PRODUCTION OF SLOW GROWING BROILER CHICKEN USING BY-PRODUCT FROM FRUIT JUICE PROCESSING

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Abstract – Acerola (*Malpighia punicifolia*) by-product derived from the industrial processing of the fruit juice was evaluated as an alternative source of nutrients in feed formulation for pasture-raised Label Rouge broiler chickens. Birds' productive performance, carcass characteristics and biometric parameters were evaluated using different levels of acerola by-product meal supplementation (0% - control, 10% and 20%). It was found a negative effect on the birds feed conversion ratio associated with the highest level of acerola by-product meal in the birds' diet. For that treatment, the increase of dietary fibers level caused the development of birds' digestive tract, especially gizzard and duodenum. Nevertheless, the supplementation with 10% acerola by-product meal did not significantly affect the feed conversion rate nor the body composition (main meat cuts, viscera, abdominal fat and gizzard percentage), but the carcass yield of birds fed both supplementation levels of the product was lower than the control. Although the production variables need to be optimized to reduce this negative effect, this study may contribute to enlarge the vision of broiler chickens producers, providing options to reduce the dependence on high technology and high cost facilities and breeds, and on grains and other rich ingredients to birds' nutrition.

I. INTRODUCTION

According to the United Nations [1] estimation, the world population will reach 9 billion people by 2050 and the global food production will need to rise by 70%. On the other hand, the society claims for more strict environmental protection laws, restricting the possibility of expanding the area used for food production. In this scenario, there is concern about the the procedures adopted by the sector of poultry production, which invests in genetic development focused on broilers able to convert high-quality ingredients better and faster, especially corn and soybean, since those ingredients should be destined for human nutrition. Because of that, the interest in poultry meat production employing less intensive rearing systems and in alternative ingredients to replace corn and soybean meal in birds ration is increasing [2]. The rearing of slow growing broiler chickens breeds in pasture-based systems provides a more natural condition to the animals, reduces the environmental impact associated with the high concentration of birds and makes possible the use of residues – or by-products – from other agricultural activities for feeding the birds. Furthermore, these production systems can include social aspects, since they can be practiced by small and medium producers, who were excluded from the broiler production market due to the high costs of equipment, facilities and supplies required in intensive systems. In this study, acerola (*Malpighia punicifolia*) by-product meal from the fruit juice processing industry was evaluated as an alternative source of nutrients in feed formulation for pasture-raised Label Rouge broiler chickens.

II. MATERIALS AND METHODS

A total of 150 one-day-old Label Rouge males and females broiler chickens were distributed in a completely randomized design with three treatments and five replicates. The treatments were: T1-control diet, based on corn and soybean meal with no addition of acerola by-product meal, T2-10% acerola by-product meal added to the basal ration, and T3-20% acerola by-product meal added to the basal ration. Acerola by-product meal was obtained by natural drying process to 12% of moisture, followed by grinding and packaging. The birds were weighed at the beginning of the experiment and distributed in 15 paddocks, with 10 birds in each. All paddocks had a covered and a pasture area. The diets were formulated to starter/grower (1-35 d) and finisher (36-87 d) phases according to NRC [3] (Table 1). The ration was provided

ad libitum during the whole experimental period. To evaluate productive performance of the birds, feed intake and weight gain were measured every two weeks and the feed conversion ratio was calculated based on those results. At 87 days of experiment, six birds – three males and three females - were randomly selected and, after a 8 h fasting period, they were weighed again, identified and slaughtered according to Brazilian laws [4,5,6].

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

	Phase					
	Starter/grower			Finisher		
Ingredients (%)	T1	T2	T3	T1	T2	T3
Corn	66.02	54.15	42.28	71.19	59.75	48.31
Soybean meal (45%)	28.94	28.70	28.45	23.84	23.77	23.69
Acerola by-product meal	-	10.00	20.00	-	10.00	20.00
Soybean oil	-	3.21	6.41	-	3.00	6.01
Dicalcium phosphate	1.05	1.06	1.08	0.73	0.74	0.74
Limestone	0.77	0.66	0.55	0.63	0.51	0.40
NaCl	0.44	0.45	0.46	0.41	0.41	0.42
L-Lysine HCl	0.19	0.18	0.17	0.05	0.04	0.02
DL methionine	0.22	0.23	0.24	0.10	0.11	0.12
L-threonine	0.02	0.03	0.03	-	-	-
Filler	1.99	0.99	-	2,75	1.38	-
Premix*	0.34	0.34	0.34	0.30	0.30	0.30
Calculated Value						
ME (kcal /kg)	2,900	2,900	2,900	2,950	2,950	2,950
Crude protein (%)	18.61	18.53	18.42	16.50	16.50	16.50
Available phosphorus (%)	0.30	0.30	0.30	0.23	0.23	0.23
Calcium (%)	0.64	0.64	0.64	0.50	0.50	0.50
Sodium (%)	0.20	0.20	0.20	0.18	0.18	0.18

* Provided per kg of diet: vitamin A, 8800 IU; vitamin D_3, 3300 IU; vitamin E, 40 IU; vitamin K_3, 3.3 mg; thiamine, 4.0 mg; riboflavin, 8.0 mg; pantothenic acid, 15 mg; niacin, 50 mg; pyridoxine, 3.3 mg; choline, 600 mg; folic acid, 1 mg; biotin, 220 µg; vitamin B_{12}, 12 µg; antioxidant, 120 mg; manganese, 70 mg; zinc, 70 mg; iron, 60 mg; copper, 10 mg; iodine, 1.0 mg; selenium, 0.3 mg. Basal ration formulated according to NRC requirements. T1-control diet; T2-10% acerola by-product meal added to the ration; T3-20% acerola by-product meal added to the ration; ME: metabolizable energy

At slaughter, the eviscerated carcass, as well as breast, legs, wings, gizzard, viscera and abdominal fat (cloacae and gizzard region) were weighed. The yield of the eviscerated carcass, gizzard, viscera and abdominal fat were assessed in relation to weight at slaughter, while the yield of meat cuts – breast, legs and wings - were assessed in relation to the eviscerated carcass. The birds' intestine and its portions (duodenum, jejunum + ileum and cecum) were measured to evaluate the effect of dietary fibers level on the intestinal tract of the birds. The results were analyzed by ANOVA and Tukey test with significance level of 5% [7]. Statistical analysis was performed using the Statistical Analysis System [8].

III. RESULTS AND DISCUSSION

The results presented in Table 2 show a negative effect on the birds' feed conversion ratio associated with the highest level of acerola by-product meal in diet. Higher content of fibers in the diet can reduce the productive performance of the birds, by reducing the utilization of nutrients and its metabolizable energy [9]. When fibrous ingredients are added to the diet, high energy level ingredients like soybean oil must be added in order to meet the energy demands of birds without changing the other nutrients in the ration. The association of the higher dietary fibers level and the addition of a higher amount of soybean oil in the ration accelerates the feed transit through the digestive tract, which explains the worse performance of the birds fed diets with 20% acerola by-product meal. The addition of 10% acerola by-product meal in the birds' diet did not affect feed consumption, weight gain or feed conversion ratio.

Table 2. Productive performance of Label Rouge broiler chickens at 42 d and 87 d.

	Feed consumption (kg)	Body weight gain (kg)	Feed conversion ratio
	42 d		
Control	4.48 ± 0.15	1.60 ± 0.07	2.80^{b} ± 0.09
10% ABM	4.37 ± 0.13	1.56 ± 0.10	2.80^{b} ± 0.13
20% ABM	4.17 ± 0.16	1.38 ± 0.05	3.03^{a} ± 0.06
	87 d		
Control	10.09 ± 0.47	3.02 ± 0.14	3.35^{b} ± 0.12
10% ABM	10.33 ± 0.16	3.04 ± 0.11	3.40^{ab} ± 0.15
20% ABM	10.27 ± 0.10	2.84 ± 0.13	3.62^{a} ± 0.19

Means in a column for the same age followed by different letters differ significantly by Tukey test ($P < 0.05$). ABM - acerola by-product meal

The results presented in Table 3 show that the birds fed rations containing acerola by-product meal had lower carcass yield than the birds of control group. For the 20% acerola group, this result can be due to the higher percentage of viscera and gizzard, associated with the physiological adaptation of the birds' digestive tract to digest fibers. Among the birds that received 10% of acerola by-product meal in the diet, body composition, evaluated by the main meat cuts, viscera, abdominal fat and gizzard percentage, did not differ from control, but the results suggest that, for this group, carcass yield could be improved by adjusting the diet formulation and so reducing the abdominal fat percentage.

Table 3. Carcass yield and body composition of Label Rouge broiler chickens.

	Control	10% ABM	20% ABM
Carcass yield (%)	$70.81^{a} \pm 2.60$	$68.58^{b} \pm 1.56$	$67.95^{b} \pm 1.64$
Legs (%)	31.81 ± 1.52	31.98 ± 1.08	31.52 ± 1.41
Breast (%)	30.76 ± 2.04	29.88 ± 2.43	29.41 ± 2.03
Wings (%)	9.96 ± 1.42	10.15 ± 0.70	10.55 ± 0.61
Viscera (%)	$13.40^{b} \pm 2.74$	$14.33^{ab} \pm 1.74$	$15.70^{a} \pm 2.50$
Abdominal fat (%)	4.60 ± 2.10	4.92 ± 2.40	4.39 ± 2.14
Gizzard (%)	$3.98^{b} \pm 1.61$	$4.49^{b} \pm 1.22$	$5.13^{a} \pm 1.75$

Means in a line followed by different letters differ significantly by Tukey test ($P < 0.05$). ABM - acerola by-product meal

The adaptation of the birds' digestive tract to digest fibers is confirmed by the biometric parameters results presented in Table 4, that show a development in the birds' duodenum and, consequently, in the birds' intestinal tract length, associated with the acerola by-product meal consumption. The development of birds' digestive tract surface is essential for the nutrients absorption.

Table 4. Biometric parameters of birds' intestinal tract.

	Control	10% ABM	20% ABM
Intestine (m)	$1.91^{b} \pm 0.09$	$2.05^{a} \pm 0.13$	$2.00^{ab} \pm 0.12$
Duodenum (m)	$0.28^{b} \pm 0.02$	$0.31^{a} \pm 0.02$	$0.32^{a} \pm 0.02$
Jejunum + Ileum (m)	1.44 ± 0.09	1.54 ± 0.12	1.48 ± 0.10
Cecum (m)	0.19 ± 0.02	0.20 ± 0.01	0.20 ± 0.02

Means in a line followed by different letters differ significantly by Tukey test ($P < 0.05$). ABM - acerola by-product meal

IV. CONCLUSION

The addition of acerola by-product meal in broiler ration and, as a consequence, the increase in dietary fibers level, caused a development of the birds' digestive tract, as an adaptation response.

Acerola by-product meal at 20% in broilers' diet caused a negative effect on feed conversion ratio and carcass yield.

Acerola by-product meal at 10% in broilers´ diets did not affect feed conversion but decreased carcass yield. So, additional research will be necessary to optimize the variables involved in the birds' production process.

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REFERENCES

1. United Nations. World populations prospect:The 2012 revision. www.unpopulation.org
2. The Poultry site. Label-Rouge: pasture based poultry production in France. URL: http://www.thepoultrysite.com/articles/1888/label-rouge-pasturebased-poultry-production-in-france
3. NRC. National Research Council. (1994) Nutrient requirements of poultry. Washington: National Academy Press.
4. BRASIL. Decreto nº 2244, de 5 de junho de 1997. Estabelece regulamentação da inspeção industrial e sanitária de produtos de origem animal. Diário oficial [da] República Federativa do Brasil, poder Executivo, Brasília, DF, 4 de jun. 1997. Seção I, p. 204.
5. BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. Portaria nº 210, de 10/11/1998. Aprova o Regulamento Técnico de Inspeção Tecnológica e Higiênico-Sanitária de carne de aves. Diário Oficial [da] República Federativa do Brasil, Brasília, DF, 26/11/1998. Seção 1, p.226.
6. BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. Instrução Normativa nº 3, de 17/10/2000. Aprova o Regulamento Técnico de Métodos de Insensibilização para o Abate Humanitário de Animais de Açougue. Diário Oficial [da] República Federativa do Brasil, Brasília, DF, 24/01/2000. Seção 1, p.14.
7. Zar, J.H. (2009). Biostatistical analysis. 5. ed. New Jersey: Prentice-Hall.
8. SAS Institute Inc. (2008). SAS/STAT 9.2 User's Guide. Cary: SAS Institute.
9. Rezende, M.J.M., Flauzina, L.P., McManus,C., Oliveira, L.Q.M. (2004). Desempenho produtivo e biometria das vísceras de codornas francesas alimentadas com diferentes níveis de energia

metabolizável e proteína bruta. Acta Scientiarum Animal Sciences 26(3):353 – 358