food and Nutrition Board, 1989: 284) which gives the levels of intake of "essential nutrients considered, in the judgement of the Committee on Dietary Allowances of the Food and Nutrition Board on the basis of available scientific knowledge, to be adequate to meet the known nutritional needs of practically all healthy persons." In recent years, much emphasis has been placed on the possible detrimental effects of a too high total fat and saturated fatty acid intake in the development of degenerative diseases of affluence. The emphasis has focussed on a suspected relationship with dietary intake of animal products, the main sources of saturated fats, resulting in dietary recommendations or goals which lower meat intake and increase that of plant foods (Truswell, 1987: 1068). However, meat forms an important part of a balanced and varied diet; it makes a major contribution to the recommended nutrient intake by providing a significant proportion of the daily requirement for protein (essential amino acids) as well as supplying a variety of vitamins and minerals (Breidenstein, 1987: 43; Johnson, 1987: 183).

The nutrient profiles for meat, including that of veal, have recently been updated in the United States of America and Australia to account for changes in veal production technology and to provide more data than was previously available (Ono *et al.*, 1986: 1352; Greenfield *et al.*, 1987: 208). The nutrient composition of cooked veal cuts was determined by Ono and his co-workers in 1986. The percentage of the RDA (Food and Nutrition Board, 1989: 285) for 23-50 year old men provided per capita by veal in America, is shown in Table 1.1. Overseas research data is, however, not readily applicable to the South African situation, because the descriptions of veal joints as well as the dissection methods of the veal carcass in the various overseas countries differ (Ono *et al.*, 1986: 1353; Greenfield *et al.*, 1987: 209).

Table 1.1: PERCENTAGE OF RDA FOR MEN AGED 23-25 YEARS PROVIDED PER CAPITA BY 100 g COOKED VEAL IN THE UNITED STATES

Protein %	Energy %	Iron %	Phosphorus %	Zinc %	Thiamin %	Riboflavin %	Niacin %	Vit B <sub>12</sub> %	Vit B <sub>6</sub> %
43,0	5,7	9,9	26,6	28,9	3,3	17,1	37,7	70,5	70,5

\* Adapted from U.S. National Live Stock and Meat Board (1991: 21)

Veal is regarded as a nutrient dense food in the United States of America. When compared to its energy content, lean veal tissue contributes more than six times the protein, three times more zinc, five times more thiamin, twice the riboflavin, five times the niacin and almost six times more vitamin B<sub>12</sub>. Similar to all other red meats, approximately 40% of the iron in veal is in the haem form, which is more readily available than iron of non-haem forms (Breidenstein & Williams, 1986: 8). The contribution of veal to the nutrient pool in South Africa has not yet been determined.

Table 1.2: AVAILABILITY AND PER CAPITA CONSUMPTION OF RED MEAT IN THE RSA\*

YEAR	BEEF		VEAL		MUTTON		PORK	
	Available (tons)	Per capita (kg)	Available (tons)	Per capita (kg)	Available (tons)	Per capita (kg)	Available (tons)	Per capita (kg)
1985	494 099	17,98	39 000	1,42	136 543	4,97	91 690	3,34
1986	488 154	17,28	76 821	2,72	116 724	4,13	89 514	3,17
1987	456 964	15,73	57 657	1,99	123 068	4,23	90 307	3,11
1988	453 815	15,20	41 868	1,40	119 823	4,01	95 695	3,20
1989	547 941	15,03	59 059	1,62	160 700	4,70	107 000	3,10
1990	597 233	16,02	60 767	1,63	166 700	4,90	118 000	3,30
1991	625 593	16,44	62 407	1,64	189 600	5,40	123 000	3,40
1992	667 582	17,19	59 418	1,53	175 600	5,00	105 000	2,90
1993	667 456	16,81	61 544	1,55	165 500	4,80	112 000	3,20

\* Adapted from Directorate Agricultural Economic Trends (1994: 61-67)

Currently, only a limited market for veal exists in South Africa and an established veal production industry producing 14-20 week old calves with carcass masses ranging from 80-120 kg such as found in the USA and Europe, is non-existent. South Africa is still lagging far behind when compared to the overseas market where veal is a generally available delicacy and calves are raised on special diets for this purpose.

The majority of the veal carcasses sold on South African markets are male calves generated in dairy herds, regarded as a burden to the producer (Cruywagen, 1988:8). However, these calves could be efficiently utilized if South Africans were to regard veal as a valuable source of nutrients (Horn-Quass, 1992: 20). Presently, the local per capita veal consumption in the RSA is much lower than that of other types of red meat (Table 1.2).

Table 1.3: MARKETING OF VEAL IN THE RSA \*

YEAR	GRADE 1		SUPER	
	NUMBERS	AVERAGE CARCASS MASS	NUMBERS	AVERAGE CARCASS MASS
1985	56117	44,6	4036	86,9
1986	51105	43,9	3163	88,9
1987	38714	42,7	1715	87,7
1988	30066	43,5	1049	86,0
1989	50748	43,5	1252	88,4
1990	62565	42,3	1435	89,6
1991	52269	41,4	1589	90,7
1992 (June)	26848	44,7	849	90,8

\* Adapted from RSA Meat Board (1992: 61)

According to Table 1.3, the majority of veal carcasses sold on the South African markets during the period from January 1985 to June 1992, were classified as Grade 1 indicating an average mass of 41,1-44,7 kg. Only approximately 4% of the total amount of veal carcasses sold during this period were graded as Super with an average carcass mass varying from 86,0-90,8 kg. In spite of a sharp decline in the sales of veal carcasses from 1985 to 1988, a significant increase was shown from 1989 to June 1992. At this time the grading system of veal in South Africa was changed.

The average market price of veal compares favourably with that of other types of red meat (Table 1.4). Since 1985 the average auction price was lower than that of lamb and mutton.

Table 1.4: AVERAGE YEARLY AUCTION PRICES OF RED MEAT  
AT CONTROLLED MARKETS \* (c/kg)

YEAR	BEEF	VEAL	PORK	LAMB & MUTTON
1985	239,3	223,9	213,2	333,1
1986	289,2	277,0	264,0	410,0
1987	400,9	407,7	314,8	475,7
1988	471,0	504,2	358,9	599,0
1989	482,6	476,8	373,5	531,1
1990	473,7	467,6	355,9	503,6
1991	474,9	467,4	355,3	478,6
1992	522,0	479,2	399,4	564,2
1993	521,6	476,8	448,3	624,4

\* Adapted from RSA Meat Board (1993(4): 1-65)

The nutritional content of American and Australian veal is very similar to that of beef (Tables 1.5 and 1.6). However, veal cuts are leaner and consequently lower in energy than corresponding beef cuts (Greenfield *et al.*, 1987: 214). An increasing demand for leaner meat in Western countries is also present amongst South African consumers. Veal could possibly fit that demand, because American and Australian veal has a low total fat as well as a low saturated fat content (Horn-Quass, 1992: 20). Therefore veal is a potential alternative to red and white meat.

Table 1.5: COMPARISON OF THE NUTRITIONAL CONTENT OF COOKED, LEAN AMERICAN VEAL AND LEAN BEEF (per 100 g edible portion)

NUTRIENT	UNIT	VEAL BLADE STEAK, BRAISED			BEEF BLADE STEAK, braised <sup>4</sup>
		Anderson <sup>1</sup>	Breidenstein <sup>2</sup>	Ono <sup>3</sup>	
Protein	g	33.68	33.98	31,40	31,06
Total fat	g	6,10	5.75	3.15	15,27
Ash	g	1.27	1.27	1.36	0,99
Energy	kJ	832	825	856,8	1130,00
Cholesterol	mg	130	163.50	182	106,00
<i>MINERALS</i>					
Iron	mg	1,45	1,54	1,79	3,68
Zinc	mg	7,00	7,33	7,10	10,27
Copper	mg	0,159	0,173	0,19	0,148
Magnesium	mg	28,00	27,40	28,40	23,00
Sodium	mg	97,0	106,0	121,0	71,00
Potassium	mg	319,0	305,0	306,0	263,00
Phosphorus	mg	260,0	255,6	266,0	235,00
<i>VITAMINS</i>					
Folacin	ug	16,0	16,785	21,7	6,00
Thiamin	mg	0,06	0,062	0,07	0,083
Riboflavin	mg	0,35	0,368	0,38	0,284
Niacin	mg	6,68	6,255	8,37	2,666
Vitamin B <sub>6</sub>	mg	0,26	0,235	0,19	0,29
Vitamin B <sub>12</sub>	ug	1,94	2,09	2,39	2,47
Pantothenate	mg	1,61	1,75	2,31	0,352
<i>FATTY ACIDS</i>					
Saturated	g	1,70	1,45	n/a	6,22
Monounsaturated	g	2,18	1,76	n/a	6,82
Polyunsaturated	g	0,55	0,53	n/a	0,52
P/S ratio		0,32	0,37	n/a	0,08

Adapted from:

<sup>1</sup> Anderson *et al.* (1989: 152)

<sup>3</sup> Ono *et al.* (1986: 1355)

<sup>2</sup> Breidenstein (1987: 50-53)

<sup>4</sup> Breidenstein (1987:48)

Table 1.6: COMPARISON OF THE NUTRITIONAL CONTENT OF COOKED, AMERICAN VEAL (LEAN AND FAT) AND LEAN BEEF (per 100 g edible portion)

NUTRIENT	UNIT	VEAL BLADE, BRAISED <sup>1</sup>	BEEF BLADE, BRAISED <sup>2</sup>
Protein	g	31,26	31,06
Total fat	g	10,9	15,27
Ash	g	1,22	0,99
Energy	kJ	940	1130,00
Cholesterol	mg	153	106,00
<i>MINERALS</i>			
Iron	mg	1,44	3,68
Zinc	mg	7,00	10,27
Copper	mg	0,164	0,148
Magnesium	mg	26,0	23,00
Sodium	mg	98	71,00
Postassium	mg	297	263,00
Phosphorus	mg	244	235,00
<i>VITAMINS</i>			
Folacin	ug	15	6,00
Thiamin	mg	0,06	0,083
Riboflavin	mg	0,35	0,284
Niacin	mg	5,50	2,666
Vitamin B <sub>6</sub>	mg	0,24	0,29
Vitamin B <sub>12</sub>	ug	1,93	2,47
Pantothenate	mg	1,52	0,352
<i>FATTY ACIDS</i>			
Saturated	g	3,64	6,22
Monounsaturated	g	3,85	6,82
Polyunsaturated	g	0,74	0,52
P/S ratio		0,20	0,08

Adapted from: <sup>1</sup> Anderson *et al.* (1989: 161)

<sup>2</sup> Breidenstein (1987: 48)

Comparison of the total fat content of lean American veal and beef (Table 1.5) shows that 100 g cooked, braised beef blade steak contains 15,27 g fat, while braised veal blade steak only contains 3,15-6,10 g fat (Anderson *et al.* 1989: 152; Breidenstein 1987: 50; Ono *et al.* 1986: 1355). Similarly, cooked Australian veal has less fat than beef (Table 1.6). Therefore, it is important that the fat content of South African veal should be determined.

Table 1.7: COMPARISON OF NUTRITIONAL CONTENT OF RAW AND COOKED LEAN AUSTRALIAN VEAL AND BEEF \* (per 100 g edible portion)

NUTRIENT	UNIT	VEAL SHOULDER STEAK		BEEF CHUCK STEAK	
		Raw	Cooked	Raw	Cooked
Water	g	74,50	68,80	74,80	57,70
Protein	g	22,70	28,90	20,50	36,90
Fat	g	2,50	3,23	2,90	6,00
Ash	g	1,10	1,30	1,10	0,90
Energy	kJ	478,00	610,00	456,00	849,00
<i>VITAMINS</i>					
Thiamin	mg	0,17	0,07	0,07	0,05
Riboflavin	mg	0,24	0,20	0,23	0,38
Niacin	mg	3,20	3,90	3,50	5,80
<i>MINERALS</i>					
Sodium	mg	99,00	101,00	65,00	49,00
Potassium	mg	330,00	370,00	340,00	240,00
Calcium	mg	4,00	5,00	6,00	7,00
Iron	mg	1,80	2,00	2,10	3,80
Magnesium	mg	22,00	24,00	21,00	19,00
Zinc	mg	3,30	4,00	6,40	11,70

\* Adapted from Greenfield *et al.* (1987: 210-215)

The lipid profiles of cooked meat (Table 1.8) as well as the comparison of fatty acids in veal and beef (Table 1.5), show that the proportion of saturated and monounsaturated fatty acids provided by veal is lower than that provided by beef. Veal contains proportionally more polyunsaturated fatty acids than beef (Table 1.5). People on a low fat, cholesterol lowering diet may therefore benefit from a relatively higher consumption of veal because it is well known that saturated fatty acids in the diet increase serum cholesterol, while monounsaturated and polyunsaturated fatty acids decrease cholesterol levels (Grundy, 1991: 471-478).

Veal contains more cholesterol than beef (Greenfield *et al.*, 1987 :214; Tables 1.4; 1.5 and 1.7). According to health professionals, dietary fat should not provide more than 30% and saturated fat less than 10% of the total energy intake. Truswell (1987: 1060-1072) summarized the dietary recommendations of seventeen different countries and found that most countries do not have a specific limitation on dietary cholesterol.

Table 1.8: CHOLESTEROL CONTENT AND LIPID PROFILES OF AMERICAN COOKED MEAT\* (per 100 g serving)

	LIPIDS	SATURATED FATTY ACIDS		MONO UNSATURATED FATTY ACIDS		CHOLESTEROL
	g	g	%	g	%	mg
Chicken, Flesh, Roasted	6.3	1.7	27	2.3	37	76
Turkey, Light Meat, Flesh, Roasted	2.7	0.9	33	0.5	19	59
Turkey, Dark Meat, Flesh, Roasted	6.1	2.1	34	1.4	23	72
Lamb, Composite of Cuts, Lean, Roasted	8.1	3.0	37	3.7	46	78
Pork, Composite of Cuts, Lean, Roasted	11.1	3.8	34	5.0	45	79
Beef, Composite of Cuts, Lean, Roasted	8.7	3.4	39	3.8	44	76
Veal, Composite of Cuts, Lean, Roasted	5.0	1.2	24	1.5	30	128

\* Adapted from Breidenstein & Williams (1986: 5 & 6)

According to the British recommendations, cholesterol intake is likely to fall if recommendations regarding intake of saturated fatty acids are implemented. These recommendations also state that evidence of cholesterol intake influencing blood cholesterol level is inconclusive. According to recommendations, in South Africa cholesterol intake should not exceed 300 mg per day (Diet Consensus Panel, 1989: 592).

Biological mechanisms should also be taken into consideration in assessing the potential effect of dietary cholesterol on blood cholesterol levels. Firstly, the human body requires cholesterol and even when dietary cholesterol is completely excluded, it will synthesize between 800 and 1500 mg/day to meet these requirements (Robinson *et al.*, 1990: 90). Secondly, dietary cholesterol is poorly digested and absorbed by the human body. Digestibility is estimated to range between 10% and 50% (Robinson *et al.*, 1990: 93). Therefore, the effect of dietary cholesterol on the blood cholesterol level is not clear. As an example, the maximum difference in cholesterol content between the types of meat shown in Table 1.8 is 69 mg. Taking the probable sampling as well as the analytical error into consideration, and assuming a maximum digestibility of 50%, then consuming, for example, turkey (light meat) instead of veal would result in a reduction in body cholesterol of not more than 40 mg. This reduction is less than 5% of the minimum requirements of 800 mg, which the body will synthesize even if no cholesterol is present in the diet. Biological differences between individuals exceed this amount. Although reductions in dietary cholesterol may result in reductions in serum cholesterol levels, the body's metabolism may adjust to the dietary reductions and the blood cholesterol levels could revert to that before the dietary reduction (Breidenstein & Williams, 1986: 5). Therefore, according to available evidence, it seems that the higher cholesterol content of veal should not be of undue concern.

Tables 1.5 to 1.7 also illustrate that the mineral and vitamin content of American and Australian veal differ from that of comparable cuts of beef. The iron and zinc content of veal, for example, is lower than that of beef. Iron from animal products is important in the human diet as it has such a high bioavailability. Not only is it relatively well absorbed, but it also enhances the absorption of iron from other foods (Bender, 1975: 438). The sodium, potassium and phosphorus content of veal is higher than that of beef.

The difference in sodium content of 35 mg/100 g is only about 1%-4% of the estimated safe and adequate dietary intake for sodium of 1100 mg-3300 mg for adults, and therefore practically insignificant (Food and Nutrition Board, 1989: 284). Table 1.5 also indicates that American veal is a much richer source of folacin than beef.

The nutrient composition of South African veal is not yet known. The nutrient composition of the seven veal cuts and products given in the South African Food Composition Tables (Langenhoven *et al.*, 1991: 33) was compiled from published American, European and Australian data. The composition of veal from these countries may differ from that of South African veal as a result of different feeding methods as well as slaughter ages. Thus, there is clearly a need for more data on the nutrient composition of South African veal.

## 1.2 Objectives of the study

Against the background of the potential importance of veal in the human diet, by contributing essential nutrients and because of a possible low fat content, the objectives of the present study were:

- 1.2.1 To determine the physical and chemical characteristics of veal cuts, raw and/or prepared according to the most appropriate cooking method.
- 1.2.2 To describe the nutrient content of raw and cooked veal cuts of carcasses found in the South African Carcass Classification System.
- 1.2.3 To relate the possible nutrient contribution of veal to a healthy diet for South Africans.
- 1.2.4 To provide appropriate and reliable South African nutritional data of veal for inclusion in the food composition tables of the Medical Research Council of South Africa.

### 1.3 Structure of the dissertation

Following this introduction (Chapter 1), the literature survey in Chapter 2 will concentrate on published data of the physical, chemical and nutritional characteristics of raw and cooked veal cuts. The experimental procedures by which South African veal cuts are characterised, are discussed in Chapter 3. Results are described in Chapter 4, and compared with published data on veal. In Chapter 5 these results are interpreted and related to healthy diets for South Africans. Conclusions and recommendations resulting from this study are given in Chapter 6.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

In this chapter, the literature survey, the physical and chemical characteristics as well as the nutrient content of raw and cooked veal cuts in the American and Australian context, as well as from other available publications, will be briefly reviewed.

Apart from veal being a generally available delicacy overseas, modern veal production also provides an alternative use for bull calves, which are mostly unwanted by the dairy and beef industries (Albright, 1983: 2208). Two types of veal are marketed in Britain (Webster, 1984: 175-176). Firstly, Bobby veal, which is the cheaper meat of calves slaughtered in the first week or two of life. Secondly, quality veal which is regarded as a delicacy. These calves are raised on milk replacer diets, usually until they reach a body mass of 160-200 kg at an age of 14-18 weeks. Most milk replacer diets for conventional calf rearing contain at least 100 mg iron/kg of feed. The meat of these calves is almost as red as that of beef.

Three types of veal are sold in America (Faustman *et al.*, 1992a: 34; American Veal Association, 1988: 1; Ono *et al.*, 1986: 1352).

- Bob veal, is obtained from animals raised on maternal milk and usually slaughtered at less than three weeks of age, producing carcasses of about 25 kg.
- Fancy veal or specially fed veal, obtained from milk-fed veal calves that are fed a milk formula throughout the feeding period and slaughtered at about 16 weeks, producing carcasses weighing about 95 kg.
- Veal from grain-fed calves which are reared on grains, hay and feed formulas. They are also slaughtered at about 16 weeks with an average carcass mass of about 95 kg.

Colour is regarded as the most significant appearance factor which determines whether or not veal will be purchased (Agboola *et al.*, 1990: 118; Kropf, 1980: 15). Muscle colour is partially dependent on the amount of myoglobin present and partially due to the chemical state of the heme in the myoglobin (U.S. National Livestock and Meat Board, 1991: 13). The paler the meat, the lower is the myoglobin content of the muscles (Bowers *et al.*, 1989: 1447). According to Riss *et al.* (1983: 1868) the pale colour of veal muscle is one of the several desirable qualities of veal. To produce the light colour desired by the consumers, it is essential to minimize the quantity of myoglobin in the muscles. For this purpose, the intake of iron (an important component of myoglobin), should be restricted. These low dietary iron levels usually result in subclinical anaemia. This causes a loss of appetite which has a negative influence on the performance and carcass characteristics of the calf (Beauchemin *et al.*, 1990: 43). The conventional milk replacer diets used to produce the traditional pale colour of veal are costly, thus increasing the feeding costs significantly (Agboola *et al.*, 1990: 117; Beauchemin *et al.*, 1990: 35).

Rearing calves on grain diets is an economically viable alternative to the traditional methods of veal production. The performance and carcass characteristics of calves fed on grains (supplemented with protein) compared favourably to those of milk-fed calves. However, the colour of the meat was darker than for milk-fed calves (Beauchemin *et al.*, 1990: 43). Feeding calves for a short time on a diet high in monosodium phosphate and vitamin E yielded the commercial acceptable pale muscle colour with reduced serum and muscle cholesterol levels, without causing anaemia (Agboola *et al.*, 1990: 118).

No specific prescriptions are given for the feeding of calves in South Africa. According to the Government Gazette (1985: 3) a bovine is considered a calf when no part of the first molar in the upper jaw has erupted. To ensure that a bovine is classified as a calf, it should be slaughtered at the age of 20 weeks (143 days) (Horn-Quass, 1992: 21). The first molar starts erupting when the calf is about 22-23 weeks old (Webster, 1984: 63). At the time of the study, veal carcasses in South Africa were graded as Grade 1 and Super. To qualify as Super, a veal carcass should have a mass of 80-90 kg with a subcutaneous fat layer of at least 1 mm, evenly distributed over the carcass. Grade 1

carcasses have an average mass of 40-50 kg with no specified subcutaneous fat distribution (Government Gazette, 1985: 10). According to studies done at the Department of Agricultural Development's Highveld Region at Potchefstroom, calves reached masses ranging from 46,9-49,8 kg at an age of about four weeks (Horn-Quass, 1992: 21).

## 2.2 Nutrient content

### 2.2.1 *General composition*

The composition of meat depends upon the genotype from which the meat was obtained, the degree of fatness to which the animal had been fed, the specific cut used, the extent of trimming, the processing treatments, packaging methods as well as storage time and conditions (Price & Schweigert, 1971: 288).

The proximate composition and energy values of American and Australian cuts of veal are given in Tables 2.1 and 2.2 respectively.

The American veal (Table 2.1) showed statistically significant differences in the proximate values between different cuts. However, these were not considered of practical importance (Ono *et al.*, 1986: 1353). Veal is leaner and lower in energy content than beef (see Table 1.4). According to Greenfield *et al.*, (1987: 214) the raw forequarter of Australian veal is the fattiest and the raw leg the leanest cut. The proximate fat content in veal muscle does not exceed 2%, in contrast to beef in which intramuscular fat levels may range from 3%-13% (Johnson *et al.*, 1988: 1072).

Lean veal is affected by cooking in that protein, fat and energy is concentrated by the moisture loss. No consistent pattern in fat change on cooking was determined (Greenfield *et al.*, 1987: 214).

### 2.2.2 Protein

The word protein is derived from the Greek word meaning "first" or "of primary importance" designating the principal nitrogenous compounds of the protoplasm of all plant as well as animal tissues.

Table 2.1: THE PROXIMATE COMPOSITION OF LEAN, SPECIALLY FED AMERICAN VEAL \* (per 100 g edible portion)

MEAT CUT	WATER (g)	PROTEIN (g)	FAT (g)	ASH (g)	ENERGY (kJ)
<b>ARM STEAK</b>					
raw	76,4	20,1	2,28	1,11	447
cooked (braised)	57,6	36,1	5,73	1,29	861
<b>BLADE STEAK</b>					
raw	76,5	19,6	3,54	1,05	485
cooked (braised)	58,4	32,9	7,06	1,22	853
<b>RIB ROAST</b>					
raw	74,9	19,8	4,27	1,00	514
cooked (braised)	63,7	25,9	8,23	1,06	773
<b>LOIN CHOPS</b>					
raw	74,7	20,2	3,59	1,07	497
cooked (braised)	56,2	33,9	9,74	1,14	974
<b>SIRLOIN CHOPS</b>					
raw	75,6	20,2	2,75	1,09	464
cooked (braised)	57,9	34,1	6,93	6,90	869
<b>CUTLETS</b>					
raw	75,6	21,3	1,83	1,14	447
cooked (pan-fried)	60,6	33,3	4,69	1,43	769

\* Adapted from Ono *et al.* (1986: 1354-1355)

Table 2.2: PROXIMATE COMPOSITION AND ENERGY CONTENT  
OF AUSTRALIAN VEAL \* (per 100 g edible portion)

MEAT CUT	WATER (g)	PROTEIN (g)	FAT (g)	ASH (g)	ENERGY (kJ)
<i>FOREQUATER</i>					
raw, lean	75,9	22,3	2,0	1,0	453
raw, lean & fat	72,9	22,0	5,2	1,0	568
cooked, lean	62,0	35,7	3,2	1,1	725
cooked, lean & fat	61,0	34,7	5,1	1,0	782
<i>LEG</i>					
raw, lean	78,4	21,1	0,3	1,6	370
raw, lean & fat	77,2	21,1	1,6	1,5	414
cooked, lean	66,7	31,8	0,9	0,9	573
cooked, lean & fat	66,2	31,6	1,6	1,6	597
<i>LOIN CHOP</i>					
raw, lean	76,4	22,6	1,5	1,2	440
raw, lean & fat	73,6	22,3	4,5	1,3	545
cooked, lean	67,4	29,8	2,7	1,3	607
cooked, lean & fat	66,2	29,1	4,7	1,5	673
<i>SCHNITZEL (sirloin)</i>					
raw, lean	75,9	23,2	1,8	1,2	461
raw, lean & fat	75,0	23,1	1,8	1,2	492
cooked, lean	65,7	31,3	3,1	1,2	647
cooked, lean & fat	65,2	31,1	3,8	1,2	669
<i>SHANK</i>					
raw, lean	77,5	21,4	0,4	1,0	379
raw, lean & fat	75,7	21,3	2,3	0,9	451
cooked, lean	66,4	30,8	2,4	1,1	612
cooked, lean & fat	63,8	29,4	6,9	0,9	744
<i>SHOULDER STEAK</i>					
raw, lean	74,5	22,7	2,5	1,1	478
raw, lean & fat	72,9	22,5	4,3	1,0	543
cooked, lean	68,8	28,9	3,2	1,3	610
cooked, lean & fat	68,0	28,4	4,3	1,2	647
<i>FAT (combined sample)</i>					
raw	49,4	19,3	1,3	0,8	1486
cooked	45,7	20,1	6,3	1,0	1685

\* Adapted from Greenfield *et al.* (1987: 214)

Every living cell contains protein and therefore a vital nutrient in the growth process (for building and maintaining body tissues). Proteins are complex nitrogenous organic compounds in which amino acids are the basic unit of structure (Robinson *et al.*, 1990: 45; U.S. National Live Stock and Meat Board, 1991: 22).

Table 2.3: AMINO ACID CONTENT OF COOKED MEATS \* (g/100 g edible portion)

AMINO ACID	VEAL	BEEF	LAMB	PORK
# Tryptophan	0,399	0,325	0,363	0,381
# Threonine	1,318	1,267	1,301	1,332
# Isoleucine	1,605	1,304	1,446	1,368
# Leucine	2,227	2,292	2,185	2,302
# Lysine	2,583	2,413	2,384	2,791
# Methionine	0,695	0,742	0,698	0,698
Cystine	0,360	0,325	0,335	0,367
# Phenylalanine	1,235	1,132	1,151	1,133
Tyrosine	1,094	0,974	0,979	1,010
# Valine	1,570	1,411	1,419	1,518
Arginine	1,979	1,833	1,863	1,966
# Histidine	0,977	0,993	0,793	1,436
Alanine	1,804	1,749	1,781	1,676
Aspartic acid	2,995	2,649	2,273	2,628
Glutamic acid	4,741	4,357	4,383	4,399
Glycine	1,454	1,582	1,568	1,291
Proline	1,225	1,281	1,292	1,074
Serine	1,337	1,109	1,188	1,165
Protein	30,4	29,0	28,3	28,3

# Essential amino acids

\* Adapted from Bodwell & Anderson (1986: 344)

The proteins in meat is high in both quality and quantity. The main determinant of protein quality is the content and distribution of amino acids, as well as differences in the bioavailability of these amino acids (Bodwell & Anderson, 1986: 341). Nine amino

acids are considered essential to the diet (Table 2.3) and should be supplied in adequate amounts and proportions to meet the requirements for growth and tissue maintenance (Mahan & Arlin, 1992: 59). Phenylalanine and methionine (essential amino acids) can be converted to tyrosine and cystine respectively. Opposite conversions from tyrosine and cystine to phenylalanine and methionine are, however, not possible. Therefore, when tyrosine and cystine are present in the diet, the requirements for phenylalanine and methionine are reduced. Thus, tyrosine and cystine are sometimes classified as semi-essential and their levels are always determined when protein quality is measured (Robinson *et al.*, 1990: 46). In general, all types of meat contain high levels of the essential amino acids as well as tyrosine and cystine. Proteins in food which contain all of the essential amino acids in quantities and proportions that can be recycled into body proteins are regarded as having high "biological values".

The composition of amino acids in meat proteins meets human needs best because it resembles the pattern of human amino acid requirement (Guthrie, 1989: 138). Furthermore, the amino acids in meat are highly available (Bodwell & Anderson, 1986: 342). The amino acid content of veal compared to that of beef, lamb and pork (Table 2.3), clearly indicates that veal is a valuable dietary source of essential amino acids.

### 2.2.3 *Total lipids and cholesterol*

Fats are important components of a balanced diet. Dietary fats add flavour, appetite appeal and satiety value to foods. Apart from being a concentrated source of energy compared to protein and carbohydrates, fats also provide essential fatty acids and aid in the absorption of the fat soluble vitamins A, D, E and K.

Edible fats are basically triglycerides which are composed of three fatty acids attached to glycerol. Most fatty acids in foods and in the body are straight even numbered carbon chains. These fatty acids may be saturated or unsaturated. Unsaturated fatty acids are further classified as monounsaturated, having one double bond in the carbon chain, or polyunsaturated with two or more double bonds in the carbon chain. Animal

fats contain both saturated and unsaturated fatty acids in a variety of proportions thus providing each type of fat with its own individual physical properties. Fats of animal origin, often classified as "saturated" contain 30%-60% saturated fatty acids, of which palmitic and stearic acids predominate. These fats also contain about 25%-50% oleic acid as well as small amounts of polyunsaturated fatty acids (Robinson *et al.*, 1990: 82-85).

The Food and Nutrition Board of the National Academy of Sciences (1989) has not established RDA's for fat and cholesterol in the diet. Current nutrient recommendations from a number of sources [The National Cholesterol Education Program of the National Heart, Lung and Blood Institute (NHLBI), the American Dietetic Association (ADA) and the American Heart Association (AHA)] recommend a dietary fat intake not to exceed 30% of the total energy intake with less than 10% derived from saturated fat as well as a maximum daily intake of cholesterol of 300 mg (U.S. National Live Stock and Meat Board, 1991: 24 & 37; Williams, 1987: 37).

Dietary fat and cholesterol from meat animal sources are major issues of human nutrition. Both the type of fat consumed as well as the total fat intake are of concern recently (Faustman *et al.*, 1992a: 33). Consumers have been educated to consume low fat, high protein products. Meat varies widely in fat content. Therefore, the amount of meat associated fat ingested will depend on the cut used, the degree of trimming, the degree to which fat drippings are used in preparation and also on the method of preparation (Robinson *et al.*, 1990: 95). The fatty acid composition of American veal is supplied in Table 2.4. "Edible portion" refers to the part of the meat customarily considered edible in the United States and Australia, respectively. Table 1.7 shows that veal has a lower total and saturated fat content than comparable cuts of beef, pork, lamb, dark meat turkey and chicken. Australian veal also has a lower fat content than beef (Table 1.6).

The fat and cholesterol content of Australian veal appears in Table 2.5. The younger the calf, the higher the cholesterol content of the blood and muscles. The high cholesterol content of colostrum probably accounts for the high blood and muscle

cholesterol levels of the unweaned calf.

Table 2.4: FATTY ACID COMPOSITION AND CHOLESTEROL CONTENT OF COOKED LEAN AMERICAN VEAL \* (per 100 g edible portion)

TYPES OF MEAT	FATTY ACIDS				CHOLESTEROL CONTENT (mg)	TOTAL LIPID CONTENT (g)
	Saturated (g)	Monoun-saturated (g)	Polyun-saturated (g)	Total (calculated) (g)		
Cutlet (pan-fried)	0,94	1,22	0,49	2,65	131,4	4,54
Arm steak (braised)	1,09	1,49	0,56	3,14	159,2	4,85
Blade steak (braised)	1,45	1,76	0,53	3,74	163,5	5,75
Sirloin chop (braised)	1,46	2,00	0,60	4,06	150,6	6,06
Loin chop (braised)	2,28	3,15	0,70	6,13	162,4	8,44
Rib cut (roasted)	1,95	2,47	0,53	4,95	127,1	6,48

\* Adapted from Breidenstein (1987: 53)

American analyses confirmed higher cholesterol content for veal than for beef (Tables 1.4 & 1.5). However, after weaning, the cholesterol level decreases.

Veal is leaner and consequently lower in energy than beef. Raw seperable veal fat (Table 2.2) is higher in moisture and protein and lower in lipid when compared to the corresponding average levels of 21,4%, 6,8% and 72,4% present in raw seperable beef fat. This may be a reflection of physiological immaturity (Greenfield *et al.*, 1987: 210 & 214; Price & Schweigert, 1971: 325).

Table 2.5: FAT AND CHOLESTEROL CONTENT OF AUSTRALIAN VEAL \*  
(per 100 g edible portion)

TYPE OF MEAT		FAT (g)	CHOLESTEROL (mg)
<i>FOREQUATER:</i>	raw	5,0	79,0
	cooked	2,6	57,0
<i>LEG:</i>	raw	1,6	82,0
	cooked	1,1	75,0
<i>LOIN CHOP:</i>	raw	3,6	66,0
	cooked	2,6	61,0
<i>SCHNITZEL:</i> (sirloin)	raw	2,8	83,0
	cooked	2,5	72,0
<i>SHANK:</i>	raw	1,1	39,0
	cooked	1,2	36,0
<i>SHOULDER STEAK:</i>	raw	3,3	63,0
	cooked	2,2	57,0

\* Adapted from Greenfield *et al.* (1987: 214)

According to Table 2.5, the raw veal forequarter cut has the highest fat content and the shank the lowest. However, all the veal cuts considerably leaner than those of beef (Greenfield *et al.*, 1987: 214).

#### 2.2.4 Total carbohydrate

Meat contains only a very small amount (less than 1%) of carbohydrate in the form of glycogen, which is used for muscle contraction. Thus meat is not considered to be a meaningful source of dietary carbohydrate (Bowers, 1992: 519; U.S. National Livestock and Meat Board, 1991: 19).

#### 2.2.5 Water

Water is an essential and major component of all living matter. It is ingested in free form and as part of almost all food (Mahan & Arlin, 1992: 142). Lean red meat contains up to 76% of its mass as water and may absorb even more water when

processed. The content being so high, water has an important influence on the quality of meat (Price & Schweigert, 1971: 181).

The water of a carcass is primarily located in the lean muscle tissue, the moisture content of adipose tissue being very low. Muscle proteins are responsible for binding the water in meat. Approximately 70% of the water contained in fresh meat is located in the myofibrils, 20% in the sarcoplasm and 10% in the connective tissue (Hamm, 1986: 139). According to Table 2.2, the moisture levels of the raw, lean sections of veal range from 74,5% (shoulder steak) to 78,4% (leg).

### 2.2.6 *Vitamins*

Vitamins may be conveniently divided into two groups on the basis of the mode of solubility. The fat soluble vitamins are A, D, E and K and the water soluble vitamins are the B complex and vitamin C. The B complex vitamins include thiamin (vitamin B<sub>1</sub>), riboflavin (vitamin B<sub>2</sub>), niacin, pyridoxine (vitamin B<sub>6</sub>), folacin (folic acid and pteroylglutamic - acid), cobalamin (vitamin B<sub>12</sub>), pantothenic acid and biotin (Mahan & Arlin, 1992: 105).

Meat is an important source of the following B complex vitamins: thiamin, riboflavin, niacin, vitamin B<sub>6</sub> and vitamin B<sub>12</sub>. It is regarded as a source, albeit not a very good one, of folacin, biotin and pantothenic acid. These vitamins perform the following main functions in the human body:

- Thiamin, in conjunction with other B vitamins, promote and regulate the chemical reactions necessary to promote growth and maintain health as well as energy production from carbohydrates.
- Riboflavin is essential for the release of energy from carbohydrates, fats and proteins. It is also needed for maintenance of good vision and a healthy skin as well as for the conversion of tryptophan (an amino acid) to niacin.
- Niacin functions in a variety of intracellular enzyme systems, including those involved in energy production. Tryptophan, an essential amino acid, is a precursor of niacin. From every 60 mg of dietary tryptophan, the body can produce

approximately 1 mg of niacin.

- Vitamin B<sub>6</sub> is a component of the enzyme system responsible for converting the amino acid tryptophan to niacin. Pyridoxal phosphate (the active form of vitamin B<sub>6</sub>) functions as a coenzyme in biochemical reactions, most of which involve amino acids.
- Vitamin B<sub>12</sub> is necessary for the synthesis of DNA (deoxyribonucleic acid), the gene containing component of cell nuclei, and is essential for growth and development. This vitamin is found only in foods of animal origin (U.S. National Live Stock and Meat Board, 1991: 32-36; Robinson *et al.*, 1990: 178-195).

Veal is a good source of niacin and vitamin B<sub>12</sub> (Tables 2.6 and 2.7). Depending on the cut, 100 g of lean cooked veal can supply 40%-112% of the RDA for niacin and 43%-83% for vitamin B<sub>12</sub> (Ono *et al.*, 1986: 1357).

Table 2.6: VITAMIN CONTENT OF LEAN, COOKED AMERICAN VEAL \* (per 100 g edible portion)

TYPE OF MEAT	THIAMIN (mg)	RIBO-FLAVIN (mg)	NIACIN (mg)	PANTOTHENIC ACID (mg)	VIT B <sub>6</sub> (mg)	FOLACIN (μg)	VIT B <sub>12</sub> (μg)
Cutlet (pan-fried)	0,089	0,392	13,067	1,447	0,467	16,274	1,726
Arm steak (braised)	0,062	0,333	9,933	1,682	0,298	19,215	1,835
Blade steak (braised)	0,062	0,368	6,255	1,749	0,235	16,785	2,091
Sirloin chop (braised)	0,055	0,388	7,533	1,435	0,345	15,608	1,726
Loin chop (braised)	0,059	0,341	10,024	0,973	0,271	15,491	1,526
Rib (roasted)	0,062	0,306	7,804	1,608	0,259	14,274	1,738

\* Adapted from Breidenstein (1987: 53)

The level of thiamin in cooked American veal compares favourably with that of cooked American beef, whereas the folacin, riboflavin, niacin and pantothenic acid content of veal is higher than that of beef (Tables 1.4 and 1.5). The levels of vitamins B<sub>6</sub> and B<sub>12</sub> are, however, lower in veal (Riss *et al.*, 1983: 1869). No retinol or carotene is present in raw, lean veal (Greenfield *et al.*, 1987: 214).

### 2.2.7 Minerals

Minerals are those elements that remain largely as ash when plant or animal tissues are burned. Approximately 4% of the body weight consists of mineral matter. The macrominerals (those occurring in appreciable amounts) account for most of the body content of minerals. About 75% of all body mineral matter consist of calcium and phosphorus. The human body also contains minute amounts of certain minerals involved in one or more metabolic processes.

Table 2.7: VITAMIN CONTENT OF AUSTRALIAN VEAL CUTS \* (per 100 g edible portion)

TYPE OF MEAT		THIAMIN (mg)	RIBOFLAVIN (mg)	NIACIN (mg)
<i>FOREQUATER:</i>	raw	0,10	0,20	3,2
	cooked	0,02	0,09	1,1
<i>LEG:</i>	raw	0,09	0,33	6,5
	cooked	0,05	0,28	4,3
<i>LOIN CHOP:</i>	raw	0,12	0,15	2,9
	cooked	0,04	0,10	1,9
<i>SCHNITZEL:</i> ( <i>sirloin</i> )	raw	0,16	0,23	4,2
	cooked	0,03	0,12	2,3
<i>SHANK:</i>	raw	0,03	0,14	1,9
	cooked	0,01	0,10	0,6
<i>SHOULDER STEAK:</i>	raw	0,12	0,17	2,3
	cooked	0,03	0,10	1,9

\* Adapted from Greenfield *et al.* (1987: 215)

They are therefore essential nutrients, but as the daily dietary requirements are less than 100 mg, they are known as trace elements (Passmore & Eastwood, 1986: 103; Robinson *et al.*, 1990: 111).

Meat is not only considered a valuable source of several minerals being rich in zinc, iron, copper, phosphorus, sulphur, potassium and magnesium, moderately high in sodium, but poor in calcium (Robinson *et al.*, 1990: 214), but *the* major dietary source of iron, zinc and phosphorus (U.S. National Livestock and Meat Board, 1991: 27). In contrast to plant protein sources, meat contains no substances (such as tannin or phytate) that could affect the digestion and absorption of specific minerals (Passmore & Eastwood, 1986: 206).

The inclusion of meat in the diet has an important positive influence on the nutritional iron status. As many as 10% of all U.S. citizens consume less iron than they need. Iron deficiencies occur frequently among infants, women between the ages of 15 and 44 and males in pre- and early teens. Although these population segments show the highest incidence of iron deficiency, no group is risk-free. Significant lack of iron results in iron-deficiency anemia (U.S. National Live Stock and Meat Board, 1991: 27).

Iron is found in hemoglobin and myoglobin, the red pigments present in blood and meat muscle respectively. Another important function of iron is as a component of the enzymes involved in energy metabolism. Dietary iron is present either in the haem or nonhaem form. Haem iron is more readily absorbed and its absorption is not affected by other dietary components. The iron in red meat consists generally of about two thirds haem iron. The older the animal, the lower the proportion of iron present as haem iron. The consumption of meat and ascorbic acid in the same meal will enhance the absorption and thus the utilization of nonhaem iron considerably (Bodwell & Anderson, 1986: 343).

Zinc is a co-factor for enzymes in many metabolic reactions. It plays an important role in DNA synthesis, is essential for protein synthesis and is necessary for growth and repair of body tissues. A mild deficiency of zinc, which may occur at any age, can slow down the rate of wound healing and decrease the ability to taste.

Table 2.8: MINERAL CONTENT OF LEAN, COOKED AMERICAN VEAL \* (per 100 g edible portion)

TYPE OF MEAT	Fe (mg)	Mg (mg)	P (mg)	K (mg)	Na (mg)	Zn (mg)	Cu (mg)
Cutlet (pan-fried)	0,98	32,6	293,0	441,0	81,0	3,54	0,071
Arm steak (braised)	1,51	30,6	279,0	345,0	95,0	6,13	0,145
Blade steak (braised)	1,54	27,4	255,0	305,0	106,0	7,33	0,173
Sirloin chop (braised)	1,34	28,9	260,0	332,0	84,0	4,79	0,145
Loin chop (braised)	1,21	26,8	289,0	291,0	89,0	4,18	0,118
Rib cut (roasted)	1,01	24,1	211,0	311,0	102,0	4,59	0,114

\* Adapted from Breidenstein (1987: 53)

Fe = Iron                      Mg = Magnesium      P = Phosphorus

Na = Sodium                K = Potassium

Zn = Zinc                    Cu = Copper

There is evidence that moderate zinc deficiencies occur more often in growing children and the elderly. Zinc is more readily absorbed from animal than from vegetable sources. Vegetable products, particularly grains, contain phytate as well as dietary fiber which depress the availability of zinc (Robinson *et al.*, 1990: 129-130; U.S. National Live Stock and Meat Board, 1991: 30).

Phosphorus plays an important role in the metabolism of carbohydrates, proteins and fats, and helps to maintain a normal acid/base balance in the body. In conjunction with calcium and vitamin D, phosphorus is responsible for the formation of bones and teeth. Proper functioning of muscles and the nervous system depend on calcium and phosphorus. Meat is regarded as one of the best sources of dietary phosphorus (Robinson *et al.*, 1990: 119; U.S. National Live Stock and Meat Board 1991: 31).

Table 2.9: MINERAL CONTENT OF LEAN AUSTRALIAN VEAL CUTS \* (per 100 g edible portion)

TYPE OF MEAT		Na (mg)	K (mg)	Ca (mg)	Fe (mg)	Mg (mg)	Zn (mg)
<i>FOREQUARTER:</i>	raw	86,0	310,0	5,0	1,6	18,0	2,8
	cooked	36,0	120,0	6,0	1,4	12,0	2,4
<i>LEG:</i>	raw	81,0	390,0	7,0	1,4	23,0	2,7
	cooked	34,0	220,0	3,0	1,2	13,0	2,5
<i>LOIN CHOP:</i>	raw	71,0	250,0	7,0	1,0	17,0	1,8
	cooked	55,0	200,0	4,0	1,1	13,0	1,7
<i>SCHNITZEL:</i> <i>(sirloin)</i>	raw	88,0	350,0	5,0	1,7	23,0	2,5
	cooked	53,0	240,0	2,0	1,3	15,0	2,1
<i>SHANK:</i>	raw	50,0	140,0	11,0	0,7	8,0	1,7
	cooked	31,0	74,0	10,0	0,7	6,0	1,8
<i>SHOULDER STEAK:</i>	raw	75,0	250,0	4,0	1,4	17,0	2,5
	cooked	51,0	190,0	2,0	1,0	12,0	2,0

\* Adapted from Greenfield *et al.* (1987: 215)

Na = Sodium      K = Potassium      Ca = Calcium

Fe = Iron      Mg = Magnesium      Zn = Zinc

The mineral content of American and Australian veal cuts are shown in Tables 2.8 and 2.9 respectively. In comparison with beef (Tables 1.4-1.6), the sodium content of American as well as Australian veal is higher than that of beef. Veal is a good source of zinc and phosphorus (Ono *et al.*, 1986: 1354-1357). The zinc as well as the iron levels of both American and Australian veal are, however, lower than in beef (Tables 1.4-1.6). This is due to physiological immaturity and special rearing practices (Greenfield *et al.*, 1987: 215).

## 2.3 Physical dissection

### 2.3.1 General

Muscle, fat and bone form the main tissues of any carcass. The proportions as well as the distribution of these tissues throughout the carcass are structural characteristics of commercial importance. The proportions of these tissues among carcasses of similar mass varies according to breed, type and growth rate. According to many consumers, quality and value for money is determined by the amount of lean meat in a carcass.

### 2.3.1 Bone

The skeleton provides a supporting framework for the soft tissues of all living bodies. The muscles and their tendons form a complete lever system throughout the body. When an animal is slaughtered the body hangs from the hind legs. The position of the skeletal parts in the soft tissues changes and the muscles go into *rigor mortis* in positions different from those in the live animal. The extent to which the muscles are stretched during *rigor mortis* will have an effect on the eating quality (Kempster *et al.*, 1982: 8-9).

### 2.3.3 Muscle

The largest component of a carcass is muscle. More than a hundred different muscles are grouped in different ways and degrees of detail. The commercial cutting of carcasses differs in countries throughout the world. This results in commercial cuts consisting of different muscles and therefore of different characteristics, thus influencing the eating quality. In some countries cutting is anatomically based and cuts have a more homogeneous grouping of muscles (Kempster *et al.*, 1982: 15).

### 2.3.4 Fat

The third component of the carcass is fat, which is deposited in different anatomical locations. The fat deposited in the muscles (intramuscular or marbling fat) is important

in muscle metabolism and serves as storage depot for excess energy. The physically separable fat includes the subcutaneous and inter muscular fat (Kempster *et al.*, 1982: 20). Subcutaneous fat includes all the fat on the surface and of the superficial musculature of a carcass which can be removed without cutting between muscles.

## 2.4 Proximate chemical analysis

The proximate composition is a term used to describe the relative amounts of the major constituents of a food. This includes the water, protein, fat and ash content (Paul & Southgate, 1983: 7). Water content is usually measured as the mass loss of a sample after drying in an oven or at a lower temperature under reduced pressure. The total nitrogen content is determined and the protein value is calculated by multiplying the total nitrogen by a factor of 6.25. Although the fat in meat is a mixture of triglycerides, phospholipids, sterols and related compounds, the total lipid content is usually determined. Carbohydrates are also regarded as one of the proximate constituents of most foods (Paul & Southgate, 1983: 7-8). However, meat contains no significant carbohydrates. The ash consists of the residue left behind when all the organic matter has been burned off and serves as an indication of the inorganic salts that were present in the original sample (Bender, 1975: 20).

In conjunction with instrumental measurements of meat quality, chemical analysis offers an objective basis for standardization of meat and meat products. Fat, moisture, protein and collagen form part of the quality assessment in meat production experiments since they are components of texture and appearance (Dransfield *et al.*, 1983: 80).

## 2.5 Heat application

### 2.5.1 General

The main objective of applying heat to food is to make it more palatable and attractive and to ensure its microbial safety. Changes that occur during cooking include physical changes in texture as well as chemical changes in flavour, odour and nutritive value

(Martland & Welshby, 1980: 53).

### 2.5.2 *Methods of heating*

Cooking methods for meat are designated as "dry" or "moist". Dry and moist heat, in relation to cooking methods, refer to the atmosphere surrounding the meat. The rate at which heat energy is supplied to the external surface is dependent on the cooking method. Notably, water vapour is a more efficient conductor of heat than dry air, thus increasing the rate of heating and accordingly decrease the cooking time. However, unless under pressure, the temperature of water vapour will not exceed 100 °C. This is lower than the external surface temperature of meat cooked in an oven or fried in deep fat (Bowers, 1992: 651).

Dry heat cooking methods are recommended for tender cuts, whereas moist heat methods are used for the tougher cuts. Less tender cuts usually contain larger amounts of connective tissue and require long, slow cooking in a moist atmosphere to tenderize the meat by solubilization of the collagen (Bowers, 1992: 651). Although the collagen content of veal is high, it is highly soluble (Boccard *et al.*, 1979: 261). Therefore, dry heat cooking methods are usually acceptable for veal. Age has a significant influence on collagen solubility. With increasing age the percentage soluble collagen decreases, resulting in a reduction in the tenderness of the meat (Cross *et al.*, 1986: 1002).

### 2.5.3 *Heat-induced changes in meat*

The type and extent of heat-induced changes in meat during cooking are influenced by the composition of the meat as well as the method and extent of heating. Heat causes changes in meat due to denaturation and coagulation of proteins, melting of fat, changes in pH and water-holding capacity as well as chemical changes in heat-labile compounds. Denaturation renders the initially soluble proteins insoluble and causes a loss of moisture. The amino acids in meat are resistant to the effect of cooking. Only slight reductions in the availability of lysine, methionine and tryptophan may occur (Bowers, 1992: 616).

As with other meat, moisture is lost during the cooking of veal, thus affecting the concentration of certain nutrients. Therefore, higher amounts of protein, fat, cholesterol and energy will be consumed per unit. No change appeared in the fatty acid composition of veal when cooked. The fatty acid pattern is more saturated in the adipose tissue than in the lean muscles of the veal (Greenfield *et al.*, 1987: 214-215).

A variable proportion of the thiamin, riboflavin and niacin content is lost during cooking (Greenfield *et al.*, 1987: 214). According to Ono *et al.* (1986: 1355) braising resulted in a higher loss of vitamins than did other cooking methods.

Cooking tends to decrease the sodium content while potassium is lost when moist cooking methods are used. On the other hand, the levels of both sodium and potassium, increase with frying or grilling. Similarly the iron and zinc levels are higher in cooked than in raw veal, due to the concentration effect (Greenfield *et al.*, 1987: 215).

## 2.6 Veal in a healthy diet

### 2.6.1 *Dietary recommendations*

Mainly two types of dietary recommendations are used to advise the public on how to plan a healthful diet. The first one is the recommended dietary allowances or RDA's (Food and Nutrition Board, 1989: 283), which recommends specific amounts of essential nutrients for men and women of different age groups to ensure that the nutritional needs of practically all healthy persons are met. The RDA's are *inter alia* used as a standard in:

- Assessment of nutrient intakes obtained from dietary surveys
- Planning of diets for institutions
- Planning of food supplies, e.g. in food aid programmes
- Nutritional labelling of foods and food products
- Calculation of the nutrient density of a nutrient in a particular food (Passmore & Eastwood, 1986: 168)

The second set of dietary recommendations are the dietary goals or guidelines. These are more recent and are aimed at reducing the chances or risk of developing chronic degenerative diseases. After comparing the guidelines of seventeen different institutions, Truswell (1987: 1060) concluded that they are remarkably similar, emphasizing that guidelines should be based on an objective review of the best scientific evidence and be regularly reviewed and updated. The diet associated with dietary guidelines for protection against degenerative disease is known as the *prudent* diet. This diet is low in fat and high in dietary fibre, and is therefore also referred to as the *low-fat, high-fibre diet*.

### 2.6.2 *Elements of the prudent diet*

In South Africa, a set of dietary guidelines for protection against the development of coronary heart disease was published in 1989 (Diet Consensus Panel, 1989: 592). These guidelines were recently updated (in a less specific form) by the Department of National Health (HMAC Subcommittee, 1992: 3) and contain the following elements:

- Eat a variety of foods from the three major food groups (body-building, energy and protective foods)
- Maintain ideal body weight by adequate physical exercise and controlled food intake
- Total fat intake should not exceed 30% of the total daily kilojoule intake
- Intake of saturated fatty acids should be not more than 10% of the daily energy intake
- Intake of polyunsaturated fatty acids should not exceed 10%
- Intake of the trans form of fatty acids should be limited
- Cholesterol intake should not exceed 300 mg/d
- In cases of under-nutrition, relevant and affordable protein sources should not be limited for the sake of limiting the cholesterol intake
- Salt intake should be limited to 3 g sodium/d (5 g NaCl)
- Fibre intake, in the form of fresh, unrefined foods should be kept at 20-30 g/d
- The maximum daily alcohol intake should be 2-3 tots (10-20g)
- Limit the intake of sugar and jam, sweets and cold drinks

- Drink at least one litre of fluid per day, most of which should be pure water
- Restrict the intake of caffeine

### 2.6.3 *The prudent diet "translated" into foods*

It is generally agreed that advice to the public regarding dietary intakes should be practical. After summarising the perceptions of a panel who discussed the translation of dietary recommendations to food selection, Leveille (1987: 1046) was of the opinion that these recommendations should be directed at two levels. The first should be a quantitative set of *goals* directed at nutrition and health professionals as well as food industry personnel. The second should be a more general set of recommendations or *guidelines*, directed at consumers. In order for the public to understand and follow these guidelines, it is important that they should be translated into foods and palatable diets. The prudent diet, based on these guidelines and goals, is currently used in the Lipid Clinic (Vorster, 1985: 36) of the Department of Nutrition of the Potchefstroom University (PU vir CHO), and contains the following foods in daily portions:

- One portion of dried beans (cooked weight: 100-200 g)
- One portion of meat, fish or eggs (cooked weight of fish and meat: 80-120 g; two eggs is equivalent to a portion of meat. When an egg is eaten, the meat portion should be reduced by half)
- Two portions of dairy products (milk, yoghurt, cottage cheese; preferably skimmed or low-fat; a portion of milk equals 250 mL)
- Six portions of whole grain cereal food, e.g. porridge, bread, breakfast cereals, rice, samp, wheat, mealie rice, etc. (In a slimming diet, a portion is similar to that of a thin slice of bread, 30-40 g)
- At least five portions of vegetables and fruit (e.g. one fruit and four vegetables). One portion more or less equals 100 g, depending on the type
- No fat, oil, salad dressing, margarine or butter is to be used in the preparation of the food. *Only* three teaspoons shortening is allowed for bread *or* oil/salad dressing for salads in the diet for weight loss, cholesterol lowering and improvement of glucose homeostasis

The "sensible guidelines" of the Department of National Health (HMAC Subcommittee, 1992: 6) also include practical advice on food choices.

#### 2.6.4 *The place of veal in the prudent diet*

From the information given above, it is clear that animal products have a place in the prudent diet, especially when low-fat products and fat-free cooking methods are used. According to the American data (Breidenstein, 1987: 50-53; also see Table 1.4), 100 g braised veal blade steak contains 5,75 g fat, while 100 g braised beef blade steak provides 15,27 g fat. Based on these figures, if veal replaces beef three times per week (120 g portions), 34,3 g less fat (1303 kJ) will be consumed. Veal's lower fat content makes American veal a valuable component to be used in the prudent diet.

Veal will, simultaneously, contribute other valuable nutrients to the diet. The nutrient density of any food may be expressed in terms of its content of nutrients and energy, each related to its specific RDA (Passmore & Eastwood, 1986: 168), using the following formula:

(Nutrient in 100 g) / (Energy in 100 g)
(RDA of nutrient) / (RDA of energy)

If the nutrient density is  $\geq 1,0$ , the food may be regarded as a satisfactory or good source of the nutrient. Table 2.10 illustrates the nutrient density of American veal (lean and lean with fat) in the diet of an adult woman requiring 8 000 kJ daily, indicating that both lean veal and lean veal with fat are outstanding sources of protein, zinc, phosphorus, riboflavin, niacin and vitamin B<sub>12</sub> and good sources of iron, magnesium and vitamin B<sub>6</sub>.

Table 2.10: NUTRIENT DENSITY OF SOME NUTRIENTS PRESENT IN COOKED AMERICAN VEAL \*

NUTRIENTS	UNIT	RDA**	LEAN VEAL		LEAN VEAL WITH FAT	
			Composition	Nutrient density	Composition	Nutrient density
Protein	g	50,0	31,90	6,23	30,10	4,98
Iron	mg	15,00	1,16	0,76	1,15	0,75
Zinc	mg	12,00	5,10	4,15	4,76	3,28
Magnesium	mg	280	28,0	0,97	26,0	0,94
Phosphorus	mg	800	250	3,05	239	2,47
Folate	µg	180	16,0	0,89	15,0	0,69
Thiamin	mg	1,1	0,06	0,53	0,06	0,45
Riboflavin	mg	1,3	0,34	2,79	0,32	2,03
Niacin	mg	15	8,42	5,48	7,97	4,4
Vit B <sub>6</sub>	mg	1,6	0,33	1,35	0,31	1,60
Vit B <sub>12</sub>	µg	2,0	1,65	10,2	1,57	6,49
Energy	kJ	8000	819		968	
Energy	MJ	8,0	0,819		0,968	

\* Nutrient density calculated according to Passmore & Eastwood, 1986:168

\*\* RDA : Recommended dietary allowances for a 25-50 year old female on a 8 000 kJ diet (Food and Nutrition Board, 1989).

\*\*\* Composition of veal: 100 g composite sample, according to Anderson *et al.* (1989: 121, 123).

## 2.7 Summary

From the literature survey it is clear that veal can play an important nutritional role in the diet of all people. Veal contributes essential nutrients to the diet and, when considering the dietary goals of reducing fat intake and the risk of degenerative Western diseases (Truswell, 1987: 1068), it may even replace high fat foods. However, to give meaningful advice to the South African public regarding veal intake, more information is needed on the nutritional characteristics of veal produced and marketed in South

Africa. Therefore, the nutrient content of raw and cooked veal cuts available in South Africa, was determined, in order to provide the consumer with reliable information.

## CHAPTER 3

### EXPERIMENTAL PROCEDURES

#### 3.1 Introduction

For the purpose of this dissertation, the physical and chemical characteristics as well as the nutrient content of raw and cooked cuts of carcasses found in the South African Carcass Classification System were determined, statistically analyzed, presented and discussed in order to draw certain conclusions and make final recommendations.

#### 3.2 Study design

The basic experimental design (Figure 3.1) incorporated thirteen carcasses of each of Grade 1 and Super veal. Each carcass was divided lengthwise into left and righthand sides respectively. For the purpose of this study the sides were allocated as follows:

- TEN right sides within each grade for the physical dissection and the proximate chemical analyses of the raw cuts.
- THREE carcasses within each grade were pooled and used for nutrient analyses, the left sides for the raw and the right sides for the cooked samples.

The experimental procedures that were followed will be discussed according to the experimental design presented in Figure 3.1.

#### 3.3 Selection of carcasses

At the time of the study (1989-1993), the South African Carcass Classification System graded the carcasses of calves according to the mass of the carcass and the thickness of the subcutaneous fat layer thereof (Government Gazette, 1985: 19). Carcasses weighing between 80 and 90 kg and with a fat layer of more than 1 mm were graded as Super; and those weighing between 40 and 50 kg and with less than 1 mm fat layer were Grade 1 carcasses.

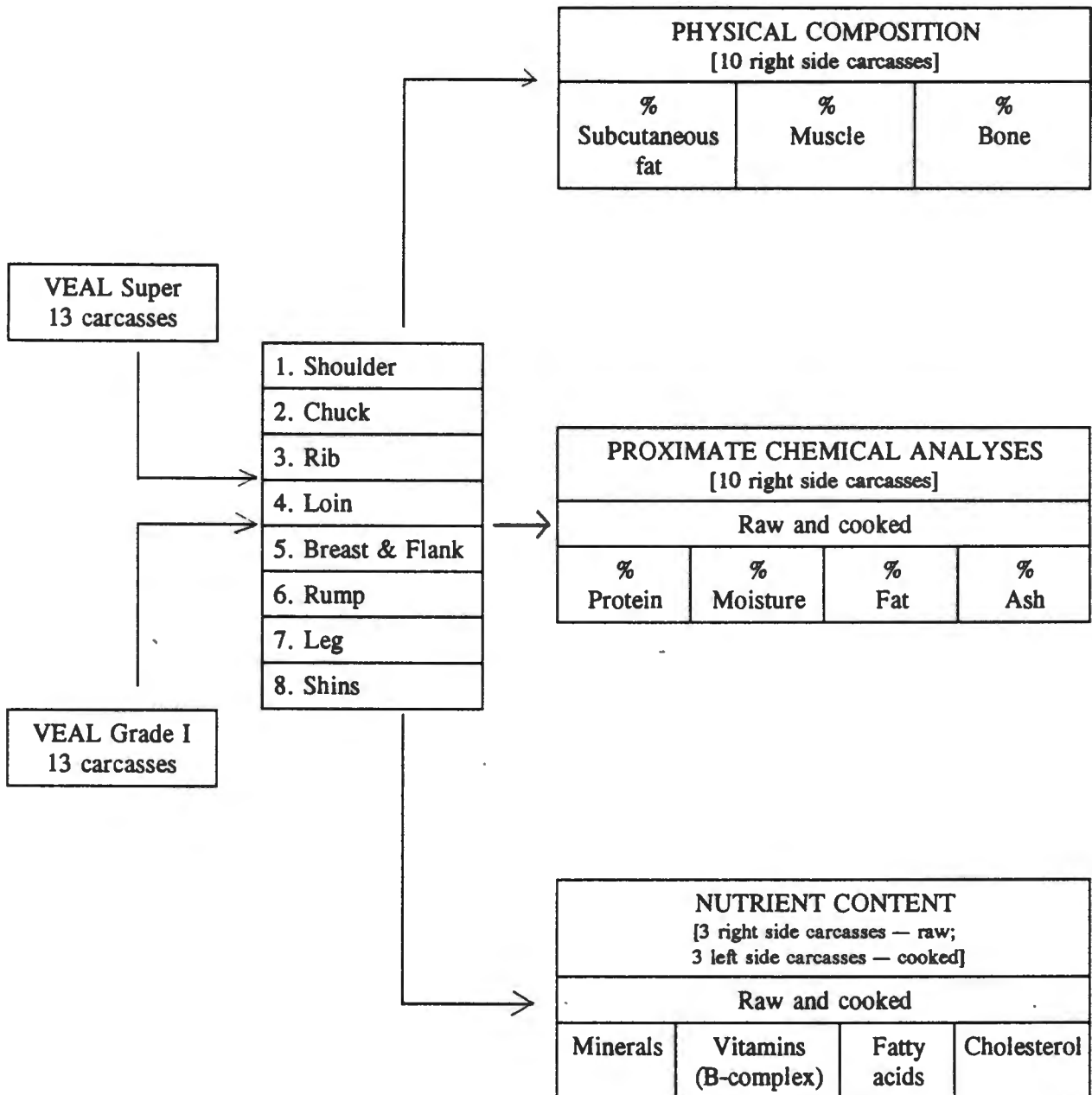


FIGURE 3.1: STUDY DESIGN

The research project only included bovines whose first molar in the upper jaw had not yet erupted, in accordance with the definition of a calf given in the Government Gazette (1985: 19).

The yield of each deboned cut was carefully recorded during a preliminary study, ensuring sufficient sample material for all analyses. However, due to the small sizes of the Grade 1 carcasses, two carcasses within each grade had to be combined for Phase 1 of the project. These two carcasses were treated as one for all analyses.

All veal carcasses were selected at the Johannesburg Abattoir in City Deep. The selected carcasses were all electrically stimulated within 10 minutes of stunning (600 volts for 60 seconds or 800 volts for 45 seconds), thereby preventing the possibility of unnatural toughening of the meat caused by a too rapid chilling rate. Carcasses were dressed, graded, labelled, split into two sides, chilled overnight at between 0°C and 5°C and transported the following day to the abattoir of the Irene Animal Production Institute (IAPI) in a refrigerated truck.

### 3.4 Cutting up of carcasses

The methods of cutting up, as well as the description of the cuts of the veal carcass in the various overseas countries, differ (Figures 3.3; 3.4). Overseas data is therefore not directly applicable to that in the South African context. During the preliminary study it was decided to divide the veal carcasses into the following eight commercial wholesale cuts, similar to those of the mutton carcass:

- |             |                     |
|-------------|---------------------|
| 1. Shoulder | 5. Breast and Flank |
| 2. Chuck    | 6. Rump             |
| 3. Rib      | 7. Leg              |
| 4. Loin     | 8. Shins            |

These cuts are presented in Figure 3.2.

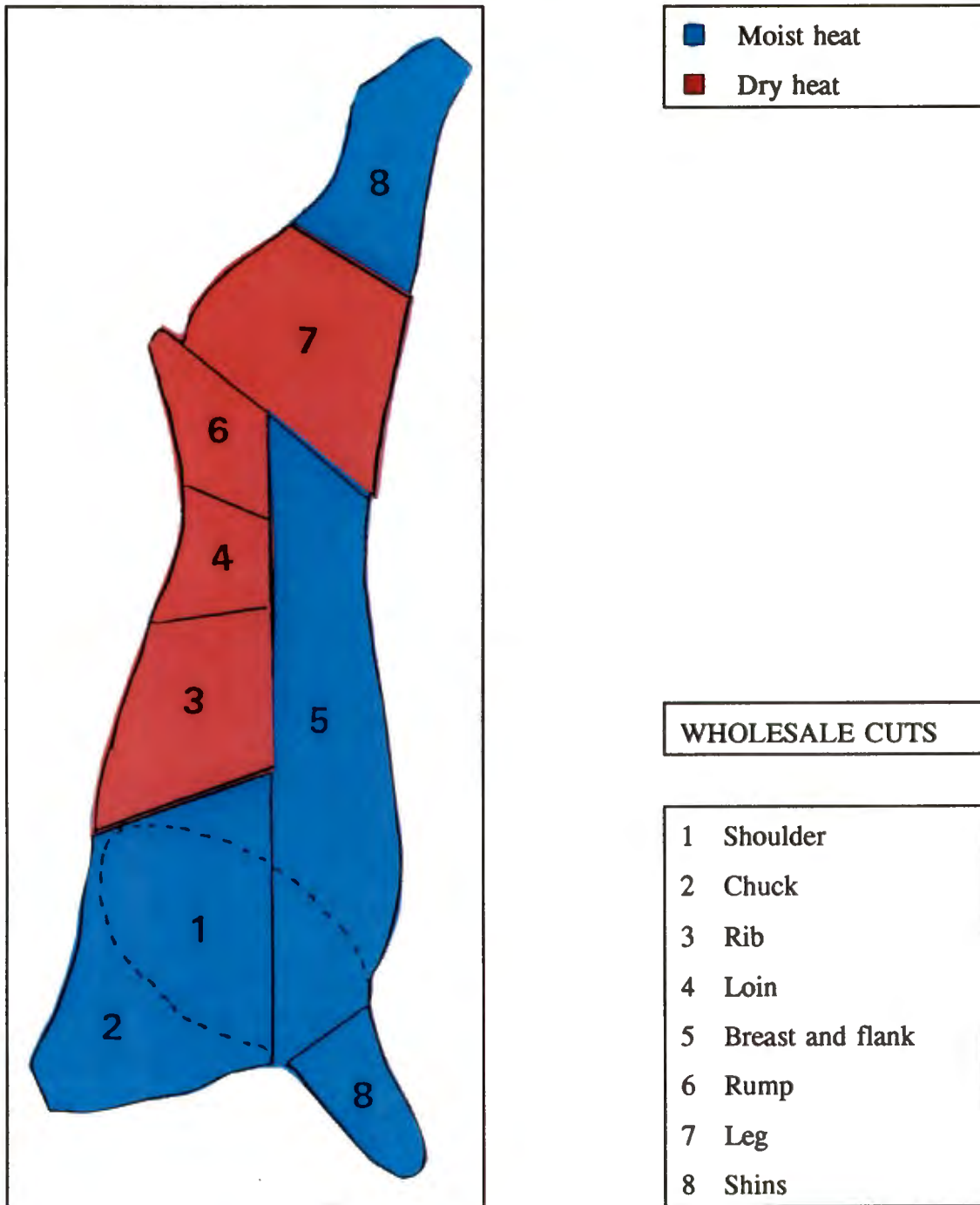


FIGURE 3.2: WHOLESALE CUTS OF THE SOUTH AFRICAN VEAL CARCASS

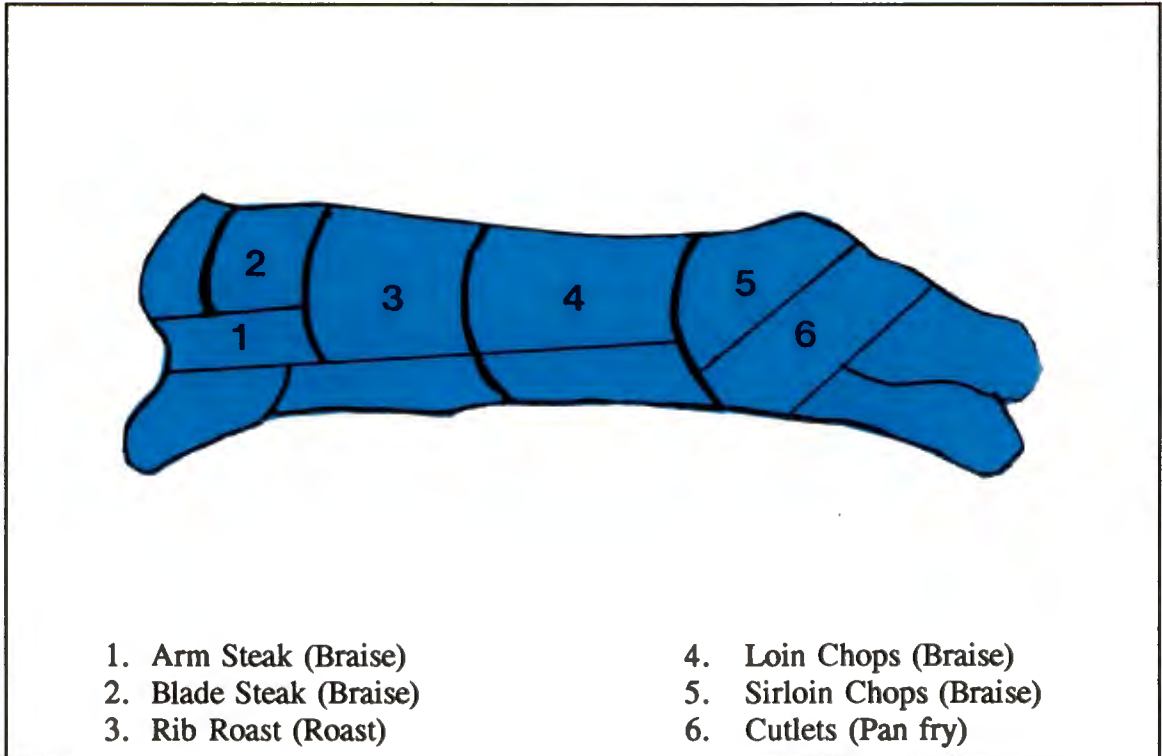


FIGURE 3.3: WHOLESALE CUTS OF THE AMERICAN VEAL CARCASSES  
(Adapted from Ono *et al.*, 1986: 1353)

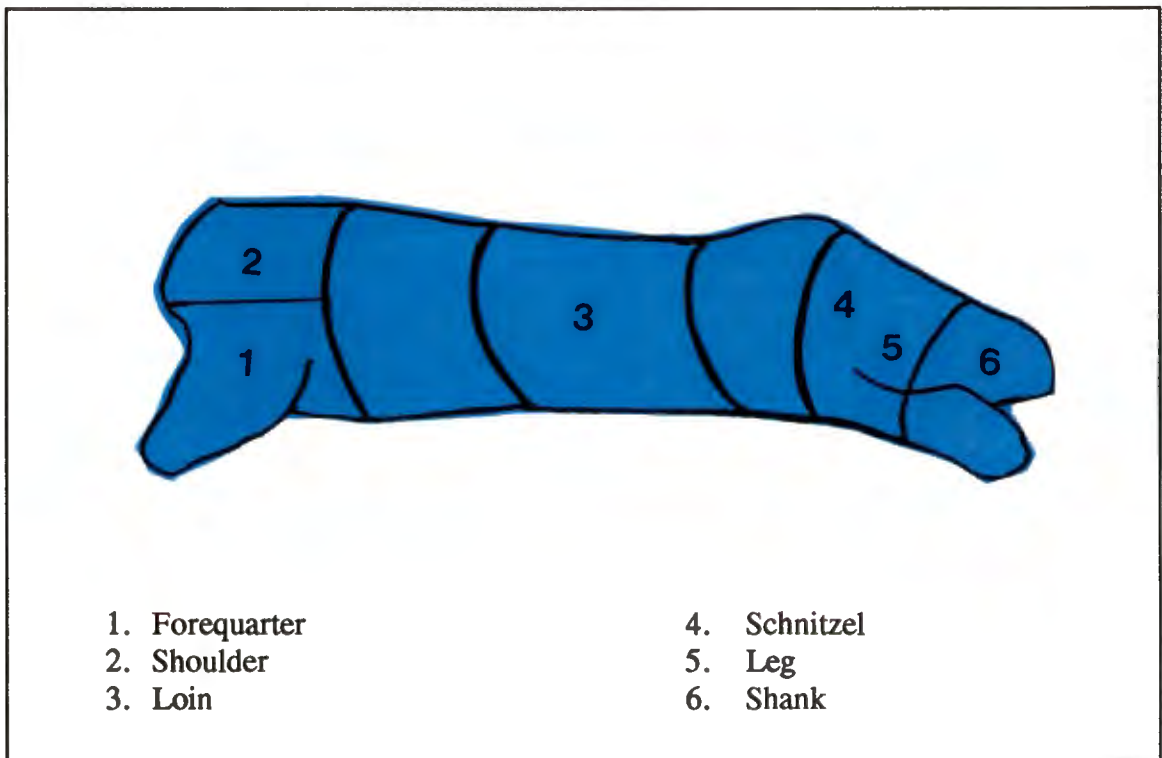


FIGURE 3.4: WHOLESALE CUTS OF THE AUSTRALIAN VEAL CARCASSES  
(Adapted from Greenfield *et al.*, 1987: 209)

### 3.5 Physical composition

Two days *post-mortem*, the ten right veal sides (Figure 3.1) within each of the two grades were subdivided into 8 cuts (Figure 3.2): 10 right sides x 2 grades x 8 cuts = 160 samples.]

Determination of the physical composition involved deboning at 10°C ambient temperature of each right side cut as well its further subdivision into subcutaneous fat, lean meat and bone. The mass of each of these three components was measured on an electronic scale in the Irene Abbatoir, for the determination of the total physical composition of each cut and of the carcass. The dissections were done at the IAPI by the trained team of the Meat Industry Centre (MIC). The data were recorded on a standard form (Appendix A) and utilized to determine carcass values for the nutrients, as results were expressed on the basis of each cut in relation to carcass composition.

### 3.6 Chemical analyses

The subcutaneous fat and lean meat of each cut were cubed, thoroughly mixed and then minced through a 5 mm and a 2 mm mesh plate respectively, by means of an electrical, industrial mincer. Representative samples of each cut were taken for the determination of protein, fat and ash content (300 g) and for the determination of moisture content (50 g). These were placed in aluminium trays and vacuum bags respectively, labelled, vacuum-packed and stored at -20 °C until analysed.

Using the above mentioned representative samples, the proximate analyses of the deboned right side cuts were done to determine the percentages of total moisture, fat, nitrogen (protein) and ash, according to the methods summarized in Table 3.1.

### 3.7 Nutrient analyses

#### 3.7.1 Preparation of samples for analyses

Three veal carcasses within each grade were used to determine the nutrient content of

each raw and cooked primal cut (Figure 3.2). Composite samples of each group of three identical cuts from the three carcasses were used in the analyses: 2 grades x 8 cuts = 16 samples raw (right sides) and 16 samples cooked (left sides). The use of composite samples is considered an acceptable approach in food composition studies (Paul & Southgate, 1983: 7-8). Composite sampling was also used by Anderson *et al.* (1989: 6), Ono *et al.* (1986: 1352) and Greenfield *et al.* (1987: 209) in their respective nutrient composition studies on American and Australian veal.

#### LEFT SIDES (16 samples — raw)

The three left sides were used for determination of the nutrient content of raw Grade 1 and Super veal. After being minced, each sample was then divided into the amounts required for the various analyses. After labelling and packaging, the samples were deep frozen (-40°C) and distributed to the laboratories responsible for the determinations (Table 3.1).

#### RIGHT SIDES (16 samples — cooked)

Each cut (Figure 3.2) of the three right sides was labelled, deboned if applicable, vacuum-packaged, aged at 4°C for 8 days *post mortem* and stored at -40°C. The cuts were thawed at 10°C for periods varying between 24-36 hours (depending on the mass) before being cooked according to the appropriate dry or moist heat cooking method determined by the preliminary study, namely:

- Dry heat cooking method
  - \* Rib
  - \* Loin
  - \* Rump
  - \* Leg
  
- Moist heat cooking method
  - \* Shoulder
  - \* Chuck
  - \* Breast and flank
  - \* Shins

Cooking losses were determined from the data recorded on a standard form (Appendix B). These forms were generated using the Quatro spreadsheet, which automatically calculated the following parameters as data were entered:

- percentage thawing loss
- percentage total cooking loss
- percentage drip loss
- percentage evaporation loss
- cooking time
- cooking rate (°C/minute)

The cooked meat obtained from each cut was chilled (4°C) overnight, deboned if applicable, cubed, thoroughly mixed and then minced twice through an electrically powered mincer using a 2 mm mesh plate. Each sample was then separated into the amount required for each analysis. After labelling and packaging the samples were deep frozen(-40°C) and distributed to the different laboratories for analysis. The nutrient analyses were completed according to Table 3.1.

### 3.7.2 *Proximate chemical analyses*

The proximate chemical analyses for macronutrients were done according to standardized methods in the Meat Chemistry laboratory of the IAPI. The different methods are summarized in Table 3.1.

- The protein content was determined by the standard Kjeldahl procedure for nitrogen (AOAC, 1990). Freeze dried samples of 0,5 grams each were used, digested with 25 mL 98% sulphuric acid and placed on the Buchi 322 distillation unit for distillation and titration. A conversion factor of 6,25 was used in the calculation of the protein content.
- The moisture content was determined by the weight loss of a 5 gram sample of each cut, after being dried in a vacuum oven at 100 °C for 24 hours.
- For the determination of the fat content a 2 gram freeze dried sample was used. Minced meat samples were loosely packed on aluminium foil pans and frozen. The frozen samples were placed in the freeze dryer at a vacuum of 0,1 mbar.

Table 3.1: NUTRIENT ANALYSES OF VEAL

NUTRIENT	METHOD	LABORATORY
Protein	AOAC (1990)	IAPI <sup>1</sup>
Fat	AOAC (1990)	IAPI
Ash	AOAC (1990)	IAPI
Moisture	AOAC (1990)	IAPI
Food energy content	Calculated from % protein & fat	
<i>MINERALS</i>		
Phosphorus (P)	Spectrophotometric, (Horwitz, 1980)	ISCW <sup>2</sup>
Calcium (Ca)	EDTA titration, (Horwitz, 1980)	ISCW
Magnesium (Mg)	EDTA titration at pH 10, (Horwitz, 1980)	ISCW
Sodium (Na) & Potassium (K)	Emmision flame spectrophotometry, (Horwitz, 1980)	ISCW
Iron (Fe), Zinc (Zn), Manganese (Mn) & Copper (Cu)	Atomic absorption, (Horwitz, 1980)	ISCW
<i>VITAMINS</i> (watersoluble)		
Thiamin (B <sub>1</sub> ) Riboflavin (B <sub>2</sub> ) Niacin Pyridoxine (B <sub>6</sub> ) Folic acid Biotin	Microbiological method, (Barton-Wright, 1961)	SABS <sup>3</sup>
Cyanocobalamin (B <sub>12</sub> )	AOAC (1990)	SABS
Calcium pantothenate	USP XXII (1990)	SABS
<i>FATTY ACID PROFILE</i>	Gas liquid chromatography	NIP, MRC <sup>4</sup>
<i>TOTAL CHOLESTEROL</i>	Gas liquid chromatography	NIP, MRC

<sup>1</sup> IAPI: Irene Animal Production Institute, Agricultural Research Council

<sup>2</sup> ISCW: Institute of Soil, Climate and Water, Agricultural Research Council

<sup>3</sup> SABS: South African Bureau of Standards

<sup>4</sup> NIP, MRC: Nutritional Intervention Programme of the Medical Research Council

Thereafter the samples were heated for 5 minutes to ensure that all the moisture had escaped. As soon as the samples were removed, they were minced and stored in tightly sealed, small sample bottles to prevent absorption of moisture from the air.

Fat was extracted from the freeze dried samples, by means of ethanol (2-3 drops), over a 8-10 hour period. The fat-ethanol solution was evaporated down until a 0,5 cm layer was left in the flask. To remove the last traces of ethanol and moisture, the samples were dried in a kiln at 67 °C for 4 hours. After cooling, the samples were weighed to determine the total amount of ethanol extractable fat.

- Ash was determined in a muffle furnace at 550 °C. Incineration of the samples was completed after six hours. After cooling, the samples were weighed to determine the ash content.
- Energy was calculated from the percentage protein and fat using the following factors:  
 $\% \text{ Protein} \times (4,184 \times 4,27) = A$   
 $\% \text{ Fat} \times (4,184 \times 9,02) = B$   
 $\text{Energy (kJ)} = (A + B)$  (Paul & Southgate, 1983).

Similar methods were used by Ono *et al.* (1986: 1353) and Greenfield *et al.* (1987: 209) for the proximate chemical analyses of American and Australian veal respectively.

### 3.7.3 Minerals

The mineral content of veal was determined with appropriate standardized methods in the laboratories of the ISCW in Pretoria. Freeze dried samples, dry ashed at 500-550 °C for at least 8 hours, were used. In the preparation of the solutions, concentrated hydrochloric acid was used as solvent. The concentrates were diluted with distilled water. Aliquots of this solution were used for the determinations of the minerals.

The SI units were used to report the laboratory data where "L" is the accepted symbol for liter and "mL" for milliliter (Young, 1987: 114).

- **Phosphorus** (colorimetric method)

The following were added to 100mL aliquot containing 0,1-0,25 mg phosphorus:

- 10 mL nitric acid (1 volume concentrated  $\text{HNO}_3$  : 2 volumes distilled water)
- 10 mL ammonium vanadate solution (2,5 g ammonium vanadate + 500 mL boiling distilled water; Add 20 mL  $\text{HNO}_3$  (c); Make up to 1 dL)
- 10 mL ammonium molybdate solution (50 g ammonium molybdate + 800 mL distilled water at 50 °C; make up to 1 dL)

The mixture was thoroughly mixed, diluted with distilled water and allowed to stand for 30 minutes for colour development. Absorption was measured at 470 nm against the blank.

- **Calcium and magnesium** (titration method)

- \* Calcium

The following reagents were added to 100 mL aliquot:

- 10 mL triethanolamine (TEA) and 10 mL sodium hydroxide (NaOH) solution (200 g NaOH in 400 mL distilled water. Dilute to 1 dL)
- 2-3 mL magnesium chloride ( $\text{MgCl}_2$ ) solution to improve the endpoint (8,4 g  $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$  (AR) in 1 dL distilled water)
- *Cal-red* indicator to give a wine-red colour.
- An excess of standardized  $\text{Na}_2\text{EDTA}$  solution (0,05 mol dL)

The resultant blue solution was titrated with a standard calcium solution (1 mg  $\text{cm}^3$  Ca) to a wine-red end point.

- \* Magnesium

30 mL aliquot was diluted to 50 mL with distilled water.

10 mL TEA (1:1), 10 mL ammonia buffer solution (pH=10; 67,5 g  $\text{NH}_4\text{Cl}$  + 200 mL distilled water + 570 mL ammonia solution (c); dilute to 1 dL) as well as a small amount of methyl thymol blue (MTB), to give a blue colour, were added. The solution was titrated with a  $\text{Na}_2\text{EDTA}$  (0,05 mol  $\text{dm}^{-3}$ ) solution to a colourless or grey end point.

The concentration of calcium plus magnesium equivalent was calculated from which

the concentration of calcium was obtained by difference.

- ***Iron, zinc, manganese and copper*** (atomic absorption spectrophotometry)

30 mL aliquots of the prepared solution were diluted to 200 mL appropriate volumes with distilled water. Absorption was determined with an atomic absorption spectrophotometer and compared against corresponding standards. An air-acetylene flame was used and absorbance was measured at the following wavelengths for each mineral:

Iron: 248,3 nm

Zinc: 213,9 nm

Manganese: 279,5 nm

Copper: 327,4 nm

In the American veal studies (Ono *et al.*, 1986: 1353) the inorganic nutrient contents, except phosphorus, were quantified by atomic absorption spectrophotometry on extracts of samples, dry-ashed at 530 °C. Phosphorus was determined on the same dry-ashed extract by the colorimetric method of Fiske and Subbarow (1925: 375).

The mineral levels of Australian veal were determined by dissolving the ash in hydrochloric acid and analysing the solution by atomic absorption spectrophotometry, as described by Wills *et al.* (1981: 274-276).

#### 3.7.4 *Vitamins*

The vitamin B complex content of veal was determined in the SABS laboratories in Pretoria. The microbiological method (Barton-Wright, 1961: 6-28), was used for the determination of thiamin, riboflavin, niacin, folacin, biotin and vitamin B<sub>6</sub>. However, for vitamin B<sub>12</sub> and calcium pantothenate determinations, the AOAC (1990: 1082) and the USP XXII (1990: 1500) methods were used respectively.

The microbiological method of Barton-Wright (1961: 6-28) includes the following general procedures:

- *Basal Medium*

For each vitamin a basal medium free of that specific vitamin was prepared. The pH was adjusted in each case with a sodium hydroxide solution using bromothymol blue as indicator. The volume (125 mL) was made up to 500 mL with distilled water.

- *Assay Procedure*

A separate standard curve had to be established for every assay, by using different ranges of each vitamin. At least three different concentrations of each test sample were assayed. All concentrations of standard and test solutions were made up in triplicate. The volume in each test tube was adjusted to 10 mL with water and incubated at 30 °C for 72 hours.

- *Preparation of the Inoculum*

The inoculum for microbiological assays is prepared by transfer from a stab culture to an inoculum medium which is incubated for 18-20 hours at 30 °C. The culture is diluted to 1 in 100 with a quarter-strength sterile Ringer solution. One drop of the diluted suspension was added to each of the assay tubes.

- *Preparation of samples for the assay*

5 g of the finely ground, frozen meat samples was suspended in 50 mL N.HCl and autoclaved for 15-20 minutes. The extract was cooled, sodium acetate solution added, the pH adjusted and the solution made up to volume. The solution was filtered, the pH of an aliquot readjusted and made up to its final volume.

- *Method of calculation*

Although the type of standard curve obtained for each vitamin may vary with each assay, it nearly always contains a strictly linear part. The slope-ratio method of computation was used for calculating the results.

### 3.7.5 *Cholesterol and fatty acid content*

Cholesterol and the major fatty acids known to be present in meat ( $C_{14:0}$ ,  $C_{16:0}$ ,  $C_{18:0}$ ,  $C_{16:1}$ ,  $18:1$ ,  $C_{18:2}$ ,  $C_{20:4}$ ) were quantitated by gas liquid chromatography in the laboratories of the South African Medical Research Council in Tygerberg. Representative samples from minced meat of each cut, vacuum packed and frozen, were analysed for fatty acid composition and cholesterol content.

Weighed duplicate samples were homogenised with a Polytron homogeniser in a chloroform-methanol (2:1) mixture, containing 0,01% Bulylatec and Lydroxytolene as an antioxidant. The extracts were analysed by gas liquid chromatography.

- ***Cholesterol***

Total cholesterol in chloroform-methanol extracts was determined by gas liquid chromatography, using stigmasterol as an internal standard. The coefficient of variation of duplicate cholesterol analyses was 2,2% (Benadé et al., 1988: 157-168).

- ***Fatty acids***

Chloroform-methanol extracts were trans-methylated with methanol-sulphuric acid and fatty acid methyl esters extracted with n-hexane, analysed by gas chromatography, as described by Benadé *et al.* (1988: 157-168) and Smuts *et al.* (1992: 129-138). Heptadecanoic acid (C<sub>17:0</sub>) was used as an internal standard. The coefficient of variation of duplicate analyses was between 1,3% and 2,5% for the major fatty acids, namely palmitic (C<sub>16:0</sub>), stearic (C<sub>18:0</sub>) and oleic (C<sub>18:1</sub>) acids.

### 3.8 Calculations and statistical analyses

A carcass value for each nutrient in raw and cooked Grade 1 and Super veal was calculated as follows (Appendix C):

The original physical analyses data of the three veal carcasses within each grade were used. The subcutaneous fat, muscle and bone of each cut were totalled, the average determined and used as a carcass value. The averages are the same for each cut in the carcass. The sum of the subcutaneous fat and muscle were obtained per cut and per carcass, representing values for "cut meat" and "carcass meat" respectively. Averages were calculated for each. Average nutrient composition values for each cut were multiplied by ten times the average "cut meat" value and totalled. This total was then divided by ten times the "carcass meat" value to give the carcass value for each nutrient per 100 g.

The nutrient density of veal was calculated for each specific nutrient according to the

method given by Passmore and Eastwood (1986: 168). Either the mean value of the eight cuts, or the calculated carcass value, or the value of a specific cut were used for this calculation, as indicated in each case.

A one way analysis of variance (with percentage fat as the main effect) was performed using the Statgraphics<sup>R</sup> package. If the main effect was significant at a 5% level, the analysis was performed at the 1% level of significance. Similarly main effects significant at a 1% level were tested at a 0,1% level.

South African and American veal data were compared using the *Kolmogorov-Smirnov Two Sample Test* and the *Comparison Mann-Whitney Test for Two Samples*.

- *Kolmogorov-Smirnov Two Sample Test*

This test determines whether two samples are from the same distribution. The procedure calculates the maximum difference between the cumulative distribution functions of the two samples. When the significance is lower than 0,05, it indicates that the distributions are significantly different from each other at the 5% level.

- *Comparison Mann-Whitney Test For Two Samples*

This test determines whether two independent samples have the same median. It is used when the samples are independent and have different sample sizes.

This procedure combines and pairs the data from the independent samples. The pairs are then summed over all observations contained in each sample and a value is calculated with which to compare the average pairs. If the statistic is large, the null hypothesis ( $H_0$ ) of the samples having identical location parameters, is rejected.

In both these tests the supposition that the two data sets were similar was accepted. The two tests were independent and the hypotheses ( $H_0$  : median RSA = median USA) accepted and ( $H_1$  : median RSA = Median USA) rejected.

## CHAPTER 4

### RESULTS

#### 4.1 Introduction

In this chapter, the results of the nutrient analyses of Grade 1 and Super veal cuts are presented and compared to the nutrient composition of American and/or Australian veal. Interpretation and possible application of the data will be discussed in chapter 5.

Average values will be discussed in conjunction with tables of analyses of variance. The format is consistent throughout the chapter. A table is presented for each variable, indicating the average nutrient content of the eight raw and cooked veal cuts in the second and third columns. The carcass value for each nutrient, calculated as indicated in Appendix C and discussed in paragraph 3.8, is given for raw and cooked veal in each table. The standard deviation as well as the coefficient of variance are given in the fourth and fifth columns respectively. The level of significance (p-value) appears in the last column of each table. The statistically significant differences are indicated in the last column as follows:

<sup>a</sup> :	$p \leq 0,001$	level of significance	0,1 %
<sup>b</sup> :	$p \leq 0,01$	level of significance	1 %
<sup>c</sup> :	$p \leq 0,05$	level of significance	5 %

In instances where the nutrient density of cooked veal is reported, this variable was calculated as indicated in section 2.6.4. Energy RDA's of 8 000 kJ for adult women, and 10 000 kJ for adult men were assumed. The carcass values of either Grade 1 or Super veal was calculated, and used for the calculation of densities of the different nutrients in veal.

Table 4.1 AVERAGE MASS (kg) OF GRADE 1 AND SUPER VEAL CUTS

CUT	1 Shoulder	2 Chuck	3 Rib	4 Loin	5 Breast	6 Rump	7 Leg	8 Shins	9 Carcass
Grade 1	2,45	3,60	1,42	1,57	3,18	1,68	5,75	3,37	23,02
Super	4,13	6,77	2,93	2,89	7,09	3,31	9,41	5,1	41,63

The physical data of the experimental material regarding the average masses of the eight carcass cuts of Grade 1 and Super as well as the average carcass masses of the two grades of veal appear in Table 4.1.

#### 4.2 Results of macronutrients in veal

Table 4.2: AVERAGE MOISTURE CONTENT OF GRADE 1 AND SUPER VEAL CUTS (g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	73,66	68,33	3,35	4,72	0,0004 *
2 Chuck	71,32	65,92	3,36	4,92	0,0000 *
3 Rib	72,52	60,78	6,79	10,11	0,0002 *
4 Loin	73,33	64,30	5,14	7,44	0,0001 *
5 Breast	66,23	53,72	6,85	11,41	0,0000 *
6 Rump	70,40	66,18	4,11	6,02	0,1716
7 Leg	73,71	67,33	4,16	5,92	0,0002 *
8 Shins	71,37	68,75	2,50	3,56	0,0374 °
9 Carcass	71,63	64,16			
<b>COOKED</b>					
1 Shoulder	63,76	55,44	6,17	3,04	0,0000 *
2 Chuck	60,31	51,03	7,94	6,96	0,0000 *
3 Rib	65,51	55,32	10,21	6,88	0,0000 *
4 Loin	65,14	53,07	7,14	3,87	0,0000 *
5 Breast	60,93	54,36	3,51	2,21	0,0000 *
6 Rump	62,80	56,07	4,69	2,37	0,0000 *
7 Leg	66,64	59,21	2,30	6,12	0,0000 *
8 Shins	63,37	59,25	5,64	2,49	0,0000 *
9 Carcass	63,68	55,69			

The between cut variation in moisture content (Table 4.2) ranged from 66,23-73,71 g for Grade 1 and from 53,72-68,75 g for Super veal which are lower than the values of 74,5-78,4 g reported by Greenfield *et al.* (1987: 214). With the exception of the rump, the moisture content of all other raw cuts is significantly higher in Grade 1 veal ( $p \leq 0,001$ ;  $p \leq 0,05$ ).

Table 4.3: AVERAGE DRY MATTER CONTENT OF GRADE 1 AND SUPER VEAL CUTS (g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANC E LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	26,34	31,67	2,92	10,07	0,0000 *
2 Chuck	28,68	34,09	2,96	9,44	0,0000 *
3 Rib	27,48	39,22	6,43	19,28	0,0000 *
4 Loin	26,78	35,71	4,89	15,65	0,0000 *
5 Breast	33,77	46,28	6,85	17,12	0,0000 *
6 Rump	29,68	35,49	3,18	9,77	0,0000 *
7 Leg	26,29	32,67	3,49	11,85	0,0000 *
8 Shins	28,61	31,26	1,45	4,85	0,0000 *
9 Carcass	28,38	35,96			
<b>COOKED</b>					
1 Shoulder	36,24	44,56	4,56	11,29	0,0000 *
2 Chuck	39,69	48,97	5,08	11,47	0,0000 *
3 Rib	34,47	44,68	5,58	14,10	0,0000 *
4 Loin	34,86	46,93	6,61	16,17	0,0000 *
5 Breast	39,07	53,64	7,98	17,22	0,0000 *
6 Rump	37,20	43,93	3,67	9,09	0,0000 *
7 Leg	33,36	40,79	4,07	10,98	0,0000 *
8 Shins	36,62	40,75	2,26	5,83	0,0000 *
9 Carcass	36,32	45,72			

Although cooking affected all cuts of both Grade 1 and Super veal, causing a loss of moisture, the moisture content of the cooked cuts of Super veal is still significantly lower ( $p \leq 0,001$ ) than that of Grade 1 veal, probably as a result of the higher fat content of Super veal. According to the carcass value, the percentage moisture loss of Grade 1

veal was 7,95 g/100 g edible portion (11,1%) (from 71,63-63,68 g) and for Super veal 8,47 g (13,2%) (from 64,16-55,69 g).

The dry matter content (Table 4.3) of the raw veal cuts varied from 26,29 g-33,77 g for Grade 1 and from 31,26 g-46,28 g for Super carcasses. These values were significantly higher ( $p \leq 0,001$ ) for Super than for Grade 1 veal. The dry matter content of all the Grade 1 and Super cuts increased on cooking. Similar to the raw cuts, the dry matter content is significantly higher ( $p \leq 0,001$ ) in all the cooked Super cuts. The average dry matter content is the reciprocal of the moisture content, because the moisture content was determined by calculation of weight loss after the samples were dried. Using the carcass values of Grade 1 veal as an example, dry matter plus moisture for raw veal is 28,38 g plus 71,63 g, which equals 100 g and for cooked veal: 36,32 g plus 63,68 g, which also equals 100 g.

According to Table 4.4 the protein content of all cuts was lower in Super than in Grade 1 veal. This was statistically most significant ( $p \leq 0,001$ ) for the raw chuck and breast cuts, followed by the rib and shins ( $p \leq 0,05$ ). The protein decrease in all other raw cuts was not statistically significant. Similarly, the protein content was significantly higher ( $p \leq 0,001$ ) in all the cooked cuts of the Grade 1 carcasses. The decrease in protein content with increasing fat content, is in agreement with the reports of Ono *et al.* (1986: 1354), Greenfield *et al.* (1987: 214) and Bowers *et al.* (1989: 1445). The highest protein content was found in the cooked Grade 1 shins, namely 31,15 g/100 g edible portion, which was slightly higher than the 30,10 g/100 g edible portion reported by Anderson *et al.* (1989: 121) for cooked separable lean and fat American veal. The lower moisture and protein content of Super veal is probably related to the higher fat content. With an RDA of 50 g for protein (Food and Nutrition Board, 1989: 285) a 100 g portion of cooked veal will contribute between 36% and 62% of the daily protein requirements of an adult woman. The increases in protein content of Grade 1 and Super veal after cooking were 6,01g and 3,24 g per 100 g.

Table 4.4: AVERAGE PROTEIN CONTENT OF GRADE 1 AND SUPER VEAL CUTS (g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	20,88	20,30	0,44	2,12	0,3637
2 Chuck	21,55	18,94	0,89	4,28	0,0007 <sup>a</sup>
3 Rib	21,19	19,09	1,36	6,67	0,0121 <sup>c</sup>
4 Loin	21,28	17,49	3,32	17,06	0,2359
5 Breast	21,27	16,95	2,12	10,91	0,0000 <sup>a</sup>
6 Rump	21,95	19,76	0,90	4,37	0,1233
7 Leg	20,89	20,05	0,83	4,06	0,2581
8 Shins	22,67	20,66	0,74	3,45	0,0163 <sup>c</sup>
9 Carcass	21,37	19,32			
<b>COOKED</b>					
1 Shoulder	28,63	27,35	0,74	2,65	0,0000 <sup>a</sup>
2 Chuck	29,33	25,16	2,41	5,80	0,0000 <sup>a</sup>
3 Rib	25,03	21,02	2,32	10,06	0,0000 <sup>a</sup>
4 Loin	25,94	20,94	2,89	12,32	0,0000 <sup>a</sup>
5 Breast	23,33	17,95	3,11	15,05	0,0000 <sup>a</sup>
6 Rump	27,62	22,96	2,68	10,60	0,0000 <sup>a</sup>
7 Leg	27,29	20,57	3,88	16,21	0,0000 <sup>a</sup>
8 Shins	31,15	28,94	1,54	5,15	0,0000 <sup>a</sup>
9 Carcass	27,38	22,56			

As expected, all raw and cooked cuts of the Super carcasses had a fat content that was significantly higher ( $p \leq 0,001$ ) than that of Grade 1. The percentage fat increased (Table 4.5), as the protein content decreased (Table 4.4). This corresponds with Klingbiel (1984), who reported that the main effect of an increase in fat content is a decrease in the proportion of moisture, protein and ash.

The fat content of the different raw and cooked cuts varied within both grades, indicating the breast and flank to be the cuts with the highest, and the shins and shoulder the cuts with the lowest fat content (Table 4.5). Greenfield *et al.* (1987 :214), reported the raw fore-quarter (Figure 3.4) (11 g/100 g) to be the fattiest cut of the carcass and the shank (3 g/100 g) the leanest. The fat content of both Grade 1 and Super veal cuts increased with cooking. The increases were 3,94 g and 5,07 g per 100 g veal respectively. The fat content of lean American veal blade (braised) is given as 6,48 g/100 g edible portion

(Anderson *et al.*, 1989: 164).

Table 4.5: AVERAGE FAT CONTENT OF GRADE 1 AND SUPER VEAL CUTS.  
(g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	4,15	10,81	3,76	50,36	0,0002 <sup>a</sup>
2 Chuck	5,56	14,36	4,61	46,88	0,0000 <sup>a</sup>
3 Rib	5,32	18,99	7,71	65,93	0,0001 <sup>a</sup>
4 Loin	5,01	15,47	5,17	52,77	0,0000 <sup>a</sup>
5 Breast	11,14	28,03	9,02	47,02	0,0000 <sup>a</sup>
6 Rump	6,33	13,46	3,03	42,62	0,0010 <sup>a</sup>
7 Leg	4,87	12,38	4,77	53,04	0,0000 <sup>a</sup>
8 Shins	4,26	8,85	3,01	45,86	0,0058 <sup>b</sup>
9 Carcass	5,90	15,74			
<b>COOKED</b>					
1 Shoulder	5,76	16,46	6,17	55,59	0,0000 <sup>a</sup>
2 Chuck	8,84	23,49	8,46	52,32	0,0000 <sup>a</sup>
3 Rib	7,91	22,62	8,49	55,64	0,0000 <sup>a</sup>
4 Loin	7,44	25,35	10,34	63,07	0,0000 <sup>a</sup>
5 Breast	15,39	35,46	11,59	45,57	0,0000 <sup>a</sup>
6 Rump	8,72	20,18	6,61	45,79	0,0000 <sup>a</sup>
7 Leg	12,07	12,25	0,10	0,85	0,0000 <sup>a</sup>
8 Shins	5,70	11,53	3,37	39,07	0,0000 <sup>a</sup>
9 Carcass	9,84	20,81			

The fat content of chuck in this study was 8,84 g/100 g in Grade 1 and 23,49 g in the Super veal, while the carcass values were 9,84 and 20,81 g/100 g respectively. However, it should be noted that analyses of American veal (separable lean veal) were done after removal of all visible subcutaneous fat, while these analyses of South African veal were conducted on meat plus fat. A comparison of the fat content of South African and American veal will be discussed in 5.4.

The ash content (Table 4.6) of all raw cuts was significantly lower ( $p \leq 0,01$ ) for Super carcasses when compared to that of Grade 1. The Grade 1 cuts when cooked, except for the shoulder, which showed similar values for both grades, had higher values than Super.

Grade 1 veal showed a decrease in ash content from 1,06 g to 1,05 g after cooking, in contrast with Super veal indicating an increase of 0,03 g/100 g. This is contrast of what could have been expected from a 7,95 g (11,1%) moisture loss. It seems that the moisture loss of 8,47 g per 100 g in the carcass value of Super veal, after cooking, approximately equals the sum of the weight increases in protein and fat content (3,24 plus 5,07 g). However, for Grade 1 the protein and fat increase (6,01 plus 3,94 g) is more than the 7,95 g moisture loss.

Table 4.6: AVERAGE ASH CONTENT OF GRADE 1 AND SUPER VEAL CUTS.  
(g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	1,05	0,98	0,04	3,92	0,0018 <sup>b</sup>
2 Chuck	1,00	0,86	0,08	8,13	0,0001 <sup>a</sup>
3 Rib	0,94	0,76	0,11	11,57	0,0000 <sup>a</sup>
4 Loin	0,88	0,84	0,13	14,56	0,0021 <sup>c</sup>
5 Breast	1,04	0,77	0,15	16,59	0,0000 <sup>a</sup>
6 Rump	1,17	0,92	0,14	13,30	0,0000 <sup>a</sup>
7 Leg	1,13	0,97	0,16	15,41	0,0004 <sup>b</sup>
8 Shins	1,12	1,03	0,05	4,44	0,0000 <sup>a</sup>
9 Carcass	1,06	0,90			
<b>COOKED</b>					
1 Shoulder	1,01	1,01	0,08	2,89	0,3401
2 Chuck	0,99	0,85	0,12	11,73	0,0000 <sup>a</sup>
3 Rib	1,03	0,88	0,11	10,94	0,0000 <sup>a</sup>
4 Loin	1,10	0,89	0,16	15,57	0,0000 <sup>a</sup>
5 Breast	1,02	0,77	0,15	16,61	0,0000 <sup>a</sup>
6 Rump	1,13	0,93	0,09	8,02	0,0022 <sup>b</sup>
7 Leg	1,09	1,06	1,22	13,14	0,0078 <sup>b</sup>
8 Shins	1,04	1,02	0,07	6,62	0,0002 <sup>a</sup>
9 Carcass	1,05	0,93			

Considering that the results for both raw and cooked veal are given per 100 g edible portion, it seems that the changes in the weight of the macronutrients after cooking reflect a concentration effect as a result of moisture loss.

As expected, the kilojoule content of all the raw and cooked cuts of Super veal carcasses is significantly higher than that of the corresponding Grade 1 cuts (Table 4.7). The energy values are directly proportional to the protein and fat content, because the food energy value is calculated from the percentage protein and fat (Table 3.1). Although the protein content of Super veal cuts is lower than that of the Grade 1 cuts, the fat content of Super veal cuts is substantially higher.

TABLE 4.7: AVERAGE FOOD ENERGY CONTENT OF GRADE 1 AND SUPER VEAL CUT (kJ/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	533	775	128,75	19,99	0,0000*
2 Chuck	596	889	169,74	22,86	0,0000*
3 Rib	566	1044	135,74	22,71	0,0000*
4 Loin	564	870	162,23	33,55	0,0000*
5 Breast	795	1347	218,99	29,78	0,0000*
6 Rump	608	844	136,26	18,78	0,0000*
7 Leg	559	849	167,43	23,77	0,0000*
8 Shins	553	707	89,49	14,20	0,0000*
9 Carcass	600	937			
<b>COOKED</b>					
1 Shoulder	729	1110	220,55	23,99	0,0000*
2 Chuck	858	1336	307,51	28,67	0,0087 <sup>b</sup>
3 Rib	746	1229	278,28	28,18	0,0000*
4 Loin	744	1331	369,41	36,49	0,0060 <sup>b</sup>
5 Breast	998	1659	381,63	28,72	0,0000*
6 Rump	822	1172	202,36	20,30	0,0000*
7 Leg	823	950	72,75	8,21	0,0000*
8 Shins	772	944	99,88	11,64	0,0000*
9 Carcass	828	1217			

Fat contributes 37,74 kJ/g and protein only 17,87 kJ/g, which explains the consistently higher energy values of the Super veal cuts. The energy levels are higher than those reported by Greenfield *et al.* (1987: 214) for Australian veal, which values ranged from 370-478 kJ. The cooked Grade 1 chuck cut has an energy value of 858 kJ. Anderson *et al.* (1989: 161-164) reported a value of 828 kJ for lean braised veal blade steak, and 940 kJ for the same cut with subcutaneous fat. Differences in the energy content of

American, Australian and South African veal cuts are expected, depending on whether fat was removed before analyses or not. Comparisons of results should therefore take note of this fact.

#### 4.3 Mineral content of veal

Comparing the values of each cut as well as the carcass values, it is clear that the phosphorus content (Table 4.8) of all raw and cooked Grade 1 cuts, is significantly higher ( $p \leq 0,001$ ) than that of the respective cuts of the Super carcasses. The phosphorus content of all cooked cuts of both Grade 1 and Super veal is higher than that of the corresponding raw cuts. This agrees with the finding of Anderson *et al.* (1989), who reported 203 mg/100 g for raw and 239 mg/100 g cooked American veal. This is probably the result of moisture loss during cooking.

Table 4.8: AVERAGE PHOSPHORUS CONTENT OF GRADE 1 AND SUPER VEAL CUTS (mg/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	201	178	16,26	8,58	0,0000*
2 Chuck	186	153	23,33	13,77	0,0000*
3 Rib	168	142	18,33	11,86	0,0000*
4 Loin	164	158	4,24	2,64	0,0024*
5 Breast	187	136	36,06	22,23	0,0000*
6 Rump	229	180	34,65	16,94	0,0000*
7 Leg	221	182	18,69	18,69	0,0000*
8 Shins	204	183	14,85	7,67	0,0000*
9 Carcass	200	164			
<b>COOKED</b>					
1 Shoulder	228	194	18,44	8,73	0,0000*
2 Chuck	221	168	29,05	14,94	0,0008*
3 Rib	207	165	22,97	12,37	0,0000*
4 Loin	221	163	31,77	16,58	0,0000*
5 Breast	194	138	30,29	18,25	0,0000*
6 Rump	243	195	26,27	12,02	0,0000*
7 Leg	221	205	8,95	4,21	0,0000*
8 Shins	217	192	13,65	6,68	0,0004*
9 Carcass	218	178			

The phosphorus content of Grade 1 veal changed from 200 g to 218 g per 100 g. This increase of 8,3% is in the same order as the mean decrease in moisture of 7,95 g per 100 g, or a decrease of 11,1% after cooking of Grade 1 veal.

According to the carcass value, the nutrient density of phosphorus is 2,6 for women, cooked Grade 1 veal for women, compared to 3,05 for American veal (Table 2.10). Therefore, South African veal, also seems to be a very good source of phosphorus.

The calcium levels of Super veal (Table 4.9) are significantly higher ( $p \leq 0,001$ ) in all raw cuts (except the shins) when compared to Grade 1. The calcium levels in both grades of raw veal varied inconsistently between cuts. Cooking had no consistent effect on the calcium content. The levels decreased in some cooked cuts (e.g. the rib) whereas most other cuts of both grades indicated increased levels.

Table 4.9: AVERAGE CALCIUM CONTENT OF GRADE 1 AND SUPER VEAL CUTS (mg/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	17,4	33,7	11,53	45,11	0,0000 <sup>a</sup>
2 Chuck	25,8	40,9	10,68	32,02	0,0001 <sup>a</sup>
3 Rib	25,6	35,1	6,72	22,18	0,0004 <sup>a</sup>
4 Loin	20,4	25,2	6,22	25,09	0,0004 <sup>a</sup>
5 Breast	18,2	25,9	5,44	24,69	0,0000 <sup>a</sup>
6 Rump	11,9	25,0	9,40	50,70	0,0000 <sup>a</sup>
7 Leg	8,2	21,0	9,06	61,99	0,0002 <sup>a</sup>
8 Shins	18,8	19,7	0,64	8,31	0,0779
9 Carcass	18,2	27,8			
<b>COOKED</b>					
1 Shoulder	24,8	29,5	2,96	10,87	0,0177 <sup>c</sup>
2 Chuck	31,2	31,0	1,03	3,31	0,8416
3 Rib	24,6	25,7	1,50	5,97	0,4510
4 Loin	36,7	28,1	4,73	14,61	0,0023 <sup>b</sup>
5 Breast	30,6	30,6	0,73	2,40	0,9966
6 Rump	26,4	26,0	0,54	2,05	0,5144
7 Leg	10,2	24,3	7,77	45,02	0,0000 <sup>a</sup>
8 Shins	21,3	27,9	3,64	14,81	0,0000 <sup>a</sup>
9 Carcass	23,3	27,9			

Riss *et al.* (1983: 1869) reported low calcium values that varied widely from 3,25-12 mg/100 g. According to their highest level of 32 mg/100 g, Ono *et al.* (1986) reported that veal should not be regarded a good source of calcium. Greenfield *et al.* (1987) also reported low calcium levels ranging, from 4-35 mg/100 g. The calculated carcass value for calcium for cooked Grade 1 veal is 23,30 g/100 g. Grade 1 veal has a calculated nutrient density for calcium, of 0,31 (Passmore and Eastwood, 1986: 168). Therefore, veal cannot be regarded as a good source of calcium.

The magnesium content (Table 4.10) of all raw cuts is significantly higher ( $p \leq 0,01$ ) in Grade 1 than in Super carcasses. Statistically significant differences ( $p \leq 0,01$ ) were observed for all cooked cuts of Grade 1 veal when compared to Super veal, except for the loin and the breast.

Table 4.10: AVERAGE MAGNESIUM CONTENT OF GRADE 1 AND SUPER VEAL CUTS (mg /100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV %)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	20,4	11,2	6,51	41,17	0,0003 <sup>a</sup>
2 Chuck	20,8	9,3	8,13	50,03	0,0000 <sup>a</sup>
3 Rib	19,4	14,0	3,82	22,86	0,0001 <sup>a</sup>
4 Loin	18,6	16,4	1,56	8,89	0,0021 <sup>b</sup>
5 Breast	22,8	11,0	8,34	49,37	0,0000 <sup>a</sup>
6 Rump	27,1	15,8	8,56	40,65	0,0000 <sup>a</sup>
7 Leg	25,1	17,0	5,73	27,22	0,0002 <sup>a</sup>
8 Shins	23,0	18,9	3,00	13,84	0,0000 <sup>a</sup>
9 Carcass	22,7	13,9			
<b>COOKED</b>					
1 Shoulder	25,2	39,1	7,64	23,76	0,0000 <sup>a</sup>
2 Chuck	25,7	42,2	9,04	26,67	0,0000 <sup>a</sup>
3 Rib	22,7	25,7	1,63	6,72	0,0002 <sup>a</sup>
4 Loin	24,3	24,2	0,11	0,44	0,2517
5 Breast	18,5	22,2	2,60	12,76	0,0656
6 Rump	27,7	16,1	6,09	28,12	0,0000 <sup>a</sup>
7 Leg	26,7	18,5	4,48	19,83	0,0001 <sup>a</sup>
8 Shins	28,0	19,2	5,01	21,27	0,0021 <sup>a</sup>
9 Carcass	25,0	25,8			

The values for the rump, leg and shins were higher in the Grade 1 cuts. However, the shoulder, chuck, rib and breast cuts showed higher levels for Super veal. The magnesium content was increased by cooking, except for the Grade 1 breast cut, in which the content decreased. Greenfield *et al.* (1987: 215) reported a magnesium content ranging from 18-23 mg/100 g, with no consistent pattern of change due to cooking. Using a mean value of 26 g per 100 g cooked veal, the nutrient density of veal for magnesium for an adult woman is 0,94 (see Table 2.10). According to Table 4.10 it appears that certain veal cuts, e.g. shoulder and chuck may be regarded as good sources of magnesium.

Table 4.11: AVERAGE POTASSIUM CONTENT OF RAW AND SUPER VEAL CUTS (mg/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	312	325	11,31	8,54	0,0030 <sup>b</sup>
2 Chuck	290	265	17,68	6,37	0,2065
3 Rib	299	250	34,65	12,62	0,0070 <sup>b</sup>
4 Loin	258	278	14,14	5,28	0,0051 <sup>b</sup>
5 Breast	309	234	53,03	19,53	0,0000 <sup>a</sup>
6 Rump	371	325	32,53	9,35	0,0001 <sup>a</sup>
7 Leg	359	335	16,87	4,89	0,0000 <sup>a</sup>
8 Shins	328	327	0,71	0,22	0,0000 <sup>a</sup>
9 Carcass	323	292			
<b>COOKED</b>					
1 Shoulder	349	333	9,31	2,73	0,0016 <sup>b</sup>
2 Chuck	331	282	27,33	8,92	0,0000 <sup>a</sup>
3 Rib	361	287	40,56	12,53	0,0000 <sup>a</sup>
4 Loin	372	272	55,38	17,20	0,0000 <sup>a</sup>
5 Breast	302	235	39,93	14,85	0,0104 <sup>c</sup>
6 Rump	384	311	41,67	11,99	0,0017 <sup>b</sup>
7 Leg	369	328	22,40	6,42	0,0000 <sup>a</sup>
8 Shins	350	290	35,41	11,07	0,0059 <sup>b</sup>
9 Carcass	348	293			

The potassium content (Table 4.11) of all cuts, except raw chuck, showed significant differences ( $p \leq 0,01$ ) between Grade 1 and Super veal. There was no consistent pattern of change in the potassium levels amongst the raw cuts. However, the potassium content

of the cooked cuts was significantly higher ( $p \leq 0,01$ ) in Grade 1 veal. Cooking increased the potassium content in all the Grade 1 cuts except the in breast. Changes caused by cooking followed an inconsistent pattern in the Super cuts. Greenfield *et al.* (1987: 215) reported a potassium level ranging from 310-390 mg/100 g, indicating a decrease when moist heat and an increase when dry heat cooking methods are used. However, the results in Table 4.11 indicate no consistent changes relating to cooking method. Linder (1991: 192) mentions that the USA RDA's of potassium for adults is 2500 mg. The potassium content (carcass value) of cooked Grade 1 veal (Table 4.11) is 348 mg, which means that for adult women the nutrient density for potassium is 1,37. Therefore, veal is regarded as a good source of potassium.

Table 4.12: AVERAGE SODIUM CONTENT OF GRADE 1 AND SUPER VEAL CUTS (mg/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	107	76	17,86	18,71	0,0000 <sup>a</sup>
2 Chuck	105	73	16,26	17,39	0,0002 <sup>a</sup>
3 Rib	86	68	12,73	16,53	0,0000 <sup>a</sup>
4 Loin	74	70	2,83	3,93	0,0894
5 Breast	60	89	20,51	27,53	0,0000 <sup>a</sup>
6 Rump	52	69	12,02	19,87	0,0556
7 Leg	91	70	14,84	10,45	0,0005 <sup>a</sup>
8 Shins	135	104	21,92	18,34	0,0030 <sup>b</sup>
9 Carcass	91	77			
<b>COOKED</b>					
1 Shoulder	84	82	1,34	1,62	0,0016 <sup>b</sup>
2 Chuck	99	82	9,28	10,22	0,0001 <sup>a</sup>
3 Rib	91	80	6,54	7,64	0,0001 <sup>a</sup>
4 Loin	91	90	2,77	2,96	0,6328
5 Breast	117	96	12,76	12,00	0,0137 <sup>c</sup>
6 Rump	79	78	1,47	1,88	0,6560
7 Leg	80	87	3,75	4,51	0,0006 <sup>a</sup>
8 Shins	105	115	5,91	5,38	0,0068 <sup>b</sup>
9 Carcass	89	89			

The sodium content (Table 4.12) of all raw cuts of Grade 1, except for loin and rump, differs significantly ( $p \leq 0,01$ ) from that of the corresponding Super cuts. Apart from the loin and breast which had lower levels, all the other Grade 1 cuts showed higher levels of sodium than the corresponding Super cuts. Levels in the cooked cuts were higher for all Grade 1 cuts, except in the leg and shins, which had lower levels. The sodium content of all Super cuts increased on cooking, irrespective of the cooking method used. The proximate carcass values of cooked Grade 1 and Super veal were similar. The Grade 1 cuts showed no consistent pattern of change on cooking. Greenfield *et al.* (1987: 215) reported values varying from 81 mg/100 g in the leg to 110 mg/100 g in the shank, which compares favourably with the values of the corresponding raw Grade 1 cuts in Table 4.12.

Table 4.13: AVERAGE COPPER CONTENT OF GRADE 1 AND SUPER VEAL CUTS (mg/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	0,274	0,744	0,33	65,29	0,1052
2 Chuck	0,244	1,108	0,61	90,38	0,0015 <sup>b</sup>
3 Rib	0,249	0,420	0,12	36,15	0,0004 <sup>a</sup>
4 Loin	0,274	0,362	0,06	19,57	0,0009 <sup>a</sup>
5 Breast	0,091	0,247	0,11	65,27	0,0140 <sup>a</sup>
6 Rump	0,150	0,636	0,34	87,44	0,0202 <sup>a</sup>
7 Leg	0,102	0,356	0,18	78,43	0,0234 <sup>a</sup>
8 Shins	0,201	0,250	0,03	15,37	0,6333
9 Carcass	0,180	0,521			
<b>COOKED</b>					
1 Shoulder	0,231	0,197	0,04	16,37	0,0292 <sup>a</sup>
2 Chuck	1,087	0,326	0,46	65,29	0,0135 <sup>a</sup>
3 Rib	0,335	0,305	0,10	35,69	0,7579
4 Loin	0,462	0,451	0,12	25,98	0,9288
5 Breast	0,304	0,456	0,13	33,13	0,1523
6 Rump	0,406	0,398	0,07	16,84	0,9015
7 Leg	0,198	0,886	0,38	69,61	0,0000 <sup>a</sup>
8 Shins	0,277	0,629	0,21	46,01	0,0084 <sup>b</sup>
9 Carcass	0,410	0,923			

According to Table 4.13, all the raw cuts of Super veal contained more copper than the corresponding Grade 1 cuts. These differences are significant ( $p \leq 0,05$ ) for all raw cuts except shoulder and shins. The copper content of the cooked cuts of Grade 1 veal varied from 0,198 mg (leg) to 1,087 mg (chuck) and that of Super from 0,197 mg (shoulder) to 0,886 mg (leg). The carcass value for cooked Super veal of 0,923 mg/100 g, was substantially higher than the 0,410 mg/100 g of Grade 1 veal. Cooking caused no consistent pattern of change in both grades. Ono *et al.* (1986: 1356) reported no significant differences between the different cuts. Therefore, it appears as if the copper content of veal increases during the growing period. From Table 1.5 it seems that the American study (Anderson *et al.*, 1989: 161; Breidenstein 1987 :48) showed lower copper values for beef than for veal.

The estimated safe and adequate daily dietary intake (ESADDI) for copper is between 1,5 mg and 3 mg (Food and Nutrition Board, 1989: 284). Therefore, 100 g of cooked Grade 1 veal will contribute approximately 21% of the ESADDI for copper.

Comparing the zinc content (Table 4.14) of the different raw cuts, Grade 1 and Super veal varied inconsistently. Significant differences ( $p \leq 0,001$ ) exist between the zinc content of all respective cooked cuts of Grade 1 and Super carcasses. This finding agrees with those of Ono *et al.* (1986: 1355) and Faustman *et al.* (1992: 303). However, the zinc content values of all cooked cuts of both Grade 1 and Super veal were substantially lower than the value of 7 g/100 g reported for American veal blade steak (lean and fat) (Anderson, 1989: 164).

The RDA for zinc is 12 mg for adult women and 15 mg for adult men (Food and Nutrition Board, 1989: 284). Although South African veal seems to have a lower zinc content than American veal, the nutrient density of Grade 1 veal is 3,14 for men and women, which indicates that South African veal can also be regarded as a very good source of zinc. The nutrient densities of American veal, lean only and lean plus fat (braised steak) are 4,15 and 3,28 respectively (see Table 2.10).

Table 4.14: AVERAGE ZINC CONTENT OF GRADE 1 AND SUPER VEAL CUTS  
(mg/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	1,72	1,85	0,09	5,51	0,4184
2 Chuck	1,35	2,28	0,65	36,23	0,3447
3 Rib	1,08	1,14	0,23	18,25	0,0021 <sup>b</sup>
4 Loin	1,02	1,12	0,87	6,61	0,0032 <sup>b</sup>
5 Breast	1,72	1,42	0,21	13,51	0,0001 <sup>a</sup>
6 Rump	1,69	1,38	0,22	14,23	0,0899
7 Leg	1,50	1,10	0,28	21,76	0,0096 <sup>b</sup>
8 Shins	1,97	2,01	0,03	1,42	0,6279
9 Carcass	1,54	1,54			
<b>COOKED</b>					
1 Shoulder	4,86	2,67	1,21	32,07	0,0000 <sup>a</sup>
2 Chuck	6,95	3,07	2,13	42,53	0,0000 <sup>a</sup>
3 Rib	2,86	1,45	0,77	35,69	0,0000 <sup>a</sup>
4 Loin	2,77	1,64	0,62	28,05	0,0000 <sup>a</sup>
5 Breast	2,61	1,46	0,63	30,97	0,0000 <sup>a</sup>
6 Rump	3,04	1,72	0,74	31,15	0,0008 <sup>a</sup>
7 Leg	2,41	1,98	0,24	10,91	0,0000 <sup>a</sup>
8 Shins	5,11	2,95	1,20	29,67	0,0001 <sup>a</sup>
9 Carcass	3,80	2,14			

The manganese content (Table 4.15) of raw Grade 1 cuts differs inconsistently from that of the corresponding raw Super cuts. These differences are significant ( $p \leq 0,05$ ) for the shoulder, chuck and rump cuts only. The manganese levels of the cooked cuts were significantly lower ( $p \leq 01$ ) in Grade 1 than in Super veal.

The available literature indicates that in the veal studies done overseas, the manganese content was not determined. The estimated safe and adequate daily intake of manganese for adults is 2,5-5,0 mg (Food and Nutrition Board, 1989: 284). The manganese content (carcass value) of cooked Grade 1 veal was 0,021 mg/100 g, giving a nutrient density of 0,03-0,07 for adult women. Clearly, veal is not a significant source of manganese.

Table 4.15: AVERAGE MANGANESE CONTENT OF GRADE 1 AND SUPER VEAL CUTS (mg/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	0,032	0,024	5,65	20,20	0,0118 <sup>c</sup>
2 Chuck	0,035	0,019	0,01	41,90	0,0064 <sup>b</sup>
3 Rib	0,036	0,037	7,07	1,94	0,7969
4 Loin	0,047	0,041	4,24	9,54	0,2116
5 Breast	0,020	0,041	0,01	48,69	0,0032 <sup>b</sup>
6 Rump	0,036	0,047	7,77	18,74	0,0346 <sup>c</sup>
7 Leg	0,033	0,040	4,95	18,56	0,2909
8 Shins	0,028	0,054	0,02	44,84	0,1186
9 Carcass	0,033	0,041			
<b>COOKED</b>					
1 Shoulder	0,013	0,045	0,02	63,21	0,0039 <sup>b</sup>
2 Chuck	0,018	0,067	0,03	66,87	0,0023 <sup>b</sup>
3 Rib	0,014	0,040	0,01	54,52	0,0004 <sup>a</sup>
4 Loin	0,014	0,054	0,02	65,21	0,0004 <sup>a</sup>
5 Breast	0,014	0,055	0,02	67,40	0,0013 <sup>b</sup>
6 Rump	0,016	0,055	0,02	61,07	0,0002 <sup>a</sup>
7 Leg	0,015	0,043	0,02	55,18	0,0001 <sup>a</sup>
8 Shins	0,015	0,042	0,02	53,76	0,0021 <sup>b</sup>
9 Carcass	0,021	0,053			

As expected, the iron content (Table 4.16) was higher in all cuts of the Super veal carcass in comparison to those of Grade 1, irrespective of whether it was raw or cooked. This was confirmed by Greenfield *et al.* (1987: 215), Buege (1989: 42) as well as Faustman *et al.* (1992b: 304). However, these differences were significant only for raw chuck, leg and shins. The differences were significant ( $p \leq 0,05$ ) for most of the cooked cuts, excluding only the shoulder and the breast.

The RDA of iron is 15 mg for women (Food and Nutrition Board, 1989: 284). Based on the above results, the nutrient density of cooked Grade 1 veal is 0,49 and for Super veal 0,61 (for women). South African veal can therefore not be regarded as a good source of iron. This is in contrast with American veal (lean and fat: braised steak)

which has a nutrient density of 0,75 for iron (see Table 2.10).

Table 4.16: AVERAGE IRON CONTENT OF GRADE 1 AND SUPER VEAL CUTS (mg/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	0,58	0,67	0,06	10,18	0,1822
2 Chuck	0,61	0,78	0,12	17,30	0,0007 <sup>a</sup>
3 Rib	0,64	0,65	7,07	1,09	0,5460
4 Loin	0,62	0,65	0,02	3,34	0,8536
5 Breast	0,57	0,64	0,05	8,18	0,0671
6 Rump	0,69	0,73	0,03	4,00	0,3884
7 Leg	0,42	0,66	0,17	31,43	0,0002 <sup>a</sup>
8 Shins	0,55	0,61	0,10	15,96	0,0142 <sup>c</sup>
9 Carcass	0,55	0,68			
<b>COOKED</b>					
1 Shoulder	0,72	1,20	0,37	38,53	0,1063
2 Chuck	0,89	1,04	0,09	8,89	0,0115 <sup>c</sup>
3 Rib	0,61	0,75	0,08	11,48	0,0011 <sup>b</sup>
4 Loin	0,66	0,75	0,05	7,24	0,0122 <sup>c</sup>
5 Breast	0,68	0,75	0,07	9,78	0,3127
6 Rump	0,78	0,95	0,10	12,04	0,0175 <sup>c</sup>
7 Leg	0,73	0,96	0,13	14,98	0,0002 <sup>a</sup>
8 Shins	0,82	1,03	0,12	12,61	0,0018 <sup>b</sup>
9 Carcass	0,75	0,94			

#### 4.4 Vitamin content of veal

Except for raw shin, the thiamin content (Table 4.17) in all raw and cooked cuts was higher for Grade 1 than for Super carcasses. The cooked cuts of the shoulder, loin and breast excluded, these differences were significant at the 99% level ( $p \leq 0,01$ ). This confirms the results of Ono *et al.* (1986: 1355). Except for the breast and rump, in which the thiamin content increased with cooking, the other cooked cuts of the Grade 1 carcasses had lower values. Super veal showed an increase in thiamin content in all cooked cuts, except in the rump where a slight decrease was indicated. The thiamin

content of the different cuts of both Grade 1 and Super veal, was substantially higher than the 0,06 mg/100 g reported by Anderson *et al.* (1989: 161) for American veal (lean and fat). The nutrient density of Grade 1 veal for thiamin (adult women) is 1,07, thus indicating that veal is a good source of thiamin. Moreover, these results also indicate that the cooking process had no adverse effects on the thiamin content.

Table 4.17: AVERAGE THIAMIN (VITAMIN B<sub>1</sub>) CONTENT OF GRADE 1 AND SUPER VEAL CUTS (mg/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV %)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	0,125	0,086	0,03	26,54	0,0040 <sup>b</sup>
2 Chuck	0,151	0,082	0,05	41,67	0,0045 <sup>b</sup>
3 Rib	0,108	0,060	0,03	40,95	0,0001 <sup>a</sup>
4 Loin	0,129	0,081	0,03	32,48	0,0028 <sup>b</sup>
5 Breast	0,104	0,050	0,04	49,59	0,0044 <sup>b</sup>
6 Rump	0,135	0,114	0,01	11,98	0,0056 <sup>b</sup>
7 Leg	0,149	0,091	0,04	34,54	0,0073 <sup>b</sup>
8 Shins	0,064	0,079	7,07	10,32	0,1695
9 Carcass	0,133	0,079			
<b>COOKED</b>					
1 Shoulder	0,104	0,097	4,95	4,93	0,2317
2 Chuck	0,117	0,090	0,02	18,15	0,0380 <sup>c</sup>
3 Rib	0,105	0,095	0,71	7,11	0,0002 <sup>a</sup>
4 Loin	0,123	0,089	0,06	43,47	0,0680
5 Breast	0,132	0,088	0,03	28,41	0,1050
6 Rump	0,142	0,110	0,02	18,03	0,0459 <sup>c</sup>
7 Leg	0,124	0,099	0,02	17,64	0,0043 <sup>b</sup>
8 Shins	0,107	0,097	6,36	6,24	0,0295 <sup>c</sup>
9 Carcass	0,124	0,087			

The riboflavin (Table 4.17) present in raw Grade 1 veal varies inconsistently between cuts compared with that of Super veal. These differences are significant ( $p \leq 0,05$ ) for the shoulder, rib, breast and rump. Except for the shin, with a slightly lower value, the riboflavin content of the cooked cuts was significantly higher ( $p \leq 0,05$ ) for Grade 1 veal. The riboflavin content was higher in the cooked cuts of both grades than in the respective raw cuts. The stability of this vitamin to ordinary cooking processes

(Anderson *et al.*, 1982: 143) might account for this result. Cooked American braised blade steak (lean and fat) contains 0,35 mg riboflavin/100 g edible portion (Anderson *et al.*, 1989: 161) which is substantially higher than the values found in this study. Therefore, with an RDA of 1,3 mg for riboflavin, it is clear that a 100 g portion of Super veal will contribute only 7,7% to 13,3% of the daily riboflavin requirements.

Table 4.18: AVERAGE RIBOFLAVIN (VITAMIN B<sub>2</sub>) CONTENT OF GRADE 1 AND SUPER VEAL CUTS (mg/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	0,098	0,104	4,60	4,56	0,0495 <sup>c</sup>
2 Chuck	0,109	0,104	4,95	4,70	0,3233
3 Rib	0,101	0,075	0,02	21,35	0,0004 <sup>a</sup>
4 Loin	0,103	0,079	0,02	18,31	0,0568
5 Breast	0,120	0,061	0,04	46,62	0,0142 <sup>b</sup>
6 Rump	0,105	0,112	4,95	4,58	0,0474 <sup>c</sup>
7 Leg	0,105	0,101	2,83	2,75	0,5420
8 Shins	0,106	0,099	4,95	4,85	0,0809
9 Carcass	0,110	0,092			
<b>COOKED</b>					
1 Shoulder	0,213	0,167	0,03	17,12	0,0294 <sup>c</sup>
2 Chuck	0,236	0,155	0,06	29,37	0,0013 <sup>b</sup>
3 Rib	0,147	0,143	0,05	24,30	0,0112 <sup>c</sup>
4 Loin	0,173	0,118	0,04	27,02	0,0109 <sup>c</sup>
5 Breast	0,137	0,100	0,03	21,83	0,0083 <sup>b</sup>
6 Rump	0,251	0,137	0,08	41,55	0,0068 <sup>b</sup>
7 Leg	0,192	0,173	0,01	7,18	0,0366 <sup>c</sup>
8 Shins	0,148	0,149	1,06	0,72	0,7027
9 Carcass	0,191	0,151			

The niacin content (Table 4.19) of all raw and cooked cuts is higher in Grade 1 than in Super carcasses. This confirms the findings of Ono *et al.* (1986: 1356). The differences were statistically significant ( $p \leq 0,05$ ), except for the raw leg and the cooked rump cuts. Although the niacin levels changed inconsistently in all the cuts of both Grade 1 and Super, cooking did not influence the niacin content to a great extent (Table 4.19).

Greenfield *et al.* (1987: 215) reported slightly lower losses (3,2-6,8 mg/100 g) during cooking.

Cooked American veal (lean and fat) contains 5,5 mg niacin/100 g edible portion (Anderson *et al.*, 1989: 161) which is lower than the values (6,28-11,30 mg/100 g) for cooked Grade 1 veal found in this study. The nutrient density of cooked Grade 1 veal is 5,6 for women, which indicates that South African veal is also an excellent source of niacin.

Table 4.19: AVERAGE NIACIN CONTENT OF GRADE 1 AND SUPER VEAL CUTS (mg/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	5,25	4,53	0,70	14,01	0,0260 <sup>c</sup>
2 Chuck	6,42	4,20	1,57	29,51	0,0237 <sup>c</sup>
3 Rib	7,46	3,85	2,56	45,22	0,0002 <sup>a</sup>
4 Loin	7,36	4,54	2,00	33,59	0,0032 <sup>b</sup>
5 Breast	6,81	4,36	1,73	31,02	0,0005 <sup>a</sup>
6 Rump	7,48	5,65	1,30	19,77	0,0005 <sup>a</sup>
7 Leg	6,47	6,47	0,22	3,53	0,1150
8 Shins	5,94	4,72	0,86	16,13	0,0004 <sup>a</sup>
9 Carcass	5,52	4,91			
<b>COOKED</b>					
1 Shoulder	9,40	5,27	2,92	39,88	0,0158 <sup>c</sup>
2 Chuck	6,28	4,90	0,97	17,40	0,0388 <sup>*</sup>
3 Rib	7,71	5,30	1,70	26,20	0,0019 <sup>b</sup>
4 Loin	11,59	4,89	4,74	57,56	0,0029 <sup>b</sup>
5 Breast	7,85	4,33	2,49	40,90	0,0002 <sup>a</sup>
6 Rump	7,87	6,23	1,16	16,51	0,1927
7 Leg	8,54	5,48	2,17	30,93	0,0034 <sup>b</sup>
8 Shins	9,30	4,90	3,11	43,89	0,0018 <sup>b</sup>
9 Carcass	8,37	5,11			

Compared to Super veal, the pyridoxine content (Table 4.20) of the raw cuts of Grade 1 carcasses was significantly higher ( $p \leq 0,05$  &  $p \leq 0,01$ ). Cooking decreased the levels

in all the Grade 1 cuts. The influence of cooking on the pyridoxine content of the Super veal cuts was inconsistent. Anderson *et al.* (1989: 161) (Table 1.6), reported a value of 0,24 mg for American veal (lean and fat), which is very similar to the Grade 1 carcass value of 0,233 mg/100 g found in this study. It seems that veal is a reasonable source of vitamin B<sub>6</sub>, providing (per 100 g) approximately 10%-12% of the RDA of 2 mg for adults (Food and Nutrition Board, 1989: 284).

Table 4.20: AVERAGE PYRIDOXINE (VITAMIN B<sub>6</sub>) CONTENT OF GRADE 1 AND SUPER VEAL CUTS (mg/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV %)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	0,394	0,200	0,14	46,19	0,0001 <sup>a</sup>
2 Chuck	0,471	0,194	0,20	58,91	0,0001 <sup>a</sup>
3 Rib	0,460	0,242	0,15	43,85	0,0003 <sup>a</sup>
4 Loin	0,469	0,199	0,19	57,16	0,0011 <sup>b</sup>
5 Breast	0,370	0,190	0,13	45,62	0,0063 <sup>b</sup>
6 Rump	0,349	0,23	0,09	31,06	0,0006 <sup>a</sup>
7 Leg	0,348	0,243	0,10	31,72	0,0041 <sup>b</sup>
8 Shins	0,356	0,186	0,12	44,19	0,0125 <sup>c</sup>
9 Carcass	0,401	0,209			
<b>COOKED</b>					
1 Shoulder	0,270	0,215	0,04	15,58	0,0004 <sup>a</sup>
2 Chuck	0,267	0,227	0,03	11,47	0,0738
3 Rib	0,258	0,200	0,04	17,19	0,0050 <sup>b</sup>
4 Loin	0,267	0,209	0,04	17,27	0,0377 <sup>a</sup>
5 Breast	0,242	0,210	0,02	10,03	0,0560
6 Rump	0,276	0,204	0,05	21,38	0,0006 <sup>a</sup>
7 Leg	0,239	0,239	0,00	0,00	0,9000
8 Shins	0,199	0,200	1,06	0,53	0,5494
9 Carcass	0,233	0,217			

Compared to Super veal, the folacin content (Table 4.21) of all the raw Grade 1 cuts (except the rump) was significantly lower ( $p \leq 0,05$ ). There was no consistent pattern of change when comparing the cooked cuts of Grade 1 and Super carcasses. These differences were significant ( $p \leq 0,05$ ) for all cuts except the shoulder, chuck and shins.

The folacin values found here were substantially lower than the values of 15,00  $\mu\text{g}/100\text{ g}$  reported by Anderson *et al.* (1989: 161) for cooked American veal (lean and fat). The nutrient density of Grade 1 veal for women is 0,55. Therefore, South African veal can be regarded as a source, albeit not a very good one, of folacin.

Table 4.21: AVERAGE FOLACIN CONTENT OF GRADE 1 AND SUPER VEAL CUTS (g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	7,40	11,50	2,16	24,16	0,0320 <sup>c</sup>
2 Chuck	4,20	9,10	3,43	51,77	0,0266 <sup>c</sup>
3 Rib	6,60	9,60	2,12	26,35	0,0461 <sup>c</sup>
4 Loin	6,80	13,30	4,63	46,20	0,0275 <sup>c</sup>
5 Breast	5,10	12,10	4,95	57,56	0,0020 <sup>b</sup>
6 Rump	6,70	7,30	0,42	6,06	0,1982
7 Leg	6,50	11,70	3,71	40,91	0,0174 <sup>c</sup>
8 Shins	6,50	12,10	3,96	42,48	0,0003 <sup>a</sup>
9 Carcass	6,06	10,85			
<b>COOKED</b>					
1 Shoulder	9,80	10,50	0,46	4,54	0,0876
2 Chuck	9,90	10,10	0,14	1,41	0,1835
3 Rib	10,00	9,10	0,60	6,31	0,0034 <sup>b</sup>
4 Loin	13,40	10,50	2,05	17,23	0,0235 <sup>c</sup>
5 Breast	6,20	9,80	2,55	31,82	0,0031 <sup>b</sup>
6 Rump	10,30	9,60	0,49	4,97	0,0198 <sup>c</sup>
7 Leg	10,60	10,20	0,25	2,39	0,0198 <sup>c</sup>
8 Shins	10,00	8,50	1,09	11,88	0,1399
9 Carcass	9,81	9,87			

Differences occurred in the vitamin B<sub>12</sub> content (Table 4.22) of all the raw cuts of Grade 1 and Super carcasses. However, the differences were significant ( $p \leq 0,05$ ) only for the chuck, breast, rump and shins. The vitamin B<sub>12</sub> levels were higher in all the cooked Grade 1 cuts than in the corresponding cuts of Super veal. These differences were significant ( $p \leq 0,05$ ) for all cuts but the rump and shins. Changes in the levels of this vitamin due to cooking were inconsistent for both grades (Table 4.22). Ono *et al.* (1986: 1356) reported a range of 1,26-1,98  $\mu\text{g}/100\text{ g}$ , which compares well with the

values found in this study. A calculated nutrient density of 10,36 for vitamin B<sub>12</sub> for women, means that Grade 1 and Super veal can be regarded as an excellent source of vitamin B<sub>12</sub>.

Table 4.22: AVERAGE CYANOCOBALAMIN (VITAMIN B<sub>12</sub>) CONTENT OF GRADE 1 AND SUPER VEAL CUTS (g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	2,00	2,10	0,04	1,75	0,4226
2 Chuck	2,00	1,90	0,07	3,62	0,0000*
3 Rib	1,60	1,80	0,14	8,57	0,1056
4 Loin	1,40	1,30	0,04	2,67	0,7027
5 Breast	1,70	1,70	0,00	0,00	0,0000*
6 Rump	1,80	1,90	0,07	3,80	0,0000*
7 Leg	1,80	2,20	0,25	12,53	0,0198*
8 Shins	2,00	1,90	0,04	1,83	0,4226
9 Carcass	1,81	1,89			
<b>COOKED</b>					
1 Shoulder	2,30	2,20	0,07	3,14	0,0000*
2 Chuck	2,40	2,10	0,18	7,95	0,0377*
3 Rib	1,90	1,30	0,42	26,52	0,0267*
4 Loin	2,20	1,40	0,57	31,43	0,0000*
5 Breast	1,70	1,50	0,14	8,84	0,0000*
6 Rump	2,10	2,00	0,11	5,24	0,0955
7 Leg	1,90	1,80	0,07	3,82	0,0000*
8 Shins	2,30	2,20	0,11	4,77	0,0955
9 Carcass	2,06	1,82			

Table 4.23 shows statistically significant ( $p \leq 05$ ) differences in the biotin content of all the raw as well as the cooked cuts of both grades of veal. All the raw cuts of Super veal had higher biotin levels than corresponding Grade 1 cuts with the exception of raw chuck. Biotin content was significantly higher in all the Grade 1 cooked cuts except the leg. The carcass value of 3,00  $\mu\text{g}/100\text{ g}$  for cooked Grade 1 veal compared to the 2,28  $\mu\text{g}/100\text{ g}$  of cooked Super veal, reflects these differences. According to the Food and Nutrition Board (1989: 284), 30-100  $\mu\text{g}$  biotin is regarded as an adequate and safe

intake. Therefore, a 100 g portion of either Grade 1 or Super veal will only contribute between 5,5% and 12,7% of the daily biotin requirements.

Table 4.23: AVERAGE BIOTIN CONTENT OF GRADE 1 AND SUPER VEAL CUTS (g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	1,90	2,20	0,25	12,22	0,0198 <sup>c</sup>
2 Chuck	2,50	2,00	0,35	15,71	0,0377 <sup>c</sup>
3 Rib	1,60	1,90	0,18	10,25	0,0377 <sup>c</sup>
4 Loin	1,60	2,00	0,25	18,94	0,0198 <sup>c</sup>
5 Breast	1,50	1,90	0,28	16,64	0,0000 <sup>a</sup>
6 Rump	1,80	2,30	0,32	15,71	0,0121 <sup>c</sup>
7 Leg	1,80	2,10	0,25	12,86	0,0198 <sup>c</sup>
8 Shins	1,50	2,00	0,39	22,55	0,0082 <sup>b</sup>
9 Carcass	1,79	2,03			
<b>COOKED</b>					
1 Shoulder	3,80	1,65	1,48	55,00	0,0011 <sup>b</sup>
2 Chuck	3,70	2,70	0,71	22,10	0,0026 <sup>b</sup>
3 Rib	2,80	2,10	0,53	21,87	0,0215 <sup>c</sup>
4 Loin	2,60	2,20	0,32	13,40	0,0565
5 Breast	3,00	1,90	0,78	31,75	0,0000 <sup>a</sup>
6 Rump	3,20	2,10	0,78	29,35	0,0082 <sup>b</sup>
7 Leg	2,50	2,90	0,25	9,25	0,0198 <sup>c</sup>
8 Shins	2,80	1,90	0,64	27,67	0,0061 <sup>b</sup>
9 Carcass	3,00	2,28			

Table 4.24 indicates significant differences ( $p \leq 0,05$ ) in the calcium pantothenate content of the raw and cooked cuts of both Grade 1 and Super veal. The levels in the raw cuts are higher in the Super carcasses, whereas for the cooked cuts, the levels are significantly higher ( $p \leq 0,01$ ) in Grade 1 veal. Similar findings were reported by Ono et al. (1986: 1356). Cooking decreased the levels of calcium pantothenate in all the Super veal cuts. However, the effect of cooking on the Grade 1 cuts was inconsistent. The levels decreased in the shoulder, chuck and loin cuts, whereas increased levels were detected in the other five cuts. The RDA for pantothenic acid is not yet established, but an intake of 4-7 mg daily is regarded as adequate and safe (Food and Nutrition Board,

1989: 285). As in the case of biotin, veal can be regarded as a medium source of pantothenic acid.

Table 4.24: AVERAGE CALCIUM PANTOTHENATE CONTENT OF GRADE 1 AND SUPER VEAL CUTS (mg/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	0,409	0,495	0,06	13,41	0,0066 <sup>b</sup>
2 Chuck	0,452	0,482	0,02	4,53	0,0668
3 Rib	0,365	0,369	2,61	0,71	0,6737
4 Loin	0,413	0,443	0,02	5,03	0,5150
5 Breast	0,258	0,392	0,10	29,29	0,0027 <sup>b</sup>
6 Rump	0,281	0,520	0,17	42,26	0,0027 <sup>b</sup>
7 Leg	0,353	0,449	0,07	16,83	0,0157 <sup>c</sup>
8 Shins	0,359	0,459	0,07	17,22	0,0320 <sup>c</sup>
9 Carcass	0,358	0,447			
<b>COOKED</b>					
1 Shoulder	0,383	0,231	0,11	35,01	0,0001 <sup>a</sup>
2 Chuck	0,418	0,229	0,13	38,53	0,0004 <sup>a</sup>
3 Rib	0,398	0,205	0,14	45,26	0,0007 <sup>a</sup>
4 Loin	0,394	0,237	0,11	35,19	0,0001 <sup>a</sup>
5 Breast	0,422	0,239	0,13	39,15	0,0009 <sup>a</sup>
6 Rump	0,401	0,237	0,12	36,35	0,0004 <sup>a</sup>
7 Leg	0,409	0,233	0,12	38,77	0,0022 <sup>b</sup>
8 Shins	0,396	0,236	0,11	35,80	0,0000 <sup>a</sup>
9 Carcass	0,411	0,232			

#### 4.5 Fatty acid and cholesterol composition of veal

Myristic acid (C<sub>14:0</sub>) is a medium chain saturated fatty acid which has proven cholesterol raising properties after consumption by humans (Grundy, 1991: 472). The myristic acid content (Table 4.25) of all the raw as well as the cooked Super cuts, was significantly higher ( $p \leq 0,01$ ) in comparison to the corresponding Grade 1 cuts, except for raw loin, for which the content was slightly lower. Cooking changed the levels of the C<sub>14:0</sub> fatty acid inconsistently in both grades of veal. These findings correspond with those of

Bowers *et al.* (1989: 1447) and Ono *et al.* (1986: 1352).

Table 4.25: AVERAGE MYRISTIC ACID ( $C_{14:0}$ ) CONTENT OF GRADE 1 AND SUPER VEAL CUTS (g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	0,21	0,71	0,36	77,66	0,0003 <sup>a</sup>
2 Chuck	0,36	0,80	0,31	52,71	0,0003 <sup>a</sup>
3 Rib	0,51	0,60	0,06	11,41	0,0079 <sup>b</sup>
4 Loin	0,49	0,48	9,61	1,97	0,2933
5 Breast	0,70	1,07	0,26	29,15	0,0005 <sup>a</sup>
6 Rump	0,54	0,69	0,11	17,13	0,0023 <sup>b</sup>
7 Leg	0,36	0,59	0,17	35,69	0,0019 <sup>b</sup>
8 Shins	0,33	0,44	0,07	18,93	0,0042 <sup>b</sup>
9 Carcass	0,42	0,71			
<b>COOKED</b>					
1 Shoulder	0,44	1,07	0,22	83,11	0,0004 <sup>a</sup>
2 Chuck	0,55	1,02	0,28	35,54	0,0001 <sup>a</sup>
3 Rib	0,49	0,89	0,23	33,33	0,0001 <sup>a</sup>
4 Loin	0,41	1,08	0,39	52,43	0,0002 <sup>a</sup>
5 Breast	0,78	1,55	0,45	38,42	0,0001 <sup>a</sup>
6 Rump	0,46	1,02	0,33	43,94	0,0000 <sup>a</sup>
7 Leg	0,40	0,52	0,06	13,88	0,0052 <sup>b</sup>
8 Shins	0,44	0,59	0,09	16,54	0,0014 <sup>b</sup>
9 Carcass	0,50	0,95			

Palmitic acid ( $C_{16:0}$ ) is also a medium chain saturated fatty acid suspected of having cholesterol raising properties in humans (Grundy, 1991: 472). Table 4.26 indicates higher values for palmitic acid in all the raw as well as in the cooked cuts of the Super carcass when compared to values of the corresponding cuts of Grade 1. This correlates with values reported by Bowers *et al.* (1989: 1448) and Ono *et al.* (1986: 1356). These differences were significant ( $p \leq 0,001$ ) for all cuts except for cooked shin. Cooking increased the  $C_{16:0}$  fatty acid content of all the cuts of both grades of veal, except for the leg, by which a slight decrease was indicated. These findings suggest that moisture loss rather than fat loss responsible was for composition changes in veal during the cooking

process.

Table 4.26: AVERAGE PALMITIC ACID ( $C_{16:0}$ ) CONTENT OF GRADE 1 AND SUPER VEAL CUTS (g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE (CV%)	SIGNIFICANCE LEVEL (P-VALUE)
<b>RAW</b>					
1 Shoulder	1,83	2,60	0,54	24,49	0,0001*
2 Chuck	2,19	3,05	0,51	23,33	0,0001*
3 Rib	2,30	3,72	1,00	33,37	0,0000*
4 Loin	2,18	3,24	0,75	27,62	0,0000*
5 Breast	3,11	4,93	1,29	32,00	0,0000*
6 Rump	2,37	3,07	0,49	18,11	0,0001*
7 Leg	2,17	2,94	0,54	21,16	0,0001*
8 Shins	1,98	2,38	0,28	13,03	0,0004*
9 Carcass	2,28	3,39			
<b>COOKED</b>					
1 Shoulder	2,45	3,39	0,54	18,55	0,0001*
2 Chuck	2,92	4,03	0,64	18,49	0,0000*
3 Rib	2,83	4,30	0,85	23,84	0,0007*
4 Loin	2,64	4,35	0,99	28,32	0,0000*
5 Breast	4,06	5,38	0,76	16,17	0,0000*
6 Rump	2,91	3,71	0,46	13,80	0,0001*
7 Leg	3,41	2,88	0,30	9,64	0,0001*
8 Shins	2,50	2,57	1,48	45,16	0,4495
9 Carcass	3,10	3,80			

Stearic acid ( $C_{18:0}$ ) is a longer chain saturated fatty acid which has recently been shown to have a no effect on cholesterol levels of man (Grundy, 1991: 477). The stearic acid content (Table 4.27) was significantly ( $p \leq 0,01$ ) higher for all the raw as well as the cooked cuts of Super veal, except for the raw shins in which the content was significantly lower ( $p \leq 0,05$ ) than in the corresponding Grade 1 cut.

Cooking increased the content of this fatty acid in all the cuts of both grades of veal, except for the Super rib which indicated a lower level after cooking. However, Bowers *et al.* (1989: 1447) reported higher levels for the Grade 1 calf whereas the findings of

Ono *et al.* (1986: 1356), indicated the opposite.

Table 4.27: AVERAGE STEARIC ACID ( $C_{18:0}$ ) CONTENT OF GRADE 1 AND SUPER VEAL CUTS (g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE CV%	SIGNIFICANCE LEVEL P-VALUE
<b>RAW</b>					
1 Shoulder	1,11	1,41	0,22	17,33	0,0002 <sup>a</sup>
2 Chuck	1,38	1,75	0,27	16,99	0,0002 <sup>a</sup>
3 Rib	1,08	1,82	0,12	30,06	0,0000 <sup>a</sup>
4 Loin	1,18	1,72	0,37	25,73	0,0002 <sup>a</sup>
5 Breast	1,47	2,17	0,49	2,27	0,0001 <sup>a</sup>
6 Rump	1,29	1,58	0,20	14,10	0,0008 <sup>a</sup>
7 Leg	1,00	1,34	0,23	20,29	0,0003 <sup>a</sup>
8 Shins	1,03	0,98	0,03	3,24	0,0239 <sup>c</sup>
9 Carcass	1,18	1,61			
<b>COOKED</b>					
1 Shoulder	1,23	1,45	0,12	9,25	0,0011 <sup>b</sup>
2 Chuck	1,56	2,36	0,46	23,54	0,0001 <sup>a</sup>
3 Rib	1,40	1,76	0,21	13,18	0,0006 <sup>a</sup>
4 Loin	1,47	2,33	0,49	25,76	0,0000 <sup>a</sup>
5 Breast	1,90	3,17	0,73	28,73	0,0000 <sup>a</sup>
6 Rump	1,51	2,14	0,37	20,15	0,0002 <sup>a</sup>
7 Leg	1,77	1,24	0,31	20,42	0,0008 <sup>a</sup>
8 Shins	1,06	1,32	0,15	13,01	0,0003 <sup>a</sup>
9 Carcass	1,56	1,98			

Palmitoleic acid ( $C_{16:1}$ ) is a medium chain monounsaturated fatty acid, the effect of which on serum cholesterol levels of man is unclear. The palmitoleic acid content (Table 4.28) was significantly ( $p \leq 0,01$ ) higher in all the raw cuts of Super carcasses compared to the corresponding cuts of Grade 1 carcasses. The trend was similar for the cooked cuts, except for the significantly ( $p \leq 0,001$ ) lower content of the leg in the Super grade. Cooking changed the levels of this fatty acid in all the cuts of both grades inconsistently. However, the carcass values indicate a mean increase in cooked Grade 1 and Super veal. Bowers *et al.* (1989: 1447) reported greater percentages for the Grade 1 animal in comparison to Ono *et al.* (1986: 1356) whose findings correlate with those in Table 4.28.

Table 4.28: AVERAGE PALMITOLEIC ACID ( $C_{16:1}$ ) CONTENT OF GRADE 1 AND SUPER VEAL CUTS (g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE CV%	SIGNIFICANCE LEVEL P-VALUE
<b>RAW</b>					
1 Shoulder	0,39	0,71	0,23	41,85	0,0005 <sup>a</sup>
2 Chuck	0,36	0,74	0,26	48,00	0,0003 <sup>a</sup>
3 Rib	0,45	0,69	0,36	35,86	0,0010 <sup>a</sup>
4 Loin	0,41	0,60	0,13	26,52	0,0024 <sup>b</sup>
5 Breast	0,59	1,00	0,28	36,89	0,0002 <sup>b</sup>
6 Rump	0,45	0,63	0,13	23,43	0,0015 <sup>b</sup>
7 Leg	0,45	0,56	0,08	15,49	0,0023 <sup>b</sup>
8 Shins	0,42	0,59	0,12	23,32	0,0021 <sup>b</sup>
9 Carcass	0,44	0,70			
<b>COOKED</b>					
1 Shoulder	0,31	0,68	0,21	42,47	0,0008 <sup>a</sup>
2 Chuck	0,36	1,02	0,38	54,75	0,0002 <sup>a</sup>
3 Rib	0,36	0,89	0,30	48,53	0,0002 <sup>a</sup>
4 Loin	0,31	1,18	0,50	67,76	0,0000 <sup>a</sup>
5 Breast	0,54	1,51	0,56	54,41	0,0001 <sup>a</sup>
6 Rump	0,34	0,97	0,37	56,67	0,0001 <sup>a</sup>
7 Leg	0,35	0,54	0,11	23,61	0,0003 <sup>a</sup>
8 Shins	0,35	0,75	0,23	42,18	0,0011 <sup>b</sup>
9 Carcass	0,63	0,90			

Oleic acid ( $C_{18:1}$ ) is a monounsaturated fatty acid with proven cholesterol lowering properties (Grundy, 1991: 472). Comparing cooked Grade 1 veal, it is of interest that the total carcass value of oleic acid of 3,64 g/100 g in balance is with the sum of the carcass values of the cholesterol raising fatty acids,  $C_{14:0}$  and  $C_{16:0}$  (3,60 g/100 g). The  $C_{18:1}$  fatty acid content (Table 4.29) of all the raw as well as of the cooked cuts, was significantly ( $p \leq 0,001$ ) higher for the Super grade. Cooking increased the levels of this fatty acid in all the cuts of both grades of veal. These differences agree with those published by Ono *et al.* (1986: 1356).

Table 4.29: AVERAGE OLEIC ACID ( $C_{18:1}$ ) CONTENT OF GRADE 1 AND SUPER VEAL CUTS (g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE CV.%	SIGNIFICANCE LEVEL P-VALUE
<b>RAW</b>					
1 Shoulder	2,71	4,19	1,05	30,42	0,0000*
2 Chuck	2,89	4,89	1,41	36,46	0,0000*
3 Rib	2,69	6,74	2,82	68,67	0,0000*
4 Loin	2,66	5,77	2,20	52,08	0,0000*
5 Breast	3,79	8,53	3,35	54,39	0,0000*
6 Rump	2,84	4,94	1,49	38,19	0,0000*
7 Leg	2,78	4,98	1,55	39,95	0,0000*
8 Shins	2,69	4,38	1,19	33,75	0,0000*
9 Carcass	2,92	5,63			
<b>COOKED</b>					
1 Shoulder	2,76	6,25	1,99	44,07	0,0000*
2 Chuck	3,36	6,80	1,99	39,18	0,0000*
3 Rib	3,26	7,51	2,45	54,43	0,0000*
4 Loin	3,31	7,23	2,26	42,99	0,0000*
5 Breast	4,54	9,11	2,63	38,56	0,0000*
6 Rump	3,47	5,93	1,42	30,27	0,0000*
7 Leg	4,18	5,15	0,56	11,91	0,0000*
8 Shins	2,94	4,62	0,97	25,78	0,0000*
9 Carcass	3,64	6,55			

Linoleic acid ( $C_{18:2}$ ) is an essential fatty acid (Robinson *et al.*, 1990: 87) with proven cholesterol lowering properties (Grundy *et al.*, 1991: 472). It is estimated that 1%-2% of the total dietary energy should be provided by linoleic acid to prevent signs of essential fatty acid deficiency. A 100 g portion of cooked Grade 1 veal provides only 0,33 g linoleic acid (0,16% of 8 000 kJ). Clearly veal cannot be regarded as a good source of linoleic acid.

Although the  $C_{18:2}$  fatty acid content (Table 4.30) differed inconsistently in all the cuts of both grades of veal, all these differences were significant ( $p \leq 0,05$ ) for the raw and ( $p \leq 0,001$ ) for the cooked cuts. The levels in most of the raw cuts were higher for Grade 1, whereas for most cooked cuts, the levels were higher in Super veal. Cooking decreased the levels of this fatty acid in all the Grade 1 cuts. However, the levels in

most cuts of Super were increased. Only the shoulder and the leg cuts indicated decreases.

Table 4.30: AVERAGE LINOLEIC ACID ( $C_{18:2}$ ) CONTENT OF GRADE 1 AND SUPER VEAL CUTS (g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE CV %	SIGNIFICANCE LEVEL P-VALUE
<b>RAW</b>					
1 Shoulder	0,58	0,36	0,16	32,94	0,0012 <sup>b</sup>
2 Chuck	0,33	0,14	0,05	14,52	0,0022 <sup>b</sup>
3 Rib	0,40	0,29	0,08	22,74	0,0037 <sup>b</sup>
4 Loin	0,34	0,34	9,54	2,78	0,1877
5 Breast	0,48	0,83	0,07	16,24	0,0054 <sup>b</sup>
6 Rump	0,38	0,33	0,04	10,71	0,0148 <sup>c</sup>
7 Leg	0,44	0,36	0,06	15,99	0,0164 <sup>c</sup>
8 Shins	0,41	0,30	0,08	21,87	0,0048 <sup>b</sup>
9 Carcass	0,43	0,36			
<b>COOKED</b>					
1 Shoulder	0,35	0,22	0,07	25,34	0,0037 <sup>b</sup>
2 Chuck	0,30	0,65	0,20	41,94	0,0003 <sup>a</sup>
3 Rib	0,92	0,70	0,04	18,23	0,0041 <sup>b</sup>
4 Loin	0,27	0,64	0,22	47,20	0,0002 <sup>a</sup>
5 Breast	0,32	0,78	0,27	48,76	0,0002 <sup>a</sup>
6 Rump	0,32	0,59	0,16	35,87	0,0004 <sup>a</sup>
7 Leg	0,39	0,33	0,07	10,64	0,0088 <sup>b</sup>
8 Shins	0,26	0,43	0,10	28,06	0,0007 <sup>a</sup>
9 Carcass	0,33	0,53			

Table 4.31 gives the arachidonic acid values of veal obtained in this study. Arachidonic acid ( $C_{20:4}$ ) is a long chain highly unsaturated fatty acid, used by the body as a precursor in the synthesis of the prostaglandins and leucotriens. These are important hormones and regulatory substances involved in *inter alia*, the inflammatory process (Rappaport, 1985: 384-386). As arachidonic acid can be synthesised from linoleic acid (Robinson *et al.* 1990: 87) it is not regarded as an essential fatty acid. Table 4.31 indicates that veal contains very little arachidonic acid: a carcass value of 0,08 and 0,05 g/100 g for cooked Grade 1 and Super veal respectively.

Table 4.31: AVERAGE ARACHIDONIC ACID (C<sub>20:4</sub>) CONTENT OF GRADE 1 AND SUPER VEAL CUTS (g/100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE CV.%	SIGNIFICANCE LEVEL P-VALUE
<b>RAW</b>					
1 Shoulder	0,10	0,04	0,05	62,68	0,0183 <sup>c</sup>
2 Chuck	0,07	0,05	0,02	26,28	0,0079 <sup>b</sup>
3 Rib	0,03	0,03	1,49	5,17	0,8836
4 Loin	0,04	0,06	0,01	28,17	0,0116 <sup>c</sup>
5 Breast	0,04	0,02	0,02	54,42	0,0364 <sup>c</sup>
6 Rump	0,06	0,03	0,02	34,31	0,0818
7 Leg	0,04	0,06	0,01	27,63	0,0193 <sup>c</sup>
8 Shins	0,08	0,05	0,02	29,53	0,0986
9 Carcass	0,06	0,04			
<b>COOKED</b>					
1 Shoulder	0,10	0,04	0,04	56,98	0,0037 <sup>b</sup>
2 Chuck	0,07	0,08	8,25	11,67	0,4050
3 Rib	0,06	0,026	0,02	60,72	0,0230 <sup>c</sup>
4 Loin	0,05	0,055	5,22	10,92	0,4467
5 Breast	0,05	0,04	9,14	21,28	0,1935
6 Rump	0,05	0,07	0,01	23,56	0,1817
7 Leg	0,11	0,05	0,06	40,78	0,0021 <sup>b</sup>
8 Shins	0,09	0,08	5,59	7,22	0,8260
9 Carcass	0,08	0,05			

The C<sub>20:4</sub> fatty acid content (Table 4.31) differed inconsistently in the raw and cooked cuts of both grades of veal. In the raw cuts these differences were significant ( $p \leq 0,05$ ) for the following raw cuts: shoulder, chuck, loin and breast. Significant differences amongst the cooked cuts were obvious only in the shoulder, rib and leg of Grade 1, which all indicated higher levels of this fatty acid. The effect of cooking varied between the individual cuts, within both grades.

Although a change in the fatty acid levels of both grades of South African veal was observed as a result of cooking, Greenfield *et al.* (1987: 214) reported no change in fatty acid composition on cooking. However, in agreement with Greenfield *et al.* (1987: 214), it was found that the fatty acid pattern was slightly more saturated in the

parts with the higher fat content. For example, according to the total fat content given in Table 4.5, cooked Super veal breast indicated the highest (35,46 g/100 g) and cooked Grade 1 shins the lowest (5,70 g/100 g) values. The polyunsaturated/saturated fatty acid ratio of the former was 0,08 and that of the latter 0,09 (calculated from Tables 4.25, 4.26, 4.27, 4.30 and 4.31).

The cholesterol content varied from 73,70-91,60 mg in the raw cuts of the Grade 1 carcasses compared to 79,30-93,53 mg in the Super cuts (Table 4.32). All the raw cuts of Super had a significantly higher ( $p \leq 0,01$ ) cholesterol content than the corresponding cuts of Grade 1 with the exception of chuck ( $p \leq 0,26$ ).

Table 4.32: AVERAGE CHOLESTEROL CONTENT OF GRADE 1 AND SUPER VEAL CUTS (mg /100 g edible portion)

CUTS	GRADE 1 n=9	SUPER n=9	STANDARD DEVIATION	COEFFICIENT OF VARIANCE CV %	SIGNIFICANCE LEVEL P-VALUE
<b>RAW</b>					
1 Shoulder	79,30	84,60	2,90	3,55	0,0009*
2 Chuck	91,60	92,00	0,40	0,44	0,2606
3 Rib	82,90	84,23	0,76	0,91	0,0028 <sup>b</sup>
4 Loin	82,20	81,37	0,69	0,85	0,0075 <sup>b</sup>
5 Breast	86,60	88,70	1,16	1,32	0,0000*
6 Rump	73,70	81,37	4,35	5,65	0,0000*
7 Leg	83,80	85,37	0,87	1,03	0,0000*
8 Shins	86,60	93,53	3,80	4,22	0,0000*
9 Carcass	84,27	86,50			
<b>COOKED</b>					
1 Shoulder	130,50	98,23	17,72	15,49	0,0000*
2 Chuck	142,53	110,40	17,62	13,93	0,0000*
3 Rib	97,57	80,3	9,43	10,60	0,0000*
4 Loin	114,80	79,20	19,52	20,13	0,0000*
5 Breast	114,63	78,63	19,74	20,42	0,0000*
6 Rump	105,23	92,73	6,88	6,95	0,0000*
7 Leg	105,57	95,87	5,34	5,30	0,0008*
8 Shins	125,73	95,23	16,71	15,13	0,0000*
9 Carcass	117,68	92,90			

The cholesterol content of the cooked cuts varied from 97,60-130,50 mg for Grade 1 and from 79,20-110,40 mg for Super veal (Table 4.32). Although the cholesterol values obtained in this study are higher than those reported overseas (Ono *et al.* 1986: 1355; Faustman *et al.* 1992: 42), the cholesterol content of cooked Super veal cuts is significantly ( $p \leq 0,001$ ) lower when compared with the values of the corresponding raw cuts. The cholesterol carcass value for cooked Super veal was 92,90 mg/100 g and for cooked Grade 1 veal 117,68 mg/100 g. Carroll *et al.* (1973 :635) as well as Faustman *et al.* (1992: 42) also found the same relationship between cholesterol and grade.

#### 4.6 Comparison of South African and American veal (calculated values)

Table 4.33: KOLMOGOROV - SMIRNOV TWO SAMPLE TEST

SOUTH AFRICAN vs AMERICAN	STATISTIC DN	SIGNIFICANCE LEVEL
RAW	0,114572	1
COOKED	0,0956618	1

The significance is not lower than 0,05. It therefore indicates that the distributions are not significantly different from one another at a 5% level.

Table 4.34: PAIRED MANN - WHITNEY COMPARISON OF TWO SAMPLES

SOUTH AFRICAN vs AMERICAN	AVERAGE RANK		TEST STATISTICS	PROBABILITY
	RSA	USA		
RAW	30,9677	30	Z = - 0,2071	Z = - 0,83592
COOKED	30,7419	30,2414	Z = - 0,103549	Z = - 0,917522

The two-tailed probability of equaling or exceeding the Z values was close to 1 for both raw and cooked veal. The high probability of similar statistical values for the two groups, means that they have similar median values. This indicates that there are no significant differences between the South African and American veal data.

## CHAPTER 5

### DISCUSSION

#### 5.1 Introduction

The main observations of this study were firstly, that the nutrient composition of South African Grade 1 and Super veal differed, although not statistically significant, from published values of American and Australian veal, as well as from the values given in the South African Food Composition Tables. Secondly, despite these differences the nutrient density values for most nutrients were in the same order as for American veal. Thirdly, the moisture loss during cooking probably accounted for differences in composition between raw and cooked cuts, indicating that cooking does not adversely affect the nutrient value of veal. Fourthly, the fat content of South African veal presently available on the market can only be compared to American and Australian veal if cognisance is taken of the fact that South African analyses were done on meat plus subcutaneous fat and not after removal of thereof.

However, before these results can be interpreted the validity of the results obtained in this study as well as the analytical methods used will be evaluated in this chapter. Furthermore, it will be determined whether these methods are comparable to those used in published literature.

The results obtained regarding the nutrient composition of Grade 1 and Super veal cuts available on the South African market will then be compared to the nutrient composition of veal as given in the local MRC Food Composition Tables (Langenhoven *et al.*, 1991: 33). Differences between results obtained and published results of American and Australian veal will be discussed.

Considering the total fat content and fatty acid composition of veal, the contribution thereof to a balanced, prudent diet, will be critically evaluated.

## 5.2 Evaluation of the validity of results

### 5.2.1 *Variation in methods and between cuts*

To be able to evaluate the validity of the results obtained in this study, the coefficient of variance of the analytical method used for the determination of each specific nutrient based on the mean value and standard deviation of each cut, was compared to the variations in the levels of the corresponding nutrient in the different cuts (Table 5.1).

According to Table 5.1 the coefficient of variance (CV) for the method of analysis for all nutrients, except folacin, was smaller than the corresponding variation in nutrient content between the different cuts. However, in twelve of the nutrients the coefficients of variance between cuts were substantially higher than those of the methods. The differences were small for fifteen of the nutrients, but still greater for the cuts than for the methods, except for folacin. Therefore, the differences in nutrient levels existing between the corresponding raw and cooked cuts of Grade 1 and Super veal carcasses, as well as the differences between the various cuts of the same grade (as determined by this study) may be regarded as real differences. This indicates that if the exact nutrient composition of diets is to be calculated, the nutrient composition of the specific cut of veal should be used. Only in some instances, for example to obtain a general idea of the nutritive value of veal, would the calculation of a mean nutritive value of the different veal cuts be scientifically valid. However, in stead of a mean value, the calculated carcass value should rather be used as it is a more precise indication of the carcass content. For example, the fat content of the raw Super veal cuts ranges from 8,9 g/100 g to 28 g/100 g with a carcass value of 15,74 g/100 g (Table 4.4). Therefore, such a carcass value should be included in the South African Food Tables and databases along with the nutritive composition of all veal cuts for both raw and cooked Grade 1 and Super veal. This will enable more accurate calculations of nutrient intakes of South Africans.

### 5.2.2 Comparison of methodology

In comparing methodology to evaluate the validity of results, two aspects should be considered. Firstly, the similarity of the material analysed. Muscle plus subcutaneous fat were analysed as an entity in this study. This will influence not only the relative content of fat, but also that of other nutrients. Secondly, different chemical/biological analytical methods may yield different results.

The same AOAC methods used in this study were used to determine the proximate chemical composition (moisture, protein, fat and ash) of American (Ono *et al.*, 1986: 1353) and Australian (Greenfield *et al.*, 1987: 211). In each case the energy values of the different cuts were calculated from their respective fat and protein values.

In the Australian study, the levels of sodium, potassium, calcium, magnesium, iron and zinc were determined by dissolving the ash in hydrochloric acid and analysing the solution by atomic absorption spectrophotometry. Bovine liver was used as reference material to ensure reliability (Greenfield *et al.*, 1987: 211).

Except for phosphorus, the inorganic nutrient content reported in the American study was determined by atomic absorption spectrophotometry on extracts of dry ashed samples. Phosphorus was determined from the same dry-ashed extract by the colorimetric method (Ono *et al.*, 1986: 1353).

Similarly to the American and the Australian studies, the iron, zinc, manganese and copper levels of South African veal were determined by atomic absorption spectrophotometry on extracts of dry-ashed samples dissolved in hydrochloric acid. However, in contrast with the Australian study in which atomic absorption spectrophotometry was used, the phosphorus content of American veal was determined by the colorimetric method of Fiske and Subbarow (1925: 375) and that of South African veal by the spectrophotometric method used by the ISCW (1989: 3). The calcium and magnesium levels of South African veal were determined in this study by means of the EDTA titration method (ISCW, 1989: 4-5) and not by atomic absorption.

TABLE 5.1: A COMPARISON OF THE COEFFICIENT OF VARIANCE (CV) FOR THE METHOD USED FOR EACH NUTRIENT AND THE CV OF NUTRIENT LEVELS OF THE DIFFERENT CUTS

NUTRIENT	CV METHOD (%)	CV CUTS (%)
Moisture	5,69	8,17
Protein	8,17	25,93
Ash	11,11	86,87
Dry matter	12,13	12,31
Fat	49,71	49,81
Cholesterol	7,87	8,34
Food energy	21,98	22,18
<i>Minerals</i>		
Phosphorus	11,69	11,82
Calcium	20,45	20,98
Magnesium	24,35	24,37
Potassium	8,96	9,04
Sodium	11,19	11,69
Copper	47,93	52,02
Zinc	23,04	28,13
Manganese	43,23	41,09
Iron	12,94	79,91
<i>Vitamins</i>		
Thiamin (Vit B <sub>1</sub> )	24,50	11,73
Riboflavin (Vit B <sub>2</sub> )	17,30	15,98
Niacin	29,13	30,05
Pyridoxine (Vit B <sub>6</sub> )	28,26	55,76
Folacin	22,82	22,56
Cyanocobalamin (Vit B <sub>12</sub> )	7,91	12,12
Biotin	20,95	21,46
Calcium pantothenate	26,46	70,90
<i>Fatty acids</i>		
Saturated	20,74	22,42
Monounsaturated	39,25	39,33
Polyunsaturated	27,69	36,36

Standard chemical AOAC (1990) methods were used by the Americans as well as the Australians to determine the levels of the B vitamins. However, in this study the B vitamins were determined by the microbiological method (Barton-Wright, 1961: 6-28), except for vitamin B<sub>12</sub> and calcium pantothenate, where the AOAC (1990: 1028) and USP XXII (1990: 1500) methods were used respectively.

The gas liquid chromatography method for the determination of the fatty acid profiles, was similar for all three studies; methyl esters prepared from a chloroform-methanol extract being analysed.

The total cholesterol content of the chloroform-methanol extract, was determined by means of gas liquid chromatography (using stigmasterol as an internal standard) in both the American (Ono *et al.*, 1986: 1353) and the South African (Benadé *et al.*, 1988: 157) studies. However, in the Australian study cholesterol was determined by an enzymatic method, after it became evident that the results agreed closely with those obtained by gas chromatography (Greenfield *et al.*, 1987: 210).

With only a few exceptions, it seems that the chemical methods used in this study to determine the specific nutrients of the different veal cuts are similar to those used in published studies on the nutrient composition of American and Australian veal. The results are therefore comparable from this point of view.

### **5.3 Comparison of the nutrient composition results from this study to published South African values for veal**

Table 5.2 compares locally published data of the nutrient values of veal with results obtained in this study. Comparable cuts and fat content were used. The South African Food Tables (Langenhoven *et al.*, 1991: 37) give a nutrient composition for only the following veal products:

- Veal, blade, braised (fat trimmed)
- Veal, blade, braised (with fat)
- Veal, Cordon Bleu

- Veal, cutlet, pan-fried
- Veal, roasted (fat trimmed)
- Veal, roasted (with fat)
- Veal, Schnitzel, pan-fried (breaded)

Therefore, the nutrient composition of veal chuck (Grade 1 and Super) was selected for comparisons, since veal blade steak is obtained from the chuck (Figures 3.2 and 3.3). The South African Tables were compiled from published nutrient composition data. In cases, as for veal, where data for South African foods was not available, international data was used (Langenhoven *et al.*, 1991: *ii*).

It should also be emphasized that this study reports the nutrient composition of veal cuts in which analyses were done on fat plus muscle. The objective in Table 5.2 is to indicate how these results compare to the data of the existing South African Food Tables. Data is corrected for fat removal (5.4) and compared with those of the American study.

### 5.3.1 *Fat content*

According to this study, the two grades of veal available on the South African market seem to have a substantially higher fat content than the published values (Table 5.2). This is especially notable for Super veal chuck with a fat content of 23,5 g/100 g compared to the 10,1 g of untrimmed veal blade.

The P/S and M/S ratios (Table 5.2) that are indicative of the cholesterol raising or lowering characteristics of a food or a diet, are also more unfavourable than the published values for veal. However, the cholesterol content of both grades of veal (110 mg-143 mg) seems to be lower than the published values of 153 mg-158 mg. The fat content and fatty acid distribution of South African veal have certain implications as discussed in 5.4.

TABLE 5.2: COMPARISON OF THE NUTRIENT COMPOSITION OF SOUTH AFRICAN VEAL, AS DETERMINED BY THIS STUDY, AND THE VALUES PUBLISHED IN THE MRC FOOD TABLES (100g cooked veal: edible portion)

NUTRIENT	UNIT	SA FOOD	TABLES *	THIS	STUDY
		VEAL BLADE-fat trimmed	VEAL BLADE-with fat	CHUCK GRADE 1	CHUCK SUPER
Moisture	g	59,2	57,0	60,3	55,4
Protein	g	32,7	31,3	29,33	25,16
Fat	g	6,5	10,1	8,84	23,49
Energy	kJ	828	940	858	1336
Cholesterol	mg	158	153	143	110
<b>Fatty acids</b>					
Saturated	g	1,81	3,64	5,03	7,41
Monounsaturated	g	2,31	3,85	3,77	7,83
Polyunsaturated	g	0,58	0,74	0,38	0,74
P/S ratio		0,32	0,13	0,08	0,09
M/S ratio		1,28	1,06	0,75	1,06
<b>Minerals</b>					
Phosphorus	mg	252	244	221	168
Calcium	mg	40,0	38,0	31,2	31,0
Magnesium	mg	28,0	26,0	25,7	42,2
Potassium	mg	305	297	331	282
Sodium	mg	101	98	99	82
Copper	mg	0,170	0,160	1,087	0,326
Zinc	mg	7,39	7,00	6,95	3,07
Manganese	mg	0,04	0,04	0,018	0,067
Iron	mg	1,5	1,4	0,89	1,04
<b>Vitamins</b>					
Thiamin (Vit B <sub>1</sub> )	mg	0,06	0,06	0,117	0,090
Riboflavin (Vit B <sub>2</sub> )	mg	0,36	0,35	0,236	0,155
Niacin	mg	5,70	5,50	6,28	4,90
Pyridoxine (Vit B <sub>6</sub> )	mg	0,250	0,240	0,267	0,227
Folacin	µg	15,0	15,0	9,90	10,10
Cyanocobalamin (Vit B <sub>12</sub> )	µg	2,0	1,90	2,40	2,10
Pantothenic acid	mg	1,59	1,52	0,418	0,239

\* Langenhoven *et al.* (1991: 33)

### 5.3.2 *Protein content*

Similarly, the protein content values of veal in this study are also found to be lower. The decrease in protein content was countered by an increase in fat content, resulting in comparable total energy values. The removal or non-removal of fat before analyses seems a logical explanation for these discrepancies.

### 5.3.3 *Minerals*

The iron and zinc contents are substantially lower than the published values of the corresponding cuts. The copper and manganese levels are, however, higher. The published values for calcium, magnesium and phosphorus were found to be similar to those of this study.

### 5.3.4 *Vitamins*

The thiamin, niacin and vitamin B<sub>12</sub> levels are substantially higher than the published values. However, in comparison to the published values, the riboflavin, folic acid and pantothenic acid values are lower in this study. It should be noted that the analytical variance for folic acid was larger than the between-cut variance. The accuracy of the folic acid values could therefore be questioned. It is also of interest that the B vitamins are all as constituents of coenzymes involved in glycolysis, energy extraction from organic molecules (tissue respiration) and fat synthesis (Robinson *et al.*, 1990: 179-199). Adipose tissue (fat) is a dynamic tissue and should not only be regarded as a storage depot for excess energy. This may explain the small differences found in the content of B vitamins of this study and published values. It therefore seems that the removal or non-removal of fat before analyses may have only small effects on the vitamin B composition of veal.

As the published nutrient values for veal were compiled from published American, European and Australian data, they are not really applicable to veal found on the South African market. Therefore, the present South African Food Tables are not accurate in

determining the nutrient content of diets containing South African veal.

#### 5.4 Comparison of South African and American veal

The published nutrient composition data of raw and cooked American veal (Anderson *et al.*, 1989: 120-121) are compared with the results of this study (Table 5.3) on the basis of total carcass values. American tables for separable lean veal only could not be used, as the South African study analysed untrimmed veal. The results of this study can therefore only be compared with the raw and cooked values of American separable lean plus fat veal.

The values published in the American Food Tables were derived from analyses of retail cuts from six USDA Choice grade carcasses of specially fed veal (SFV) and six bob veal composite samples from twelve USDA Good grade carcasses. The SFV was from animals fed on a specially formulated liquid diet and marketed at an age of about sixteen weeks, at a carcass weight of about 200-220 pounds (90,9-100 kg). The bob veal was from animals fed primarily on maternal milk and marketed at four weeks of age or younger, yielding carcasses of about 50 pounds (22,7 kg). These two types of carcasses are equally available on the American market. However, because of the large difference in carcass weights, the retail weight of American SFV is much higher than that of bob veal. The values shown for veal in the Food Tables represent a combination of the two types of veal in the proportion of 15% for bob and 85% for SFV (Anderson *et al.*, 1989: 6).

According to carcass mass, Grade 1 and Super veal are available on the South African markets in the proportion of 93,3% and 6,7% respectively (RSA Meat Board Statistics, Jan 1991-Jun 1992). No retail weights are available for South African veal. In order to compare the results of this study with those published in the American Food Tables, weighted values (93,3% of Grade 1 and 6,7% of the Super carcass values) for South African veal are compared to American veal in Table 5.3. The weighted values for South African chuck are compared to those of published American shoulder blade (seperable lean and fat) in Table 5.4.

TABLE 5.3: THE NUTRIENT COMPOSITION OF COOKED AMERICAN \* AND SOUTH AFRICAN \*\* VEAL (100 g cooked veal: edible portion)

NUTRIENT	UNIT	AMERICAN		SOUTH AFRICAN	
		RAW	COOKED	RAW	COOKED
Moisture	g	72,84	57,08	71,31	63,14
Protein	g	19,35	30,1	21,23	27,06
Ash	g	1,04	1,2	1,05	1,04
Fat	g	6,77	11,39	6,56	10,57
Energy	kJ	601	969	623	854
Cholesterol	mg	82	114	84	116
<b>Fatty acids</b>					
C14:0	g	0,26	0,41	0,44	0,53
C16:0	g	1,48	2,32	2,35	3,15
C18:0	g	0,92	1,41	1,21	1,59
C16:1	g	0,29	0,47	0,46	1,34
C18:1	g	2,21	3,84	3,10	3,83
C18:2	g	0,36	0,63	0,43	0,34
C20:4	g	0,07	0,1	0,06	0,08
<b>Minerals</b>					
Phosphorus	mg	203	239	197,51	215,61
Calcium	mg	15	22	18,77	23,57
Magnesium	mg	24	26	22,11	25,04
Potassium	mg	315	325	320,67	343,96
Sodium	mg	82	87	89,62	89,22
Copper	mg	0,109	0,114	0,20	0,44
Zinc	mg	3,06	4,76	1,54	3,69
Manganese	mg	0,028	0,036	0,03	0,02
Iron	mg	0,83	1,15	0,56	0,76
<b>Vitamins</b>					
Thiamin	mg	0,08	0,06	0,13	0,12
Riboflavin	mg	0,27	0,32	0,11	0,19
Niacin	mg	7,5	7,97	5,48	8,15
Vitamin B <sub>6</sub>	mg	0,41	0,31	0,39	0,23
Folacin	µg	13	15	6,38	9,81
Vitamin B <sub>12</sub>	µg	1,34	1,57	1,82	2,04
Pantothenic acid	mg	1,31	1,26	0,37	0,40

\* Separable lean and fat - Anderson *et al.* (1989: 121)

\*\* Weighted carcass values, see text 5.4

As mentioned in 3.8, two different statistical methods (the paired Mann-Whitney and the Kolmogorov-Smirnov tests) were utilized to determine the significance of the differences between the raw and cooked American and South African composition data for veal. Both tests indicated no significant differences between the American and South African data.

Although the differences between the American veal data and the weighted South African data are not statistically significant, it is conceivable that in instances where veal is eaten regularly, these slight differences may result in larger differences in the contribution of veal to total nutrient intake. Of particular importance in this regard is the lower total fat content of South African veal, which has an application in the design of low-fat diets. From Table 5.4 it can be seen that cooked South African veal chuck has higher levels of moisture, potassium, copper, thiamin, niacin and vitamin B<sub>12</sub>, lower levels of phosphorus, calcium, iron, riboflavin, folacin and pantothenic acid and similar levels of protein, magnesium, sodium, zinc and pyridoxin than cooked American veal shoulder blade.

From Tables 5.3 and 5.4 it seems that the saturated fatty acid content of South African veal tends to be higher than that of American veal. Miller *et al.* (1987: 527) reported these fatty acids to be positively associated with the triglyceride content of veal. Consequently, higher levels of triglycerides are accompanied by higher levels of the C<sub>16:0</sub>, C<sub>18:0</sub> and C<sub>18:1</sub> fatty acids, which are the major fatty acids in triglycerides and the main type of lipid deposit during the fattening process in ruminant animals (Miller *et al.*, 1987: 527; Marmer *et al.*, 1984: 109).

According to Table 5.3, the ratio between the cholesterol lowering fatty acids (C<sub>18:1</sub>, C<sub>18:2</sub>, C<sub>20:4</sub>) and the cholesterol raising fatty acids (C<sub>14:0</sub>, C<sub>16:0</sub>) is 1,67 for American veal and 1,15 for South African veal. Therefore, although the total fat content of South African veal tends to be lower, the fatty acid composition of American veal is more favourable. This is probably related to feeding practices.

Table 5.4: THE NUTRIENT COMPOSITION OF COOKED AMERICAN SHOULDER BLADE (SEPARABLE LEAN AND FAT) \* AND SOUTH AFRICAN\*\* VEAL CHUCK  
(100 g cooked veal: edible portion)

NUTRIENT	UNIT	AMERICAN SHOULDER BLADE	SOUTH AFRICAN CHUCK
Moisture	g	56,98	59,69
Protein	g	31,26	29,05
Fat	g	10,09	9,82
Energy	kJ	940	891
Cholesterol	mg	153	142,5
<i>Fatty acids</i>			
Saturated	g	3,64	5,03
Monounsaturated	g	3,85	3,72
Polyunsaturated	g	0,74	0,37
<i>Minerals</i>			
Phosphorus	mg	244,0	217,5
Calcium	mg	38,0	31,2
Magnesium	mg	26,0	26,8
Potassium	mg	297	327,0
Sodium	mg	98,0	97,9
Copper	mg	0,164	1,032
Zinc	mg	7,00	6,69
Manganese	mg	0,036	0,021
Iron	mg	1,44	0,90
<i>Vitamins</i>			
Thiamin (Vit B <sub>1</sub> )	mg	0,06	0,115
Riboflavin (Vit B <sub>2</sub> )	mg	0,35	0,245
Niacin	mg	5,50	6,19
Pyridoxin (Vit B <sub>6</sub> )	mg	0,24	0,260
Folacin	µg	15,0	9,92
Cyanocobalamin (Vit B <sub>12</sub> )	µg	1,93	2,52
Pantothenic acid	mg	1,52	0,394

\* Anderson *et al.* (1989: 161)

\*\* Weighted values determined for South African chuck, according to paragraph 5.4

Cholesterol levels are inversely related to the triglyceride and therefore the total lipid levels (Miller *et al.*, 1987: 527). However, not only does this study indicate that South African veal has a lower total fat content than American veal, lower cholesterol levels (Table 5.3) were also observed for the former. Buege (1989: 41) reported that the cholesterol content of veal from calves fed on special formulas was significantly higher than that from grain-fed calves. Feeding programmes could therefore be responsible for these differences. The higher moisture content of South African veal correlates with its lower protein content.

South African veal seems to have slightly lower iron levels than American veal (Tables 5.3 and 5.4). Faustman *et al.* (1992: 304) reported a high correlation between the total pigment and total iron. Buege (1989: 45) indicated similar total iron values for specially fed veal. The total iron concentrations in veal from grain-fed calves were about twice that of the specially fed calves. Australian veal showed the highest iron levels, followed by American and South African levels of 1,54 and 0,89 mg respectively. The reason for the lower than expected iron level determined in this study is not clear. It may be the result of a lack of iron supplements which are usually included in the special diets given to specially fed veal (SFV) calves. The phosphorus content of the American and South African veal compares favourably. No values are available for Australian veal. The magnesium and sodium values of American and South African veal also compare well.

Although both South African and American veal are excellent sources of niacin, the higher content of South African veal (8.15 mg/100 g) compared to the American veal (7,97 mg /100 g) deserves special mention. Maize is the staple food of most South Africans. Most of the niacin in maize is in unavailably bound (Robinson *et al.*, 1990: 186) and the essential amino acid, tryptophan, a precursor of niacin, is also limited in maize plant protein. On the other hand, the high content of available niacin in veal and its protein of high biological value, make it a valuable food in preventing pellagra especially in the South African context.

Therefore it is clear that the nutrient composition of veal presently available on the South African market differs slightly, but not significantly so, from that of American veal. The most important differences are probably the lower total fat, the higher saturated fatty acid, lower iron and higher niacin content of the South African product. Breeding and feeding practices, as well as age at the time of slaughter, are probably responsible for these differences.

## 5.5 The place of veal in the prudent diet

The dietary goals or guidelines of the prudent diet aim at providing recommendations to the public on how to lower the risk of developing Western diseases of affluence (Truswell, 1987: 1068). The main emphasis of these recommendations is that less than 30% of the total energy intake should be in the form of fat, and that the poly- and monounsaturated fatty acid to saturated fatty acid ratio should be equal to or greater than one.

Veal is an animal product and could therefore replace other animal products in the diet. To evaluate the place of South African veal in the prudent diet, the nutrient contribution of veal, beef, fish, chicken, egg and cheese, containing the same amount of fat, as well as the nutrient density of these foods for specific nutrients, are compared in Tables 5.5 and 5.6 respectively. The amount of each food was adjusted to keep the total fat content (8,84 g) identical.

From Table 5.5 it can be seen that South African veal is relatively higher in saturated fatty acids than South African beef, fish, egg or chicken. Tables 4.24-4.26 show that the major saturated fatty acid in veal is palmitic acid ( $C_{16:0}$ ). However, the mono- and polyunsaturated fatty acid content of veal is also higher than that of beef and cheese, resulting in improved or similar polyunsaturated and monounsaturated to saturated fatty acid ratios. It therefore seems that the ratios of the cholesterol lowering or raising fatty acids in veal and beef are similar. According to Table 5.5, cheese has the most undesirable polyunsaturated and monounsaturated to saturated fatty acid ratios.

Table 5.5: NUTRIENT CONTRIBUTION OF DIFFERENT ANIMAL PRODUCTS CONTAINING THE SAME AMOUNT OF FAT

	UNIT	VEAL <sup>1</sup>	BEEF <sup>2</sup>	FISH <sup>3</sup> (Salmon)	EGG <sup>3</sup>	CHICKEN <sup>3</sup>	CHEESE <sup>3</sup>	RDA
Weight/8,84g fat	g	100	58,62	121,1	85,83	65,00	58,93	
Fat	g	8,84	8,84	8,84	8,84	8,84	8,84	
Protein	g	29,33	15,72	24,83	10,81	17,5	18,56	50
Moisture	g	60,31	32,99	83,20	64,37	38,7	27,76	
Energy	kJ	858	614	777	547	651	643	8000
Cholesterol	mg	143	52	53	103	57	44	
<b>Fatty acids</b>								
Saturated	g	5,03	3,96	1,99	2,58	2,46	5,38	
Mono-unsaturated	g	3,72	2,99	3,37	3,44	3,47	2,37	
Poly-unsaturated	g	0,37	0,18	2,76	1,12	1,93	0,25	
P/S ratio		0,10	0,05	1,39	0,43	0,78	0,05	
M/S ratio		0,74	0,76	0,74	1,33	1,41	0,44	
<b>Minerals</b>								
Iron	mg	0,89	1,48	1,33	1,33	0,85	0,12	15
Zinc	mg	6,95	4,80	1,24	0,99	1,26	1,65	12
Copper	mg	1,09	0,05	0,10	0,10	0,05	0,03	1,5-3,0
<b>Vitamins</b>								
Thiamin (B <sub>1</sub> )	mg	0,12	0,13	0,02	0,11	0,04	0,18	1,1
Riboflavin(B <sub>2</sub> )	mg	0,24	0,14	0,23	0,34	0,11	0,31	1,3
Niacin	mg	6,28	2,45	6,66	0,09	5,53	0,59	15
Pyridoxine(B <sub>6</sub> )	mg	0,27	0,25	0,58	0,04	0,26	0,08	1,6
Folacin	µg	9,90	7,30	12,11	39,48	4,35	33,0	180
Cyanocobalamin (B <sub>12</sub> )	µg	2,40	1,32	2,99	1,63	0,20	0,77	2,0

<sup>1</sup> Results obtained in this study from Grade 1 veal: Chuck cut (cooked)

<sup>2</sup> Results obtained in the same project from Age A, Fat code 1 beef: Chuck cut (cooked), (Schönfeldt 1993: 212-220)

<sup>3</sup> Values in SA Food Composition Tables (Langenhoven *et al.*, 1991: 1-245)

<sup>4</sup> Recommended Daily Allowances for adult women (Food and Nutrition Board, 1989: 284-285)

However, these ratios may be misleading, as recent information (Grundy, 1991: 471) is that the saturated stearic fatty acid (C<sub>18:0</sub>) does not influence serum cholesterol levels and may be regarded as neutral. Although the ratio of cholesterol lowering to cholesterol raising fatty acids in South African veal (1,15) is slightly lower than that for American veal (1,67), it is greater than 1, which makes South African veal acceptable for inclusion in the prudent diet.

Of all the foods given in Table 5.5, veal seems to be the best source of protein, zinc, copper and niacin, as well as an equally good source of thiamin, riboflavin, vitamins B<sub>6</sub> and B<sub>12</sub>.

Table 5.6: NUTRIENT DENSITIES\* OF DIFFERENT FOODS WITH THE SAME AMOUNTS OF FAT

NUTRIENT	VEAL <sup>1</sup>	BEEF <sup>2</sup>	FISH <sup>3</sup>	EGG <sup>3</sup>	CHICKEN <sup>3</sup>	CHEESE <sup>3</sup>
Protein	5,47	4,10	5,11	3,16	4,36	4,62
<b>Minerals</b>						
Iron	0,55	1,48	0,91	1,50	0,70	0,10
Zinc	5,40	5,21	1,06	1,21	1,29	1,71
Copper	6,76	0,43	0,69	1,00	0,38	0,24
<b>Vitamins</b>						
Thiamin	0,99	1,54	0,22	1,48	0,44	2,04
Riboflavin	1,72	1,41	1,82	3,86	1,04	2,99
Niacin	3,90	2,13	4,57	0,09	4,53	0,49
Vitamin B <sub>6</sub>	1,57	2,04	3,73	0,33	2,00	0,62
Folacin	0,51	0,53	0,69	3,21	0,22	2,28
Vitamin B <sub>12</sub>	11,18	8,59	15,39	11,93	1,23	4,79

\* Nutrient density calculated according to Passmore and Eastwood (1986: 168)

<sup>1</sup> Results obtained in this study from Grade 1 veal: Chuck cut (cooked)

<sup>2</sup> Results obtained in the same projects from Age A, Fat code 1 beef: Chuck cut(cooked) (Schönfeldt 1993: 212-220)

<sup>3</sup> Values in SA Food Composition Tables (Langenhoven *et al.*, 1991: 1-245)

The niacin content of veal makes it an especially useful food to balance the diets of most South Africans. This is confirmed by the calculated nutrient densities of these nutrients in the different animal products, given in Table 5.6.

From the above it can be seen that compared to other animal products, South African veal will contribute more saturated fatty acids to the diet (except for cheese), but at the same time, less veal can be eaten to fulfill other nutrient requirements. Therefore, despite the slightly higher saturated fatty acid content of veal, it is a valuable source of protein and several vitamins and minerals and could be included on a regular basis in a prudent diet.

In a prudent diet containing 9000 kJ, if 25% of the energy is provided by fat, approximately 60 g of fat can be eaten daily. A 100 g portion of cooked Grade 1 veal from which visible fat was not removed, will provide between 5,7 and 15,4 g of fat, depending on the cut (see Table 4.4). If the subcutaneous fat is removed from veal, such a portion will contribute even less fat. Considering the fat content as well as other valuable nutrients of veal, it is clear that veal can be included on a regular basis in the prudent diet.

## CHAPTER 6

### CONCLUSIONS AND RECOMMENDATIONS

#### 6.1 Conclusions

The nutrient composition of South African veal was determined in this study by analytical methods comparable to those recently used to characterize American (Ono *et al.*, 1986: 1353) and Australian (Greenfield *et al.*, 1987: 212), respectively. The coefficients of variance (CV%) of the analytical methods were smaller than the between-cut variances, which validates these results.

The main observations of the study were:

- \* South African veal is lower in total fat, although not significantly, and slightly higher in saturated fatty acid content than American veal.
- \* South African veal is an excellent source of protein, zinc, copper, riboflavin, niacin, vitamin B<sub>6</sub> and vitamin B<sub>12</sub> and should be used more often to balance South African diets low in protein and niacin.
- \* South African veal can also be regarded as a good source of iron, thiamin and folacin.
- \* The moisture loss upon cooking accounted for most of the differences in nutrient composition found between raw and cooked veal. Therefore, cooking methods used in this study did not adversely influence the nutrient composition of veal. It seems that the vitamins in veal are heat-stable when correct cooking methods are used.
- \* The nutrient composition of veal, as determined by this study, also differs from the values given in the South African Food Tables.

This study supplied new and valid information concerning the nutritional composition of South African veal. The study proved veal to be a valuable source of protein as well as several minerals (phosphorus, magnesium, potassium, copper and zinc) and vitamins (thiamin, niacin, riboflavin, vitamins B<sub>6</sub> and B<sub>12</sub>). The study further demonstrated that veal can be included on a regular basis in the prudent diet.

## 6.2 Recommendations

Despite the slightly higher saturated fatty acid content compared with American veal, South African veal can be a valuable food in healthy and even low-fat diets. Veal is a nutrient dense food and in comparison to other animal foods, less veal can be consumed to meet other nutrient requirements. When comparing the nutrient contribution of veal and beef containing equal amounts of fat, more nutrients will be supplied by veal. According to South African data (Schönfeldt, 1993: 215) 100 g cooked beef chuck (A - age, Fat code 1) contains 15,08 g fat, while 100 g cooked Grade 1 veal chuck provides 8,58 g of fat. Based on fat content, if veal replaces beef three times a week (120 g portions), 22,3 g less fat (684 kJ) will be consumed. Veal is traditionally covered in bread crumbs and deep fat fried or served with a rich creamy high energy sauce (Rogers, 1990: 106). Provided veal is served without adding energy to the cut as indicated, it could replace beef in a low fat diet. It can therefore be recommended that veal may easily regularly replace beef in the diet to lower fat intake.

It is also recommended that the nutrient composition data of veal, as determined by this study, should be incorporated as a carcass value as well as per cut into the South African Food Tables.

The consumption of veal should be increased by providing the South African public with valid and recent information, educating them to regard veal as a valuable source of nutrients and simultaneously creating a reliable market where veal could be purchased at reasonable prices.

Economically viable feeding programmes should be developed for calves producing veal.

These feeding programmes could concentrate on producing a product with a lower saturated fatty acid content. More research should also be done to produce veal with a higher iron content. Optimising feeding programmes would promote the most efficient use of bull calves in commercial dairy herds. The quality as well as the profitability of veal production could be increased.

Veal is internationally regarded as a delicacy. The results of this study could be utilised to focus on the potential of marketing veal in South Africa as a healthy food and as a delicacy.

## REFERENCES

- AGBOOLA, H.A., CAHILL, V.R., CONRAD, H.R., OCKERMAN, H.W., PARKER, C.F., PARRETT, N.A. & LONG, A.R., 1990. The effects of individual and combined feeding of high monosodium phosphate and alphatocopherol supplemented milk replacer diets and an alternate protein diet on muscle colour, composition and cholesterol content of veal. *Journal of Animal Science*, 68: 117-127.
- ALBRIGHT, J.L., 1983. Status of animal welfare awareness of products and direction of animal welfare research in the future. *Journal of Dairy Science*, 66: 2208.
- AMERICAN VEAL ASSOCIATION, Inc., 1988. *Guide for the care and production of milk-fed veal calves*. 2nd ed. p 1-11.
- ANDERSON, B.A., CLEMENTS, M.J., DICKEY, L.E., EXLER, J. & HOKE, I.M., 1989. *Composition of foods: Lamb, veal, and game products, raw, processed, prepared*. United States Department of Agriculture. p i-251.
- ANDERSON, L., DIBBLE, M.V., TURKKI, P.R., MITCHELL, H.S. & RYNBERGER, H.J. 1982. *Nutrition in health and disease*. Philadelphia: J.B. Lippincott Company. p 1-352.
- AOAC, 1990. Official methods of analysis. 15th ed. *Association of Official Analytical Chemists*, Washington, DC. p 1080-1085.
- BARTON-WRIGHT, E.C. 1961. *Practical methods for the microbiological assay of the vitamin B complex and amino acids*: p 6-28.
- BEAUCHEMIN, K.A., LACHANCE, B. & ST. LAURENT, G., 1990. Effects of concentrated diets on performance and carcass characteristics of veal calves. *Journal of Animal Science*, 68: 35-44.
- BENADÉ, A.J.S., FINCHAM, J.E., SMUTS, C.M., LAI TUNG, M.T., CHALTON, D., KRUGER, M., WEIGHT, M.J., DAUBITZER, A.K. & TICHELAAR, H.Y., 1988. Plasma low density lipoprotein composition in relation to atherosclerosis in nutritionally defined Vervet monkeys. *Atherosclerosis*, 74: 157-168.
- BENDER, A.E., 1975. *Nutritional value of meat*. In: Meat. Eds. Cole, D.J.A. & Lawrie, R.A., London, Butterworth. p 10-20.
- BOCCARD, R.L., NAUDÉ, R.T., CRONJE, D.E., SMIT, M.C., VENTER, H.J. & ROSSOUW, E.J. 1979. The influence of age, sex and breed of cattle on their muscle characteristics. *Meat Science* 3: 261-280.

- BODWELL, C.E. & ANDERSON, B.A., 1986. Nutritional composition and value of meat and meat products. In: *Muscle as food*. Eds. Bechtel, P.J., Academic Press, Orlando. p 335-345. ✓
- BOWERS, J. 1992. *Food theory and applications*. 2nd ed. U.S.A., Macmillan, p 600-660.
- BOWERS, J.A., CRAIGH, J. & WILLIAMS, J.C. 1989. Sensory characteristics, texture, colour and selected nutrient content of veal muscle. *Journal of Food Science* 54(6): 1444-1449. ✓
- BREIDENSTEIN, B.C. 1987. Nutrient value of meat. *Food and Nutrition News* 59(2): 43-58, March/April. ✓
- BREIDENSTEIN, B.C. & WILLIAMS, J.C., 1986. *Red meat: Nutrient composition and actual consumption*. Chicago: National live stock & Meat board. p 1-21.
- BUEGE, D.R. 1989. *Production and characteristics of grain fed veal*. Wisc. cattle feeder day proceed: 37-48. ✓
- CARROL, K.K., HAMILTON, R.M.G. & MCLEOD, G.K. 1973. Plasmacholesterol levels in suckling and weaned calves, lambs, pigs and colts. *Lipids* 8: 635. ✓
- CROSS, H.R., DURLAND, P.R. & SEIDEMAN, S.C. 1986. Sensory qualities of meat. In: *Muscle as food*. Bechtel, P.J. Orlando, Academic Press. p 1002. ✓
- CRUYWAGEN, C.W. 1988. Kalfsvleisproduksie kan lonend wees. *Landbouuus*, 41: 8. ✓
- DIET CONSENSUS PANEL. 1989. Dietary recommendations for the prevention of coronary heart disease. *SAMJ*. 76: 591-592. ✓
- DIRECTORATE AGRICULTURAL ECONOMIC TRENDS. 1994. *Abstract Agricultural Statistics* Department of Agriculture Economics and Marketing, Republic of South Africa. p 61-67. ✓
- DRANSFIELD, E., CASEY, J.C., BOCCARD, R., TOURAILLE, C., BUTCHER, L., HOOD, D.E., JOSEPH, R.L., SCHON, I., CASTEELS, M., COSENTINO, E. & TINBERGEN, B.J. 1983. Comparison of chemical composition of meat determined at eight laboratories. *Meat Science*, 8: 79-92. ✓
- FAUSTMAN, C., SPECHT, S.M., CLARK, R.M., MALKUS, L.A., BENDEL, R.B. & KINSMAN, D.M. 1992. Lipid composition of bob and special-fed veal. *Journal of Muscle Food*, 3: 33-44. ✓
- FAUSTMAN, C., YIN, M.C. & NADEAU, D.B. 1992. Colour stability, lipid stability and nutrient composition of red and white veal. *Journal of Food Science*, 57(2): 302-304. ✓

- FISKE, C.H. & SUBBAROW, Y. 1925. The calorimetric determination of phosphorus. *Journal of Biological Chemistry*, 66: 375. ✓
- FOOD AND NUTRITION BOARD, NATIONAL ACADEMY OF SCIENCES & NATIONAL RESEARCH COUNCIL, 1989. *Recommended dietary allowances*. 10th ed., National Academy Press, Washington, D.C.: 1-285. ✓
- GOVERNMENT GAZETTE, 1985. *Meat grading regulations*. RSA. 243(9935): 3-19, Sept. ✓
- GREENFIELD, H., KUO, Y.C., HUTCHINSON, G.I. & WILLS, R.B.H. 1987. Composition of Australian foods. 34. Beef and Veal. *Australian Food Technology*, 39(5): 208-215. ✓
- GRUNDY, S.M. 1991. *How much does diet contribute to premature coronary heart disease?* In: Stein, O., Eisenberg, S, & Stein, Y. *Atherosclerosis IX. Proceedings of the ninth International Symposium in Atherosclerosis*. Rosemont, Chicago, Illinois, USA October 6-11: 471-478. ✓
- GUTHRIE, H.A. 1989. *Introductory nutrition*. 7th ed. St. Louis, Missouri: Times Mirror/Mosby College Publishing. p 130-138. ✓
- HAMM, R. 1986. Functional properties of the myofibrillar system and their measurements. In: *Muscle as food*. Ed. Bechtel, P.J. Orlando, Academic Press. p 459. ✓
- HMAC SUBCOMMITTEE: Nutrition services. 1992. *Sensible diet-guidelines for South Africans*. Pretoria, Department of National Health and Population Development: p 1-9. ✓
- HORN-QUASS, J. 1992. Making veal production profitable. *A Central Bureau Report*. (1): 20-21.
- HORWITZ, W. (Ed). 1980. *Official Methods of Analysis of the AOAC*. 13th ed. AOAC. Washington. D.C. p 3-5. ✓
- JOHNSON, A.R., 1987. The nutrient composition of Australian meats and poultry: A preface. *Australian Food Technology* , 39(5): 183-184. ✓
- KEMPSTER, T., CUTHBERTSON, A. & HARRINGTON, G. 1982. *Carcass evaluation in livestock breeding, production and marketing*. London, Granada. p 12-25. ✓
- KLINGBIEL, J.F.G. 1984. *Ontwikkeling van 'n graderingstelsel vir beeskarkasse*. D.Sc.- thesis, University of Pretoria, South Africa. ✓
- LANGENHOVEN, M., KRUGER, M., GOUWS, E. & FABER, M. 1991. *MRC food composition tables*. 3rd ed. Tygerberg: Medical Research Council. p 1-245. ✓

- LEVEILLE, G. 1987. Principles and issues in translating dietary recommendations to food selection. *American Journal of Clinical Nutrition*, 45 (5): 1046-1047. ✓
- LINDER, M.C. 1991. *Nutritional Biochemistry and Metabolism: With clinical Applications*. 2nd Ed. London, Prentice Hall. p 1-603.
- MAHAN, L.K. & ARLIN, M.T., 1992. *Krause's food, nutrition and diet therapy*. 8th ed. Philadelphia, W.B. Saunders Comp. p 12-60. ✓
- MARMER, W.N., MAXWELL, R.J. & WILLIAMS, J.E. 1984. Effects of dietary regimen and tissue site on bovine fatty acid profile. *Journal of Animal Science*, 59: 109. ✓
- MARTLAND, R.E. & WELSHBY, D.A. 1980. *Basic Cookery*. London, Heineman. p 50-235. ✓
- MILLER, G.J., FIELD, R.A., MEDIEROS, L. & NELMS, G.E. 1987. Lipid characteristics in fresh and broiled loin and round steaks from cocentrate fed and pasture grazed steers. *Journal of Food Science*, (52)3: 526-529. ✓
- ONO, K., BERRY, B.W. & DOUGLASS, L.W. 1986. Nutrient composition of some fresh and cooked retail cuts of veal. *Journal of Food Science*, 51(5): 1352-1357. ✓
- PASSMORE, R, & EASTWOOD, M.A. Eds. 1986. DAVIDSON AND PASSMORE: *Human nutrition and dietetics*. 8 th ed. London Churchill Livingstone. p 168-206. ✓
- PAUL, A.A. & SOUTHGATE, D.A.T. 1983. *The composition of foods*. London: HMSO. p 5-10.
- PRICE, J.F. & SCHWEIGERT, B.S., 1971. *The science of meat and meat products*. San Francisco, Freeman. p 287-300. ✓
- RAPAPORT, S.I. 1985. *Blood and lymph*. In: West, J.B. ed. Best and Taylors physiological basis of medical practice. 11 th ed. London, Williams & Wilkens. p 384-386. ✓
- RISS, T.L., BECHTEL, P.J., RICHARD, M.F., KLEIN, B.P. & McKEITH, F.K. 1983. Nutrient content of special veal ribeyes. *Journal of Food Science*, 48: 1868-1871. ✓
- ROBINSON, C.H., LAWLER, M.R., CHENOWETH, W.L. & GARWICK, A.E. 1990. *Normal and therapeutic nutrition*. 17th ed. New York, Macmillan. p 46-214. ✓
- ROGERS, J. 1990. *What food is that and how healthy is it?* Sydney, Weldon. p 106-107.

- RSA MEAT BOARD, 1989. *RSA livestock and meat statistics*. (5): 1-35.
- RSA MEATBOARD. 1993. *RSA Livestock and meat statistics*. 4: 3.
- RSA MEAT BOARD. 1992. *Veal statistics*. Jan 1985-June 1992 in: RSA livestock and meat statistics. p 10-61.
- Schönfeldt, H.C. 1993. *Nutritional composition of beef in: Workshop proceedings: Meat as Food*. p 212-220.
- SMUTS, C.M., KRUGER, M., VAN JAARVELD, P.J., FINCHAM, J.E., SCHALL, R., VAN DER MERWE, K.J. & BENADÉ, A.J.S. 1992. The influence of fish oil supplementation on plasma lipoproteins and arterial lipids in Vervet monkeys with established atherosclerosis. *Prostaglandins Leukotrienes and Essential fatty acids*, 47: 129-138.
- TRUSWELL, A.S. 1987. Evolution of dietary recommendations, goals and guidelines. *American Journal of Clinical Nutrition*. 45: 1060-72.
- U.S. NATIONAL LIVE STOCK AND MEAT BOARD. 1991. *Lesson on meat*. U.S.A. p 1-136.
- U.S. NATIONAL LIVE STOCK AND MEAT BOARD. 1990. *Nutrient values of muscle foods*. p 1-30.
- USP XXII. 1990. *The United States Pharmacopeia*. 22 nd rev. p 1500.
- VORSTER, E. 1985. *Vesel 'n growwe towerwoord*. Pretoria, Femina Uitgewers. p 36.
- WEBSTER, J. 1984. *Calf husbandry, health and welfare*. London, Granada. p 202.
- WILLIAMS, J.C., 1987. Contribution of red meat to the U.S. diet. *Food and Nutrition news*, 59(1): 37-40.
- WILLS, R.B.H., MAPLES, J. & GREENFIELD, H. 1981. Composition of Australian foods. 7 Minerals in Lebanese, Chinese and fried take-away foods. *Australian Food Technology* 3: 274-276.
- YOUNG, D.S., 1987. Implementation of SI units for clinical laboratory data. *Annals of Internal Medicine*. 106: 114-129.

## APPENDIX A: FORM USED FOR PHYSICAL COMPOSITION DATA - Phase 2

Quick code: _____ Slaughter date: _____						
Number: _____			Freezing date: _____			
Grade: _____						
Mass of side before cutting: _____						
CUT NO.	CUT (kg)	STARTING MASS (kg)	BONE (kg)	SUBCU-TANEOUS FAT (kg)	MUSCLE (kg)	TOTAL CALCULATED (kg)
1.	Shoulder					
2.	Chuck					
3.	Rib					
4.	Loin					
5.	Breast & flank					
6.	Rump					
7.	Leg					
8.	Shins					

## APPENDIX B: FORMULAS FOR DETERMINING COOKING LOSS

TASTE PANEL LEADER: .....	
Project: .....	Project leader: .....
Slaughter date: .....	Sample code: .....
Panel date: .....	Panel code: .....
* THAWING DATA *	
* Mass raw + thawing loss + bag (g) .....	...A...
* Mass bag + drip (g) .....	...B...
* Mass bag without drip (g) .....	...C...
* COOKING DATA *	
* Time in: D                      Cooking time (h): * Time out: E                      (calculated)	E - D
Thermocouples	
<u>Number</u> <u>Start</u> <u>End</u>	
Oven        .....        .....	
Sample     .....    ...F...    ...G...	
Cooking tempo (calculated):	$(G - F) \div (E - D) \text{ (min)}$
	Mass (g)
* Mass of pan + rack .....	...H...
* Mass of pan + rack + bag + wire + raw meat .....	...I...
Mass raw meat (g) - calculated	I - H
* Mass pan + rack + bag + wire + drip + cooked meat ..	...J...
* Mass pan + rack + bag + wire + drip + fat .....	...K...
Mass total drip (g) - calculated	K - H
Mass cooked meat (g) - calculated	J - K
* Mass pan + rack + bag + wire + drip + residue drip ..	...L...
Mass drip left in pan (g) - calculated	L - H
CHARACTERISTICS OF DRIP REMARKS	Volume (mL)
* Drip .....	...M...
* Stock .....	...N...
Total volume of fat (mL) - calculated	M - N
Mass of fat (g) - calculated	$(M - N) \times 0,9$
% Total cooking loss (calculated)	$(I-H) - (J-K) \div (I-H) \times 100 = O$
% Drip loss (calculated)	$(K-H) \div (I-H) \times 100 = P$
% Evaporation loss (calculated)	O - P
% Thawing loss (calculated)	$(B-C) \div \text{Mass of meat before freezing} \times 100$

## APPENDIX C: DETERMINATION OF CARCASS VALUE

SERIALC	AGE	CUT	REP	A	B	C	D	E	F	G	H	I	J	K	L	M
				SUBFAT	MUSCLE	BONE	TOTAL	CSUBFAT	CMUSCLE	SMEAT	CMEAT	ASMEAT	ACMEAT	ARP	O*T	RP/100
GR6	2	1	11	0.00	1.78	0.52	2.30	0.00	17.12	1.78	17.12	1.91	17.48	201.00	3832.40	199.90
GR7	2	1	12	0.00	1.92	0.56	2.48	0.00	17.30	1.92	17.30					
GR8	2	1	13	0.00	2.02	0.52	2.54	0.00	18.03	2.02	18.03					
GR6	2	2	11	0.00	2.72	0.74	3.46	0.00	17.12	2.72	17.12	2.73	17.48	186.00	5071.60	
GR7	2	2	12	0.00	2.64	0.96	3.60	0.00	17.30	2.64	17.30					
GR8	2	2	13	0.00	2.82	0.92	3.74	0.00	18.03	2.82	18.03					
GR6	2	3	11	0.00	1.19	0.32	1.51	0.00	17.12	1.19	17.12	1.10	17.48	168.00	1853.60	
GR7	2	3	12	0.00	1.18	0.36	1.54	0.00	17.30	1.18	17.30					
GR8	2	3	13	0.00	0.94	0.26	1.20	0.00	18.03	0.94	18.03					
GR6	2	4	11	0.00	1.20	0.32	1.52	0.00	17.12	1.20	17.12	1.22	17.48	164.00	2000.80	
GR7	2	4	12	0.00	1.24	0.38	1.62	0.00	17.30	1.24	17.30					
GR8	2	4	13	0.00	1.22	0.34	1.56	0.00	18.03	1.22	18.03					
GR6	2	5	11	0.00	2.52	0.76	3.28	0.00	17.12	2.52	17.12	2.55	17.48	187.00	4774.73	
GR7	2	5	12	0.00	2.64	0.56	3.20	0.00	17.30	2.64	17.30					
GR8	2	5	13	0.00	2.50	0.56	3.06	0.00	18.03	2.50	18.03					
GR6	2	6	11	0.00	1.38	0.28	1.66	0.00	17.12	1.38	17.12	1.38	17.48	229.00	3160.20	
GR7	2	6	12	0.00	1.30	0.30	1.60	0.00	17.30	1.30	17.30					
GR8	2	6	13	0.00	1.46	0.33	1.79	0.00	18.03	1.46	18.03					
GR6	2	7	11	0.00	4.70	0.88	5.58	0.00	17.12	4.70	17.12	4.73	17.48	221.00	10460.67	
GR7	2	7	12	0.00	4.64	1.04	5.68	0.00	17.30	4.64	17.30					
GR8	2	7	13	0.00	4.86	1.08	5.94	0.00	18.03	4.86	18.03					
GR6	2	8	11	0.00	1.74	1.48	3.22	0.00	17.12	1.74	17.12	1.86	17.48	204.00	3794.40	
GR6	2	8	12	0.00	1.90	1.48	3.38	0.00	17.30	1.90	17.30					
GR8	2	8	13	0.00	1.94	1.54	3.48	0.00	18.03	1.94	18.03					

A + B + C = D (Original physical dissection values).  
E and F : Average of total subcutaneous fat and muscle to give a carcass value, which is the same for each cut in the carcass.  
G : Subcutaneous fat and muscle for each cut.  
H : Subcutaneous fat and muscle - carcass values.  
I : Average value of G for repetitions 11, 12 and 13 for each cut.

J : Average value of H for repetitions 11, 12 and 13 for each cut.  
K : Average value of nutrients (in this case phosphorus value for raw Grade I).  
L : (10 x I x K)  
M : Total of L/(J x 10)