



AGRARIAN SCIENCES

Pasta waste in the feeding of meat quail

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Abstract: This study was undertaken to investigate the performance, carcass characteristics, and economic viability of diets including pasta waste in meal form (PWM) for quail. A total of 450 unsexed meat quail (*Coturnix coturnix coturnix*) were distributed into five treatments (0, 10, 20, 30, and 40% inclusion of PWM) in a completely randomized design with six replicates, each with 15 birds. The following rearing periods were evaluated: Phase 1 - 1 to 21 days; and period of 1 to 42 days. In Phase 1, the PWM levels did not influence feed intake (FI), and the PWM inclusion levels for optimal weight gain (WG) and feed conversion (FC) were estimated at 20.70% and 22.8%, respectively. In the cumulative period of 1 to 42 days, the PWM levels did not lead to differences in FI, WG, or FC. The yields of carcass and cuts were not influenced by the treatments; however, abdominal fat yield decreased as the PWM levels in the diets were increased. Economic analysis showed a reduction of the feeding cost in the studied phases. Pasta waste meal can be included up to the level of 40% without incurring losses in the performance or carcass yield of meat quail.

Key words: alternative feedstuff, by-products, carcass characteristics, economic analysis, performance.

INTRODUCTION

Feeding represents the largest share of expenditures in the production of quail, since the main basis of their diet are corn and soybean meal, the most costly ingredients. In this scenario, to minimize feeding costs, the use of alternative ingredients in the diet of quail has been a frequent object of research. Among the tested feedstuffs, the waste resulting from losses that occur during the production of pasta or parts of it that are not sold by the food industry may constitute a good alternative to compose quail diets, from the nutritional and economic points of view.

The composition of pasta waste as is includes 88.47% dry matter, 3543 kcal/kg

nitrogen-corrected apparent metabolizable energy (AMEn), 12.66% crude protein, 0.09% ether extract, 0.08% calcium, and 0.27% phosphorus (Silva et al. 2012a). In terms of amino acids, the ingredient contains 0.21% lysine, 0.17% methionine, 0.44% methionine + cystine, 0.25% threonine, 0.43% arginine, 0.41% valine, 0.37% isoleucine, 0.76% leucine, and 0.23% histidine (Silva et al. 2012b) for chickens. The AMEn and digestible amino acid values described above are higher than those found in corn (7.88% CP), which has 3364 kcal AMEn/kg, 0.19% lysine, 0.15% methionine, 0.29% methionine + cystine, 0.29% threonine, 0.34% arginine, 0.31% valine, and 0.24% isoleucine (Rostagno et al. 2017).

Pasta waste inclusion levels up to 20% did not affect the production performance or

carcass characteristics of free-range chickens in a study led by Paes et al. 2015 and Omele et al. 2013a substituted 0, 25, 50, 75, and 100% of corn for pasta waste in the diet of chickens during the starter phase and showed that replacing up to 75% of the dietary corn does not affect their feed intake, weight gain, or feed conversion, and reduces the feeding cost. In another study, Omele et al. 2013b recommended partial or total substitution of corn for pasta waste, as the latter ingredient does not compromise performance and improves the economic viability of feeding chickens in the starter phase. Experiments with chickens and turkeys have been conducted by Akinola & Ekine 2014 and Ironkwe et al. 2015, however studies with quail no have been found in the literature.

Therefore, the present study was carried out to examine the effect of including pasta waste in meal form (PWM) in diets for meat quail on their performance and carcass characteristics and on the economic viability of this feeding strategy.

MATERIALS AND METHODS

The experiment was developed in the Laboratório de Avicultura do Departamento de Zootecnia da Universidade Federal Rural de Pernambuco, located in Recife - PE, Brazil, after approval of the Ethics and Biosafety Committee of the institution (approval no. 087/2016).

A total of 450 unsexed European quail (*Coturnix coturnix coturnix*) at one day of age, with an average weight of 9.37 ± 0.09 g, were housed in 0.5024-m^2 , 50-cm-high circles covered with a plastic screen (to prevent their escape). The circles were equipped with a cup drinker with 2-L capacity and a tray feeder (26 cm wide \times 1 cm high) covered with a screen (used until 14 days), which was replaced by a trough feeder on the second week. Wood shavings were used

as bedding material, in a thickness of 5 cm. A 40-W incandescent light bulb was placed in the center of each circle to heat the chicks during the first days of life. The circles were arranged in four rows in a room measuring 4 m (width) \times 8 m (length) equipped with air conditioners and exhaust fans. Temperature and air relative humidity data were recorded daily by thermo-hygrometers. Table I describes the average weekly temperature and air relative humidity values.

The quails were distributed into five treatments in a completely randomized design with six replicates with 15 birds per experimental unit. All units were designed to have a uniform average weight. The treatments consisted of a diet without PWM inclusion (0%) and four diets including 10, 20, 30, or 40% PWM. The tested ingredient, spaghetti waste meal, was received in its whole form and then ground through a hammer mill with a 2-mm sieve. Samples of ground PWM, corn grain, and soybean meal, which were used in the diets, were harvested and sent to the laboratory of nutrition for the analysis of some components. The pasta waste meal contained 88.62% dry matter (DM), 10.54% crude protein (CP), 1.83% crude fiber, and 0.50% ash, in the fresh matter. The CP contents of corn and soybean meal were 7.86% and 45.9%, respectively.

The experimental diets (Table II) were formulated according to the nutritional requirements suggested by Silva & Costa 2009, and the ingredient composition followed the recommendations of Rostagno et al. 2011, except for the CP in PWM, for which the previously mentioned value of 10.54% was used.

Performance, carcass characteristics, and the economic viability of using PWM in the diets were evaluated. For the performance assessment, all birds and ortos were weighed every seven days to calculate feed intake (FI),

Table I. Means and standard deviations for weekly temperature and air relative humidity.

Week	Temperature (°C)		Air relative humidity (%)	
	Maximum	Minimum	Minimum	Maximum
1 st	33.30±0.96	30.61±1.10	58.29±3.00	53.07±3.05
2 nd	32.96±0.53	29.45±0.91	63.43±4.47	52.93±2.34
3 rd	32.61±1.18	27.58±0.71	67.07±2.71	54.07±1.46
4 th	32.03±1.65	26.96±0.73	64.93±2.71	53.64±1.21
5 th	30.90±0.70	26.33±1.14	66.36±3.11	54.07±2.07
6 th	30.15±0.72	25.13±0.56	64.88±1.83	53.55±0.92

Source: developed by the authors.

weight gain (WG), and feed conversion (FC). Feed conversion was determined by dividing FI by WG.

For the economic evaluation, the cost per kilogram of each diet (CDT) used in Phases 1 and 2 was calculated based on the prices of ingredients described in Table I. In addition to the costs of the diets, we also calculated the average feeding cost in Phase 1 (AFCPI); total average feeding cost (TAFC); average gross margin (AGM); and average gross rate of return (AR), according to formulae described by Lana 2000:

$$1. AFCPI = (INT * CDT);; 2. TAFC = INT * CDT$$

$$3. AGM = AGR - TAFC; 5. AR = \frac{AGM}{AGR} * 100$$

Where:

INT = feed intake in each phase; AGR = price paid per kilo, charged in the supermarkets during the course of the experiment (R\$ 19.93).

The evaluated variables were subjected to analysis of variance at the 5% probability level. When the means were significant, the broken-line model with two slopes, described by Robbins et al. (1979), was applied for weight gain and feed conversion, or a regression analysis was performed for the economic variables,

using Statistical Analyses System version 9.0 (SAS 2004).

The statistical model below was applied:

$$y_{ik} = \mu + T_i + \epsilon_{ik}$$

Where:

y_{ik} = studied variable, referring to treatment i ; μ = overall mean of the characteristics; T_i = effect of the different levels of pasta waste meal ($i = 0, 10, 20, 30,$ and 40%); and ϵ_{ik} = random error associated with each observation.

RESULTS

Table III shows the results of performance variables. In Phase 1, the PWM inclusion levels of 10, 20, 30, and 40% in the diets did not influence feed intake (FI). However, a better response was observed for weight gain (WG) at the PWM inclusion level of 20.78% ($\hat{Y} = 141.20 + 0.1899 * (20.78 - X) + 0.1899 * (X - 20.78)$), and a lower feed conversion (FC) was seen at the PWM inclusion level of 22.81% ($\hat{Y} = 1.92 + 0.0008 * (22.81 - X) + 0.0008 * (X - 22.81)$). In the cumulative period of 1 to 42 days, there were no significant differences for FI, WG, or FC.

Table II. Price of ingredients and diet composition and cost.

Ingredient	Cost of ingredient ²	Phase 1 - 01 to 21 days					Phase 2 - 22 to 42 days				
	R\$/kg	PWM inclusion level (%)					PWM inclusion level (%)				
		0	10	20	30	40	0	10	20	30	40
Corn (grain)	0.54	48.33	39.85	31.36	22.88	13.77	55.27	46.72	38.18	29.63	21.09
Soybean meal	1.48	45.73	44.80	43.86	42.92	42.10	38.71	37.85	36.98	36.12	35.25
PWM	0.45	0.00	10.00	20.00	30.00	40.00	0.00	10.00	20.00	30.00	40.00
Soybean oil	3.30	2.32	1.69	1.06	0.43	0.02	3.39	2.78	2.17	1.56	0.95
Calcitic limestone	0.20	1.26	1.25	1.24	1.23	1.22	1.03	1.03	1.02	1.01	1.00
Dicalcium phosphate	3.46	1.03	1.04	1.05	1.06	1.08	0.82	0.83	0.84	0.85	0.86
Common salt	1.00	0.38	0.38	0.39	0.39	0.39	0.33	0.33	0.33	0.34	0.34
DL-methionine	26.80	0.39	0.39	0.39	0.39	0.38	0.21	0.20	0.20	0.20	0.20
L-threonine	7.74	0.21	0.23	0.25	0.26	0.28	0.03	0.04	0.06	0.07	0.09
L-lysine	8.28	0.13	0.16	0.19	0.22	0.24	0.00	0.00	0.00	0.00	0.00
Vit./min. premix ¹	14.44	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Coccidiostat	9.52	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Inert (sand)	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00
Total		100	100	100	100	100	100	100	100	100	100
Cost per kg of diet (R\$)		1.214	1.183	1.151	1.119	1.093	1.100	1.067	1.034	1.001	0.968
Calculated nutritional (%) and energy composition											
AMEn (kcal/kg)		2900	2900	2900	2900	2900	3050	3050	3050	3050	3050
Crude protein		25.00	25.00	25.00	25.00	25.00	22.00	22.00	22.00	22.00	22.00
Calcium		0.85	0.85	0.85	0.85	0.85	0.70	0.70	0.70	0.70	0.70
Available phosphorus		0.32	0.32	0.32	0.32	0.32	0.27	0.27	0.27	0.27	0.27
Met. + cys., dig.		1.04	1.04	1.04	1.04	1.04	0.80	0.80	0.80	0.80	0.80
Lysine, dig.		1.37	1.37	1.37	1.37	1.37	1.10	1.08	1.06	1.04	1.02
Threonine, dig.		1.04	1.04	1.04	1.04	1.04	0.78	0.78	0.78	0.78	0.78
Tryptophan, dig.		0.29	0.29	0.29	0.29	0.29	0.25	0.25	0.25	0.26	0.26
Sodium		0.17	0.17	0.17	0.17	0.17	0.15	0.15	0.15	0.15	0.15
Chloride		0.28	0.28	0.27	0.26	0.26	0.25	0.24	0.24	0.23	0.23
Potassium		1.02	0.92	0.74	0.43	0.45	1.12	1.03	0.84	0.47	0.56

Table II. Continuation

Fat		4.84	4.01	3.18	2.34	1.70	6.05	5.23	4.41	3.59	2.78
Fiber		3.26	3.19	3.13	3.06	2.99	3.01	2.94	2.88	2.82	2.75
Analyzed composition (%)											
Dry matter		89.58	89.55	89.45	89.67	90.56	89.88	89.79	89.94	89.94	89.86
Gross energy (kcal/kg)		4119	4021	3940	3954	3906	4175	4112	4100	4175	4009
Crude protein		25.00	24.96	25.50	24.90	25.00	23.11	23.45	22.97	23.44	22.53
Ether extract		4.65	3.70	2.70	1.76	1.04	5.51	4.94	4.27	3.67	2.46
Ash		5.67	5.51	5.10	5.39	5.66	4.86	4.74	4.50	4.63	4.38

Carcass characteristics are described in Table IV. The PWM inclusion levels did not influence the hot carcass weights or the yields of hot carcass, breast, drumstick + thigh, wings, back, heart, liver, or gizzard. However, abdominal fat yield declined linearly ($Y = 1.9694 - 0.02449X$, $R^2 = 0.64$).

Table V presents the results obtained in the economic analysis of the use of PWM in quail diets. In Phase 1 and in the cumulative period, feeding costs improved, according to the following equations: reduction in AFC Phase 1, $\hat{Y} = 0.3324 - 0.0006X$; reduction in Total AFC, $\hat{Y} = 0.94817 - 0.0021X$. The cost in R\$/kg of carcass, average gross margin, and average rate of return did not differ significantly.

DISCUSSION

The PWM inclusion levels estimated at 20.70 and 22.8% for optimal WG and FC to the phase 1 (Table III) may be associated with the better utilization of the energy from the diets. The starch present in pasta may be in gelatinized form; i.e., the molecule is expanded due to the breakage of hydrogen bonds resulting from the drying process of this feedstuff at high temperatures for long periods. According to Svihus et al. 2005 and Svihus 2014, in this form, the starch is more

susceptible to the action of amylolytic enzymes in the digestive tract, which allows for a better utilization thereof in comparison with its non-gelatinized structure.

The insignificant results in the cumulative period of 1 to 42 days are explained by the facts that PWM does not carry anti-nutritional factors that might affect animal performance; has an energy and protein composition of 3543 kcal/kg AMEn and 12.66% CP; and has a digestible amino acid percentage similar to that of corn Silva et al. 2012a, b. These characteristics favored the formulation of balanced diets for the different treatments, which met the nutritional requirements of the quail despite the withdrawal of part of the corn from the diet for the inclusion of PWM.

Our findings corroborate the data reported by Baghbanzafar et al. 2013, who used 0, 10, 20, or 30 kg pasta meal per 100 kg of diet and did not observe alterations in the feed intake, weight gain, or feed conversion in broilers. Similar results were found Omele et al. 2013a, who reported no alterations in the weight gain or feed conversion of broilers fed diets containing 0, 24, and 36 kg pasta waste per 100 kg.

The PWM inclusion levels did not influence the carcass weight or the yields of hot carcass, breast, drumstick + thigh, wings, back, heart, liver, or gizzard. It can thus be inferred that the

Table III. Means and standard deviation for feed intake (FI), weight gain (WG), and feed conversion (FC) of quail fed diets with inclusion of pasta waste meal (PWM) levels.

PWM level (%)	Phase I – 1 to 21 days		
	FI, g	WG, g	FC, g/g
0	274.89±6.20	141.56±4.35	1.92±0.08
10	281.05±3.66	144.82±4.22	1.94±0.04
20	279.75±2.97	146.09±6.91	1.92±0.09
30	276.52±8.06	139.46±2.62	1.98±0.04
40	283.53±6.54	138.48±2.33	2.06±0.08
<i>P</i> -value	0.1700	0.0001	0.0039
PWM level (%)	Cumulative period - 1 to 42 days		
	FI, g	WG, g	FC, g/g
0	823.65±33.52	253.94±10.60	3.29±0.10
10	848.90±30.72	258.08±11.06	3.29±0.08
20	855.64±27.83	264.42±14.92	3.24±0.12
30	844.02±19.59	258.27±10.59	3.27±0.08
40	855.88±22.65	251.86±8.91	3.39±0.05
<i>P</i> -value	0.2600	0.7353	0.5828

utilization of nutrients from PWM, especially amino acids, was similar to that of corn and soybean meal, since the highest PWM inclusion level allowed for the withdrawal of a considerable quantity of corn (~35 kg) and soybean meal (~5 kg) per 100 kg of diet. Silva et al. 2012a, b highlighted that PWM has energy metabolizability coefficients greater than 90% and digestibility coefficients (as-is basis) of 94.1, 93.8, 95.9, 77.9, 93.4, 90.7, 94.7, 95.7% for the respective essential amino acids: lysine, methionine, methionine + cystine, threonine, arginine, valine, isoleucine, and leucine. This might have contributed to the similar results of the diets with PWM and diets based solely on corn and soybean meal as macro-ingredients. Therefore, the high metabolizability and digestibility coefficients in PWM enable its use

as an alternative to corn, especially when it is cheaper than the latter ingredient.

The current results for the yields of carcass, breast, drumstick + thigh, heart, liver, and gizzard agree with the findings of Akinola & Ekine 2014, who did not observe an effect for these variables when testing a maximum PWM level of approximately 40 kg/100 kg of diet. In a trial involving 20, 30, or 40 kg pasta meal per 100 kg of diet for broilers, Omele et al. 2013b did not find differences in the percentage yields of carcass, heart, or liver. Ironkwe et al. 2015 worked with turkeys and stressed that the yields of breast, drumstick, wing, back, liver, heart, and gizzard were not influenced by the inclusion of 16.67, 33.33, or 50 kg PWM per 100 kg of diet.

Abdominal fat yield declined linearly, which suggests that the low fat content in PWM (0.26%;

Table IV. Means and standard deviations for absolute and relative weights of the carcass of meat quail fed diets with inclusion of pasta waste meal (PWM) levels.

Variable	PWM inclusion level (%)					P-value
	0	10	20	30	40	
	Absolute weight (g)					
Live weight	263.87±5.30	260.30±8.09	258.67±12.86	260.07±11.68	255.52±7.82	0.6680
Hot carcass	190.60±1.86	188.51±5.10	185.97±7.26	185.79±6.84	185.28±3.71	0.0692
	Yield (%)					
Hot carcass	72.72±0.99	73.13±1.50	71.93±1.46	71.28±1.89	71.19±1.19	0.1079
Breast	41.71±1.46	41.79±0.80	41.53±1.05	42.80±1.32	42.99±1.53	0.1751
Drumstick + thigh	28.19±0.87	28.11±2.82	29.32±0.83	29.40±0.88	28.55±0.90	0.4158
Wings	7.41±0.19	7.37±0.63	7.05±0.22	7.26±0.43	7.55±0.33	0.2727
Back	22.29±1.65	21.09±1.16	22.14±1.56	20.92±0.75	20.85±1.42	0.2027
Heart	1.10±0.06	1.10±0.06	1.19±0.08	1.11±0.07	1.13±0.08	0.1663
Liver	2.57±0.23	2.57±0.17	2.50±0.18	2.69±0.34	2.79±0.21	0.2460
Gizzard	2.06±0.29	2.04±0.24	1.93±0.12	1.86±0.13	1.82±0.24	0.2843
Abdominal fat	1.84±0.47	1.83±0.40	1.74±0.38	1.28±0.29	0.92±0.33	0.0001

Table V. Means and standard deviations for costs and economic return of meat quail fed diets with inclusion of pasta waste meal (PWM) levels.

PWM inclusion level (%)	Feeding cost (R\$/bird)		Cost (R\$/kg carcass)	AGR (R\$/kg)	AGM (R\$/kg)	AR (%)
	Phase I	Cumulative period				
0	0.333±0.01	0.937±0.03	4.883±0.17	19.98	15.09±0.17	75.56±0.88
10	0.332±0.01	0.938±0.03	4.931±0.10	19.98	15.05±0.10	75.32±0.54
20	0.322±0.01	0.917±0.02	4.936±0.14	19.98	15.04±0.14	75.29±0.73
30	0.312±0.01	0.877±0.02	4.743±0.26	19.98	15.24±0.26	76.26±1.30
40	0.306±0.01	0.864±0.02	4.753±0.14	19.98	15.23±0.14	76.21±0.73
P-value	0.0001	0.0001	0.1710		0.1710	0.1710
Regression	Linear	Linear	ns	-	ns	ns
R ²	0.81	0.90	-	-	-	-

ns - non-significant effect; AGR - average gross revenue; AGM - average gross margin; AR - average gross rate of return.

as-is basis) associated with its high energy value (3543 kcal AMEn/kg), according to Silva et al. 2012a, provided a reduction in the lipid levels of the diets containing PWM (Table III). This is explained by the fact that the gradual increase in PWM led to a decrease in the dietary inclusion of corn, soybean oil, and soybean meal, whose ether extract contents were higher than those of PWM, which might have contributed to a decrease in adipose tissue deposition.

The better feeding cost (Table V) obtained in the studied phases may be explained by the lower cost of the diets containing PWM, since feed intake was the same across all treatments. These data corroborate those found by Ironkwe et al. 2015, who reported an improvement in the feeding cost of turkeys fed diets containing pasta meal. Similar results were also published by Omele et al. 2013b for broilers consuming diets containing pasta meal.

CONCLUSIONS

Pasta waste meal may be included up to 40% in the diet of quail without compromising their productive performance or carcass yield. Its inclusion levels provide a reduction of feeding costs and not affect the average rate of return.

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Jussiede Silva Santos conceived the original idea and carried out the experiments; Maria do Carmo Mohaupt Marques Lüdke and Wilson Moreira Dutra Júnior supervised the project; Julia da Silva Barros, Juliane Garlet Viapiana and Clariana Silva Santos supported in the carried out the experiments; Carlos Bôa-Viagem Rabello and Marcos José Batista dos Santos contributed to the statistical analysis.

