Amino acid composition of South African beef

10/14/2017

Determining the amino acid profile of selected cuts from four age groups of South African beef, as additional to the previously approved project on the nutrient content of South African beef, in order to determine protein quality.

Industry Sector: Cattle And Small Stock

Research Focus Area: Red Meat Safety, Nutritional Value, Consumerism And Consumer Behaviour

Research Institute: Animal And Wildlife Science, University Of Pretoria

Researcher: Prof Hettie Schönfeldt PhD

Team Members

Title	Initials	Surname	Qualification
Dr	N.	Hall	Ph.D
Dr	B.	Pretorius	Ph.D

Year Of Completion : 2017

Aims Of The Project

- To determine the amino acid profile of South African beef
- To determine the validity of using nitrogen and a specific Jones factor to define protein quantity
- To determine the protein quality of South African beef in the context of human nutrition

Executive Summary

Globally protein quality is under the spotlight. The importance of protein quality was emphasized by both the 2007 and the 2011 Food and Agriculture Organization/ World Health Organization (FAO/WHO) Protein and amino acid requirements in human nutrition reports. These reports questioned the validity of current measures to determine crude protein content and protein absorption, and called for more research. Locally, the national Department of Health Directorate Food Control's most recent legislation on food labelling and advertising requires that in order to make protein content claims, amino acid data in addition to crude protein (nitrogen), is needed.

During this project, raw and cooked beef cuts (prime rib, rump and shoulder) from all four age groups according to the South African classification system were sent for amino acid analyses at the ARC Irene Analytical laboratory.

Aligning with international debates, a literature review was completed to investigate existing literature on the validity of using the Jones factor of 6.25 to quantify the amount of protein from nitrogen within the red meat matrix. Amino acid data obtained was also compared to the use of the Jones factor to quantify the total protein content of red meat, and alternative factors were explored – similar to what has been done by Sosulki et al. in 1990. Mariotti et al (2008) also queried the use of 6.25 as the converting factor for red meat. Our study found that complete amino acid profiles of local beef amounted to 91% on average of protein based on total Nitrogen content (in weight). This indicates that there is an overestimation of protein in beef when the conversion factor of 6.25is used.

For local legislative purposes, the study found that all cuts from all age groups contain adequate quantities of the essential amino acids as required by the R.429 Food Labelling Legislation. This provides the scientific evidence required for South African beef to make protein content and functional protein claims on packaging and in marketing activities.

Technology Transfers

1. Participation of the Human Nutrition and Health Committee Meeting of the International Meat Secretariat (Canada, 1-3 July, 2015) (Addendum 2)
2. Participation of the Human Nutrition and Health Committee Meeting of the International Meat Secretariat (Oslo, Norway, 15-18 July, 2016) (Addendum 2)

Reports To Industry

1. NRF-THRIP progress report 2014
2. NRF-THRIP final report 2015
3. RMRD SA Progress report 2014
4. RMRD SA Progress report 2015

Scientific Articles

1. Schönfeldt H.C., Pretorius B. and Hall, N. (2016) ‘Bioavailability of Nutrients’, In: Caballero, B., Finglas, P., and Toldrá, F. (eds.) The Encyclopedia of Food and Health vol. 1, pp. 401-406. Oxford: Academic Press.
2. Article to be submitted after presenting “Updating and expanding the Food Composition Table for Western Africa“ at International Food Data Conferences (IFDC) – Official INFOODS conference. Center for Science in the Science and Technology Pole, Buenos Aires, Argentina. 11-13 October 2017.
3. Article to be submitted after presenting “Amino acid and protein content of lean beef“ at International Food Data Conferences (IFDC) – Official INFOODS conference. Center for Science in the Science and Technology Pole, Buenos Aires, Argentina. 11-13 October 2017.

Theses

1. Hall, N. 2015. Sustainable red meat from a nutrition perspective. University of Pretoria.

Conferences, Symposia

1. Co-author FAO/INFOODS (2017) Updating and expanding the Food Composition Table for Western Africa. 12th International Food Data Conference (IFDC) – Official INFOODS conference.
   Center for Science in the Science and Technology Pole, Buenos Aires, Argentina. 11-13 October 2017.
2. Schönfeldt, H.C., Hall, N., Pretorius, B. and Van Deventer, M.M. (2017) Amino acid and protein content of lean beef. 12th International Food Data Conference (IFDC) – Official INFOODS conference. Center for Science in the Science and Technology Pole, Buenos Aires, Argentina. 11-13 October 2017.

Literature Review

1. Hall, N.G. and Schönfeldt, H.C. (2013) 'Total nitrogen vs amino-acid profile as indicator of protein content of beef', Food Chemistry. 140 (3): 608-612.

Popular Article

Globally Protein Quality Is Under The Spotlight

Hettie Schönfeldt, Beulah Pretorius, Nicolette Hall, Maricia van Deventer

Department of Animal and Wildlife Sciences, Institute of Food, Nutrition and Well-being, University of Pretoria.

There has been much discussion regarding protein and amino acid requirements for both adults and children over the past few years.

Conventionally, protein content is determined by analysing the total nitrogen content in a food, and multiplying this by a standard conversion factor to obtain protein quantity – referred to as "crude protein". Because proteins are made up of chains of amino acids, they can be hydrolysed and the separate amino acids can then be measured. The sum of the amino acids then represents the protein content (by weight) of the food. This is sometimes referred to as a "true protein". This method however needs sophisticated equipment and is more expensive.

A project at the University of Pretoria aimed to determine the protein content and amino acid profile of South African beef (raw and cooked) and to establish if different cuts in the carcass and/or age of the animal influences the amino acid profile of South African beef.

Crude protein and amino acid analyses were done on 36 meat samples from Bonsmara carcasses from fat code two and all four age groups according to the South African Carcass Classification System. Three cuts (rump, prime rib and shoulder) were selected from each carcass and analyses were done on both raw and cooked meat.

Age had no significant effect on the sum of all amino acids (true protein) in both raw and cooked cuts. In the cooked cuts crude protein were found to be significantly different between the age groups for the different cuts. It should however be noted that these differences, although statistically significant, probably have little relevance in terms of human dietary requirements for protein as they differ by less than 2 g per 100 g cooked meat.

The data generated by this study is of further interest as discussions regarding the validity of nitrogen analyses for protein quantity determination and methods used to assess protein quality unfold. Table 1 shows the percentage of total amino acids to protein calculated with the Jones factor. It would be more appropriate to base estimates of protein on amino acid data.

Table 1: Percentage of sum of amino acids ('true protein') to protein calculated from total nitrogen using the Jones-factor ('crude protein')

Cut	Raw / Cooked	Percentage (Sum of amino acids / protein calculated from total nitrogen x 100)
Rump	Raw	95%
	Cooked	89%
Prime rib	Raw	97%
	Cooked	90%
Shoulder	Raw	94%
	Cooked	89%

Instead of simply focussing on total protein, attention has shifted to the greater importance of protein quality than actual quantity, emphasising the presence of individual amino acids in a food. One method of measuring protein quality is determining the quantity of the total essential amino acids and the digestibility of the protein source (PDCAAS). Data on the amino acid composition of foods is therefore essential in order to contribute to the current global discussion.

Protein quality answers two important questions namely, how much protein as well as what kind of protein should be consumed. Dietary proteins are classified as either being complete or incomplete. Some foods, such as animal source food, contain all indispensable (essential) amino acids and are referred to as a complete protein. Plant foods, on the other hand, lack one or more essential amino acid, which renders these sources of protein “incomplete”. Amino acids containing sulfur (including methionine and cysteine) and lysine most commonly limit the nutritional value (quality) of proteins in the human diet. Concentrations of these amino acids are, generally, considered lower in plant foods than in food of animal origin. In table 2 the lysine, methionine and cysteine content of commonly consumed food products is reported. Other essential amino acids, lysine and tryptophan, are also consistently found at lower concentrations in plant-based rather than animal-based foods. For example, tryptophan and lysine are limiting in corn; lysine in wheat, sorghum, and other cereals; and methionine in soybeans and other legumes. Including a small amount of lean beef in combination with plant-based foods can increase the protein quality of the meal.

Table 2: Lysine, methionine and cysteine content of commonly consumed food products

Food source	**Food**	**Range (mg/100g) from different studies**		
		Lysine	Methionine	Cysteine
Animal products	Beef and Veal (edible flesh)	**531–591**	**147–182**	**78–182**
	Chicken (edible flesh)	**384–606**	**88–215**	**64–114**
	Offal	**375–506**	**138–181**	**62–132**
	Mutton and lamb (edible flesh)	**438–589**	**131–198**	**63–144**
	Hen eggs	**375–467**	**181–249**	**113–189**
	Fish (fresh, all types)	**380–689**	**120–290**	**28–144**
Legumes	Chick-pea	**406–463**	34–106	50–94
	Cowpea	**394–479**	50–119	48–106
	Soya bean	**313–477**	53–114	51–114
Cereals & grain products	Barley	159–250	**63–250**	**81–194**
	Maize	100–214	**53–175**	**38–200**
	Millet	100–244	**84–246**	**69–169**
	Rice (brown or husked)	198–263	**117–194**	30–79
	Rye (whole meal)	151–281	**59–181**	**85–156**
	Wheat (whole grain)	131–249	**63–156**	**111–212**
Roots and tubers	Potato	**163–488**	54–125	7–81

The protein and indispensable amino acid profile of lean beef is reported in table 3. This is compared to the recommended protein requirement of 0.66 g/kg body weight/ day and the amino acid scoring pattern

for children older than 3 years, adolescents and adults. According to the South African Food Based Dietary Guideline a serving of red meat can be eaten daily, but should not be more than 90g/day.

Table 3: Dietary protein and indispensable amino acid profile of cooked beef, cow's milk, cooked soya beans compared to the recommended amino acid scoring pattern for children (3-10years), adolescents and adults

		Cooked lean beef	Full cream cow's milk	Cooked soya beans	Recommended protein and amino acid scoring pattern for older children, adolescents and adults
	"Crude" protein (g/100g)	31.8	3.25	18.21	0.66 g/kg/day50kg person = 33g 70 kg person = 46g
Amino acid (mg/g total protein)	Histidine (His)	28	28	25	16
	Isoleucine (Ile)	44	54	44	30
	Leucine (Leu)	74	94	74	61
	Lysine (Lys)	97	79	61	48
	Sulphur amino acids (SAA) Methionine (Met) + Cysteine (Cys)	63	39	27	23
	Aromatic amino acids (AAA) Phenylalanine (Phe) + Tyrosine (Tyr)	73	97	83	41
	Threonine (Thr)	44	48	40	25
	Tryptophan (Thp)	16	12	13	6.6
	Valine (Val)	46	59	46	40

The study found that South African beef from all age groups adheres to the requirements as set out by the Department of Health to be labelled and proclaimed as a complete, quality protein.

It is of interest to note that the true protein was consistently lower in the cooked meat compared to the raw meat and that the different cuts varied in the respective amino acid profiles. While the measurement of crude protein (total nitrogen multiplied by a factor) is adequate for many purposes, amino acid data would provide a better assessment of the nutritional value of a food. Through this study the amino acid profile of South African lean beef was determined and is available for future studies.

Acknowledgement: This study was funded by Red Meat Research and Development of South Africa (RMRD SA) and the National Research Foundation Technology and Human Resources for Industry Programme (NRF-THRIP) (Project id: Tp1208076284).

Please contact the Primary Researcher if you need a copy of the comprehensive report of this project – Prof H.C. Schonfeldt on hettie.schonfeldt@up.ac.za

Animal Products, Cattle and Small Stock, Consumerism and Consumer Behaviour, Nutritional Value, Red Meat Consumption, Red Meat Safety

2017, Paper, Schonfeldt, UP

< Blackfly outbreak predictive model

> Improved red meat marketing in South Africa

DEADLINES for RESEARCHERS 2021

Proposals for 2021: TBC
Progress reports: 28 Jan 21
Final reports: 29 Jan 21 Final includes comprehensive report and popular article

COMMITEE MEETINGS for 2021

RMRDSA CSS Planning - TBC
Project Committee - TBC
Pork Planning - TBC

Calendar

< Apr 2021 >

Sun	Mon	Tue	Wed	Tur	Fri	Sat
				1	2	3

4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

PORK Priority Areas

Cattle & Small Stock Programmes

1 Sustainable natural resource utilisation

2 Improvement of Livestock production and forage

3 Management of agricultural risk to create a resilient Red Meat sector

4 Sustainable health and welfare for the Red Meat sector

5 Enhancement of production and processing of Animal Products

6 Consumer and market development of the Red Meat sector

7 Commercialisation of the emerging sector