EFFECT OF SEX AND LIVE WEIGHT ON BULLFROG (*RANA CATESBEIANA*) MEAT COMPOSITION

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Background

Bullfrog meat is not only appreciated for its exquisite flavor but also as a source of protein of high biological value. Due to its low fat and cholesterol contents, bullfrog meat also has a low caloric level. These characteristics, associated with a high digestibility after cooking (around 88%), make it suitable for caloric restricted diets (JONG & NOLL, 1988). Contrary to most frog-producing countries, which obtain their frogs from hunting, Brazil, since 1995, has been the world's greatest frog producing country using the farming system (LIMA et al., 1999) and have developed an unique slaughtering technology as well. Most frogs raised in Brazil belong to the bullfrog (*Rana catesbeiana*) species, which has showed the best adaptation capacity and productivity (FONTANELLO et al., 1987). Despite all the advances in frog farming and slaughtering systems, past literature studies on bullfrog meat composition (AZEVEDO & OLIVEIRA, 1988; CORRÊA, 1988; BARBALHO, 1991; LEMOS & ANTUNES, 1993/94; LINDAU & NOLL, 1988) have great discrepancies, possibly because they were conducted on non-uniform animal samples of different growth histories. These studies did not consider composition variation due to live weight, gender, and overall conditions under which the frogs were raised. Since these factors account for compositional differences in meat of traditional commercial animals, it is also possible that the discrepancies found in frog meat composition can be affected by such factors.

Objectives

This paper aims to establish the chemical composition profile of bullfrog meat obtained from farm-raised animals during their post-metamorphosis development, to provide information leading to the production of standardized quality frog meat.

Methods

An experimental lot of 750 animals of *Rana catesbeiana* species, metamorphosed during winter, of both gender and initial weight of 50 ± 5 g was studied. They were kept in fattening stalls and raised under the farming system developed by LIMA & AGOSTINHO (1988) using trout bran ration and fly larvae. In order to maintain animal density in the stalls with 50 animals/cm^2, another lot of 750 animals was formed and raised under conditions similar to those of the experimental lot. Frogs from this second lot of similar weight and size (marked by toe removal) were used to replace those harvested or dead frogs from the experimental lot. **Animals**: At intervals of 28 days, frogs in the experimental lot were weighed and a sufficient number of those attaining the selected weight (50, 100, 150, 200, 250 and 300 ± 5 g) were slaughtered to guarantee at least 3 frogs of each gender. In order to obtain sufficient muscle sample to determine meat composition, a larger number of animals of 50 and 100 g was slaughtered. **Slaughtering**: The selected frogs were identified, weighed and maintained off feed for 48 hours before slaughtering. After stunning by immersion in water and ice (1:1) for 15 minutes, the frogs were bled through cardiac veins cutting, and their carcasses were eviscerated, washed and bath chilled in a tank containing water and ice. The leg muscles were removed and wrapped in labeled plastic bags and kept in a freezer (-18°C) until the chemical analyses were conducted. **Chemical Analyses**: The leg muscles of each frog were thawed for 12 hours at 4°C before deboning and thorough mincing in a Marconi sample homogenizer. The meat mixture was analyzed in triplicates for moisture, protein, fat and ash contents. All the analytical methodologies were those of the AOAC (1996), except for the fat content analysis, which followed the method of BLIGH & DYER (1989). **Statistical Analysis**: Data were subjected to variance analysis using the SAEG (version 5.0) program. Linear regression analysis was conducted for carcass chemical composition during frog growth (weight). To evaluate the effect of sex on the chemical composition of frog meat, regression models, obtained for each sex, were tested for their equality.

Results and Discussion

Gender did not affect the chemical composition of bullfrog meat ($P > 0.05$) in the live weight band studied. This result is rather different from those observed in pork (NOLD et al., 1999) and beef (MULVANEY, 1991), where intact males have leaner muscles with greater moisture and lower fat content. These results may be in part due to the fact that in the weight band studied, the frogs had not yet entered the fattening phase, which would require the study of animals of a greater live weight. Other factor to be considered is the fact that frogs possess a specific organ for fat accumulation (fat body), which is not present in traditional meat animals. Support for this hypothesis can be provided by the fact that a positive correlation ($r = 0.87$; $P < 0.01$) was found (RAMOS et al., 1998) between total fat body mass and fat content extracted from bullfrog meat, which is in agreement with LOUMBOURDIS & KYRIAKOPOULOU-SKLAVOUNOU (1991) studies on *Rana ritibunda*. According to FITZPATRICK (1976), both carcass and fat body contents in frogs exhibit a seasonal development and are correlated and used for maintaining metabolic functions, including hibernation and reproduction. Such evidences would probably explain the avoidance of muscle fat accumulation in frogs.

Table 1 shows the chemical composition of bullfrog meat of varying live weights. Although the differences are minimal, regression analysis showed ($P < 0.05$) that in the live weight band studied, which embodies the commercial frog weights in Brazil, moisture content tends to remain stable. On the other hand, protein content tends to increase while fat and ash contents tend to decrease with increasing live weight.

Table 2 compares the average chemical composition of bullfrog meat with those found in the literature. The observed differences may be attributed to various factors such as habitat, collecting region or raising conditions, ration type, season, age and genetic constitution. Except for BARBALHO (1991), all the other authors analyzed randomly picked bullfrogs, without controlling any of the mentioned factors.

Another source of differences may be variations in the methodologies used for fat determination, which presented the highest content differences. According to JOHNSON (1971) and WU & KÖHLER (2000), the amount of extracted fat is dependent on the method used and its efficiency is correlated to the chemical nature of the fat and to the types of association they are involved with. Lipids that are hydrophobically associated may be extracted with non-polar solvents such as ether, chloroform or benzene. On the other hand, those associated with membranes require polar solvents, such as methanol or ethanol, to disrupt the hydrogen bonds and/or the electrostatic forces between them and the proteins. In addition, covalently bound lipids cannot be directly extracted by any solvent unless an acid or basic hydrolysis of the sample is first carried out, as shown by AZEVEDO & OLIVEIRA (1988) and LINDAU & NOLL (1988) who used the AOAC Soxhlet method of continuous extraction, only with extracts from hydrophobically-associated lipids. BARBALHO (1991) also used the Soxhlet method but after acid digestion of the samples, which included covalently bound lipids in the extracted fat. Although CORRÊA (1988) and LEMOS & ANTUNES (1993/94) have used a fat determination method similar to that used in this experiment, which also extracts membrane bound lipids, any other changes, such as solvent volume and time of extraction and mixture, may be accounted for fat content differences. However, the discrepancies found between these author's data and ours may most likely be due to differences in frog hereditary and management practices.

Conclusions

At least for the Brazilian commercial frog weights tested in this experiment, sex is not an important factor in determining frog meat composition. As for nutritional concerns, heavier bullfrogs should be recommended, as their meat tends to have a higher protein content and lower fat content.

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Table 1. Chemical composition[a] of bullfrog (*Rana catesbeiana*) meat from animals of varying live weight bands

Time[b] (days)	Live weight (g)	Protein (%)	Fat (%)	Moisture (%)	Ash (%)
45	49.1 ± 4.0	16.85 ± 0.23	1.24 ± 0.08	80.94 ± 0.09	1.06 ± 0.03
101	91.0 ± 4.2	16.36 ± 0.43	1.24 ± 0.08	80.18 ± 0.56	1.03 ± 0.02
157	139.9 ± 6.3	17.00 ± 0.63	1.24 ± 0.13	79.67 ± 0.45	1.09 ± 0.02
269	188.0 ± 4.7	17.74 ± 0.54	1.09 ± 0.09	79.62 ± 0.66	1.05 ± 0.01
353	245.6 ± 9.0	17.44 ± 0.40	1.02 ± 0.06	80.11 ± 0.59	1.01 ± 0.02
493	287.6 ± 14.9	18.48 ± 0.23	0.99 ± 0.23	79.03 ± 0.62	0.96 ± 0.03

[a] Values in this table are means of six samples (3 males and 3 females) for each live weight band, and express as mean ± standard deviations.
[b] Days after metamorphosis to attain the specified live weight.

Table 2. Comparison of bullfrog (*Rana catesbeiana*) meat composition with literature data

References	Chemical composition (%)			
	Moisture	Protein	Fat	Ash
Experiment[a]	79.99 ± 0.80	17.67 ± 0.94	1.08 ± 0.22	1.03 ± 0.05
Azevedo & Oliveira (1988)	77.70 ± 3.53	18.22 ± 0.52	0.33 ± 0.11	0.75 ± 0.06
Corrêa (1988)	82.45 ± 1.57	15.94 ± 0.03	0.79 ± 0.13	0.94 ± 0.05
Lindau & Noll (1988)	83.68 ± 3.69	16.52 ± 1.60	0.31 ± 0.12	0.89 ± 0.16
Barbalho (1991)	79.98	14.20	1.21	-
Lemos & Antunes (1993/94)	-	-	0.79	-

[a] Values in this table are means of 84 samples (42 males and 42 females), and express as mean ± standard deviations.