# CHEMICAL COMPOSITION OF SOUTH AFRICAN GAME SPECIES

Jeannine Neethling[1,2], Louw C. Hoffman[1] and Nina Muller[2]

[1] Department of Animal Sciences, Faculty of Agriculture, Stellenbosch University, Stellenbosch, South Africa

[2] Department of Food Science, Faculty of Agriculture, Stellenbosch University, Stellenbosch, South Africa

**Abstract – The chemical composition of the meat derived from the *longissimus thoracis et lumborum* (LTL muscle) of six commercially important South African game species was investigated in this study. The moisture, protein, intramuscular fat (IMF) and ash content (g/100 g) was established for 12 animals per species. The moisture and protein content of blesbok LTL differed (p≤0.01) between genders, but the magnitude of the differences was presumed not to be of biological relevance. An intermediate negative correlation (r = -0.58) existed between the moisture and protein content of game meat. Kudu and red hartebeest meat had the highest average crude protein content (23.8 g/100 g), followed by impala, blesbok, springbok (22.9, 22.6 and 22.6 g/100 g, respectively) and lastly gemsbok (21.9 g/100 g). Springbok meat had the highest (p≤0.01) IMF content compared to the five other species, though all IMF values were considered low (≤3.0 g/100 g). It is evident from this study that the nutritional value of game meat will differ between species and should be marketed according to species and not just under a generic name. The meat derived from South African game species can be marketed as being high in protein and low in fat.**

**Key Words – ash, intramuscular fat, moisture, protein**

## I. INTRODUCTION

South African game species are still wild and free-living, unlike the majority of ungulates that are farmed-with in Australia, Europe and New Zealand [1]. Consequently, the chemical composition of the meat can vary with the species type, gender, animal age, muscle anatomical location, dietary regime, region (or farm) and season (wet vs. dry) [2, 3]. Age and gender are generally not considered with the commercial harvesting of game species, as only mature animals are harvested. In addition, game harvesting usually occurs at night when it is difficult to judge the gender of some game species.

The dietary regime of South African game species differ, as they can be classified as browsers, selective grazers, non-selective grazers or mixed feeders (browse and graze). These dietary differences together with the species type will influence the chemical composition of the meat [3].

Nutritional information on the variety of South African game species is limited [4], which often negatively influences the marketing of the meat derived from these species [5]. The aim of this study was therefore to establish the chemical composition (moisture, protein, IMF and ash content) of a variety of commonly harvested South African game species: springbok (*Antidorcas marsupialis*); gemsbok (*Oryx gazella*); blesbok (*Damaliscus pygargus phillipsi*); impala (*Aepyceros melampus*); red hartebeest (*Alcelaphus buselaphus*); and kudu (*Tragelaphus strepsiceros*).

## II. MATERIALS AND METHODS

Twelve animals (6 male and 6 female) per species (springbok, gemsbok, blesbok, impala, red hartebeest and kudu) were randomly harvested from various farms in South Africa. All animals of a species originated from the same farm and was randomly selected from the population. The harvesting occurred in accordance with the *Guidelines for the Harvesting of Game for Meat Export* [6].

The LTL muscle was sampled from the left side of each carcass. Next the *longissimus lumborum* (LL) section of the LTL muscle was sub-sampled, homogenised, vacuum-packed and frozen at -20°C prior to chemical analysis.

The moisture, protein, IMF and ash content (g/100 g) of the species meats was determined in duplicate. A 2.5 g of the homogenized meat sample was dried at 100°C for 24 h, to determine the moisture content in accordance with the official method nr 934.01 of the Association of Official Analytical Chemists [7]. The crude protein content was determined on a dry, defatted and finely ground sample encapsulated in a Leco™ foil sheet, in accordance with the official method nr 992.15 of the Association of Official Analytical Chemists [8]. The latter results were given as the nitrogen content (% nitrogen) which was subsequently multiplied by a conversion factor of 6.25 to obtain the crude protein content of each sample. The IMF content was determined on 5 g of the homogenized samples and by use of a rapid solvent extraction method using chloroform:methanol (1:2, v/v) [9]. The ash content was determined on a moisture-free sample that was dried at 500°C for 6 h, in accordance with the official method nr 942.05 of the Association of Official Analytical Chemists [10].

## III. RESULTS AND DISCUSSION

Table 1 indicates the level of significance (p-values) for the influence of the main effects (species and gender) and their interaction on the chemical composition (g/100 g) of the meat derived from six game species. There was a significant interaction between species type and gender for the moisture and protein content (Table 1). Species type and gender influenced ($p \leq 0.01$) the IMF content of the meat derived from the six game species (Table 1).

The mean moisture content of the meat from male blesbok was higher ($p \leq 0.05$) compared to female blesbok, while no gender differences ($p > 0.05$) were present for the moisture content of the meat derived from the other five game species (Table 2). Similarly, no gender differences ($p > 0.05$) were present for the mean crude protein content of springbok, gemsbok, impala, red hartebeest and kudu meat, whereas the mean crude protein content was highest ($p \leq 0.04$) in the meat from female blesbok, as compared to male blesbok (Table 2).

Table 1 Level of statistical significance (p-values) for the main effects (species [S] and gender [G]) and their interaction (SxG) on the chemical composition (g/100 g) of the meat from six game species

| Chemical composition | Species | Gender | SxG |
|---|---|---|---|
| Moisture content | <0.00 | 0.46 | 0.05 |
| Protein content | <0.00 | 0.91 | 0.04 |
| IMF content | <0.00 | 0.01 | 0.07 |
| Ash content | 0.26 | 0.55 | 0.77 |

SxG, interaction between species and gender; IMF, intramuscular fat content.

Table 2 Influence of the interaction between the main effects (species and gender) on the moisture and protein content (g/100 g) of the meat from six game species (Means ± SD)

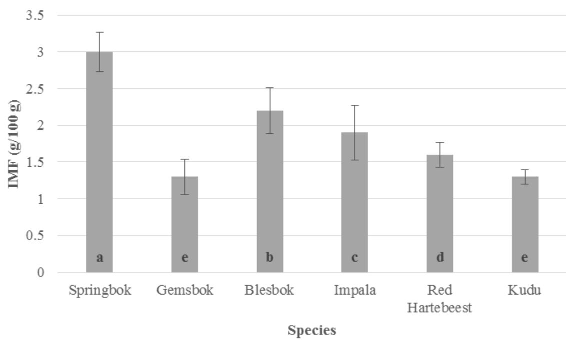
| Species | Gender | Moisture | Protein |
|---|---|---|---|
| Springbok | Female | $72.9^{e} \pm 0.90$ | $22.8^{def} \pm 0.78$ |
| | Male | $73.6^{de} \pm 0.30$ | $22.3^{efg} \pm 0.76$ |
| Gemsbok | Female | $76.5^{a} \pm 0.75$ | $21.6^{g} \pm 0.76$ |
| | Male | $76.2^{a} \pm 0.71$ | $22.3^{efg} \pm 0.82$ |
| Blesbok | Female | $74.1^{cd} \pm 0.82$ | $23.1^{bcde} \pm 0.57$ |
| | Male | $74.9^{b} \pm 0.32$ | $22.1^{fg} \pm 0.87$ |
| Impala | Female | $74.6^{bc} \pm 0.55$ | $22.7^{def} \pm 0.37$ |
| | Male | $75.0^{b} \pm 0.37$ | $23.0^{cde} \pm 0.68$ |
| Red Hartebeest | Female | $74.1^{cd} \pm 0.85$ | $23.7^{abc} \pm 0.88$ |
| | Male | $73.5^{de} \pm 0.68$ | $23.9^{ab} \pm 0.74$ |
| Kudu | Female | $74.5^{bc} \pm 0.20$ | $23.5^{abcd} \pm 0.30$ |
| | Male | $74.1^{cd} \pm 0.71$ | $24.0^{a} \pm 0.82$ |

$^{a-g}$Means within a column with superscripts that do not have a common letter indicate significant differences ($p < 0.05$) between species and/or genders.

The meat derived from gemsbok had the highest ($p \leq 0.01$) moisture content and the lowest ($p \leq 0.01$) protein content, as compared to the other game species (Table 2). The moisture content of the meat from most of the species differed ($p \leq 0.01$), except for that of blesbok vs. impala, blesbok vs. kudu, and kudu vs. red hartebeest (Table 2). Furthermore, the mean protein content of springbok, blesbok and impala meat differed significantly from gemsbok, red hartebeest and kudu meat (Table 2). An intermediate negative correlation ($r = -0.58$) existed between the moisture and protein content of the meat from all species except springbok (Table 2). There was a stronger negative correlation ($r = -0.63$) between the moisture and IMF content. The latter was evident in the meat from springbok, as it had the highest ($p \leq 0.01$) IMF content (Fig. 1) and lowest ($p \leq 0.01$) moisture content (Table 2).

The IMF content of the other game species also differed ($p \leq 0.01$), being lowest in gemsbok and kudu (Fig. 1). Nonetheless, the IMF content of all species was ≤3.0 g/100 g (Fig. 1). The IMF content also differed ($p \leq 0.01$) between genders and was highest in the meat from female animals (2.0 g/100 g ± 0.60), as compared to males (1.8 g/100 g ± 0.64). The ash content did not differ between species or genders (Table 1) and the data is therefore not provided.

Figure 1. Differences in the intramuscular fat content (IMF) of the meat derived from six game species




Neethling *et al.* [11] found a strong negative correlation ($r = -0.82$; $p \leq 0.01$) between the moisture and protein content of six blesbok muscles, while a weak negative correlation ($r = -0.34$; $p \leq 0.01$) existed between the moisture and IMF content. The former correlation was attributed to the low IMF content of the meat derived from blesbok [11]. However, in this study springbok meat had the highest IMF content of 3.0 g/100 g (Fig. 1) and therefore a stronger negative correlation existed between the moisture and IMF content for springbok meat. It can therefore be anticipated that when game meat has a low IMF content (≤3.0 g/100 g), a stronger negative correlation can exist between the moisture and protein content, as compared to the moisture and IMF content.

A previous study on gender differences in the chemical composition of blesbok meat found no gender differences in the mean moisture and protein content of the meat derived from the LTL muscles of blesbok [11]. The differences in the moisture and protein content between genders for blesbok meat in this study is small (Table 2) and although it is of statistical significance, the differences are presumed not of biological relevance. However, gender differences in IMF content (Fig. 1) was expected, as the meat from female animals generally have higher IMF content as compared to males [12-18]. Yet, it is anticipated that the 0.2 g/100 g difference in IMF content of the meat from male and female game species will not have an influence on meat palatability (flavour, juiciness and tenderness) or consumer perception.

During the last decade, consumers have become more concerned with the energetic and nutritional value of foodstuffs [19]. In addition, consumers have become more aware of game meats, as they generally contain higher levels of proteins and lower IMF content, as compared to meats derived from domestic species [1, 20]. Furthermore, Hoffman *et al.* [21] found that tourists visiting South Africa (83% of respondents) regarded the low fat content of game meat as the top beneficial attribute.

The differences in the moisture content between species will most probably not influence consumer perception. However, the differences in the protein and IMF content of the meat derived from the different game species can influence the amount and type of volatile aroma compounds produced and therefore the final meat flavour [22].

It has been proposed that blesbok meat can be marketed as being low in fat and high in protein [11]. The latter is also relevant to the meat derived from the other five game species in this study.

## IV. CONCLUSION

The species from which game meat is derived can greatly influence its nutritional value. The meats derived from the game species in this study should be marketed as such (springbok, gemsbok, blesbok, impala, red hartebeest and kudu) and not under a generic name (such as ‘game meat’ or ‘venison’). Furthermore, the meat derived from these game species can be marketed as being low in fat and high in protein.


## ACKNOWLEDGEMENTS

The financial assistance of the National Research Foundation (NRF) towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at, are those of the authors and are not

necessarily to be attributed to the NRF. Special thanks to the following people for their contributions to this study: Mr. D. Du Plessis (Savanna Game Estate, Kimberley, South Africa), Mr. L. Van Deventer (Brakkekuil farm, Witsand, South Africa), Mr. K. Landman (Pongola Game Reserve, Pongola, South Africa), and Mr. A. Le Roux (Van Zyl Vleis, Kimberley, South Africa).

## REFERENCES


1. Hoffman, L. C. & Wiklund, E. (2006). Game and venison – meat for the modern consumer. Meat Science 74: 197-208.
2. Lawrie, R. A. & Ledward, D. A. (2006). Lawrie's meat science. Cambridge, England: Woodhead Publishing Limited.
3. Hoffman, L. C. (2007). The meat we eat: are you game? Retrieved from http://hdl.handle.net/10019.1/292
4. Medical Research Council (MRC) (2010). *Condensed Food Composition Tables for South Africa* (edited by P. Wolmarans, N. Danster, A. Dalton, K. Rossouw and H. Schönfeldt), 1st ed. Pp. 8-1:8-28. Medical Research Council, Parow Valley, Cape Town, South Africa.
5. Issanchou, S. (1996). Consumer expectations and perceptions of meat and meat product quality. Meat Science 43: 5-19.
6. Van Schalkwyk, D. L. & Hoffman, L. C. (2010). Guidelines for the harvesting of game for meat export. Namibia: AgriPublishers.
7. AOAC International (2002a). Loss on drying (moisture) at 95-100°C for feed. AOAC Official Method 934.01. In Official method of analysis, 17th ed. Arlington, Virginia, USA: Association of Official Analytical Chemists Inc.
8. AOAC International (2002b). Dumas combustion method. AOAC Official Method 992.15. In Official method of analysis, 17th ed. Arlington, Virginia, USA: Association of Official Analytical Chemists Inc.
9. Lee, C. M., Trevino, B. & Chaiyawat, M. (1996). A simple and rapid solvent extraction method for determining total fats in fish tissue. Journal of Association of Official Analytical Chemists International 79: 487-492.
10. AOAC International (2002c). Ash of animal feed. AOAC Official Method 942.05. In Official method of analysis, 17th ed. Arlington, Virginia, USA: Association of Official Analytical Chemists Inc.
11. Neethling, J., Hoffman, L. C. & Britz, T. J. (2014). Impact of season on the chemical composition of male and female blesbok (*Damaliscus pygargus phillipsi*) muscles. Journal of the Science of Food and Agriculture 94: 424-431.
12. Hoffman, L. C., Kritzinger, B. & Ferreira, A. V. (2005). The effects of region and gender on the fatty acid, amino acid, mineral, myoglobin and collagen contents of impala (*Aepyceros melampus*) meat. Meat Science 69: 551-558.
13. Renecker, T. A., Renecker, L. A. & Mallory, F. F. (2005). Relationship between carcass characteristics, meat quality, age and sex of free-ranging Alaskan reindeer: a pilot study. Rangifer 25: 107-121.
14. Sampels, S., Pickova, J. & Wiklund, E. (2005). Influence of production system, age and sex on carcass parameters and some biochemical meat quality characteristics of reindeer (*Rangifer tarandus tarandus*). Rangifer 25: 85-96.
15. Hoffman, L. C., Kroucamp, M. & Manley, M. (2007). Meat quality characteristics of springbok (*Antidorcas marsupialis*). 2: chemical composition of springbok meat as influenced by age, gender and production region. Meat Science 76: 762-767.
16. Hoffman, L. C., Van Schalkwyk, S. & Muller, M. (2009). Effect of season and gender on the physical and chemical composition of black wildebeest (*Connochaetus gnou*) meat. South African Journal of Wildlife Research 39: 170-174.
17. Kandeepan, G., Anjaneyulu, A. S. R., Kondaiah, N., Mendiratta, S. K. & Lakshmanan, V. (2009). Effect of age and gender on the processing characteristics of buffalo meat. Meat Science 83: 10-14.
18. Daszkiewicz, T., Kubiak, D., Winarski, R., Koba-Kowalczyk, M. (2012). The effect of gender on the quality of roe deer (*Capreolus capreolus* L.) meat. Small Ruminant Research 103: 169-175.
19. Żochowska-Kujawska, J., Sobczak, M. & Lachowicz, K. (2009). Comparison of the texture, rheological properties and myofibre characteristics of SM (*Semimembranosus*) muscle of selected species of game animals. Polish Journal of Food and Nutrition Sciences 59: 243-246.
20. Wood, J. D., Richardson, R. I., Nute, G. R., Fisher, A. V., Campo, M. M., Kasapidou, E., Sheard, P. R. & Enser, M. (2003). Effects of fatty acids on meat quality: a review. Meat Science 66: 21-32.
21. Hoffman, L. C., Muller, M., Schutte, De W., Calitz, F. J. & Crafford, K. (2005). Consumer expectations, perceptions and purchasing of South African game meat. South African Journal of Wildlife Research 35: 33-42.
22. Wood, J. D., Enser, M., Fisher, A. V., Nute, G. R., Richardson, R. I. & Sheard, P. R. (1999). Manipulating meat quality and composition. Proceedings of the Nutrition Society 58: 363-370.