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Proximate, amino acid and mineral composition of ostrich meat

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The proximate composition, amino acid composition and mineral composition of three different muscles from the legs of seven ostriches were determined. Results indicated that components analyzed remained relatively constant between different muscles. Ostrich meat is characterized by an extremely low intramuscular fat content. Values for water, protein, ash, amino acid and mineral contents are in agreement with values obtained for beef and chicken. Copyright © 1996 Published by Elsevier Science Ltd

INTRODUCTION

Ostrich farming is a rapidly growing industry throughout the world and ostriches are becoming an important source of meat for humans. Utilization of ostrich meat is hampered due to a lack of public knowledge about the nutritive value and that scientific information about the nutrient composition of ostrich meat is limited (Harris *et al.*, 1994; Sales, 1995). Due to the emphasis placed on the nutritive value of food by consumers a great need exists for information on nutritional composition of ostrich meat. The present study was therefore undertaken in attempt to gain some information on the proximate, amino acid and mineral composition of some muscles which are generally used in the ostrich meat industry.

MATERIALS AND METHODS

Seven ostriches (age range 12–14 months) which were raised on a commercial ostrich farm were electrically stunned and killed after a fasting period of 24 h in an ostrich abattoir. Carcasses were allowed to chill for 6 h at ±3 °C before the *iliofibularis*, *femorotibialis medius* and *gastrocnemius pars interna* were excised from the left legs. External fat and epimysial connective tissue were removed, and each sample was ground, homogenized, vacuum packed in plastic bags and stored at −20°C until analyzed.

Moisture content was determined by drying a 5–10 g sample at 105°C to constant weight (Boccard *et al.*, 1981), ashing was performed at 650°C for 2 h (Perez & Andujar, 1980), protein content was determined by the block digestion method and ether-extractable intramuscular fat content by solvent extraction (AOAC, 1995).

Amino acids were determined in freeze-dried, fat-free samples by ion-exchange chromatography of the acid-hydrolyzed protein. Samples of each muscle were hydrolyzed with 6 M HCl in a sealed tube for 32 h in an oil bath at 110°C. A Beckman amino acid analyzer (Model 6300) was used for separating amino acids using sodium citrate buffers.

A dry ashing procedure was used to prepare the samples for mineral analysis. Sodium, potassium, calcium, magnesium, phosphorus, iron, copper, zinc, manganese and aluminium contents of the digestates were determined by direct current plasma emission spectrometry (Pinta, 1982).

STATISTICAL ANALYSIS

Results were analyzed using the General Linear Models (GLM) procedures of the Statistical Analysis System (SAS, 1988). Individual animals were used as blocks to remove variation, due to differences between animals, from the error sum of squares (Neter & Wasserman, 1974). Means for individual muscles were compared, where appropriate, by using least significant differences (Snedecor & Cochran, 1991).

RESULTS AND DISCUSSION

Proximate compositions (wet weight basis) of different muscles are presented in Table 1.

Water, protein and ash content did not differ ($P > 0.05$) between muscles. This shows the relatively consistency of these components between muscles. Intramuscular fat content was higher ($P < 0.05$) in the *iliofibularis* than either the *femorotibialis medium* or the

Table 1. Proximate composition (g/100 g edible portion) of different ostrich muscles (mean ± SD)

Component	Muscle		
	Iliofibularis	*Femorotibialis medius*	*Gastrocnemius pars interna*
Water	$76.24^{a} \pm 0.529$	$76.41^{a} \pm 0.529$	$76.15^{a} \pm 0.454$
Protein (N×6.25)	$21.0^{a} \pm 0.576$	$20.81^{a} \pm 0.718$	$21.6^{a} \pm 0.486$
Intramuscular fat	$0.92^{a} \pm 0.227$	$0.61^{b} \pm 0.148$	$0.43^{b} \pm 0.126$
Ash	$1.03^{a} \pm 0.132$	$1.13^{a} \pm 0.040$	1.04a ± 0.077
M/P[c]	$3.63^{a} \pm 0.110$	$3.68^{a} \pm 0.152$	$3.53^{a} \pm 0.092$

[a–b] Values in rows with different superscripts differ significantly ($P < 0.05$).
[c] Moisture to protein ratio.

gastrocnemius pars interna. In a previous study (Sales, 1995), it has been found that intramuscular fat contents were lower than those of the present study. However, the distributions of intramuscular fat content between the different muscles were of the same ranking.

Amino acid composition (g/100 g protein) for the different muscles analyzed are shown in Table 2.

Except for a few amino acids muscles showed a similar pattern in amino acid composition. Valine and methionine were higher ($P < 0.05$) in the *iliofibularis* than in either the *femorotibialis medium* or the *gastrocnemius pars interna*. Leucine was lower ($P < 0.05$) in the *gastrocnemius pars interna* than the *iliofibularis* while glycine was significantly higher in *gastrocnemius pars interna* than in the other two muscles. The present results are in agreement with findings that the protein content as well as the amino acid composition of the protein remains remarkably constant independent of cut (Schweigert, 1987).

The mineral compositions (g/100 g) of different muscles are shown in Table 3.

Similar to other meat species potassium is quantitatively the most important mineral in ostrich muscles, followed by phosphorus (Lawrie, 1990). The concentration of both phosphorus and magnesium were lower ($P < 0.05$) in the *gastrocnemius pars interna* between muscles, while iron and zinc were highest ($P < 0.05$) in the *femorotibialis medium*.

Proximate, amino acid and mineral composition of ostrich meat compared to that of beef and chicken are presented in Table 4.

Protein and ash contents are constant between species. The exceptionally low intramuscular fat content of ostrich meat in relation to that in beef or chicken is clearly illustrated in Table 4. The well-known inverse relation between moisture and fat content in meat is clearly illustrated in Table 4. Beef with a low water content has a high intramuscular fat content while the reverse is true for ostrich meat.

As in beef and chicken, ostrich meat is characterized by a high content of lysine, leucine, aspartic acid and glutamic acid. Ostrich meat is higher in phenylalanine and lower in histidine than either beef or chicken and intermediate with regard to valine, methionine, isoleucine and leucine. Except for arginine and aspartic acid it is lower in the contents of the non-essential

Table 2. Amino acid composition (g/100 g protein) of different ostrich muscles (mean ± SD)

Component	Muscle		
	Iliofibularis	*Femorotibialis medius*	*Gastrocnemius pars interna*
Essential			
Lysine	$8.43^{a} \pm 0.319$	$8.72^{a} \pm 0.540$	$8.3^{a} \pm 0.629$
Threonine	$3.96^{a} \pm 0.166$	$3.92^{a} \pm 0.173$	$3.82^{a} \pm 0.167$
Valine	$5.35^{a} \pm 0.308$	$4.75^{b} \pm 0.328$	$4.92^{b} \pm 0.496$
Methionine	$2.93^{a} \pm 0.056$	$2.80^{b} \pm 0.099$	$2.74^{b} \pm 0.108$
Isoleucine	$4.96^{a} \pm 0.277$	$4.58^{a} \pm 0.367$	$4.60^{a} \pm 0.488$
Leucine	$9.11^{a} \pm 0.272$	$8.78^{ab} \pm 0.430$	$8.43^{b} \pm 0.522$
Phenylalanine	$5.07^{a} \pm 0.591$	$4.73^{a} \pm 0.435$	$4.71^{a} \pm 0.437$
Histidine	$1.95^{a} \pm 0.246$	$2.07^{a} \pm 0.270$	$2.07^{a} \pm 0.210$
Non-essential			
Arginine	$7.27^{a} \pm 0.749$	$6.77^{a} \pm 0.423$	$6.68^{a} \pm 0.524$
Aspartic acid	$9.99^{a} \pm 0.321$	$9.66^{a} \pm 0.452$	$9.67^{a} \pm 0.680$
Serine	$3.00^{a} \pm 0.219$	$3.06^{a} \pm 0.175$	$3.00^{a} \pm 0.182$
Glutamic acid	$16.1^{a} \pm 0.459$	$16.1^{a} \pm 0.713$	$15.5^{a} \pm 1.030$
Glycine	$4.05^{b} \pm 0.225$	$4.02^{b} \pm 0.147$	$4.61^{a} \pm 0.420$
Tyrosine	$3.13^{a} \pm 0.220$	$3.17^{a} \pm 0.184$	$3.09^{a} \pm 0.118$
Alanine	$5.65^{a} \pm 0.183$	$5.28^{a} \pm 0.288$	$5.44^{a} \pm 0.466$
Protein (%)[c]	$91.0^{a} \pm 1.739$	$92.4^{a} \pm 0.754$	$92.5^{a} \pm 1.726$

[a–b]Values in rows with different superscripts differ significantly ($P < 0.05$).
[c]Dry matter and fat free basis.

Table 3. Mineral composition (mg/100 g edible portion) of different ostrich muscles (mean ± SD)

Component	Muscle		
	Iliofibularis	*Femorotibialis medius*	*Gastrocnemius pars interna*
Major elements			
Sodium	$40.6^{a} \pm 6.161$	$41.1^{a} \pm 2.673$	$46.6^{a} \pm 6.321$
Potassium	$272^{a} \pm 36.528$	$266^{a} \pm 5.992$	$268^{a} \pm 30.075$
Calcium	$9.00^{a} \pm 4.509$	$7.29^{a} \pm 1.254$	$8.71^{a} \pm 4.030$
Magnesium	$22.1^{a} \pm 1.215$	$22.14^{a} \pm 0.690$	$20.57^{b} \pm 1.272$
Phosphorus	$214^{ab} \pm 11.568$	$220^{a} \pm 4.981$	$205.86^{b} \pm 8.494$
Minor elements			
Iron	$2.51^{a} \pm 0.241$	$2.40^{a} \pm 0.200$	$1.97^{b} \pm 0.229$
Copper	$0.10^{a} \pm 0.052$	$0.10^{a} \pm 0.031$	$0.09^{a} \pm 0.097$
Zinc	$1.06^{c} \pm 0.113$	$2.76^{a} \pm 0.489$	$2.20^{b} \pm 0.589$
Manganese	$0.05^{a} \pm 0.008$	$0.07^{a} \pm 0.030$	$0.05^{a} \pm 0.006$
Aluminium	$1.37^{a} \pm 1.046$	$1.07^{a} \pm 0.595$	$1.29^{a} \pm 0.696$

$^{a-c}$Values in rows with different superscripts differ significantly ($P < 0.05$).

Table 4. Proximate, amino acid and mineral composition of ostrich meat in comparison to beef and chicken

Component	Species		
	Ostrich	Beef	Chicken
Proximate composition (g/100)	(1)	(2)	(3)
Water	76.27	71.6	75.46
Protein	21.12	20.94	21.39
Intramuscular fat	0.65	6.33	3.08
Ash	1.07	1.03	0.96
Amino acids (g/100 g protein)	(1)	(4)	(4)
Lysine	8.48	9.12	8.96
Threonine	3.90	4.64	4.16
Valine	5.00	5.28	4.80
Methionine	2.82	2.72	2.40
Isoleucine	4.71	5.12	4.64
Leucine	7.78	8.00	7.52
Phenylalanine	4.84	4.48	4.48
Histidine	2.03	3.20	3.04
Arginine	6.89	6.72	6.24
Aspartic acid	9.78	9.60	9.12
Serine	3.02	4.48	4.00
Glutamic acid	15.89	17.28	16.48
Glycine	4.22	5.60	4.82
Tyrosine	3.13	3.84	3.52
Alanine	5.46	6.40	5.76
Minerals (mg/100 g)	(1)	(5)	(3)
Sodium	43	61	77
Potassium	269	350	229
Calcium	8	7	12
Magnesium	22	20	25
Phosphorus	213	180	173
Iron	2.3	2.1	0.9
Copper	0.10	0.14	0.05
Zinc	2.0	4.3	1.5
Manganese	0.06	0.04	0.02

(1)Present study.
(2)USDA (1986); separable lean only; all grades.
(3)USDA (1979); flesh without skin.
(4)Paul & Southgate (1978).
(5)Holland *et al.* (1991); lean only.

amino acids serine, glutamic acid, glycine, tyrosine and alanine than either beef or chicken.

Phosphorus, manganese and iron are higher and sodium lower in ostrich meat than either beef or chicken, while potassium, calcium, magnesium copper and zinc classify ostrich as intermediate between beef and chicken. Harris *et al.* (1994) reported values of 62.39 ± 5.24 and 2.87 ± 0.88 mg/100 g for sodium and iron in the *iliofibularis* when cooked to an internal temperature of 63°C. The low sodium content of ostrich meat has an advantage for people who have to consume a low sodium diet. Iron is considered to be the most important minor mineral in meat, especially for the adult woman. The amount of iron potentially available from foods, however, not only depends upon the amount of iron present, but also on the nature of that iron (Monson *et al.*, 1978). This has to be investigated in ostrich meat.

CONCLUSIONS

The present results indicate that ostrich meat is similar in protein content, amino acid and mineral composition to meat from other conventional meat animals. The low intramuscular fat and sodium contents of ostrich meat has an advantage in the marketing of ostrich meat as a health product to the developed world where coronary heart disease is a major health problem. The determination of fatty acid profiles and human diet studies, however, are essential to further develop this proposal.

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