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Performance, Carcass Traits and Economic Availability of Muscovy Ducks Fed on Different Nutritional Plans in Different Housing Densities

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ABSTRACT

The present study aimed to evaluate ducks on performance, carcass traits and economic availability, fed on different phases of nutritional plans and in different housing densities. Two hundred and forty Muscovy ducks of creole lineage were used, distributed in boxes with water and food *ad libitum*. The experimental design was completely randomized in a factorial arrangement of 3x2 with three nutritional plans (3, 4 and 5 phases) and two housing densities (2 and 3 birds/m2) with four replicates. The ducks had weekly performance evaluations, and after 90 days, four birds in each treatment were slaughtered for evaluation of carcass traits. Differences ($p<0.05$) were observed on performance, carcass traits and economic analysis. The nutritional plans with 3 phases showed better results for feed intake and weight gain, as well as provided lower total cost production and higher operating profit. Ducks in higher densities showed smaller feed intake, weight gain, higher pro-ventricle weight and better results for total meet production, crude income and operating profit. In summary, nutritional plans with reduced phases (3 phases) and extensions of energy-protein relationships showed better results for ducks on performance and carcass traits in densities of 3 birds/m². More studies are necessary to determine other nutritional requirements for ducks in housing for a better nutritional and management control.

INTRODUCTION

In the Poultry Industry, ducks have the peculiar feature to provide a range of final products that goes from the meat and egg production, feathers for ornamental purposes, liver with fat for production of pates to many other products for a market increasingly on the rise, but little explored in Latin America (Avicultura industrial, 2005). In Brazil, duck meat consumption is restricted to 13 grams/habitant/year. In China, for example, this consumption is 1.5 kg/habitant/year and in Europe remains at 1 kg/habitant/ year. Duck meat is also very consumed in the United States and in countries with Arabic ethnicity, such as Egypt and Saudi Arabia (Wawro *et al.*, 2004; Avicultura Industrial, 2005).

There are few researches regarding on how to manage ducks, most of them are related to the nutritional aspect, and some have suggested only technical recommendations. For example, the current recommendation (Coates & Ernst, 2000) suggested that the density of ducklings in the first two-weeks should be ½ m2/bird, and increased up to at least 1 m2/bird in the first four-weeks, and if birds remain in the housing after one month, give them at least 2 m2/bird. Moreira (1993) recommended setting the free-range stocking of 1 bird/m² when their weight reaches 3.0 to 3.5 kg (females) and 4.5 to 5.5 kg (males) with slaughter age ranging from 3 to 6 months. And together with the density, the physiological and ethological features should be taken into consideration. O'Driscoll & Broom (2011) reported that more water was needed in the housing ambient for improvement of the duck`s health aspects.

Moreover, the quality of poultry meat has become increasingly important, since sensory features as appearance and meat tenderness are required by the consumer (Beraquet, 1999), and these are strongly related to all of the the phases of bird management.

The nutritional factor is important not only in raising ducks system, but also for all poultry production. The feed cost is one of the limiting factors in animal production, and only in the poultry sector, it represents approximately 70% of the total production cost (Cruz, 2016).

According to Togashi (2000), the poultry production in some regions of Brazil is limited due to low grain availability. This means that the nutritional study is very essential for poultry production to reduce the feed cost and, consequently, the cost of production. The increasing demand for a better feed control in poultry, added to the high cost and increase of bird consumption in the world market, are factors that motivated researchers to seek alternatives for a conventional concept used in modern poultry management system, especially in poultry feed.

Considering the above, the present study aimed to evaluate the performance, carcass traits and economic availability of ducks on different phases of nutritional plans and housing densities.

MATERIAL AND METHODS

The study was conducted in the facility of Poultry Sector, Department of Animal and Plant Production (DPAV), Faculty of Agrarian Sciences (FCA), Federal University of Amazonas (UFAM), located in the south sector of the university campus, Manaus, in the State of Amazonas, Brazil.

Two hundred and forty Muscovy ducks (*Cairina Moscharadomesticus*) of creole lineage were used distributed in boxes with water and food *ad libitum*. The experimental design was completely randomized in a 3x2 factorial design with three nutritional plans (P1 with 3 phases (1-35 days; 36-70 days and 71-90 days), P2 with 4 phases (1-28 days; 29-49 days, 50-72 days and 73-90 days) and P3 with 5 phases (1-14 days; 14-28 days, 29-63 days, 64-76 days and 77-90 days)), and two housing densities (2 birds/m^2 and 3 birds/m^2) with 4 replicates (8 ducks in boxes with 2 birds/m^2 and 12 ducks in boxes with 3 birds/m^2).

The experimental diets were formulated according the production stages and nutritional plans (Table 1), according to the nutritional requirements and reference values for broilers (Rostagno *et al.*, 2011) adapted to ducks.

The birds started the experimental period with 1-day of age and were evaluated at 90 days. Weekly, in the experimental phase, the birds were weighed to obtain the performance variables. The feed intake was determined by the quotient between the total feed intake and the quantity of poultry. The weight gain was determined by the total weight of each plot divided by the number of birds plot, and feed conversion was determined by relation between the amount of feed consumed and the weight gain in addition to considering the final weight of the experiment.

At 90 days of age, after 12 hours of fasting, four ducks of each treatment were randomly selected, identified and weighed. Next, these were electrically stunned (40 V; 50 Hz), with the birds slaughtered by a cut in the jugular vein. The carcasses were immersed into hot water (60ºC for 62s), plucked and eviscerated according Mendes & Patricio`s (2004) recommendations, and the carcass yield was determined in relation to live weight. Edible viscera (heart, gizzard, pro-ventricle and liver) were separated and individually weighed to measure the yields.

In economic analysis, the fixed costs consisted of labor, facilities and equipment depreciation (Martins *et al.*, 2006). The feed cost was considered only as the variable cost. For analysis of the production cost per kilogram of meat the feed intake was considered and the production per treatment. The feed cost considered the nutritional plans cost per kg (P1 = US$ 0.35/kg; P2 = US$ 0.44/kg; e P3 = US$ 0.52/kg). For live weight of duck in Manaus/AM considering a cost of US$ 3.71/kg (according to the current value of the dollar in R$ 2,69). Crude Income (CI) and Operating Profit (OP) were used with economic indicators according to Martin *et al.* (1998).

Data were submitted to analysis of variance and means compared by Tukey test at 5% of significance using the statistical program SAS (2008).

RESULTS AND DISCUSSION

The results of performance of ducks are show in Table 2. Differences were observed in feed intake, weight gain and feed conversion ($p<0.05$), among nutritional plans and feed intake and weight gain ($p<0.05$) between housing densities. However, no interaction ($p>0.05$)

Table 1 – Ingredients and nutritional composition of experimental diets

	Nutritional Plans											
	Nutritional Plan1			Nutritional Plan 2				Nutritional Plan 3				
Phases[4]	Init.	Gro.	Term.	Init.	Gro. I	Gro. II	Term.	P-init.	Init.	Gro. I	Gro. II	Term.
Ingredients												
Corn (8,76%)	62.040	72.791	75.790	59.614	68.952	71.479	74.589	59.614	62.295	67.750	71.600	77.006
Soybean Meal (46%)	34.150	23.443	20.761	34.600	26.386	23.770	20.983	34.600	31.916	26.608	23.602	18.304
Limestone	0.910	1.139	0.795	0.876	1.120	0.756	0.792	0.876	1.084	1.116	0.757	0.973
Dicalcium Phosphate	1.798	1.580	1.321	1.806	1.570	1.772	1.325	1.806	1.549	1.574	1.773	1.069
Salt	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350
DL-Methionine 99%	0.252	0.197	0.142	0.254	0.171	0.133	0.143	0.254	0.247	0.172	0.246	0.171
Vit./Min Supplement	0.500[1]	0.500[2]	0.500[3]	0.500[1]	0.500[2]	0.500[2]	0.500[3]	0.500[1]	0.500[1]	0.500[2]	0.500[2]	0.500[3]
Soybean oil	-	-	0.340	2.000	0.952	1.240	1.318	2.000	2.060	1.930	1.172	1.628
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Nutritional levels[5]												
Met. Energy (kcal/kg)	2.913	3.032	3.100	3.015	3.050	3.100	3.150	3.015	3.050	3.100	3.150	3.200
Crude Protein (%)	21.000	17.000	16.000	21.000	18.000	17.000	16.000	21.000	20.000	18.000	17.000	15.000
Calcium (%)	0.890	0.900	0.700	0.890	0.900	0.800	0.700	0.990	0.900	0.900	0.800	0.700
Methionine + Cystine (%)	0.924	0.764	0.684	0.924	0.764	0.700	0.684	0.924	0.890	0.764	0.702	0.684
Methionine (%)	0.577	0.471	0.404	0.578	0.458	0.408	0.405	0.578	0.558	0.458	0.410	0.419
Phosphorus Available (%)	0.450	0.400	0.350	0.450	0.400	0.435	0.350	0.450	0.400	0.400	0.350	0.300
Sodium (%)	0.183	0.176	0.174	0.183	0.178	0.176	0.174	0.183	0.181	0.178	0.176	0.172

[1] Vit./mineral supplement – initial – content in 1 kg = Folic Acid 800 mg, Pantothenic Acid 12.500 mg, Antioxidant 0,5 g, Biotin 40 mg, Niacin 33.600 mg, Selenium 300 mg, Vit. A 6.700.000 UI, Vit.B1 1.750 mg, Vit.B12 9.600 mcg, Vit.B2 4.800 mg, Vit.B6 2.500 mg, Vit.D3 1.600.000UI, Vit.E 14.000 mg, Vit. K3 1.440 mg. Mineral supplement– content in 0,5 kg = Manganese 150.000 mg, Zinc 100.000 mg, Iron 100.000 mg, Copper 16.000 mg, Iodine 1.500 mg

[2] Vit./mineral supplement – growth – content in 1 kg = Folic Acid 650 mg, Pantothenic Acid 10.400 mg, Antioxidant 0,5 g, Niacin 28.000 mg, Selenium 300 mg, Vit. A 5.600.000 UI, Vit.B1 0,550 mg, Vit.B12 8.000 mcg, Vit.B2 4.000 mg; Vit.B6 2,080 mg, Vit.D3 1.200.000 UI, Vit.E 10.000 mg, Vit. K3 1.200 mg. Mineral supplement – content in 0,5 kg = Manganese 150.000 mg, Zinc 100.000 mg, Iron 100.000 mg, Copper 16.000 mg, Iodine 1.500 mg

[3] Vit./mineral supplement – termination – content in 1 kg = Pantothenic Acid 7.070 mg, Antioxidant 0,5 g, Niacin 20.400 mg, Selenium 200 mg, Vit. A 1.960.000 UI, Vit.B12 4.700 mcg, Vit.B2 2.400 mg, Vit. D3 550.000 UI, Vit. E 5.500 mg, Vit. K3 550 mg. Mineral supplement – content in 0,5 kg = Manganese 150.000 mg, Zinc 100.000 mg, Iron 100.000 mg, Copper 16.000 mg, Iodine 1.500 mg

[4] P-Init. = Pre-Initial; Init. = Initial; Gro. = Growth; Term. = Termination

[5] Estimated levels based on dry matter

between nutritional plans and housing densities could be observed. Nutritional plans with three phases and higher densities showed a positive influence on duck growth, with a direct relationship between the lower feed intake and reduction on feed conversion, with similar results observed by Feijó *et al.* (2016).

Graças *et al.* (1990), affirms that a reduction in feed intake can be caused by increased in housing density, with less physical space, the birds have difficult access to feeders for these. However, according to the results of Garcia *et al.* (2002) and Cruz *et al.* (2013), increasing housing density can promote greater results of meat/m², therefore, an alternative to increase the productive and economic performance of poultry production. Moreover, to formulate an ideal diet, that is, to present maximum performance and economic results, it's necessary to deeply understand the nutritional poultry requirements (Trindade Neto *et al.*, 2009), as proposed in this study, from the results that demonstrated the better nutritional energy-protein relations for ducks.

Table 2 – Performance of ducks fed on different phases of nutritional plans in different housing densities.

Factors	Variables			
	Feed intake (g)	Weight gain (g)	Feed conversion (kg/kg)	Slaughter Weight (kg)
Nutritional Plans				
3 phases	8,876.92[a]	2,753.36[a]	3.25[a]	2.72
4 phases	8,735.74[a]	2,477.97[a]	3.54[ab]	2.68
5 phases	10,027.01[b]	2,372.59[b]	4.27[b]	2.47
Densities				
2 birds/m²	10,025.03[b]	2,75122[a]	3.72	2.84
3 birds/m²	8,401.42[a]	2,318.06[b]	3.66	2.41
Effect	*p*-value			
Nutritional plans	0.01 *	0.03 *	0.02 *	0.57 [ns]
Densities	0.02 *	0.01 *	0.72 [ns]	0.06 [ns]
Interaction	0.25 [ns]	0.34 [ns]	0.26 [ns]	0.12 [ns]
CV (%)	9.52	10.78	14.70	19.43

CV - Coefficient of variation; * Means followed by lowercase letters in column differ in 5% by Tukey test ($p<0.05$); ns - not significant.

In the poultry industry, the cost of feeding represented 75% of total production costs and, with 40% to 45% of protein composed this cost (Sakomura

& Silva, 1998). In general, the formulation of poultry diets in thermo neutral environment seeks to meet the requirements of crude protein (CP), metabolizable energy (ME), vitamins and minerals. However, this may contain excess of essential amino acids (Cella, 2001), and there may be potential unbalances in feed composition.

The results for the carcass traits are shown in Table 3. Differences weren't observed for carcass yield, feathers, legs and fat (p>0.05) between nutritional plans, housing densities and interaction. It was observed that nutritional plans with more phases, regardless of the density used, showed better results for carcass traits, with similar results observed by Lisboa *et al.* (1999), Figueiredo *et al.* (1999), Araújo *et al.* (1999), Takahashi (2006) and Santos *et al.* (2012) that studied different commercial lineages of broilers and didn't observed significant differences in relationship of management and carcass traits.

Table 3 – Carcass traits of ducks fed on different phases of nutritional plans in different housing densities.

Factors	Variables			
	Carcass (%)	Feathers (%)	Legs (%)	Fat (%)
Nutritional Plans				
3 phases	68.00	12.08	3.09	1.94
4 phases	69.44	10.13	3.01	1.69
5 phases	71.44	10.62	3.16	1.53
Densities				
2 birds/m²	68.48	10.51	2.85	2.08
3 birds/m²	70.76	11.38	3.32	1.36
Effect	*p*-value			
Nutritional plans	0.60 ns	0.52 ns	0.80 ns	0.57 ns
Densities	0.41 ns	0.55 ns	0.06 ns	0.03 ns
Interaction	0.09 ns	0.07 ns	0.09 ns	0.23 ns
CV (%)	9.71	25.18	14.19	24.09

CV - Coefficient of variation; ns - not significant.

Researchers affirm that the management is directly related to the carcass results for broilers, but, that doesn't mean that it will always influence the carcass results, cuts or visceras of the birds. Hellmeister Filho *et al.* (2004) didn`t observe differences in carcass traits of free-range broilers when compared to management with or without access to picket. Almeida & Zuber (2000) who also study free-range broilers didn`t observe the effect of management system on carcass traits.

The results of edible visceras are show in Table 4. Differences weren't observed for liver, gizzard, pro-ventricle and heart weights (p>0.05) between nutritional plans, housing densities and interaction. However, it was observed that lower densities provided better numerical results of edible viscera (gizzard, liver and heart), and didn't negatively affect these carcass traits.

Table 4 – Edible visceras of ducks fed on different phases of nutritional plans in different housing densities.

Factors	Variables			
	Liver (g)	Gizzard (g)	Pro-ventricle (g)	Heart (g)
Nutritional Plans				
3 phases	46.25	72.50	100.00	150.00
4 phases	43.75	75.00	112.50	175.00
5 phases	36.25	61.25	87.50	162.50
Densities				
2 birds/m²	44.16	71.66	91.67	183.33
3 birds/m²	40.00	67.50	108.33	141.67
Effect	*p*-value			
Nutritional plans	0.42 ns	0.06 ns	0.23 ns	0.67 ns
Densities	0.52 ns	0.39 ns	0.16 ns	0.08 ns
Interaction	0.33 ns	0.06 ns	0.07 ns	0.06 ns
CV (%)	27.04	16.80	26.14	24.63

CV - Coefficient of variation; ns - not significant.

Despite of peculiar characteristics between species, slow-growing broilers tend to have characteristics very similar to those observed in the management systems currently used for ducks. But, it is very important to highlight the poor literature about the management systems for ducks, with appropriate technical and informative recommendations.

There's need to work on a management of animals that can meet the growing commercial interest that exists in duck meat, that can be obtained by producing birds with slow development and management in higher input systems, with the objective of attending the niche market made up for a range of consumers, according to the affirmatives of Lewis *et al.* (1997) and Carrijo *et al.* (2002).

The results of economic analysis are shown in Table 5. Differences were observed for total production cost and operating profit (p<0.05) among nutritional plans, and for total meat production, crude income and operating profit (p<0.05) between housing densities. However, no interaction (p>0.05) between nutritional plans and housing densities could be observed for economic analysis.

Nutritional plans with reduced phases showed better results in the evaluation of economic performance of ducks, that show how feeding has a significant influence on the financial aspect in poultry production, mainly in the cutting segment, where food cost becomes extremely essential to the development of birds.

Table 5 – Economic analysis of ducks fed on different phases of nutritional plans in different housing densities.

Factors	Variables			
	Total Meat Production (kg/m²)	Total Cost of Production (US$/kg)	Crude Income (US$)	Operating Profit (US$)
Nutritional Plans				
3 phases	4.93	1.39[a]	79.38	51.34[a]
4 phases	5.06	1.77[b]	77.04	42.76[a]
5 phases	5.08	2.33[c]	79.04	32.06[b]
Densities				
2 birds/m²	4.15[b]	1.92	64.79[b]	33.42[b]
3 birds/m²	5.90[a]	1.74	92.18[a]	50.69[a]
Effect	*p*-value			
Nutritional plans	0.85 [ns]	0.01 *	0.86 [ns]	0.01 *
Densities	0.01 *	0.10 [ns]	0.01 *	0.01 *
Interaction	0.10 [ns]	0.09 [ns]	0.11 [ns]	0.29 [ns]
CV (%)	11.73	13.48	11.74	16.39

CV - Coefficient of variation; * Means followed by lowercase letters in column differ in 5% by Tukey test ($p<0.05$); ns - not significant.

The total meat production linear growth with increase of housing density, for example, significantly influenced the meat production by square meter, with similar results observed by Goldflus *et al.* (1997), who talks about the direct influence of housing densities on performance, carcass traits and financial poultry production.

CONCLUSIONS

In summary, nutritional plans with reduced phases and extensions of energy-protein relationships showed better results for ducks on performance and carcass traits in densities of 3 birds/m². More studies are necessary to determine other nutritional requirements for ducks in housing for a better nutritional and management control.

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