CARCASS YIELD AND SENSORIAL ANALYSIS OF MEAT FROM BROILER CHICKEN FED WITH TILAPIA BYPRODUCTS MEAL

Rendimento de carcaça e análise sensorial da carne de frangos alimentados com farinha de resíduo da filetagem de tilápia

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ABSTRACT

There are several ingredients that can replace those commonly used in the manufacture of animal ration in order to reduce production costs, as tilapia by products meal. However, as byproducts, more studies should be done to achieve the exact effects over the final product. An experiment was carried out aiming at evaluate the effects of the inclusion of five different levels (0%, 2%, 4%, 6% and 8%) of tilapia (*Oreochromis niloticus*) byproducts meal (TM) on poultry diets on carcass yield and sensory characteristics of broiler chicken meat. 480 one day old chicks, Cobb strain, were used to set the experiment with five treatments arranged in completely randomized design, with six replicates, and 16 birds per experimental unit. At the end of the experiment (42 days), the carcass yield parameters, breasts, drumsticks, thighs, wings, relative weight of the liver, and percent of abdominal fat were evaluated. A sensorial test of the meat was performed by 45 non-trained testers. The samples were evaluated using a structured hedonic scale, comprising nine steps to characterize the following senses: aroma, flavor, color, texture and whole quality. The addition of 8% TM to the diet fed to broiler chickens during total rearing period (1 to 42 days) is feasible without altering yield and sensorial quality of the meat.

Index terms: Fish meal, alternative ingredients, carcass quality.

RESUMO

Existem diversos ingredientes que podem substituir aqueles que são comumente utilizados na produção das dietas animais com o intuito de reduzir os custos de produção, como o resíduo da filetagem de tilápia. No entanto, em se tratando de resíduos, estudos adicionais são necessários para avaliar os seus exatos efeitos sobre o produto final. Assim, um experimento foi desenvolvido para avaliar os efeitos da inclusão de cinco diferentes níveis (0%, 2%, 4%, 6% e 8%) de resíduo da filetagem de tilápia (*Oreochromis niloticus*) (FT) nas dietas de frangos de corte sobre o rendimento de carcaça e características sensoriais da carne. Foram utilizados 480 pintos de um dia, da linhagem Cobb, distribuídos num delineamento experimental inteiramente casualizado, com cinco tratamentos, seis repetições e 16 aves por unidade experimental. Ao final do período experimental (42 dias), os parâmetros de rendimento de carcaça, peito, coxa, sobrecoxa, asa, peso relativo do fígado e percentual de gordura abdominal foram mensurados. A análise sensorial da carne foi realizada por 45 provadores não treinados. As amostras foram avaliadas utilizando a escala hedônica estruturada, composta por nove pontos para as seguintes características: aroma, sabor, cor, textura e qualidade global. Considerando o período total (1 a 42 dias) pode-se incluir 8% de FT nas rações de frangos de corte, sem prejuízo para os parâmetros de rendimento e qualidade sensorial da carne.

Termos para indexação: Farinha de peixe, ingredientes alternativos, qualidade de carcaça.

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INTRODUCTION

The poultry rearing is one of the most technologically advanced agricultural activities, with most of the chicken reared focused on meat production. To properly support such advanced and expensive activity, the lowest costs production is an unavoidable requirement. Therefore, as production costs increase, the nutritionists are demanded to search for news, as well as cheaper, technological alternatives. Thus, the use of byproducts from the fish industry can stand environmental and public benefit and can be advantageous from the economical viewpoint, reducing the cost of animal production (ARVANITOYANNIS; KASSAVETI, 2008).

The large quantity of residues generated by the tilapia processing is a consequence of the small yield of fish cuts for human consumption: only the fillet. Consequently, approximately 64% of the fish become byproducts, within the multiple processing procedures (PONCE; GERNAT, 2002).

Therefore, the use of fish byproducts for animal feeding, besides representing an alternative source of

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income for the fishery industry, has the additional advantage on preventing environmental pollution (WANG; PARSONS, 1998). Furthermore, it is important to emphasize that the tilapia byproduct meal has high levels of crude protein and ether extract and the supplementation of this ingredient in the animal diets could reduce the inclusion of soybean meal and soybean oil, reducing the cost of production.

The use of fish meal in the poultry diets may result in an off-flavor of the meat or eggs, depending, mainly, on the oil content in the meal, but also on the duration of the diet consumption, age of birds, and temperature of the carcass or eggs (NATIONAL RESEARCH COUNCIL-NRC, 1994).

Despite the significant amount of information on the variation of the nutritional value of these byproducts, the number of researchers evaluating the effects of their use in broiler chicken diets over performance, carcass yield as well as on the quality of the meat produced is scarce.

Therefore, this study aimed to evaluating the effect of the inclusion on poultry diets of different levels of tilapia fish byproducts meal produced by the tilapia fillet production industry on carcass yield and sensorial characteristics of the broiler chicken meat.

MATERIAL AND METHODS

The experiment was carried out on avian experimental station in Marechal Cândido Rondon – PR – Brazil, using 480 chicks, Cobb strain, one day old and mean weight of 43.87 g, with five treatments [poultry diet inclusion 0% (control), 2%, 4%, 6% and 8% tilapia (*Oreochromis niloticus*) byproducts meal (TM)] distributed in a completely randomized design, with six replicates and 16 birds per experimental unit.

The diets were isoenergetic and isonutritional, according to Rostagno et al. (2005) recommendations for two phases of the birds: 1 to 21 days and 22 to 42 days (Table 1). During all the experiment the birds received water and food *ad libitum*. The birds were weighed weekly and feed intake was recorded. Mortality was recorded daily.

At the 42nd day, four chickens, representing the mean weight of the plot (±10%), was randomly removed from each experimental unit, composing 24 chickens per treatment. Twelve birds were used to compute the carcass yield, breasts, drumsticks, thighs, and wings, and also the body/liver ratio and percent abdominal fat for each treatment. The other 12 birds were used for the sensorial tests for each treatment. The selected birds were submitted to water dietary regimen for 12 hours prior to evaluation.

Later, the chickens were slaughtered by rupture of the jugular vein, and after bleeding and deplumation, they were eviscerated and their carcasses were weighed with the aid of a digital scale. For computation of yield after slaughtering, the liver and the abdominal fat were separately weighted, and their percents ratio to the weight of the body at the slaughtering were determined. As "abdominal fat" it was considered that fat deposited near the Bursa of Fabricius and the gizzard. The carcass yield (without the feet, head and neck) was evaluated as a function of the weight of the chicken at the slaughtering and the yield of the parts was evaluated as a function of the carcass weight.

After the slaughtering, the chicken breast and legs (drumsticks and thighs) were removed and separated to sensorial test trial. The parts were individually packed into plastic bags suitable for food storage and kept into a freezer until processing.

To certify the microbiological quality of the samples, a coliform *bacilli* analysis and counting were performed at 35 °C and 45 °C. According to this, the samples were suitable for human consumption comprising $<10^3$CFU/g (CFU = colony forming unit of the microorganism per gram of meat), since the tolerated limit is 10^4CFU/g.

The sensorial evaluations were performed according to Dutcosky (2007) methodology, using 45 non-trained testers, randomly selected from the group of food technology undergraduate students. For sensorial test trial, a hedonic rating scale from 1 to 9 (1: disliked extremely; 2: dislike very much; 3: dislike moderately; 4: dislike slightly; 5: neither like nor dislike; 6: like slightly; 7: like moderately; 8: like very much; 9: like extremely) was used to evaluate the following characteristics of the chicken meat: aroma, flavor, color, texture and whole quality.

One day prior to the sensorial analysis, the samples were defrosted at 4 °C temperature inside a standard refrigerator. After defrosting, the skin of legs and breasts were removed and a 5% common salt (NaCl) solution per kilogram of meat was added. After salt seasoning, the samples of each treatment were placed into a baking pan, which was then wrapped in aluminum foil with the shining surface turned inwards.

After roasting, each sample was unwrapped and the meat was cut into portions, of approximately 20 g each, and distributed to the testers. The samples for each tester were identified with a randomly chosen number and heated at the maximum potency in a microwave oven, for 30 seconds, to reach temperatures ranging from 45 °C to 50 °C. The heated samples were subjectively evaluated into an individual cabin, under white light. The individual cabins are necessary, since besides providing privacy, they guarantee the ideal conditions for the proper degustation by the tester.

Table 1 – Ingredients and nutrient composition of the experimental diets.

	1 to 21 days					1 to 42 days				
	Levels (%)									
Ingredients (%)	0	2	4	6	8	0	2	4	6	8
Corn	55.42	57.03	58.65	60.26	61.87	62.93	64.54	66.15	67.77	69.38
Soybean meal 45%	37.04	34.69	32.34	29.99	27.64	29.09	26.74	24.39	22.04	19.69
Soybean oil	2.96	2.24	1.52	0.79	0.07	3.88	3.16	2.44	1.71	0.99
Dicalcium phosphate	1.85	1.46	1.06	0.66	0.26	1.62	1.22	0.82	0.42	0.02
Limestone	0.91	0.77	0.64	0.50	0.37	0.83	0.70	0.56	0.43	0.30
NaCl	0.50	0.48	0.47	0.45	0.43	0.46	0.44	0.43	0.41	0.39
DL-Met 98%	0.32	0.31	0.31	0.31	0.31	0.24	0.24	0.24	0.24	0.24
L-Lys HCl 78.5%	0.30	0.31	0.32	0.33	0.34	0.27	0.28	0.29	0.30	0.31
L-Thr 98%	0.12	0.12	0.12	0.12	0.12	0.09	0.09	0.09	0.09	0.09
Antioxidant[1]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Anticoccidial[2]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Supplement mineral[3]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Supplement vitamin[4]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Choline chloride 60%	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Growth promoter[5]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Inert	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Tilapia fish byproducts meal	0.00	2.00	4.00	6.00	8.00	0.00	2.00	4.00	6.00	8.00
Total	100	100	100	100	100	100	100	100	100	100
EM (kcal/kg)	3.002	3.002	3.002	3.002	3.002	3.151	3.151	3.151	3.151	3.151
CP (%)	21.99	21.99	21.99	21.99	21.99	18.99	18.99	18.99	18.99	18.99
Ca (%)	0.908	0.908	0.908	0.908	0.908	0.805	0.805	0.805	0.805	0.805
Avaiable P (%)	0.454	0.454	0.454	0.454	0.454	0.402	0.402	0.402	0.402	0.402
Digestible Lys (%)	1.276	1.276	1.276	1.276	1.276	1.073	1.073	1.073	1.073	1.073
Digestible Met (%)	0.605	0.612	0.619	0.627	0.634	0.503	0.510	0.517	0.524	0.531
Digestible Met+Cys (%)	0.907	0.907	0.906	0.906	0.907	0.772	0.772	0.772	0.772	0.772
Digestible Trp (%)	0.240	0.236	0.232	0.222	0.223	0.201	0.197	0.192	0.188	0.184
Digestible Thr (%)	0.829	0.829	0.829	0.829	0.829	0.697	0.697	0.697	0.697	0.697
K (%)	0.834	0.805	0.778	0.748	0.719	0.709	0.681	0.652	0.623	0.595
Na (%)	0.218	0.218	0.218	0.218	0.218	0.202	0.202	0.202	0.202	0.202

[1]BHT (Hydroxy Butyl Toluene); [2]Salinomycin – 12%; [3]Supplement mineral (content/kg premix): Mg – 16.0 g; Fe – 100.0 g; Zn – 100.0 g; Cu – 2.0 g; Co – 2.0 g; I – 2.0 g; Se – 0.25 g; [4]Supplement vitamin (content/kg premix): vit. A – 10.000.000 UI; vit. D_3 – 2.000.000 UI; vit. E – 30.000 UI; vit. B_1 – 2.0 g; vit. B_6 – 4.0 g; Pantotenic Acid – 12.0 g; Biotin – 0.10 g; vit. K_3 – 3.0 g; Folic Acid – 1.0 g; Nicotinic Acid – 50.0 g; vit. B_{12} – 15.000 mcg; [5]Avilamycin 10%.

As statistical procedures, the data collected were submitted to ANOVA by the SAS (STATISTICAL ANALYSIS SYSTEM, version of 9.2) program. The comparison of means for carcass yield and sensorial data analysis was performed by the Dunnett test, at $p > 0.05$, to compare the reference group (0% of tilapia byproduct meal) with every the studied levels (2, 4, 6 and 8%) of this feed ingredient.

RESULTS AND DISCUSSION

There was no difference ($p > 0.05$) among the different level of TM inclusion to the poultry diets compared to the control treatment (0%) on yield parameters evaluated (Table 2).

Similarly, evaluating the effect of different levels of TM on the broiler diets, Ponce and Gernat (2002) and

Maigualema and Gernat (2003) also found no differences ($p > 0.05$) on carcass yield parameters. However, the mean value for carcass yield (76.10%) found in this study was higher than those values (69.10% and 68.82%, respectively) found by those authors for the same parameter.

The liver plays an important role in the lipid metabolism. Therefore, depending on the amount of dietary level present in the diet, the weight of that organ may be altered (RABIE; SZILÁQYI, 1998), mainly as a consequence of the increased metabolic activity. Data on body/liver ratio found in this work, however, were not affected by the different levels of TM added to the poultry diets. Studying different sources of animal protein to feed broiler chickens, Ojewola, Ukoha and Okoye (2005) also did not observe effects ($p > 0.05$) on liver weight parameter.

No differences ($p > 0.05$) were observed for abdominal fat deposition, independently of TM level of inclusion on diet. The digestibility of diet fat is affected by the fatty acids profile. The utilization of unsaturated fatty acids is higher than the utilization of saturated ones, leading to an increment on the metabolizable energy and a higher deposition of fat, due to storage of triglycerides in fat deposits on adipose tissue (CRESPO; ESTEVE-GARCIA, 2001). Considering the characteristic of the lipid fraction of the tilapia meal is a high content of unsaturated fatty acids (HUANG; HANG; LEE, 2004) the diet fatty acids profile may affect the deposition of abdominal fat.

The accumulation of abdominal fat in broiler chickens may be a consequence of several different factors such as: sex, age, genotype, environmental temperature (LEENSTRA, 1986), energetic density of the diet (KEREN-ZVI et al., 1990) and origin of the lipid source of the diet (SANZ et al., 2000), among others. Despite the high fat content of the fish meal used in this study, the abdominal fat deposition was not affected by increasing levels of TM on diets. The high fat content of fish meal is attributed to the presence of viscera which provides a high fat content on diets and consequently higher fat intake by the birds.

Concerning the sensorial characteristics of the drumstick/thigh and breast meat of the broiler chicken (Table 3) no differences were found ($p > 0.05$) among the different TM levels in the poultry diets.

The lipid quantity of meat can be modulated particularly the fatty acids profile, using different sources of lipids on diets. Many studies have analyzed the effect of increasing polyunsaturated fatty acids levels on diet over meat quality, emphasizing mainly the sensorial characteristics and acceptability of consumers concerned to poultry processed products, fresh meat as well as oxidation of fat during storage (CHARTRIN et al., 2006).

The lipid fraction of the fish is characterized by a high content of unsaturated fatty acids, which despite be a nutritional advantage, have a higher oxidation speed (HUANG; HANG, LEE, 2004). The fat oxidation is the main factor on reduction of meat products quality, originating rancid and undesirable odors and flavors that affect both sensorial values and the nutritional values of the product. The development of undesirable flavors is caused mainly by the fast oxidation of the phospholipids highly unsaturated (RUIZ et al., 2001).

Besides fatty acids profile, another factor that can affect the flavor of chicken meat when fed on fish meal is the off-flavor. The characteristic, and sometimes "exquisite", strange taste that this type of meal produces is attributed to two organic compounds: the methyl-isoborneol and the geosmina (TUCKER, 2006).

Table 2 – Effect of the inclusion of different levels of tilapia byproducts meal (TM) on the characteristics of carcass, relative weight of the liver and deposition of abdominal fat of 42 days old broiler chickens.

	TM levels on diets						
Parameters (%)	0	2	4	6	8	Mean	CV (%)
Carcass Yield [ns]	76.49	75.71	76.02	75.60	76.67	76.10	3.57
Yield of Drumstick [ns]	12.09	12.44	12.45	12.69	12.76	12.49	6.86
Yield of Thigh [ns]	15.81	15.35	14.54	15.38	15.34	15.28	8.21
Yield of Wing [ns]	10.67	10.35	10.53	10.68	10.33	10.51	6.67
Yield of Breast [ns]	34.12	35.27	35.43	34.97	35.10	34.98	6.37
Body/Liver Ratio [ns]	1.70	1.77	1.78	1.75	1.89	1.78	19.49
Abdominal Fat [ns]	1.08	1.31	1.42	1.69	1.52	1.40	38.33

ns = non significant by the Dunnett test at 5% probability ($p > 0.05$), when the control treatment (0% TM) was compared with each one of the studied levels of TM.

Table 3 – Mean grades for the sensorial attributes of aroma, flavor, color, texture and whole quality of the roasted meat of the leg (drumsticks/thighs) and breast of broiler chickens fed on poultry diet containing different levels of tilapia byproducts meal (TM).

	TM levels on the diet					
	0	2	4	6	8	
			Leg			
Characteristic						CV (%)
Aroma ns	6.71	6.17	6.81	6.67	6.76	24.04
Flavor ns	6.98	6.26	7.02	6.98	6.74	22.12
Color ns	6.79	6.76	6.64	7.07	6.88	22.81
Texture ns	6.93	6.48	6.76	7.21	6.79	25.18
Whole Quality ns	6.83	6.55	6.95	7.00	6.93	20.51
			Breast			
Aroma ns	6.81	6.59	6.95	7.00	7.09	22.02
Flavor ns	6.93	6.48	6.81	7.24	6.86	24.48
Color ns	6.90	6.57	6.57	7.19	6.93	26.27
Texture ns	7.31	6.81	6.83	7.52	7.00	22.27
Whole Quality ns	7.07	6.59	6.98	7.14	7.05	21.85

ns = non significant by the Dunnett test at 5% probability ($p > 0.05$), when the control treatment (0% TM) was compared with each one of the studied levels of TM.

The uniformity of the color on the broiler chicken skin and meat are important parameters, which lead consumers to select the product and had influence on final quality of the product for consumption (QIAO et al., 2002).

The texture is a sensory property that consumer uses commonly to determine the quality and acceptability of the meat (ISSANCHOU, 1996) and the best quality is expressed in terms of higher tenderness and higher succulence. The palatability of the meat is associated to the texture and according to Baracho et al. (2006) it can be affected by *ante-mortem* factors such as: species, genetic factors, age, nutritional state and stress, among others. *Rigor mortis*, electric stimulus, cooling speed and pH are *post-mortem* factors that also influence the texture of the chicken meat.

The variable "whole quality" involves all the characteristics evaluated (texture, aroma, color and flavor), which are considered as a global sum of the factors. Within this study, the values for whole quality had no differences ($p > 0.05$). However, the mean grade 7, corresponding to "liked regularly" in the hedonic scale, observed in this trial, indicates a good acceptability of meat by the consumers.

CONCLUSION

The inclusion of tilapia byproducts meal on poultry diets, independently of the percentage added (up to 8%) can be used as alternative ingredient to feed broiler chickens, from 1 to 42 days of age, without affecting yield parameters and sensorial quality of the meat of breast, drumstick and thigh.

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