The chemical characteristics of five springbok (*Antidorcas marsupialis)* and blesbok (*Damaliscus pygarcus phillipsi)* muscles

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Abstract

Game meat is considered to be a very healthy red meat because of its chemical composition, yet very little is known about the chemical composition of different game muscles. The chemical composition of *M. biceps femoris*, *M. longissimus et lumborum*, *M. rectus femoris*, *M. semitendinosus* and *M. supraspinatus* of springbok (n=10) and blesbok (n=10) were determined. The springbok and blesbok were harvested in the Gariep nature reserve to minimise environmental and feeding differences. There were differences in the moisture content between muscles for both species, but the biggest difference could be seen in blesbok where the *M. longissimus et lumborum* differed significantly from all the other muscles. The protein content of blesbok and the fat content of springbok differed significantly amongst the muscles. No significant differences were observed between blesbok muscles concerning fat content, while the protein content of springbok muscles did not differ. When the mineral content was considered, significant differences were detected amongst the muscles of the springbok for magnesium, iron and zinc, while the blesbok muscles differed significantly for calcium and magnesium only. Both species showed no differences between the five muscles for the minerals phosphorous, sodium and copper. Knowing the chemical composition of muscles can be very valuable to improve the overall eating quality of meat.

Introduction

People have become more health-conscious and consumers have become much more informed about food components with potential health benefits, as well as those posing health threats. Of the latter, saturated fat and cholesterol are the main culprits usually focussed on. Higgs (2000) noted that consumers perceive all fat in meat to be saturated although serious effort has been made by the meat industry to improve the fatty acid content of various meat species. Consumers have since been demanding food products with low cholesterol and low fat contents.

South African consumers were shown to consider fat content as a very important criterion when purchasing meat (Hoffman, Muller, Schutte and Crafford, 2004), which clearly paves the way for the possibility of promoting game meat as a low fat red meat – several authors have commented on the low fat content of game meat (Hoffman, 2000; Hoffman, Kroucamp & Manley, 2007). Higgs (2000) noted that lean beef as part of a low saturated fat diet caused plasma cholesterol and low-density lipoprotein (LDL)-cholesterol levels to be reduced in a fashion similar to equal amounts of chicken and fish. Thus, red meat with a fairly high amount of lean muscle (low in fat) definitely has a place in the modern consumer's nutrition as far as health benefits are concerned.

Consumers are demanding meat that is more tender and juicy, thus, meat with higher moisture levels might be more favourably accepted by consumers. Springbok is presently the most extensively cropped game species in South Africa (Hoffman, 2000). Hoffman, Muller, Schutte, Calitz and Crafford (2005) found that most respondents to their questionnaire have eaten springbok meat before and that it was one of the three game species found to be regularly available in supermarkets and restaurants.

The aim of this study was to report on the chemical differences between five muscles of the springbok and blesbok. No information exists on muscle differences of game meat – usually only data on the *M. longissimus dorsi* or *M. biceps femoris* are reported. Thus, this study aspires to expand the amount of information currently available on game meat.

Materials and methods

Ten springbok (*Antidorcas marsupialis*) and ten blesbok (*Damaliscus pygarcus phillipsi*) were randomly harvested at the Gariep Nature Reserve in South Africa. All animals were male and carcass weight varied between 17.4 kg and 30.4 kg for springbok and 16.4 kg and 42.2 kg for blesbok. Animals were harvested at night by a professional cull team, using similar culling methods to those described by Lewis, Pinchin and Kestin (1997), and only head or neck shots were taken to minimise animal stress. Animals were exsanguinated within 5 minutes of harvesting and carcasses were hung by the Achilles tendon. Bled and eviscerated skin-on carcasses were transported to Stellenbosch, with a temperature-controlled vehicle, where they were skinned and processed further approximately 24 h after harvesting. Samples were individually vacuum packed and frozen at –20 ºC.

Chemical analyses were performed on finely minced muscle samples. Total moisture (100ºC, 24 h) and ash content (500ºC, 5h) were determined according to AOAC method numbers 934.01 and 942.05, respectively (AOAC, 1997). Total lipid content was determined by extracting lipids with chloroform: methanol (2:1 v/v) solution by the solvent extraction method described by Lee, Trevino and Chaiyawat (1996). Total crude protein was determined by means of the Dumas Combustion method (AOAC method 968.06; AOAC, 1997) using the LECO FP 528, while the mineral composition was determined by direct current plasma emission spectrometry (Pinta, 1982).

The experiment consisted of a randomised block design with muscle as main effect replicated in 10 blocks (10 animals) per species. The standard GLM procedure was used when the chemical data were statistically analysed (SAS, 1999) after determining that the data was normally distributed.

Results and discussion

Of the five springbok muscles investigated, the *M. longissimus et lumborum* differed significantly ($P<0.05$) from both the *M. rectus femoris* and *M. semitendinosus* but not from the other muscles. The blesbok *M. longissimus et lumborum* was the only muscle of the five that differed significantly ($P<0.05$) from the other muscles in its moisture content. The moisture content for all the springbok and blesbok muscles investigated were much higher than those values reported by Sayed, Frans and Schönfeldt (1999) for mutton (60.7%), pork (55.0%) and beef (65.4%).

Table 1. Least squared means of moisture, fat and protein analysis of five springbok and blesbok muscles

	Biceps femoris	***Longissimus et lumborum***	***Rectus femoris***	***Semitendinosus***	***Supraspinatus***
Springbok					
Moisture (%)	$72.613 \pm 1.212^{a,b}$	72.157 ± 1.682^{b}	74.157 ± 1.102^{a}	73.857 ± 0.969^{a}	$74.087 \pm 0.810^{a,b}$
Fat (%)	$2.241 \pm 0.718^{a,b}$	$2.273 \pm 0.579^{a,b}$	$2.140 \pm 0.168^{a,b}$	1.814 ± 0.346^{b}	2.213 ± 0.491^{a}
Protein (%)	23.681 ± 1.411	24.184 ± 1.476	22.581 ± 1.450	23.409 ± 0.569	22.422 ± 1.258
Blesbok					
Moisture (%)	75.046 ± 1.864^{a}	73.470 ± 1.300^{b}	73.962 ± 0.538^{a}	74.547 ± 1.607^{a}	74.869 ± 0.936^{a}
Fat (%)	2.056 ± 0.331	2.089 ± 0.364	2.434 ± 0.561	1.886 ± 0.401	2.653 ± 0.853
Protein (%)	20.810 ± 1.694^{b}	22.678 ± 1.446^{a}	21.898 ± 0.939^{b}	22.143 ± 1.562^{b}	20.799 ± 1.602^{b}

[a, b] Muscles with different superscripts differ significantly ($P<0.05$).

In this study, the fat content of springbok muscles averaged 2.14% and the blesbok fat content averaged 2.22% which is within the value of 2-3% reported by Hoffman (2000). Of the five springbok muscles investigated (Table 1), only the *M. semitendinosus* and the *M. supraspinatus* differed significantly ($P<0.05$) from each other in fat contents. No significant differences occurred amongst the investigated blesbok muscles where fat content was considered.

In terms of protein content, no significant differences could be detected amongst the investigated springbok muscles (Table 1). In the blesbok, however, the *M. longissimus et lumborum* differed significantly ($P<0.05$) from the other four muscles.

Game meat contains higher levels of the macro-minerals calcium and magnesium, as well as the trace elements iron and copper, than the meat from domesticated animals (Niemenin, 1992). Significant differences were detected amongst the muscles of the springbok for magnesium, iron and zinc, while the blesbok muscles differed significantly for calcium and magnesium (Table 2). Both species showed no differences between the five muscles for the minerals phosphorous, sodium and copper. Hoffman *et al.* (2007) reported lower mineral values for male springbok than the values found for springbok muscles in the present study (Table 2), except for calcium, which was found to be much higher.

Table 2. Least squared means of the mineral (mg/100g) analysis of five springbok and blesbok muscles

Minerals	*Biceps femoris*	*Longissimus et lumborum*	*Rectus femoris*	*Semitendinosus*	*Supraspinatus*
Springbok					
Phosphorus	220.56 ± 20.05	222.01 ± 23.54	191.35 ± 14.56	207.23 ± 19.05	171.68 ± 23.04
Calcium	9.58 ± 0.66	11.48 ± 0.37	9.74 ± 0.77	8.82 ± 1.10	11.32 ± 0.95
Magnesium	28.46 ± 1.33[a]	27.30 ± 0.46[a, b]	24.90 ± 0.52[a, b]	26.81 ± 0.88[a, b]	23.47 ± 1.70[b]
Sodium	15.14 ± 2.24	12.82 ± 1.83	13.45 ± 2.72	12.59 ± 3.00	14.48 ± 2.40
Iron	2.92 ± 0.11[a, b]	3.27 ± 0.10[a]	2.20 ± 0.09[d]	2.30 ± 0.12[c, d]	2.69 ± 0.31[b, c]
Copper	0.09 ± 0.02	0.08 ± 0.03	0.07 ± 0.02	0.04 ± 0.02	0.06 ± 0.02
Zinc	2.56 ± 0.12[b]	1.77 ± 0.06[b]	4.89 ± 0.24[a]	2.87 ± 0.16[b]	5.58 ± 0.38[a]
Blesbok					
Phosphorus	161.21 ± 11.59	190.37 ± 9.71	180.03 ± 9.36	193.74 ± 13.21	164.46 ± 16.06
Calcium	7.74 ± 0.50[b]	10.75 ± 0.72[a]	7.90 ± 0.50[b]	8.24 ± 0.49[b]	8.22 ± 0.38[b]
Magnesium	24.46 ± 1.96[a, b]	27.65 ± 1.14[a]	25.79 ± 0.73[a, b]	27.57 ± 1.53[a]	22.93 ± 0.83[c]
Sodium	12.77 ± 1.73	13.28 ± 1.51	12.07 ± 4.93	13.79 ± 3.20	15.47 ± 3.38
Iron	2.78 ± 0.20	3.30 ± 0.20	3.09 ± 0.17	2.58 ± 0.13	3.09 ± 0.16
Copper	0.05 ± 0.02	0.06 ± 0.03	0.06 ± 0.01	0.07 ± 0.02	0.06 ± 0.02
Zinc	2.04 ± 0.14[b]	1.67 ± 0.11[b]	5.29 ± 0.26[a]	2.33 ± 0.11[b]	6.03 ± 0.34[a]

[a, b, c] Muscles with different superscripts differ significantly ($P<0.05$) for the specified mineral.

Conclusions

Differences amongst the five muscles of both springbok and blesbok were detected for all chemical compounds tested, with exceptions being protein content in springbok and fat content in blesbok. In order to make an informed decision regarding the eating quality of meat, it is important to know the chemical composition of the different muscles as the eating quality of meat can be greatly influenced by its chemical composition. For example, differences in fat and moisture contents may cause certain muscles to be juicier than others and meat cuts from these muscles will most probably be preferred by consumers. Because of its low fat content game meat can thus be seen as a healthier red meat.

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