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Inclusion of guava wastes in feed for broiler chickens[1]

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ABSTRACT - The objective of this study was to evaluate the effect of including guava wastes in the feed on the performance and carcass yield of broiler chickens. An experiment was carried out with 300 male Cobb strain chicks, in a randomized complete design with five levels of waste and five replications. A reference diet based on corn and soybean meal and four feeds with 3, 6, 9 or 12% guava waste were evaluated. The feed intake, weight gain and feed conversion were assessed weekly; the weight at slaughter and the weight and yield of eviscerated carcass, carcass without feet and head, breast, drumstick, thigh, wing, back, edible viscera and abdominal fat were assessed. The inclusion of guava waste in the feed promotes performance and carcass yield similar to that obtained with the feed based on corn and soybean meal, therefore this agro-industrial by-product can be used at levels of up to 12% in feeds for broiler chickens.

Key Words: agro-industrial by-products, alternative foods, carcass, commercial cuts

Inclusão de resíduo de goiaba em rações para frangos de corte

RESUMO - Com o objetivo de avaliar o efeito da inclusão de resíduo de goiaba na ração sobre o desempenho e rendimento de carcaças de frangos de corte foi realizado um experimento com 300 pintos machos Cobb, em delineamento inteiramente casualizado, com cinco níveis de resíduo e cinco repetições. Avaliaram-se uma ração-referência à base de milho e farelo de soja e quatro rações com 3, 6, 9 ou 12% de resíduo de goiaba. Semanalmente, avaliaram-se o consumo de ração, o ganho de peso e a conversão alimentar; o peso ao abate e o peso e rendimento de carcaça eviscerada, carcaça sem pés e cabeça, peito, coxa, sobrecoxa, asa, dorso, vísceras comestíveis e gordura abdominal. A inclusão de resíduo de goiaba na ração promove desempenho e rendimento de carcaça semelhante ao obtido com ração à base de milho e farelo de soja, portanto esse subproduto agroindustrial pode ser utilizado em níveis de até 12% em rações para frangos de corte.

Palavras-chave: alimentos alternativos, carcaça, cortes comerciais, subprodutos agroindustriais

Introduction

In the poultry production, corn and soybean meal are the most used ingredients in the diet formulations for birds. On the other hand, the price oscillations of these products in the market increase production costs, an important factor for planning the production chain of the poultry sector. With the purpose of reduce production costs without harming animal performance, alternative feed have been used, regionally available, in the diet formulation, in total or partial substitution for corn and soybean in the broiler chicken feeding systems.

Brazil produces approximately 390,000 tones of guava annually, and is outstanding in the international scenario (Agrianual, 2004) as the greatest producer of red guavas. The most of the production is destined for industrialization which produces 4 to 30% of its weight in wastes that consist mainly of seeds (Mantovani et al., 2004) with high potential for use in animal feeding.

In addition to the potential for use in animal feeding, there is the great concern of the environmentalists with the pollutant power of wastes discarded by agro-industries in the world, reinforcing the need to plan the management these wastes (Kabori & Jorge, 2005).

Guava waste has high values of crude fiber, close to 61%, and high contents of ether extract, around 12%, constituting good source of linoleic acid; and apparent metabolizable energy values of 1,401 kcal/kg (AME) and

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corrected apparent metabolizable energy 1,336 kcal/kg (AMEn) based on dry matter, determined in free range broiler chickens (Silva et al., 2007) and 1,808 kcal/kg of AMEn determined in laying hens (Guimarães, 2007).

Studies on the use of guava waste in feed for laying hens proved that its inclusion in the diet did not influence the performance characteristics in the periods from 30 to 39 weeks of age (Guimarães, 2007). Thus, the objective of the present study was to evaluate the effect of using guava waste on the performance and carcass yield of broiler chickens.

Material and Methods

The experiment was conducted from December 14th 2007 to January 24th 2008 using 300 broiler chickens, males, strain Cobb with one-day old, vaccinated against the diseases of Marek, Gumboro and Newcastle and selected according to the initial average weight (approximately 41 g), housed in a masonry shed built in east-west direction, 3.0 m ceiling height, with (1.00 × 1.25 m) 52 boxes, concrete floor covered with wood chips.

Until the 13rd day, infantile tubular feeders and pressure drinkers were used, were substituted with bell shaped drinkers, in the same proportion, one feeder and one drinker per box.

The chicks in each experimental plot were heated artificially until the 15th day of lodging by 100 watt incandescent lamps, installed at 20 cm from the ground and regulated according to growth and the environment temperature, while the artificial illumination was with 100 watt incandescent lamps. The broiler chickens were submitted the ilumination continuous program of 24 hours.

The climatic variables were monitored for 24 hours by a small weather station containing a black globe thermometer, one wet-bulb thermometer and one dry-bulb thermometer and maximum and minimum thermometer. The values were recorded every day, at 8 a.m. and 4 p.m. and used in the calculations of maximum temperature, minimum temperature, relative humidity, black globe temperature and of the Black Globe Humidity Index (BGHI) in the experimental phases. The black globe humidity index was obtained according to Buffington et al. (1981).

The birds were distributed as a randomized complete design, with five treatments and five replications of 12 birds.

The experimental treatments consisted of: a reference diet based on corn and soybean meal; and the other four without: 3, 6, 9 and 12% of guava waste, all isonutritive (Table 1).

The rations were formulated using the ingredients composition and nutritional requirement data reported by Rostagno et al. (2005). However, for guava waste the following chemical composition data were used obtained in analysis at the Animal Nutrition Laboratory: 90.81% dry matter; 10.09% crude protein; 10.86% ether extract; 56.01% crude fiber; 0.11% total phosphorus; 0.037% available phosphorus; and 0.025% calcium. Thus the following were considered the determinate values in the metabolism assay (Lira, 2008) for apparent metabolizable energy corrected by nitrogen balance of 1,358 kcal/kg; literature data (cited by Guimarães, 2007): 9.67% linoleic acid; 1.4% oleic acid; 0.81% palmitic acid; 0.17% methionine; 0.32% cystine; 0.16% lysine and 0.23% threonine.

The feeding program applied had 4 phases (from 1 to 7 days, 8 to 21 days, 22 to 35 days and 36 to 42 days) and the feed was supplied ad libitum throughout the experimental period. Feed intake and weight gain were quantified weekly in each experimental unit for the feed conversion calculations.

At 42 days of age, two birds were selected by weight mean and fasted for 6 hours. Afterwards, the birds were weighed again, identified and slaughtered to determine the weight of the eviscerated carcass with feet and head, breast, drumstick, thigh, wing, dorsum, gizzard (with fat), liver, heart and abdominal fat (cloaca and gizzard region). The yield of the eviscerated carcass with feet and head was determined in relation to weight at slaughter, while the parts were determined in relation to the eviscerated carcass weight with feet and head.

The regression equations to evaluate the levels of guava waste inclusion were fitted using the Sisvar statistical computer program - Statistical Analysis System – DEX/UFLA (Ferreira, 2003), using all the variables, established by linear or quadratic model regression, according to the best understanding.

Results and Discussion

The weekly values of the maximum and minimum temperatures, relative humidity, black globe temperature and black globe humidity index (BGHI) in the experimental phases (Table 2) did not indicate thermal stress in the birds.

The levels of guava waste inclusion did not promote differences (P>0.05) in the diet intake of broiler chickens in the periods from 8 to 14 days, 15 to 21 days, 22 to 28 days, 29 to 35 days, 36 to 42 days and 1 to 42 days of age, of which the averages were 469.04, 799.86, 1,052.90, 1,170.74, 1,266.70 and 4,956.11 g, respectively (Table 3). The results indicated that the ether extract contents and the kind of

Table 1 - Composition of the experimental feed

Ingredient	Phase from 1 to 7 days					Phase from 8 to 21 days					Phase from 22 to 35 days					Phase from 36 to 42 days				
	Level of guava waste (%)					Level of guava waste (%)					Level of guava waste (%)					Level of guava waste (%)				
	0.0	3.0	6.0	9.0	12.0	0.0	3.0	6.0	9.0	12.0	0.0	3.0	6.0	9.0	12.0	0.0	3.0	6.0	9.0	12.0
Corn	57.017	57.017	52.810	48.604	44.397	57.414	53.207	49.001	44.794	40.587	60.258	56.051	51.845	47.638	43.431	62.453	58.247	54.040	49.833	45.627
Soybean meal (45%)	36.529	36.529	36.658	36.787	36.916	35.195	35.324	35.454	35.583	35.412	31.636	31.765	31.894	32.023	32.153	28.599	28.728	28.857	28.986	29.116
Guava waste	0.000	0.000	3.000	6.000	9.000	0.000	3.000	6.000	9.000	12.000	0.000	3.000	6.000	9.000	12.000	0.000	3.000	6.000	9.000	12.000
Soybean oil	1.786	1.786	2.852	3.917	4.983	3.295	4.360	5.426	6.492	7.558	4.273	5.339	6.404	7.410	8.536	5.316	6.382	7.448	8.513	9.579
Dicalcium phosphate	1.933	1.933	1.944	1.955	1.966	1.836	1.847	1.858	1.869	1.880	1.691	1.702	1.713	1.724	1.735	1.571	1.582	1.592	1.603	1.614
Limestone	0.879	0.879	0.872	0.866	0.859	0.853	0.846	0.840	0.833	0.827	0.805	0.799	0.792	0.786	0.779	0.768	0.761	0.754	0.748	0.741
Common salt	0.515	0.515	0.517	0.519	0.521	0.502	0.505	0.507	0.509	0.511	0.478	0.480	0.482	0.486	0.486	0.460	0.462	0.463	0.462	0.469
Mineral premix 1	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Vitaminic premix 2	0.120	0.120	0.120	0.120	0.120	0.100	0.100	0.100	0.100	0.100	0.100	0100	0100	0100	0100	0.100	0.100	0.100	0.100	0.100
DL - methionine99	0.398	0.398	0.397	0.395	0.394	0.280	0.279	0.278	0.277	0.275	0.257	0.256	0.254	0.253	0.252	0.260	0.258	0.257	0.256	0.255
L - lysine HCL	0.446	0.446	0.448	0.450	0.452	0.253	0.255	0.257	0.260	0.262	0.244	0.246	0.248	0.250	0.252	0.295	0.297	0.299	0.301	0.303
L - threonine	0.188	0.188	0.193	0.197	0.201	0.082	0.086	0.090	0.095	0.099	0.069	0.073	0.077	0.082	0.860	0.089	0.093	0.098	0.102	0.106
Choline HCL 60%	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.040	0.040	0.040	0.040	0.040
Cygro (3)(3) 3	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	-	-	-	-	-
Zinc bacitracin	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	-	-	-	-	-
Calculated nutritional composition																				
Metabolizable energy (kcal/kg)	2,950	2,950	2,950	2,950	2,950	3,050	3,050	3,050	3,050	3,050	3,150	3,150	3,150	3,150	3,150	3,250	3,250	3,250	3,250	3,250
Crude protein (%)	22.030	22.030	22.030	22.030	22.030	21.140	21.140	21.140	21.140	21.140	19.730	19.730	19.730	19.730	19.730	18.596	18.596	18.596	18.596	18.596
Available P (%)	0.469	0.469	0.469	0.469	0.469	0.449	0.449	0.449	0.449	0.449	0.418	0.418	0.418	0.418	0.418	0.392	0.392	0.392	0.392	0.392
Calcium (%)	0.939	0.939	0.939	0.939	0.939	0.899	0.899	0.899	0.899	0.899	0.837	0.837	0.837	0.837	0.837	0.787	0.787	0.787	0.787	0.787
Methionine (%)	0.724	0.722	0.719	0.717	0.714	0.602	0.597	0.595	0.592	0.590	0.559	0.556	0.554	0.551	0.549	0.546	0.543	0.541	0.538	0.536
Methionine + cystine (%)	1.063	1.063	1.063	1.063	1.063	0.931	0.931	0.931	0.931	0.931	0.873	0.873	0.873	0.873	0.873	0.845	0.845	0.845	0.845	0.845
Lysine (%)	1.498	1.498	1.498	1.498	1.498	1.311	1.311	1.311	1.311	1.311	1.212	1.212	1.212	1.212	1.212	1.173	1.173	1.173	1.173	1.173
Thryptofan (%)	0.266	0.264	0.262	0.260	0.257	0.258	0.256	0.227	0.252	0.249	0.2385	0.236	0.234	0.231	0.229	0.221	0.218	0.216	0.214	0.212
Threonine (%)	1.019	1.019	1.019	1.019	1.019	0.891	0.891	0.891	0.891	0.891	0.724	0.824	0.824	0.824	0.824	0.797	0.797	0.797	0.797	0.797
Sodium (%)	0.223	0.223	0.223	0.223	0.223	0.218	0.218	0.218	0.218	0.218	0.208	0.208	0.208	0.208	0.208	0.201	0.201	0.201	0.201	0.201
Crude fat (%)	4.255	5.559	6.864	8.168	9.473	5.7535	7.058	8.362	9.666	10.971	6.777	8.081	9.386	10.690	11.995	7.850	9.154	10.459	11.763	13.068
Linoleic acid (%)	2.251	3.040	3.828	4.617	5.406	3.063	3.852	4.640	5.429	6.218	3.619	4.407	5.196	5.985	6.774	4.201	4.990	5.779	6.567	7.356
Crude fiber (%)	3.283	5.141	6.999	8.858	10.716	3.203	4.670	6.136	7.603	9.070	3.047	4.514	5.981	7.448	8.915	2.910	4.377	5.844	7.311	8.778

[1] Mineral premix in the phases of 1 to 7, 8 to 21 and 22 to 35 days of age (quantity by kilogram of product): Fe, 50 g; Co, 1.0 mg; Cu, 10.0 mg; Mg, 80.0 mg; Zn, 50.0 mg; I, 1.0 mg. And in the phase from 36 to 42 days (quantity by kilogram of product): Fe, 12,500.00 mg; Cu, 2,000.00 mg; I, 190.00mg; Mn, 18,750.00 mg; Se, 77.00 mg; Zn, 12,500 mg.

[2] Vitaminic premix in the phases of 1 to 7, 8 to 21 and 22 to 35 days (quantity per kilogram of product): vit. A, 10,000 U.I.; vit. D_3, 2,000 U.I; vit. E, 30 U.I.; vit B_1, 2.0 m; vit. B_2, 6.0 mg; vit.B_6,4.0 mg; vit. B_{12}, , 0.015 mg; pantothenic acid, 12.0 mg; biotin, 0.1 mg; vit. K_3, 3.0 mg; folic acid, 1,0 mg; nicotinic acid, 50,0 mg; Se, 0,25 mg. And in the phase from 36 – 42 days (quantity by kilogram of product): folic acid, 45 mg; pantothenic acid, 1,080.00 mg; biotin, 9.00 mg; niacin, 3,380.00 mg; piridoxine, 90 mg; riboflavin, 730.00 mg; thiamine, 165.00 mg; vit. A, 900,000.00 UI; vit. B12, 1,630.00 mg; vit. D3 230,000.00 UI; vit. E, 1,800.00 UI.

[3] Maduramicin ammonium aplha 1 %.

Table 2 - Weekly values of the climatic variables during the experimental phases

Phase (days)	Maximum temperature (°C)	Minimum temperature(°C)	Relative humidity (%)	Black globe temperature (°C)	BGHI
1 to 7	33.06 ± 1.80	24.77 ± 2.91	78.00 ± 2.30	31.04 ± 2.29	81.43 ± 2.50
8 to 14	31.34 ± 1.45	25.04 ± 3.11	80.00 ± 1.90	28.71 ± 2.15	78.85 ± 2.36
15 to 21	30.91 ± 1.47	24.54 ± 2.96	80.00 ± 1.40	29.61 ± 2.65	79.63 ± 2.95
22 to 28	32.25 ± 1.08	24.84 ± 2.83	82.00 ± 1.60	30.11 ± 0.96	80.63 ± 2.05
29 to 35	32.04 ± 0.97	25.52 ± 2.78	83.00 ± 1.80	29.50 ± 1.47	80.01 ± 1.62
35 to 42	32.61 ± 1.54	25.73 ± 2.70	82.00 ± 1.50	29.50 ± 1.62	80.09 ± 1.75

fiber (cellulosic) of the guava waste present in the ration had no action on the gastrointestinal epithelium at these ages, considering the best development of the intestinal epithelium and the enzymatic system as the bird age advanced, improving the nutrient digest and developemnt. The nutrient digestion and absorption capacity undergo significant adaptations in the post-hatch period and can be further influenced by the feeding level and diet composition (Corring, 1980). During the period of development and maturing of the gastrointestinal tract, mainly from the 7 to 10 days post-hatch, increasing nutrient deficiency is observed (Uni et al., 1995).

Guimarães (2007) did not observe differences in the diet intake in the periods from 33 to 36 and 36 to 39 weeks and throughout the experimental period, from 30 to 39 weeks, when 0, 2, 4, 6 and 8% guava waste was included in diets for laying hens. However, for the period from 1 to 7 days, there was quadratic effect of supplying guava waste on the diet intake, because the level of 3% guava waste resulted in the maximum intake level of 202.54 g, while the inclusion of 12% resulted in the minimum level of 185.62 g (Table 3). This response of the birds in this week may have occurred because of an attempt to adapt by the organism, whereas, according to Corring (1980), the processes which involve nutrient digestion and absorption make remarkable adaptations in the post-hatch period when processes are influenced by feeding level and diet composition, mainly in the first 7 to 19 days post-hatch (Uni et al., 1995).

The weekly weight gain did not differ (P>0,05) among the guava waste levels in the phases from 8 to 14, 15 to 21, 22 to 28, 29 to 35 and 36 to 42 days. In the total period of 1 to 42 days, respective averages were observed of 359.06,

Table 3 - Performance of broiler chickens fed on feed with diverse levels of guava waste

Item	Phases (days)	Level of guava waste (%)					Average	CV	F
		0	3	6	9	12		(%)	
	1 – 7	199.29	202.54	201.35	195.71	185.62	196.90	3.70	6.53*(1)
	8 – 14	470.31	468.65	462.63	467.68	475.93	469.04	3.21	0.51ns
Feed intake, g	15 – 21	799.35	793.68	807.38	790.41	808.48	799.86	3.14	0.51ns
	22 – 28	1,044.67	1,047.53	1,055.85	1,058.13	1,058.31	1,052.90	1.61	0.70ns
	29 – 35	1,185.24	1,153.34	1,183.54	1,126.81	1,204.76	1,170.74	4.60	1.62ns
	36 – 42	1,263.74	1,229.11	1,268.39	1,244.76	1,327.50	1,266.70	5.78	1.31ns
	1 – 42	4,958.76	4,903.81	4,975.06	4,879.79	5,063.11	4,956.11	2.91	1.23ns
	1 – 7	177.79	175.14	172.48	169.83	167.18	172.48	4.15	6.87*(2)
	8 – 14	359.28	360.33	353.48	356.34	365.85	359.06	4.07	0.50ns
Weight gain, g	15 – 21	562.05	547.93	550.51	582.15	560.90	560.71	5.53	0.95ns
	22 – 28	658.36	655.62	660.46	658.47	660.15	615.11	1.36	0.23ns
	29 – 35	594.50	615.24	610.29	525.60	590.27	587.18	12.92	1.12ns
	36 – 42	619.98	520.01	600.44	590.48	607.20	587.62	14.94	1.00ns
	1 – 42	2,966.13	2,884.91	2,945.41	2,878.77	2,953.09	2,925.66	5.61	0.31ns
	1 – 7	1.13	1.14	1.15	1.15	1.12	1.14	3.31	0.54ns
	8 – 14	1.31	1.30	1.31	1.31	1.30	1.31	2.07	0.24ns
Feed conversion, kg:kg	15 – 21	1.42	1.44	1.48	1.36	144	1.43	5.27	1.49ns
	22 – 28	1.59	1.60	1.60	1.61	1.60	1.60	1.56	0.47ns
	29 – 35	1.99	1.87	1.95	2.14	2.04	2.00	13.18	0.95ns
	36 – 42	2.04	2.36	2.11	2.11	2.19	2.16	16.51	1.09ns
	1 – 42	1.67	1.70	1.69	1.70	1.72	1.70	4.74	0.24ns

[1] $\hat{Y} = 199.29 + 1.0955\ X - 0.0889\ X^2$ (r^2 = 58.76); [2] $\hat{Y} = 177.79 - 0.5306\ X$ (r^2 = 26.06).
* Significative at 5% of probability; ns – non-significant at 5% of probability.
F, value of the F test.

560.71, 615.11, 587.18, 587.62 and 2,925.66 g (Table 3). Guimarães (2007) observed no significant effect at the levels of 0, 2, 4, 6 and 8% guava waste in e laying hens feed on the laying percentage in the periods of 33 to 36 and 36 to 39 weeks and in all the experimental period from 30 to 39 weeks. This indicated that the synergic performance of the ether extract and crude fiber in the feed with the guava waste did not negatively influence the gastrointestinal transit and consequently improved the use of the nutrients for weight gain.

In the period from 1 to 7 days of age, the weight gain decreased (P>0.05) linearly and it was observed that for each 1% of guava waste inclusion, there was a decrease in the weight gain of 0.5306 g/bird/week (Table 3), that can be justified by the bird age, which is a factor that influences the digestion process and is related to maturation of the organs of the digestive system, including the production of digestive enzymes of the birds (Nitsan et al.,1991). After hatch, the digestive system of young birds is anatomically complete, thus, if compared with the adult birds, its functional capacity is considered immature, whereas, after eclosion, the organs of the digestive tract develop more rapidly. The intestine suffers great alteration in its functional maturation, such as the increase of the surface area of digestion and absorption and in the quantity and quality of the digestive secretions (Maiorka, 2000), which may have interfered in the use of the waste nutrients for weight gain of the birds in this phase and may have been further aggravated by the high crude fiber content (56.01%) of the guava waste that was difficult for the birds to use.

The levels of guava waste did not influence (P>0.05) the feed conversion in any of the experiment phases or in the total period from 1 to 42 days. The conversions rates observed were of 1.14, 1.31, 1.43, 1.60, 2.00, 2.16 and 1.70 for the phases from 1 to 7 days, 8 to 14 days, 15 to 21 days, 22 to 28 days, 29 to 35 days, 36 to 42 days and from 1 to 42 days, respectively (Table 3). Similarly, Guimarães (2007) did not observe the effect between the inclusion of guava waste levels of 0, 2, 4, 6 and 8%, in laying hen feed, on the feed conversion, in all the periods evaluated and in the total period of 30 to 39 weeks.

There were no differences (P>0.05) among the guava waste inclusion levels for absolute weight of the eviscerated carcass, eviscerated carcass without feet and head, the breast, drumstick and thigh; and for eviscerated carcass yield, eviscerated carcass without feet and head and the breast and drumstick, indicating that including guava waste in the feed did not interfere in these evaluated parameters, but showed respective averages for absolute gain of 2,624.40 g, 2,458.52 g, 778.00 g, 310.12 g and 368.60 g and for relative weights of 87.95%, 82.36%, 29.65% and 11.80% (Table 4).

Jácome et al. (2002) studied the effect of the inclusion of 0, 10 and 20% of coconut meal in the broiler chickens diet and did not observe significant differences on the yield of eviscerated carcass, eviscerated carcass without feet and head and the breast and drumstick of broiler chickens fed diet up to the 20% inclusion level of coconut waste, that has nutritional profile similar to guava waste.

There was a quadratic effect for weight at slaughter, so that the 12% guava waste level resulted in the maximum weight level, 3.074.17 g, while the inclusion level of 6% of the waste resulted in the minimum level, 2.922.11 g. There was linear effect for the thigh yield (P<0.05) and, for each 1% of guava waste inclusion, there was a decrease of 0.10% in yield (Table 4).

There was no difference (P>0.05) between the levels of guava waste for the absolute weights of wings and dorsum and for wing yield, back and abdominal fat (Table 5), thus guava waste inclusion in the feed did not interfere in these evaluated parameters, but showed averages for absolute weight of 220.40 g and 391.20 g, respectively, and for yield of 8.40; 14.9; and 2.66%, while, for the weight of abdominal fat, there was linear effect (P<0.05) and for each 1% guava waste, there was a 1.0703 g increase (Table 5). The increase in the weight of abdominal fat can be justified by the increase in the soybean oil content of the feeds, with the increase in the level of guava waste inclusion. Lima et al. (1996) stated that including soybean oil at levels of up to 3%, at maximum temperatures of 31.7 °C and minimum of 24.5 °C, increased the abdominal fat deposition in females in relation to eviscerated carcass without feet and head.

Jácome et al. (2002), in an experiment on the effect of including 0, 10 and 20% coconut meal in feed for broiler chickens, did not observe significant differences in the yield of wing, back and abdominal fat of broiler chickens fed with diet up to the 20% inclusion level of coconut waste, which has a nutritional profile similar to guava waste.

There were no differences (P>0.05) among the guava waste levels for the absolute weight and heart and liver yield, which showed respective averages for absolute weight of 14.55 g, 42.73 g and for relative weight of 0.56% and 1.62% (Table 6). However, waste inclusion in the diet had a linear effect (P<0.05) on the absolute weight and yield, which increased 0.8661 g and 0.0308% for each 1% of inclusion in the diet (Table 6).

The increase in the gizzard weight can be justified by higher particle sizes of the feed, resulting from increase in the guava waste levels, that consists mainly of seeds, that

Table 4 - Absolute weight at slaughter and absolute and relative weights of the eviscerated carcass, eviscerated carcass without feet and head and the prime cuts (breast, drumstick and thigh) of broiler chickens fed on feed with diverse levels of guava waste

Item	Guava waste level (%)					Average	CV	F
Absolute weight (g)	0	3	6	9	12		(%)	
Slaughter	3,018.41	2,939.22	2,922.11	2,967.10	3,074.17	2,984.20	3.87	5.07(1)
Carcass	2,641.00	2,583.50	2,613.00	2,590.50	2,694.00	2,624.40	4.49	0.72ns
Carcass without feet and head	2,473.00	2,416.10	2,418.20	2,420.10	2,565.20	2,458.52	5.34	1.19ns
Breast	790.20	770.00	775.80	753.20	800.80	778.00	5.02	1.11ns
Drumstick	315.00	313.00	304.00	306.40	312.20	310.12	6.12	0.30ns
Thigh	387.60	364.80	369.00	367.80	353.80	368.60	6.03	1.51ns
Relative weight (%)								
Carcass	87.11	89.14	87.83	88.20	87.45	87.95	1.62	1.52ns
Carcass without feet and head	81.57	83.37	81.24	82.38	83.25	82.36	2.56	1.03ns
Breast	29.91	29.81	29.71	29.06	29.75	29.65	3.14	0.65ns
Drumstick	11.75	12.10	11.64	11.83	11.60	11.65	5.01	0.58ns
Tight	14.66	14.36	14.05	13.74	13.43	14.05	4.13	14.08(2)

[1] $\hat{Y} = 3{,}018.41 - 36.746X + 3.4494X^2$, ($r^2 = 74.04\%$); [2] $\hat{Y} = 14.664 - 0.1025X$; ($r^2 = 72.85\%$).
* and **: Significant at 5 and 1% probability, respectively; ns – non-significant at 5% probability.
F - value of F test.

Table 5 - Values of absolute and relative weight of non-prime cuts (wing and dorsum) and abdominal fat in broiler chickens at 42 days of age fed on feed with diverse levels of guava waste

Parameter	Guava waste level (%)					Mean	CV	F
Absolute weight (g)	0	3	6	9	12		(%)	
Wing	224.40	213.40	218.20	222.40	223.60	220.40	7.20	0.42ns
Dorsum	392.40	388.00	380.20	374.60	420.80	391.20	7.62	1.81ns
Abdominal fat	63.31	66.52	69.73	72.94	76.15	69.73	14.68	4.92*(1)
Relative weight (%)								
Wing	8.52	8.26	8.37	8.58	8.28	8.40	6.91	0.31ns
Dorsum	14.83	15.02	14.56	14.46	15.63	14.90	6.04	1.33ns
Abdominal fat	2.30	2.70	2.70	2.80	2.80	2.66	14.80	1.37ns

[1] $\hat{Y} = 63.306 + 1.0703X$, ($r^2 = 82.78\%$); ns – non-significant at 5% probability.
F - value of F test.

Table 6 - Values of absolute and relative weights of edible viscera (heart, liver and gizzard) of broiler chickens at 42 days of age fed on feed containing diverse guava waste levels

Parameter	Guava waste level (%)					Means	CV	F
Absolute weight (g)	0	3	6	9	12		(%)	
Heart	14.22	13.90	15.10	14.84	14.71	13.35	13.72	0.29ns
Liver	44.73	43.43	42.50	41.48	41.50	41.83	16.35	0.19ns
Gizzard	33.38	35.97	38.57	41.17	43.77	38.57	9.25	26.51**(1)
Relative weight (%)								
Heart	0.54	0.54	0.58	0.57	0.55	0.56	13.05	0.34ns
Liver	1.69	1.68	1.62	1.60	1.53	1.62	13.90	0.39ns
Gizzard	1.28	1.38	1.47	1.56	1.65	1.47	9.85	20.35**(2)

[1] $\hat{Y} = 33.378 + 0.8661X$, ($r^2 = 76.80\%$); [2] $v = 1.2856 + 0.0308X$, ($r^2 = 67.31\%$).
**: Significant at 1% probability; ns – non-significant at 5% probability.
CV - coefficient of variation; F - value of F test.

can cause higher contractions of the gizzard muscles and promote greater muscular mass, because, according to Getty (1981), in the muscular stomach, the contractions were rhythmized and pressed on muscle, in an action of the gastric movements, helped by the presence of small stones (mainly sand, silica and granite), which result in a faster contraction of the musculature.

Conclusions

Guava waste can be used as an alternative ingredient in feed for broiler chickens in the period from 1 to 42 days, because, at levels of up to 12%, with no effect on the productive performance of the birds or the economic viability of the production.

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