Brazilian Journal of Poultry Science
Revista Brasileira de Ciência Avícola

ISSN 1516-635X Jul - Sep 2008 / v.10 / n.3 / 185 - 188

Ostrich (*Strutio camelus*) Meat Protein Quality and Digestibility

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■ Keywords

Casein, digestibility, ostrich meat, protein quality.

ABSTRACT

The purpose of the study was to evaluate ostrich meat protein quality, as its consumption has significantly increased in the last few years in Brazil. Male Wistar rats were distributed in groupe of six elements. The standard group received a casein-based diet, the control group received a protein-free diet, and the experimental group received ostrich meat diet as protein source. The evaluated biological parameters were protein efficiency ratio (PER), net protein ratio (NPR), net protein utilization (NPU), and true digestibility (TD). There were differences ($p<0.05$) among treatment groups for all evaluated biological parameters. Mean true digestibility values were 92.12% and 75.77% for casein and ostrich meat, respectively.

INTRODUCTION

Ostrich production has increased in Brazil, and has attracted the interest of farmers, particularly to its potential of producing red meat with low fat content (Marinho *et al*., 2004; Godoy, 2005).

Ostrich is highly productive, offering quality products with high added value, such as meat, feathers, leather and other byproducts (Souza, 2004; Balog & Almeida Paz, 2007). Meat is currently the main drive of commercial ostrich production. Despite being consumed and appreciated for a long time, ostrich meat is being rediscovered due to its resemblance to beef in terms of appearance, flavor, and texture (Souza, 2004; Pereira *et al*., 2006).

The interest in non-conventional animal species, such as ratites (emus and ostriches), for the meat of supply is increasing; nevertheless, the use of these food sources is still poorly documented (Féron, 1995; Pereira *et al*., 2006).

In Brazil and in other countries of Latin America, Africa and Asia, the wild fauna is an important protein source of food for people, particularly in poor areas (Reis *et al*., 2007). In large urban centers, the meat of these animals is sold in restaurant and special meat shops with very high prices.

As the ostrich is an exotic bird and its production is relatively recent in Brazil, there are few studies on its nutritional value and possible dietary applications for the prevention and/or treatment of specific pathologies. Therefore, this study aimed at evaluating the protein quality and the digestibility of ostrich meat.

MATERIAL AND METHODS

In order to prepare the experimental diets, the percentage composition of ostrich meat was determined (Table 1). Analyses were carried out in triplicate using thigh fillet, following the criteria mentioned below.

Arrived: March/2008
Approved: August/2008

Table 1 – Percentage composition of ostrich (Struttio camelus) meat.

Parameter	g/100g	%
Protein	23.9	-
Ashes	0.87	-
Lipids	1.13	-
Humidity	-	81.27%

In order to determine humidity, 5g of raw meat were weighed and heated in a circulating-air oven (Nevoni®) at 105ºC for 24 hours, according to the methodology described in the Manual of Analytic Norms of the Institute Adolf Lutz (Pregnolato & Pregnolato, 1985). Total protein was determined using the micro-Kjeldhal method for nitrogen quantification, according to the Association of Official Analytical Chemists (AOAC) (1998). Ashes were determined using 5g of the dry sample obtained for humidity analysis: the sample was burnt in a muffle at 525ºC for 6 hours according to the methodology described in the Manual of Analytic Norms of the Institute Adolf Lutz (Pregnolato & Pregnolato, 1985). Lipids were determined using the method of Bligh & Dyer (1959).

The experimental diets (Table 2) were based in AIN-93G (Reeves *et al*., 1993) with protein content fit in 9.5% (Pires *et al*., 2006). The test diet was prepared cooking the ostrich meat similarly as to domestic thermal treatment in the Laboratory of Diet Techniques of the Nutrition School of Centro Universitário do Leste de Minas as follows: dry heat was applied for 13 minutes, when the meat reached 98°C at the end of the cooking process. The sample was then dehydrated in a forced-ventilation oven (Nevoni®) at an average temperature of 65 ± 2°C for 8 hours. The cooked and dehydrated meat was ground in a domestic processor (Walita®) to obtain the meal to be used to manufacture the diet. The meal was placed in duly identified plastic bags and refrigerated (4°C).

Table 2 – Composition of the experimental diets used in the biological assay (g/100g complete diet).

Ingredients	D1	D2	D3
Ostrich meat	___	___	13.16
Casein	___	13.45	___
Mineral mix (AIN-93G-MX)	3.5	3.5	3.5
Vitamin mix (AIN-93G-VX)	1	1	1
Soybean oil	7	7	6.85
Choline bitartrate	0.25	0.25	0.25
Corn starch (q.s.p 100)	59.75	46.3	46.74
L-cystine	0.3	0.3	0.3
Food fiber (cellulose)	5	5	5
Dextrinized corn starch	13.2	13.2	13.2
Sucrose	10	10	10

D1- non-protein diet; D2- standard diet (casein); D3- test diet (ostrich meat).

The standard group received the casein-based diet, the control group was fed the nitrogen-free diet, whereas the experimental group received the diet with ostrich meat as protein source.

Animals and biological assay

Eighteen newly-weaned *Wistar* var. *albinus* male rats (*Rattus novergicus*), with an average age of 21 days, were used. Animals were divided into three groups (n=6), with differences in average group weight not higher than 10g, as recommended by the AOAC (1997). The rats were housed in individual cages, and maintained at 22 ± 3°C and a 12-h light/dark cycle. Food and water were supplied *ad libitum*.

During the experimental period, protein efficiency ratio (PER), net protein ratio (NPR), net protein utilization (NPU), and true digestibility (TD) were determined.

PER was calculated according to the AOAC (1975). This method relates weight gain to protein intake. NPR was determined according to Bender & Doell (1957): the weight gain of the test group is summed to the weight loss of the protein-free group, and the result is divided by the protein intake of the test group. NPU values were established by the nitrogen retention difference between the test group and the control group divided by the amount of nitrogen ingested by the test group. For NPU determination, rats were euthanized on the 14th experimental day, and their carcasses were dried in a forced-ventilated oven at 105ºC for 24h. Carcasses were then chilled, weighed, ground, and defatted with petroleum ether in a Soxhlet extractor for 6h, after which they were macerated to determine the level of nitrogen in the carcass.

In order to calculate digestibility, diets were marked with carmine (100mg/100g diet), and feces were collected between day 7 and 14, and individually stored under refrigeration. After the collection period, feces were dried in a forced-ventilation oven at 105ºC for 24h, and then chilled, weighed, defatted, and macerated to determine nitrogen content.

Digestibility indicates protein bioavailability, showing the amount of ingested protein that is hydrolyzed by digestive enzymes ad absorbed by the body. When some peptide bonds are not hydrolyzed during the digested process, part of the protein is excreted in the feces or metabolized by microorganisms in the large intestine (Monteiro *et al*., 2004). True digestibility was calculated by measuring the amount of nitrogen ingested in the diet, the amount excreted in the feces, and metabolic loss in the feces, which corresponds the fecal nitrogen of the protein-free diet group.

Data analysis

Data were submitted to the t-test or analysis of variance (ANOVA), using the test of Duncan to compare treatment means at a 5% significance level.

RESULTS AND DISCUSSION

Animal weight gain reflects the quality of the ingested protein source. Therefore, analyzing the variation in body weight between experimental groups (Table 3), we see that the D2 presented the highest weight gain, which was expected, as casein is a protein source with optimal digestibility. This was followed by D3 and D1, respectively. However, no differences ($p>0.05$) were detected between D2 and D3 groups.

Table 3 – Final weight, weight variation, and total and protein intake of the rats.

Group	Weight (g)		Intake (g)	
	Final	Weighted variation	Feed	Protein
D1[1]	34.16±2.54	-9.33±2.62	60.31±6.45	5.72±0.36
D2[2]	97.00±10.08	60.00±9.34	165.96±19.35	15.76±1.83
D3[3]	107.16±7.00	57.00±12.08	170.72±11.74	16.21±1.11

D1- non-protein diet; D2- standard diet; D3- test diet – (see details in Table 2).

Differences ($p<0.05$) between groups D2 and D3 were observed for all analyzed biological parameters (Table 4). It must be noted that the coefficient of variation was lower than 5%.

Table 4 – Mean values of the protein quality biological parameters analyzed in the standard and experimental groups.

Group	PER[1]	RPER(%)[1a]	NPR[2]	RNPR(%)[2a]	NPU[3]	TD(%)[4]
D2	4.38	100	4.38	100	60.97	92.12
D3	4.07	92.92	2.94	67.12	61.35	75.77

1: PER (protein efficiency ratio); 1ª:RPER (protein efficiency ratio relative to casein); 2: NPR (net protein ratio); 2ª RNPR (net protein ratio relative to casein); 3: NPU (net protein utilization); 4: TD (true digestibility).

Babji *et al*. (1980) experimentally assessed the protein quality of mechanically separated meat of the neck and the back of roasted chicken (NBRC) and of the carcass of cooked chicken (CCC). The relative protein efficiency ratio (RPER) of NBRC and CCC were 93.48% and 96.58%, respectively, which were slightly higher than that found for ostrich meat in the present study. Although ostrich meat PER value was lower than that determined for casein, it is still higher than the PER value of 2.3 (RPER of 92%) described by Schaafsma (2000) for beef, as well as that determined by Macneil *et al*., (1978) for chicken meat, which RPER was 76% in relation to casein.

PER relates weight gain to the amount of protein ingested during the experimental period; however, any variation in weight gain caused by other effects may generate some confusion as to the protein efficiency of the used diets. Therefore, the parameter NPR and *in vivo* digestibility are more reliable than PER to determine the protein quality of foods (Sarwar *et al*., 1989).

As to relative net protein ratio (RNPR), Jong & Noll (1988) found 92.63% for frog meat in relation to casein, a slightly higher value than that observed for ostrich meat in the present study, whereas Pires *et al*. (2006) reported 101.07% for beef.

Mean *in vivo* digestibility values were 92.12% and 75.77% for casein and ostrich meat, respectively, and presented statistical difference ($p<0.05$). According to Paleari *et al.* (1998), the digestibility of lean beef is 92%, whereas other studies showed digestibility values of 88-89% (Hernandez *et al*., 1996), 90.3% (Abdel-Azis *et al*., 1997), and 98% (Schaafsma *et al*., 2000).

CONCLUSIONS

Based on the results obtained under the conditions of the present study, it is possible to conclude that the biological indicators of protein quality of ostrich meat were lower as compared to those of casein.

The information produced by the present study are both nutritionally and economically important, and may contribute for the dissemination of information on ostrich meat in Brazil.

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