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Performance and meat chemical composition of quails fed with different sorghum levels instead of corn

Desempenho e composição química de carne de codornas alimentadas com diferentes níveis de sorgo em substituição ao milho

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ABSTRACT

The objective of this study was to evaluate the effect of replacing corn with sorghum in feed on performance, carcass yield, and composition of specialized meat cuts in quails. A total of 1200, 1-day-old female quails were raised up to 42 days of age. The completely randomized design consisted of four treatments with six replicates each and with 50 quails in each cage. Treatments consisted of four levels of sorghum replacement in the diet (0, 40, 60, and 100% sorghum). All birds were weighed to assess the weight gain. Feed conversion was calculated as the relationship between feed intake and weight gain. Mortality was reported daily and calculated at the end of each week. At 42 days, the birds were slaughtered and the carcass, thigh and drumstick, and breast yields were assessed. Mineral matter, ether extract, and crude protein analyses were performed using breast cuts and thigh + drumstick cuts. No significant differences were noted in cut performance, yield, or composition. Thus, it can be concluded that the ground grain sorghum can entirely replace corn in quail feed, as it does not negatively affect carcass performance, yield, and nutritional quality.

Key words: *alternative feed, coturniculture, animal nutrition, **Sorghum bicolor**.*

RESUMO

Objetivou-se avaliar o efeito da substituição do milho pelo sorgo sobre o desempenho, rendimento de carcaça e composição dos cortes nobres em codornas para corte. Foram alojadas 1.200 codornas de corte, fêmeas de um dia de idade até os 42 dias, distribuídas em um delineamento inteiramente casualizado, composto de quatro tratamentos, com seis repetições cada, sendo que, em cada gaiola, foram alojadas 50 codornas. Os tratamentos consistiram de quatro níveis de substituição do milho pelo sorgo (0, 40, 60 e 100% de sorgo). Todas as aves foram pesadas para obtenção do ganho de peso. A conversão alimentar foi calculada pela relação entre o consumo de ração e o ganho de peso, considerando o peso das aves mortas. A mortalidade era registrada diariamente e calculada ao final de cada semana. Aos 42 dias, as aves foram abatidas e obtidos os rendimentos de carcaça, coxa+sobrecoxa e peito. Para os cortes de peito e coxa+sobrecoxa, foram realizadas análises de matéria mineral, extrato etéreo e proteína bruta. Não se observaram diferenças significativas nas variáveis de desempenho, rendimento e composição de cortes. Conclui-se que o sorgo grão moído pode substituir totalmente o milho em rações para codornas de corte, pois não compromete os índices de desempenho, rendimento e qualidade nutricional da carcaça.

Palavras-chave: *alimento alternativo, coturnicultura, nutrição animal, **Sorghum bicolor**.*

INTRODUCTION

Coturniculture has been developed in Brazilian agricultural markets and research is contributing to improve and establish this activity as a profitable source in poultry production (PIZZOLANTE et al., 2006). It requires low investment costs and provides fast return, making it a promising activity (PASTORE et al., 2012). However, feed costs are responsible for over 70% of the total quail production costs (FURLAN et al., 1999).

Research concerning quail nutrition has mainly focused on determining the nutritional requirements and food assessment for layer and meat-type quail lineages. Non-conventional feeds have been an increasing focus of such research, especially when they do not compete with human food, are discarded by agribusiness, or have lower cost than conventional feeds. The lack of technical information on alternative feeds restricts or even prevents their use, so studies that enable the partial or total replacement of the most expensive ingredients with economical alternatives is a factor that contributes to production viability.

The main ingredient in bird diets is corn, which accounts for 60% to 70% of costs. As it is a commodity, its price is subject to exchange rate and market prices, which may cause imbalances in the input internal supply and change the purchasing strategy of producers who seek to reduce costs and increase profits (MOURA et al., 2010).

For livestock activities, which are highly dependent on corn, unconventional ingredients have been sought to provide partial or total replacement (SANTOS et al., 2006). According to SCHEUERMANN (2003), among the options investigated, the one that most closely matches the nutritional characteristics of corn is sorghum (***Sorghum bicolor*** L. Moench).Cost of sorghum is between 70% and 80% of the corn cost and technically can replace up to 100% of the corn in the diets of broilers (ROCHA et al., 2008) and layers (ASSUENA et al., 2008), without compromising these birds' performance.

The objective of this study was to evaluate the effect of replacing corn with sorghum on performance, carcass yield, and composition of specialized cuts in quail meat.

MATERIAL AND METHODS

Birds were raised in an experimental battery containing galvanized wire cages, at a height of 1.2m from

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the floor, each with dimensions of 0.50×0.80m. Each cage was equipped with an automatic chick drinker, a trough-type feeder. After 15 days, the automatic chick drinkers were replaced with tumbler-type drinkers. For every six cages, there was an infrared-type hood. A thermometer was used to measure the temperature and keep it in the optimal range for the age and lineage.

A total of 1200 female quails (***Coturnix coturnix*** japonica) were housed from ages of one day to up to 42 days. Birds were distributed in a completely randomized design, consisting of four treatments with six repetitions each. Fifty quails were housed in each cage. The quail lineage that was raised is considered of dual purpose-layer and meat-type. Treatments consisted of four levels of sorghum replacement in the diet (0, 40, 60, and 100% sorghum). A two-phase rearing and feeding program was used according to the birds' age, with the starter phase from one to 21 days of age and growing phase from 22 to 42 days of age (Table 1).

The diets used in the experiment were formulated and developed with tannin-free sorghum and/or corn and soybean meal, and energy and nutritional levels were formulated based on the recommendations of ROSTAGNO et al. (2011). Diets were formulated according to the nutritional levels of food determined through chemical analysis performed at the Raw Materials and Feed Analysis Laboratory of the Faculty of Veterinary Medicine at the Universidade Federal de Uberlândia. According to SOUZA-SOARES & SIEWERDT (2005), quail feed must be fine grain, and so, all diets used during this experiment were ground and passed through a 1.8-mm sieve.

Feed and drinking water (3-5mg ml^{-1} of chlorine) were provided ad libitum. Natural and artificial light were provided for 24h during the first seven days and for 18h during the following 35 days. Beak trimming was carried out at 28 days of age as a palliative measure to reduce cannibalism that occurred during the fourth week. Beak trimming, which involved cutting the upper beak tip by using a scissors, was performed during the coolest period of the day, between 6 and 8 AM, to avoid excess bleeding.

At 42 days, all birds were weighed on a digital scale (Ramuza DP300; accuracy 50g), to obtain the weight gain. Feed conversion was calculated as the relationship between feed intake and weight gain, considering the dead birds' weight. Mortality was reported daily and calculated at the end of each week.

In order to obtain carcass yield (without feathers and gutted) of specialized cuts (thigh + drumstick and breast), five quails per repetition (30 per treatment) of average treatment weight (±5%) were slaughtered, according to the rules and official procedures (BRASIL, 1998).

After weighing for yield calculation, the breast and thigh + drumstick cuts were placed in plastic bags, labeled, and stored under -20°C for further chemical composition evaluation. Samples were ground in an electric meat grinder (PCP-22L), homogenized, placed on aluminum trays, and subsequently pre-dried in a forced ventilation oven at 65°C for 96h to obtain the dry matter content. From the dry sample, mineral matter, ether extract, and crude protein analyses were performed according to the methodology proposed by the Brazilian Compendium of Animal Nutrition (BRASIL, 2009). All data on cut composition were calculated and expressed related to natural matter.

Table 1 - Percentage composition of quail feed in the starter phase (1-21 days) and growing phase (22-42 days) formulated with different sorghum levels replacing corn.

Ingredients (%)	Starter				Growing			
	0% sorghum	40% sorghum	60% sorghum	100% sorghum	0% sorghum	40% sorghum	60% sorghum	100% sorghum
Grain corn 8.0%	49.82	29.89	19.92	0.00	56.52	33.91	22.60	0.00
Sorghum 8.6%	0.00	19.29	28.93	48.23	0.00	21.90	32.85	54.76
Soybean meal 46.5%	44.88	44.75	44.68	44.55	37.34	37.17	37.08	36.91
Soybean oil	2.09	2.82	3.19	3.92	3.20	4.03	4.44	5.27
Limestone	1.15	1.13	1.12	1.10	0.99	0.97	0.96	0.94
Bicalcium Phosphate	0.97	1.01	1.02	1.06	0.89	0.93	0.96	1.00
Common salt	0.48	0.49	0.49	0.50	0.49	0.50	0.50	0.51
DL-Methionine	0.14	0.15	0.15	0.16	0.12	0.13	0.13	0.14
L-Threonine	0.04	0.04	0.05	0.05	0.01	0.01	0.01	0.02
L-Lysine HCL	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03
Premix	0.40*	0.40*	0.40*	0.40*	0.40**	0.40**	0.40**	0.40**
Composition								
ME (Kcal kg^{-1})	2,900	2,900	2,900	2,900	3,050	3,050	3,050	3,050
Crude Protein (%)	25.00	25.00	25.00	25.00	22.00	22.00	22.00	22.00
Calcium (%)	0.85	0.85	0.85	0.85	0.75	0.75	0.75	0.75
Available Phosphorus (%)	0.32	0.32	0.30	0.32	0.30	0.30	0.30	0.30
Sodium (%)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Digestible Methionine (%)	0.48	0.48	0.48	0.49	0.42	0.43	0.43	0.43
Digestible Met+ Cis (%)	0.80	0.80	0.80	0.80	0.72	0.71	0.71	0.71
Digestible Lysine (%)	1.27	1.26	1.26	1.25	1.08	1.08	1.08	1.09
Digestible Threonine (%)	0.89	0.89	0.89	0.90	0.76	0.76	0.76	0.76
Digestible Tryptophan (%)	0.28	0.28	0.28	0.28	0.24	0.24	0.25	0.25

*Premix (composition per kg of product): vit. A, 2,000.000IU; vit. D3, 600.000IU; vit. E, 3.500mg kg^{-1}; vit. B1, 625mg; vit. B2, 1562.50mg; vit. B6, 650mg; biotin, 15.65mg; choline, 104.125mg; vit. K, 458mg; folic acid, 250mg; vit. B12, 2875mg; selenium, 78mg; manganese, 30.000mg; iron, 12.500mg; zinc, 20.000mg; copper, 2.000mg; iodine, 187mg.

After residues normality verification of the performance data, Kruskal-Wallis test was performed to determine the differences among treatments (P<0.05). For performance evaluation and cut composition, Scott-Knott test was applied, to verify the significant differences among treatments (P<0.05), by using the Statistical Programm Action 2.3 (R Development Core Team, 2008).

RESULTS AND DISCUSSION

The weight gain, feed conversion, and mortality of 42-day-old quails were not affected by the different levels of ground grain sorghum (P>0.05), as shown in table 2. Even with the interference of cannibalism in weight gain during the third week, the weight at 42 days of age were higher than the 0.128kg average weight gain reported by GRIESER (2012) in a Japanese quail stock fed corn-based feed with the same nutritional level. Behavioral changes during livestock rearing can manifest as feather pecking, depression, and increased injuries on the head and body, which can directly affect the birds' welfare and productivity (JONES, 1996). Beak trimming is a management practice that has been widely performed in the poultry industry in order to reduce feather pecking, cannibalism, mortality, and bird performance loss and to further provide better utilization of feed (CLOUTIER et al., 2000).

The feed conversion values were similar to those observed by other authors. GRIESER (2012) showed a feed conversion of 4.16kg kg^{-1}, and SILVA et al. (2011) showed an average value of 4.22kg kg^{-1} in European quail stocks fed corn-based diets at different nutritional levels (protein content ranging from 25% to 33%). Even with increased mortality during the third week of the experiment, as a result of cannibalism among the birds, the mortality values (%) at the end of the present experiment were better than the results reported by MORI et al. (2005), which were 13.24% in 42-day-old quail stocks fed corn-based diet.

The similarity in performance for birds fed with different levels of ground sorghum can be attributed to the proximity of the sorghum and corn nutritional values, and that it is possible to formulate diets with very similar nutritional values for both metabolizable energy and crude protein for these two grains. Additionally, MOURA et al. (2010) found no effect of replacing corn with low-tannin sorghum on any performance characteristics of laying Japanese quails. These results confirm the nutritional sorghum compatibility with corn and demonstrate its potential for full use in the feed for this kind of bird.

Table 2 - Weight gain (WG), feed conversion (FC), and mortality of quails (***Coturnix coturnix*** japonica) fed with different sorghum levels replacing corn between 1-42 days old.

Treatments	WG (kg)	FC (kg/kg^{-1})	Mortality (%)
0% sorghum	0.143	4.643	12.48
40% sorghum	0.143	4.611	9.97
60% sorghum	0.143	4.605	9.97
100% sorghum	0.146	4.601	10.44
p Value	0.48	0.96	0.70
VC%	3.19	2.75	40.56

Means followed by different letters in the column differ significantly according to the Kruskal-Wallis test at 5% significance (P<0.05).

Sorghum inclusion in quail diets did not influence the carcass and breast and thigh + drumstick yields (P>0.05; Table 3). Other researchers reported similar values of carcass and breast, and thigh + drumstick yields in their evaluations of quail performance at 42 days of age when fed with corn-based feed (MORI et al., 2005; GRIESER, 2012). The similarity in the values is explained by the similarity in the nutritional values of corn and sorghum.

Most previous research of the yields for sorghum-fed birds only refers to broilers. Similar results were obtained by GUALTIERI & RAPACCINI (1990), LATCH et al. (2003), and CAROLINO et al. (2014), who reported no differences in carcass yield and GARCIA et al. (2005) and CAROLINO et al. (2014) who reported no difference in cut yields.

No significant differences (P>0.05) were noted among the treatments with respect to the percentages of dry matter, crude protein, and fat and mineral matter in the cuts—thigh + drumstick and breast (Table 4), showing satisfactory results for including ground sorghum in the diet of meat-type quail. Previous research of the chemical composition of cuts of birds fed with sorghum has only addressed broiler chickens. GARCIA et al. (2005) and CAROLINO et al. (2014) showed that chicken carcass composition did not differ when corn was replaced with sorghum, which is the same effect that we observed in this study using quails.

CONCLUSION

Ground grain sorghum can be used to completely replace corn in the diet of meat-type quail. The replacement is economically viable and does not compromise the carcass performance, yield, or nutritional quality indices.

Table 3 - Carcass, breast and thigh + drumstick yield of 42-day-old quails *(**Coturnix coturnix** japonica)* fed with different sorghum levels replacing corn.

Treatment	Live weight (g)	Carcass yield (%)	Breast (%)	Thigh + drumstick (%)
0% sorghum	137.33	80.39	33.31	21.00
40% sorghum	137.94	79.85	32.92	20.91
60% sorghum	132.17	81.06	34.23	21.11
100% sorghum	137.69	80.35	33.17	21.02
p Value	0.06	0.32	0.12	0.57
VC%	2.02	0.62	1.71	0.38

Means followed by different letters in the column differ by Scott-Knott test at 5% significance (P<0.05).

Table 4 - Composition in protein, fat and mineral content of 42 day old quails *(**Coturnix coturnix** japonica)* breast and thigh + drumstick, fed with different sorghum levels replacing corn.

Treatment	----------Dry matter (%)----------		----------Protein (%)----------		----------Fat (%)----------		----------Mineral Matter (%)---------	
	Thigh+drumstick	Breast	Thigh+ drumstick	Breast	Thigh+drumstick	Breast	Thigh+ drumstick	Breast
0% sorghum	35.40	33.22	19.56	20.40	8.18	6.7	4.09	2.75
40% sorghum	35.53	33.35	20.14	21.57	8.39	6.71	4.22	2.63
60% sorghum	35.63	33.84	21.07	21.50	7.35	7.11	4.06	2.49
100% sorghum	36.31	34.35	20.57	20.81	8.36	6.98	4.17	2.83
p Value	0.70	0.56	0.17	0.09	0.13	0.51	0.87	0.72
VC%	4.04	4.49	5.21	5.41	11.65	12.37	10.41	19.10

BIOETHICS AND BIOSSECURITY COMMITTE APPROVAL

All procedures in this study were performed in accordance to Registration Protocol CEUA/UFU 147/13 approved by the Ethics Committee on the Use of Animals at Federal University of Uberlândia.

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