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Nutritional composition, metabolizability coefficients and use of passion fruit pulp waste in the diet of meat quail

Composição nutricional, coeficientes de metabolizabilidade e utilização do resíduo da polpa do maracujá na alimentação de codornas de corte

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Highlights:
The inclusion of the waste in meat-quail diets is an alternative to its improper disposal.
The waste exhibited nutritional potential due to high nutrient values.
Passion fruit pulp waste can be included at up to 12% in the diet of meat quail.

Abstract

Two experiments were undertaken to evaluate the chemical composition and metabolizability coefficient of passion fruit pulp waste and its effect on the production performance of meat quail when included in their diet at different levels. In experiment I, a metabolism trial was conducted as a completely randomized design (CRD) involving 90 meat quail that received one of two treatments (control diet and test diet), with five replicates and nine birds per plot. To determine the metabolizability coefficients, the total collection method was performed from 18 to 21 days of age. In experiment II, 225 European quail were allotted to one of five treatments (0, 3, 6, 9 and 12% inclusion of passion fruit pulp waste) in a CRD with five replicates and nine birds per experimental unit. No significant differences were observed ($p>0.05$) for weight gain, feed intake, feed conversion or carcass yield between the different waste inclusion levels. The nutritional composition of the waste was 2,925.75 kcal AME/kg, 2,922.09 kcal AMEn/kg, 20.86% ether extract and 10.72% crude protein. Passion fruit pulp waste can be included up to 12% in the diet of meat quail from one to 42 days of age without affecting their production performance or carcass characteristics, and its use is economically viable.
Key words: Agroindustry. Alternative feedstuffs. Animal nutrition. Quail farming.

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Resumo

Dois experimentos foram conduzidos, para avaliar a composição química, coeficientes de metabolizabilidade do resíduo da polpa do maracujá (RPM) e seu efeito em diferentes níveis de inclusão na dieta sobre o desempenho de codornas de corte. No experimento I, foram utilizadas 90 codornas de corte, em ensaio de metabolismo, em um delineamento inteiramente casualizado (DIC), com dois tratamentos (ração referência e ração teste), cinco repetições e nove aves por parcela. Para determinar os coeficientes de metabolizabilidade foi utilizado o método de coleta total de excretas, dos 18 aos 21 dias de idade das aves. No experimento II, foram utilizadas 225 codornas europeias, em um delineamento inteiramente casualizado, com cinco tratamentos (0; 3; 6; 9 e 12% de inclusão do resíduo da polpa do maracujá), e cinco repetições com nove aves por unidade experimental. Não foram observadas diferenças significativas (p>0,05) para ganho de peso, consumo de ração, conversão alimentar e rendimento de carcaça nos diferentes níveis do resíduo. A composição nutricional do resíduo da polpa do maracujá foi de 2.925,75 kcal de EMA/kg, 2.922,09 kcal de EMAn/kg, 20,86% de extrato etéreo e 10,72% de proteína bruta e pode ser incluído até o nível de 12%, sem afetar o desempenho produtivo e características de carcaça, sendo o seu uso economicamente viável na formulação de dietas para codornas de corte de um a 42 dias de idade.

Palavras-chave: Agroindústria. Alimentos alternativos. Coturnicultura. Nutrição animal.

Introduction

Quail farming is a widespread activity around the world. The segment has been highlighted for its considerable growth over the years and entry in the meat production chain, where quail meat represents an excellent source of animal protein (Caetano et al., 2017). It is a highly productive activity due to the relatively fast animal growth, short production cycle, low initial investment and rapid financial return (Santos, Cunha, Silva, & Soares, 2017).

Feeding has been one of the most relevant factors in quail farming, where it accounts for approximately 70% of total production costs. Therefore, alternative feedstuffs must be studied to replace traditional ingredients such as corn and soybean meal, which are responsible for the elevated final expenses (Ibrahim, Sabuc, & Abu-Taleb, 2018).

Almeida et al. (2014) stated that the Brazilian food industry is one of the largest in the world, and this is especially true for the production and sale of fruits, whose processing generates wastes that are not used in human nutrition. These may consist of skin (hulls, husks, peel, rind, etc.), seeds, bagasse, among other parts, which contain nutrients that would enable them to be included in animal diets as a way to lower production costs without compromising animal performance (Fachinello et al., 2016).

Passion fruit stands out in this scenario, as only 23.50% of the fruit are used in juice making and the remaining 76.50% are waste composed of peel and seeds, which are good sources of essential fatty acids, carbohydrates, proteins and minerals. Brazil is the biggest producer and consumer of passion fruit worldwide (Reis et al., 2015). The improper disposal of this material causes environmental pollution, and an alternative destination to the numerous tons produced would be of great economic, scientific and technological interest (Ferrari, Colussi, & Ayub, 2004; Salemdeeb, Ermgassen, Kim, Balmford, & Al-Tabbaa, 2017).

Before being used in animal diets, agro-industrial wastes must be chemically evaluated, since there may be considerable nutritional variations (Adeola & Ileleji, 2009). Fachinello et al. (2016) investigated the nutritional composition of passion fruit seed meal for meat quail and found 5,569 kcal/kg gross energy, 11.34% crude protein and 18.84% ether extract. Zanetti et al. (2017) evaluated the effects of including passion fruit seed waste at different levels in broiler-hen diets and observed that, in the period of one to 42 days of age, levels up to 12.5% did not compromise carcass yield.

The present study thus proposes to examine the nutritional and energy compositions and metabolizability coefficients of passion fruit pulp waste and its effect when used at different levels in the diet of meat quail from one to 42 days of age.

Material and Methods

The experiment was developed at the Quail Farming Section at CECA/UFAL, located in Rio Largo - LA, Brazil. All procedures were approved by the Ethics Committee on Animal Use at the Federal University of Alagoas (approval no. 12/2018). The study was supported by the Coordination for the Improvement of Higher Education Personnel (Funding code 001).

Experiments

Experiment I - (Composition of passion fruit pulp waste and metabolizability coefficients)

The passion fruit pulp waste (composed mainly of seeds, with small fractions of pulp) was provided by the juice and ice cream company Fika Frio® (Maceió - AL, Brazil), after the pulp was extracted. The material was dried in the sun and stirred every two hours, for five days. After grinding, the waste was stored in an adequate place until it was incorporated into the experimental diets.

To determine the chemical composition of passion fruit pulp, the concentrations of dry matter (DM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), ether extract (EE), mineral matter (MM) and gross energy (GE) were analyzed following the methodology of D. J. Silva & Queiroz (2006). The analyses took place at the Laboratory of the Federal University of Paraíba.

Ninety non-sexed quail were used for the metabolism trial. The quail were allotted to one of two treatments in a completely randomized design with five replicates and nine birds per experimental unit. The treatments consisted of a corn- and soybean meal-based control diet (Table 1) formulated to meet the nutritional requirements of European quail as recommended by J. H. V. Silva and Costa (2009) and a test diet (control diet with 12% of its content replaced with passion fruit pulp waste).

The experimental period was nine days, which consisted of five days of acclimation followed by five days of excreta collection (18 to 21 days of age), during which period the animals had water and experimental diets freely available. The total excreta collection method was applied, which involved the use of 1% ferric oxide in the feed to mark the start and end of collections, as described by Sibbald and Slinger (1963). To collect the excreta, trays (part of the cage set) were lined with plastic and placed under each compartment to individualize the material and prevent contamination and losses. The collected excreta were weighed and packed in labeled plastic bags which were then preserved in a freezer at -18 ºC. At the end of the experimental period, the samples were homogenized, dried in a forced-air oven (55 ºC and 72 h) and ground for later analysis.

The amount of feed consumed and the total excreta produced per experimental unit were measured. Chemical analyses of diets and excreta took place at the Animal Nutrition Laboratory at the Federal University of Paraíba, according to the methodologies described by D. J. Silva and Queiroz (2006).

The metabolizability coefficients of DM, CP, EE, NDF and ADF were calculated by using formulae proposed by Matterson, Potter, Stutz and Singsen (1965). The apparent metabolizable energy (AME) and nitrogen-corrected AME (AMEn) values of the diets and of the waste were calculated based on the results from the laboratory analyses of diets and excreta. Data were subjected to analysis of variance (α=0.05) using R Core Team (2016) software.

Table 1
Control diet

Ingredient (%)	Control diet
Corn	55.631
Soybean meal (45%)	39.380
Passion fruit waste	0.000
Soybean oil	1.556
Dicalcium phosphate	1.183
Limestone	1.004
Common salt	0.342
DL-methionine	0.232
L-lysine HCl	0.226
L-threonine	0.143
Vitamin supplement[1]	0.100
Mineral supplement[2]	0.050
BHT	0.050
Zinc bacitracin	0.050
Cygro®	0.050
Total	**100.00**
Calculated composition	
Met. energy Poultry (Kcal/kg)	2.950
Crude protein (%)	23.00
Total calcium (%)	0.750
Available phosphorus (%)	0.350
Sodium (%)	0.160
Digestible methionine (%)	0.530
Digestible lysine (%)	1.300
Digestible threonine (%)	0.900

Note: [1]Provides per kilogram: vit. A 13,440.000 IU; vit. D 3,200.000 IU vit. E 28,000 mg/kg; vit. K 2,880 mg/kg; thiamin 3,500 mg/kg; riboflavin 9,600 mg/kg; pyridoxine 5,000 mg/kg; cyanocobalamin 19,200 mcg/kg; folic acid 1,600 mg/kg; pantothenic acid 25,000 mg/kg; niacin 67,200 mg/kg; biotin 80,000 mcg/kg; antioxidant 0.40 g/kg. [2]Provides per kilogram: Mg 150,000 ppm; Zn 140,000 ppm; Fe 100,000 ppm; Cu 16,000 ppm; Se 600 ppm; I 1,500 ppm.

Experiment II – (Performance, carcass characteristics and economic viability)

A total of 225 non-sexed European quail (*Coturnix coturnix*) were housed in cages in a battery system from one to 42 days of age. Each cage was equipped with trough feeders, siphon drinkers and excreta-collection trays. The birds were allotted to one of five treatments (0, 3, 6, 9 or 12% inclusion of passion fruit pulp waste) in a completely randomized design with five replicates and nine birds per plot.

The experimental diets (Table 2) were corn- and soybean meal-based and formulated to meet the nutritional requirements of European quail as recommended by J. H. V. Silva and Costa (2009). The inclusion of passion fruit pulp waste in the diets was based on the values obtained in the metabolism trial.

Climatic variables were recorded daily, at 08h00 and 16h00. The following mean values were detected: maximum temperature 27.55 °C, minimum temperature - 26.05 °C, relative humidity

- 77%; black globe humidity index (calculated using the formula proposed by Buffington et al. (1981)) - 76.11%.

Weight gain, feed intake and feed conversion were evaluated in the periods of one to 21 days, 22 to 42 days and one to 42 days of age. At 42 days of age, two quail (one male and one female) with the average live weight of each experimental unit were selected and deprived of solid feed for six hours. After this period, they were slaughtered, plucked and eviscerated. Subsequently, their carcasses were sectioned into cuts, which were then weighed. The following variables were measured: slaughter weight (g) and absolute (g) and relative (g) weights of carcass, prime cuts (breast and legs) and edible offal (heart, liver and gizzard).

Table 2
Centesimal and calculated composition of the experimental diets

Ingredient (%)	Passion fruit pulp waste inclusion level (%)				
	0.0	3.0	6.0	9.0	12.0
Corn	55.631	52.627	49.622	46.617	43.612
Soybean meal (45%)	39.380	39.131	38.880	38.629	38.378
Passion fruit waste	0.000	3.000	6.000	9.000	12.000
Soybean oil	1.556	1.769	1.983	2.196	2.409
Dicalcium phosphate	1.183	1.199	1.215	1.231	1.247
Limestone	1.004	0.992	0.981	0.969	0.957
Common salt	0.342	0.345	0.347	0.349	0.352
DL-methionine	0.232	0.238	0.245	0.251	0.257
L-lysine HCl	0.226	0.242	0.259	0.275	0.291
L-threonine	0.143	0.156	0.170	0.183	0.197
Vitamin supplement[1]	0.100	0.100	0.100	0.100	0.100
Mineral supplement[2]	0.050	0.050	0.050	0.050	0.050
BHT	0.050	0.050	0.050	0.050	0.050
Zinc bacitracin	0.050	0.050	0.050	0.050	0.050
Cygro®	0.050	0.050	0.050	0.050	0.050
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated composition					
Met. energy Poultry (Kcal/kg)	2.950	2.950	2.950	2.950	2.950
Crude protein (%)	23.00	23.00	23.00	23.00	23.00
Total calcium (%)	0.750	0.750	0.750	0.750	0.750
Available phosphorus (%)	0.350	0.350	0.350	0.350	0.350
Sodium (%)	0.160	0.160	0.160	0.160	0.160
Digestible methionine + cystine (%)	0.940	0.940	0.940	0.940	0.940
Digestible methionine (%)	0.530	0.530	0.530	0.530	0.530
Digestible lysine (%)	1.300	1.300	1.300	1.300	1.300
Digestible threonine (%)	0.900	0.900	0.900	0.900	0.900

Note: [1]Provides per kilogram: vit. A 13,440.000 IU; vit. D 3,200.000 IU vit. E 28,000 mg/kg; vit. K 2,880 mg/kg; thiamin 3,500 mg/kg; riboflavin 9,600 mg/kg; pyridoxine 5,000 mg/kg; cyanocobalamin 19,200 mcg/kg; folic acid 1,600 mg/kg; pantothenic acid 25,000 mg/kg; niacin 67,200 mg/kg; biotin 80,000 mcg/kg; antioxidant 0.40 g/kg. [2]Provides per kilogram: Mg 150,000 ppm; Zn 140,000 ppm; Fe 100,000 ppm; Cu 16,000 ppm; Se 600 ppm; I 1,500 ppm.

An economic analysis was carried out considering the changes in live weight, feed intake and diet costs, in accordance with the methodology described by Lana (2000). The prices of ingredients referred to the period during which the experiment was conducted in 2018. At the said time, the 1-day-old quail was purchased for BRL 1.40 and its sale at the end of the period was estimated at BRL 16.00/kg of slaughtered quail.

The following ingredient prices (kg) were adopted in the calculation of diet costs: corn - BRL 0.83; soybean meal - BRL 1.56; passion fruit waste - BRL 0.15; dicalcium phosphate - BRL 6.00; calcitic limestone - BRL 0.89; salt - BRL 1.00; soybean oil - BRL 3.89; DL-methionine - BRL 25.00; L-lysine - BRL 8.89; L-threonine - BRL 12.00; vitamin supplement - BRL 15.00; mineral supplement - BRL 10.00; zinc bacitracin - BRL 15.00; Cygro® - BRL 18.50; and BHT - BRL 36.75.

The variables were analyzed statistically using R Core Team (2016) software. Results were subjected to analysis of variance at the 5% probability level.

Results and Discussion

Experiment I - (Composition of passion fruit pulp waste and metabolizability coefficients)

The passion fruit pulp waste (Table 3) showed a DM content of 93.95% and a DM metabolizability coefficient of 47.96%. According to Lousada et al. (2006), the DM content of passion fruit pulp waste may vary according to the time of exposure for drying and to storage conditions.

Table 3
Chemical and energy composition and metabolizability coefficients of the nutrients in passion fruit pulp waste

Analyzed component	Value
Dry matter (%)	93.95
Crude energy (kcal/kg)	5,595.48
Apparent metabolizable energy (kcal/kg)	2,925.75
Nitrogen-corrected apparent metabolizable energy (kcal/kg)	2,922.09
Crude protein (%)	10.72
Ether extract (%)	20.86
Neutral detergent fiber (%)	63.29
Acid detergent fiber (%)	60.77
Mineral matter (%)	1.71
Organic matter (%)	92.24
Metabolizability coefficient	
Dry matter (%)	47.96
Crude protein (%)	30.11
Ether extract (%)	90.31
Neutral detergent fiber (%)	39.25
Acid detergent fiber (%)	34.34
Nitrogen-corrected apparent metabolizable energy (%)	59.03

The energy value of the test ingredient was 5,595.48 kcal/kg. This high GE content is likely related to the high EE content (20.86%) as well as the elevated metabolizability coefficient of EE (90.31%) found in this study.

Passion fruit pulp waste showed 2,925.75 kcal/kg AME and 2,922.09 kcal/kg AMEn and an AMEn metabolizability coefficient of 59.03%. These values are similar to the 2,976.00 kcal/kg AME and 2,939.00 kcal/kg AMEn described by Fachinello et al. (2016) in passion fruit seed meal for meat quail.

The CP content and the metabolizability coefficient of CP in passion fruit pulp waste were 10.72 and 30.11%, respectively. This CP content is lower than the 12.40% found by Malacrida and Jorge (2012) in the nutritional composition of passion fruit seeds.

Neutral and acid detergent fiber contents in the meal were 63.29 and 60.77%, respectively. It is important to consider that high fiber contents in quail diets are undesirable, since non-ruminants do not secrete enzymes capable of hydrolyzing β-bonds, which might affect the passage time of digesta through the intestine (Ao, Cantor, Pescatore, Pierce, & Dawson, 2009).

The passion fruit pulp waste showed a MM content of 1.71%, which is higher than the 1.40% found by Togashi et al. (2008) in seeds of passion fruit. These differences in MM values may be linked to characteristics pertaining to the soil and fertilization used in the cultivation of the fruit, since mineral nutrition is an important factor in the quality of passion fruit (Aular, Casares, & Natale, 2014).

There was no significant difference ($p>0.05$) for AME, AMEn (Table 4), or the metabolizability coefficients of DM, CP, EE, NDF, ADF and GE. These findings demonstrate that there were similarities between the treatments including 0 and 12% of the waste.

Table 4
Metabolizability coefficients of control diet and diet containing 12% passion fruit pulp waste

Variable	Passion fruit pulp waste inclusion level			
	0%	12%	p	CV (%)
AME	3,389.97	3,515.33	0.26	4.71
AMEn	3,371.57	3,495.32	0.27	4.76
DM	67.55	67.07	0.86	6.08
CP	50.08	51.58	0.72	12.82
EE	80.59	84.51	0.06	3.31
NDF	26.94	31.42	0.06	10.55
ADF	17.97	20.06	0.21	12.64
GE	74.73	75.15	0.80	3.35

AME - Apparent metabolizable energy; AMEn - nitrogen-corrected apparent metabolizable energy; DM - dry matter; CP - crude protein; EE - ether extract; NDF - neutral detergent fiber; ADF - acid detergent fiber; GE - gross energy.
CV (%) – coefficient of variation; p - P-value.

High amounts of fiber reduce the total diet digestibility, leading birds to increase their feed intake in order to meet their nutritional needs (Zanetti et al., 2017). Conversely, Hetland, Svihus, & Choct (2005) described that, at appropriate levels in diets, fiber tends to prolong the retention time of digesta in the upper part of the gastrointestinal tract, stimulating the development of the gizzard and production of endogenous enzymes, thereby improving the digestibility of starch, lipids and other compounds, which was confirmed in the current study.

Experiment II – (Performance, carcass characteristics and economic viability)

Regarding the utilization of the by-product, no significant difference was observed ($p>0.05$) for feed intake, weight gain or feed conversion in the evaluated periods (Table 5) between the inclusion levels of 0 and 12%. These findings show that the quail fed diets containing passion fruit pulp waste did not have their performance compromised, as the results were similar to those observed in the group fed the basal diet. Similar results were reported by Togashi et al. (2008), who examined the performance of broiler hens from one to 42 days of age fed diets containing 4 or 8% passion fruit peel and seed separately. Those authors found that performance was not compromised up to the inclusion of 8% passion fruit seeds in the diet.

According to Zanetti et al. (2017), the high soluble-fiber contents of the waste (60.77% ADF) may increase the viscosity of digesta in the small intestine, reducing digestibility and nutrient absorption and slowing peristalsis. Moreover, birds may increase their feed intake in an attempt to meet any occasional nutrient deficiency, which was not the case in the present study. This suggests that, despite the inclusion of passion fruit pulp waste, the diets satisfactorily met the quail's nutritional requirement, maintaining their performance at adequate levels.

On these bases, the high EE values in the passion fruit pulp waste (20.86%) might have acted synergistically with the fiber, preventing it from having a negative effect on the gastrointestinal epithelium. The increased retention time of digesta may improve digestive tract functioning, thereby benefiting nutrient digestibility without, however, reducing the animals' production performance (Jiménez-Moreno, González-Alvarado, González-Sánchez, Lázaro, & Mateos, 2010).

Table 5
Feed intake (FI), weight gain (WG) and feed conversion (FC) of meat quail fed diets with different levels of passion fruit pulp waste

	Passion fruit pulp waste inclusion level (%)					
Variable	**0.0**	**3.0**	**6.0**	**9.0**	**12.0**	**p**	**CV (%)**
			01 to 21 days of age				
FI	265.29	266.86	268.85	276.89	270.09	0.17	2.80
WG	138.49	140.79	141.42	146.27	141.63	0.23	3.61
FC	1.92	1.90	1.90	1.89	1.91	0.93	2.42
			22 to 42 days of age				
FI	624.97	629.97	620.03	671.60	655.45	0.15	5.59
WG	127.87	129.48	121.75	135.35	135.23	0.65	12.43
FC	4.91	4.92	5.12	5.00	4.89	0.90	8.05
			01 to 42 days of age				
FI	890.26	896.83	888.87	948.49	925.54	0.11	4.40
WG	266.35	270.27	263.16	281.61	276.86	0.54	6.98
FC	3.34	3.34	3.38	3.37	3.35	0.95	3.61

p - P-value; CV (%) - coefficient of variation.

The absolute and relative weights of carcass, prime cuts (breast and legs) and edible offal (heart, liver and gizzard) of the quail at 42 days of age (Table 6) were not influenced (p>0.05) by the passion fruit pulp waste inclusion levels. This lack of significant differences is an expected result, considering that there was no significant effect in the metabolism trial (Experiment I). It is also expected when the tested diets are isonutritive and when the nutritional value of the feedstuff is properly analyzed (Freitas, Fuentes, Santos, Guerreiro & Espíndola, 2006), demonstrating that protein deposition in the birds' body was satisfactory up to the level of 12%.

Table 6
Absolute weight (g) and relative weights (%) of carcass, prime cuts and edible offal of meat quail fed diets with different levels of passion fruit pulp waste

Variable	**Passion fruit pulp waste inclusion level**						
Absolute weight (g)	**0%**	**3%**	**6%**	**9%**	**12%**	**p**	**CV (%)**
Slaughter weight	263.80	266.10	262.80	278.20	272.80	0.37	5.12
Carcass	199.99	200.16	195.32	209.32	206.09	0.37	5.73
Breast	79.90	83.45	78.42	85.02	85.10	0.27	7.01
Legs	42.38	41.36	43.46	44.93	42.67	0.55	7.82
Heart	2.26	2.18	2.20	2.25	2.02	0.07	6.22
Liver	5.45	5.23	4.96	4.97	5.24	0.77	13.38
Gizzard	4.64	4.76	4.34	5.10	4.65	0.15	9.48
Relative weight (%)^{NS}							
Carcass	75.77	75.22	74.32	75.28	75.53	0.71	2.24
Breast	39.88	41.71	40.15	40.63	41.29	0.24	3.41
Legs	21.19	20.65	22.06	21.45	20.69	0.07	3.85
Heart	1.13	1.09	1.13	1.08	1.00	0.07	6.51
Liver	2.74	2.61	2.54	2.37	2.56	0.66	15.16
Gizzard	2.33	2.38	2.23	2.44	2.25	0.44	8.64

CV(%) - coefficient of variation; p - P-value.

The passion fruit pulp waste inclusion level of 12% reduced the diet cost by BRL 0.04, compared to the treatment without its addition (Table 7). The average gross revenue indicated that the treatments including 9 and 12% of the waste generated the highest financial return: BRL 4.50/quail and BRL 4.43/quail, respectively. The average gross margin of the diet containing 12% of waste was BRL 1.80/quail, representing a financial return of BRL 0.17/quail, in comparison with 0% of inclusion (BRL 1.63/quail), which means a 10.25% increase according to the relative gross margin.

The average profitability indicates that the return obtained with each unit of BRL spent per kilogram of the diet consumed by the quail was highest at the inclusion level of 12.0% (46.56%), which provided an average profitability index of 9.48%.

Table 7
Economic viability of passion fruit pulp waste inclusion levels

	Economic variable[1]								
Level (%)	ALW (kg/quail)	AFI (kg/quail)	DC (BRL/kg)	AFC (BRL/quail)	AGR (BRL/quail)	AGM (BRL/quail)	RGM (%)	AP (%)	RPI (%)
0.0	0.266	0.890	1.37	1.22	4.26	1.63	100.00	133.87	100.00
3.0	0.270	0.897	1.36	1.22	4.32	1.70	103.91	139.10	103.91
6.0	0.263	0.889	1.35	1.20	4.21	1.61	98.31	133.83	99.97
9.0	0.281	0.948	1.34	1.27	4.50	1.83	111.67	143.70	107.34
12.0	0.277	0.925	1.33	1.23	4.43	1.80	110.25	146.56	109.48

[1]ALW - average live weight; AFI - average feed intake; DC - diet cost; AFC - average feeding cost; AGR - average gross revenue; AGM - average gross margin; RGM - relative gross margin; AP - average profitability; and RPI - relative profitability index.

Conclusions

The nutritional composition of passion fruit pulp waste included 2,925.75 kcal AME/kg, 2,922.09 kcal AMEn/kg, 20.86% ether extract and 10.72% crude protein, which demonstrate its excellent potential for inclusion in the diet of meat quail.

Passion fruit pulp waste can be included up to 12% in the diet of meat quail from one to 42 days of age without affecting their production performance or carcass characteristics, and its use is economically viable.

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