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Original Article

Proximate composition, fatty acids and cholesterol content of meat cuts from tegu lizard *Tupinambis merianae*

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Abstract

The proximate composition, fatty acid composition and cholesterol content of three different cuts of meat from tegu *Tupinambis merianae* were determined. Moisture (72.0±0.7%), protein (23.6±0.7%), fat (4.0±1.3%) and ash (1.2±0.2%) did not differ from values obtained from beef or chicken meat. The cholesterol content (18.2±5.8 mg/100 g tissue) was similar among the cuts and was lower in tegu meat than in other meats of similar fat content such as beef, chicken or fish. The relation between polyunsaturated and saturated fatty acids (1.09) was comparable to that of some species of fish, and the fat presents nutritional qualities comparable with those of chicken meat.
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1. Introduction

The tegus of the genus Tupinambis (Sauria: Teiidae) comprise a group of carnivorous lizards of considerable size that inhabit the South American plain, east of the Andes (Presch, 1973). The southernmost species, *Tupinambis merianae* (formerly *T. teguixin*) and *Tupinambis rufescens* (Cei and Scolaro, 1982), have been traditionally used by aboriginal populations as a source of meat, fat and leather (Norman, 1987). In the last decades, an intensive exploitation has been initiated in Argentina since these species are an exportable source of leather for the design of luxury articles (Fitzgerald et al., 1991). Between 1976 and 1985, over 16 million skins of Tupinambis were exported from Argentina (Chardonnet et al., 2002). Such a situation caused international concern, leading to the inclusion of these species in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Even though the quota has been restricted, the authorized exportation is still enormous, amounting to a million annual leathers for the period 1997/2003 (Basso et al., 2005). More recently, programs for breeding these animals in captivity have been devised (Mercolli and Yanosky, 1994; Noriega, et al., 1996; Vega Parry and Manes, 2000; Noriega et al., 2002) that mitigate the pressure on natural populations while permitting their integral utilization (González et al., 1999; De Bargas et al., 2003; Basso et al., 2004). In addition to the skin, the meat of tegu as a source of food is of culinary interest, and its quality in this respect has been already reported in the literature (Donadío and Gallardo, 1984; Norman, 1987).

The aim of the present work was to determine some of the characteristics of tegu meat cuts of interest from the standpoint of human nutrition: their proximate composition and that of their lipids and fatty acids. It is shown that tegu may be a source of good quality food, providing meat that is low in cholesterol and balanced in fatty acids of interest for the human diet.

2. Materials and methods

Young tegu specimens (18 months old, with an average weight of 2700 g) were obtained from the experimental

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farm of the Facultad de Agronomía y Zootecnia de Tucumán (Argentina). The chosen cuts (the back, the tail and the legs) constitute the edible parts due to their more considerable volume.

The specimens had been subjected to a diet based on poultry by-products, supplemented with vitamins, minerals and soybean flour (Vega Parry and Manes, 2000). The carcasses (1570 ± 17 g) were separated and kept at a temperature of −20 °C.

2.1. Proximate analysis

Moisture, fat, protein and ash contents were determined in accordance with standard methods of AOAC (1995). Protein determination involved the Kjeldahl assay (N × 6.25). Fat was determined by extracting samples in a Soxhlet apparatus using anhydrous dietylether as solvent. Moisture was quantified by oven-drying 1–2 g samples at 105 °C overnight. Ash was determined after incineration in a furnace at 550 °C.

Lipids were extracted according to the Bligh and Dyer (1959) procedure. Neutral and polar lipids were separated by thin layer chromatography (TLC) using a modification of the gradient-thickness technique developed by Bazán and Joel (1970). This modification consisted of spotting the sample on the thinnest part of the plate, in order to allow the major components (the triacylglycerols) to move to the thickest zone of the TLC plate during chromatography. The phospholipids (PL) remained at the origin of the plates. The lipid classes were identified with the help of commercial standards.

After TLC, the lipid spots were visualized under UV light after spraying the plates with 2′–7′ dichlorofluorescein in methanol. The silica support containing the lipids was scraped from TLC plates into tubes, the lipids were eluted with chloroform: methanol (2:1) and the solvent was evaporated under nitrogen.

Fatty acid methyl esters (FAME) were obtained from lipids using boron trifluoride methanol 14% (Sigma-Aldrich) according to Morrison and Smith (1964) procedure. FAME were analyzed by gas chromatography (GC) with a Varian Aerograph 3700 equipped with a flame detector (FID) system and a glass column (2 m × 0.2 cm ID) packed with a polar phase (15% OV 275 on 80–120 Chromosorb WAW, Supelco, Bellefonte, PA). Peaks were identified by comparison of their retention times with those of commercial standards. Methyl heneicosanoic (21:0) was used as internal standard for quantitation.

Cholesterol was determined colorimetrically in the lipid extracts by a commercially available enzymatic assay (Wiener Labs, SACIC, Rosario, Argentina). The method was checked and validated for the present samples. It was linear in the range of 0.25–40 mg of cholesterol/mL, the reproducibility among determinations was about 3%, and the recovery of cholesterol from the silica support after elution was 98.2 ± 0.8%.

Energetic values (kcal/g) were calculated by multiplying protein content by 4 and that of fat by 9, and adding up the results. The data were multiplied by 4.184 to convert them to kJ/g.

The diverse cuts were analyzed in nine different specimens.

Results were analyzed according to an Analysis of Variance (ANOVA) (Steel and Torrie, 1980) to determine significant ($P < 0.05$) differences between data.

3. Results and discussion

The proximate composition of collected tegu meat cuts, including protein, fat, moisture, ash and cholesterol are presented in Table 1. The calculation of energetic values per cut is also included. The content of water, protein and ash do not differ ($P < 0.05$) significantly among cuts, but there are some differences in the lipid content. Thus, the content of intramuscular fat is slightly higher in the loin than in the tail and the back leg cuts. Whereas these differences are not statistically significant, there is a significantly higher cholesterol content ($P < 0.05$) in the loin than in the other analyzed cuts.

The higher content of cholesterol in the back cuts (loin) corresponds with a higher content of fat and lower level of water in these tissues. The inverse relation between moisture and fat content is illustrated by comparing the cuts and has already been observed in numerous tissues and species (Piironen et al., 2002). The content of cholesterol of the fat tissue of *T. merianae* is 400 mg/100 g (data not shown). Because of the lower fat level, the content of cholesterol in edible portions (meat) oscillates between 14.2 and 24.8 mg/100 g of tissue. In comparison with meats from other species with fat proportions similar to those studied here, *T. merianae* meat presents a lower level of cholesterol than either beef or chicken meat, with levels ranging from 55 to 80 mg/100 g (USDA, 2003, National Nutrient Data Base). Moreover, there is considerably higher cholesterol content in the meat of some fishes, (perch: 90 mg/100 g

Table 1
Proximate composition (g/100 g), cholesterol and energy (calculated) from *T. merianae* meat cuts ($n = 9$)

Component	Meat cut (mean ± S.D.)			
	Tail	Back leg	Loin	Mean tissues
Water	2.6 ± 1.8	72.3 ± 4.0	71.2 ± 2.9	72.0 ± 0.7
Protein[a]	23.5 ± 0.7	24.1 ± 0.7	23.2 ± 0.6	23.6 ± 0.7
Fat (Soxhlet)	3.4 ± 1.8	3.2 ± 1.0	5.5 ± 1.1	4.0 ± 1.3
Ash	1.2 ± 0.2	1.3 ± 0.3	1.1 ± 0.2	1.2 ± 0.2
Cholesterol[b]	15.5 ± 1.0	14.2 ± 4.1	24.8 ± 4.8	18.2 ± 5.8
Energy[c]	523 (125)	523 (125)	594 (142)	546.6 ± 41 (130.6 ± 9.8)

[a] Based on the nitrogen content (N × 6.25).
[b] mg/100 g fresh tissue.
[c] kJ/100 g fresh tissue (kcal/100 g fresh tissue).

Table 2
Fatty acid profiles of lipids in *Tupinambis merianae* intramuscular fat (mean ± S.D.; $n = 9$)

F A (% M E)	TAG	DAG	FFA	PL	Total FA
14:0	0.15 ± 0.01	0.26 ± 0.06	0.29 ± 0.09	0.30 ± 0.08	0.15 ± 0.02
16:0	18.41 ± 0.80	26.63 ± 2.90	17.52 ± 1.31	24.84 ± 1.90	18.49 ± 1.77
16:1	8.10 ± 0.14	8.31 ± 0.47	7.97 ± 0.78	6.51 ± 1.30	8.10 ± 0.61
16:2	n.d.	0.56 ± 0.03	n.d.	0.57 ± 0.04	0.01—
18:0	5.10 ± 0.22	7.62 ± 0.80	5.74 ± 0.42	9.45 ± 0.60	5.14 ± 0.46
18:1	42.80 ± 1.58	41.87 ± 1.81	34.81 ± 2.91	39.22 ± 0.75	42.77 ± 3.94
18:2 ($n-6$)	22.16 ± 2.24	10.56 ± 2.90	23.03 ± 1.41	12.62 ± 0.60	22.66 ± 1.20
18:3 ($n-3$)	1.33 ± 0.27	0.71 ± 0.17	3.14 ± 1.24	0.88 ± 0.02	1.33 ± 0.20
$x-1$	0.88 ± 0.04	0.88 ± 0.27	n.d.	0.96 ± 0.08	0.88 ± 0.06
20:3 ($n-9$)	0.18 ± 0.05	0.03 ± 0.05	0.08 ± 0.06	0.06 ± 0.08	0.18 ± 0.04
20:4 ($n-6$)	0.50 ± 0.08	0.61 ± 0.29	1.90 ± 0.79	1.73 ± 0.31	0.51 ± 0.05
20:5 ($n-3$)	0.10 ± 0.03	0.33 ± 0.06	0.91—	0.70 ± 0.12	0.11 ± 0.02
22:4 ($n-6$)	0.20 ± 0.05	0.55 ± 0.31	n.d.	1.17 ± 0.16	0.21 ± 0.04
22:5 ($n-3$)	0.07 ± 0.03	0.19 ± 0.13	0.15—	0.14 ± 0.02	0.07 ± 0.03
22:6 ($n-3$)	0.02 ± 0.01	0.50 ± 0.23	0.59 ± 0.34	0.20 ± 0.06	0.02 ± 0.01
$x-2$	n.d.	0.36 ± 0.17	1.35—	0.66 ± 0.48	0.01—
Total (μmol/g fat)	323.28 ± 19.03	2.58 ± 0.12	2.77 ± 0.39	2.20 ± 0.30	330.83 ± 28.33
SFA	23.66	32.65	23.68	35.16	23.78
MUFA	50.96	50.12	42.82	45.75	50.87
PUFA	25.36	17.23	32.50	19.13	25.99
SFA/UFA	0.31	0.48	0.31	0.54	0.31
PUFA/SFA	1.07	0.53	1.37	0.54	1.09

TAG, triacylglycerols; DAG, diacylglycerols; FFA, free fatty acids; PL, phospholipids; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; UFA, unsaturated fatty acids; n.d., not detectable; *x*, not identified peaks. The fatty acid composition of each lipid class is expressed as percentage of the total fatty acid present. The content of each lipid was determined with the aid of an internal standard.

tissue, rainbow trout: 59 mg/100 g, (USDA, 2003, National Nutrient Data Base) than in tegu lizard.

The approximated energy content, calculated on the basis of the values of protein and fat, throws a value (average ± S.D.) for all the cuts of 547 ± 42 kJ/100 g (131 ± 10 kcal/100 g) of fresh tissue. These figures are similar to those of bovine and chicken meat, 573 kJ (137 kcal) and 619 kJ (148 kcal)/100 g, respectively (from data base of the USDA).

The fatty acid profile of intramuscular fat of *T. merianae* meat is shown in Table 2. Oleic acid (18:1) is the most abundant fatty acid in all the lipid fractions studied. Linoleic acid (18:2) is the second major fatty acid in triacylglycerols (TAG) and in free fatty acids (FFA), and palmitic (16:0) in diacylglycerols (DAG) and in phosholipids (PL). In addition, there is a significant ($P < 0.05$) difference in stearic acid (18:0) concentration, which is greater in DAG and PL than in TAG and FFA. This is illustrated in the sum of the saturated fatty acids (SFA), which is greater in DAG and PL than in TAG and FFA.

Neutral lipids constituted about 98% of the fat content in the analyzed cuts. Therefore the fatty acid profile of the total fat is similar to the neutral lipids profile particularly, TAG.

In the TAG and FFA of tegu meat, linoleic acid (18:2) constitutes about 20% of the total of fatty acids. This results in a polyunsaturated fatty acid (PUFA) to SFA ratio of 1.07 and 1.37, respectively. According to the general nutritional guidelines of the Department of Health (1994) of the UK, a ratio of 0.4 or more is recommended as a balanced fatty acid intake on a healthy diet (Wood et al., 2003). Therefore, *T. merianae* meat fulfills this condition. Again, comparing its ratios with those of other species, as provided by the USDA database, (PUFA/SFA: beef = 0.1, chicken = 0.9, rainbow trout = 0.7, perch = 2.0) the tegu meat has a quality similar to that of some fishes and chicken meat.

As shown in Table 2, the intramuscular fat of the studied cuts has a high content of monounsaturated fatty acids (MUFA) (50%) and PUFA (25%). Recently, nutritionists have focused on the advantages of a diet which is rich in MUFA and PUFA, such as the Mediterranean diet, in the prevention of atherosclerosis (Moreno and Mitjavila, 2003). Thus, as a way of reducing the risk of cardiovascular disease, it has been recommended to maintain a diet that provides a 1:1.5:1 relation among PUFA, MUFA and SFA. The ratio in *T. merianae* meat (about 1:2:1) is very close to the recommended values.

4. Conclusions

The present results indicate that, compared to beef or chicken meat, and also some fishes, the lizard meat has low cholesterol content, similar or lower PUFA:SFA ratio and a PUFA:MUFA:SFA ratio very close to that recommended by nutritionists. Therefore, the meat of

T. merianae is an interesting alternative to be considered as a component of the human diet.

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