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NUTRITIONAL METHODS TO INDUCE MOLTING IN LAYING HENS IN CAGE-FREE SYSTEM

(*Métodos nutricionais para induzir a muda em galinhas poedeiras em sistema livre de gaiolas*)

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ABSTRACT - The objective of this study was to evaluate the productive performance, the efficiency of forced seedlings, and the quality of eggs of Black Avifran laying hens reared in *Cage-Free* System using alternative foods as an induced seedling method. The experiment lasted 56 days, divided into two phases. The first stage called the molting phase lasted 14 days, and the next phase was divided into two periods of 21 days post-molting. A total of 144 laying hens were divided into three treatments and six replicates with 8 laying hens each. The experimental treatments were: T1 - partial quantitative food restriction; T2 - Ground corn; T3 - Dry grains of the distillery with corn soluble (DDGS). In the seedling phase, the following were evaluated: days to cease posture, food intake, percentage of laying, and weight loss of laying hens. In the post-molting phase, egg quality, egg weight, shell weight, albumen weight, yolk weight, yolk color, yolk percentage, shell and albumen percentage, Haugh Unit, egg production, feed intake, feed conversion by mass and dozen eggs were evaluated. The use of corn and DDGS promoted a significant difference ($p<0.05$) only for the parameters: food intake, feed intake, and yolk color, which obtained lower values when compared to the conventional method. It is assumed that the consumption time of the ingredients (14 days) was not enough for the laying hens to achieve the expected weight loss of 25%. However, a satisfactory time was obtained to cease the posture. Corn and DDGS can be used as an alternative method to feed restriction for the induced seedling of Black Avifran laying hens reared in the *Cage-Free* system, as they do not alter the performance and quality of eggs in the post-molting period.

Key words: alternative systems, co-products**,** forced changes, performance.

RESUMO - Objetivou-se avaliar o desempenho produtivo, a eficiência da muda forçada e a qualidade dos ovos de poedeiras da raça Negra Avifran criadas em Sistema *Cage-Free* com o uso de alimentos alternativos como método de muda induzida. O experimento teve duração de 56 dias, divididos em duas fases. A primeira etapa denominada fase de muda durou 14 dias, e a fase seguinte foi subdividida em dois períodos de 21 dias pós-muda. Foram utilizadas 144 aves, três tratamentos, e seis repetições com 8 aves cada. Os tratamentos experimentais foram: T1 - restrição parcial quantitativa de alimentos; T2 - Milho moído; T3 - Grãos secos da destilaria com solúvel em milho (DDGS). Na fase de muda foram avaliados: dias para cessar a postura, consumo do alimento, porcentagem de postura e a perda de peso das aves. Na fase pós-muda, avaliou-se: a qualidade do ovo, peso do ovo, peso da casca, peso do albúmen, peso da gema, cor da gema, porcentagem de gema, casca e albúmen, Unidade Haugh, produção de ovos, consumo de ração, conversão alimentar por massa e dúzia de ovos. A utilização de milho e DDGS promoveu diferença significativa ($p<0,05$)

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consumo de alimento, consumo de ração e cor da gema, que obtiveram valores menores quando comparados ao método convencional. O tempo de consumo dos ingredientes (14 dias) não foi suficiente para que as aves atingissem a perda de peso esperada. Obteve-se um tempo satisfatório para a variável cessar a postura, indicando que a utilização das fontes nutricionais foi eficiente. O milho e DDGS podem ser utilizados como método alternativo à restrição alimentar para a muda induzida de galinhas poedeiras Negra Avifran criadas em sistema *Cage-Free*, pois não alteram o desempenho e a qualidade dos ovos no período pós-muda.

Palavras-chave - coprodutos, desempenho, muda forçada, sistemas alternativos.

INTRODUCTION

The use of forced seedling methods alternative to conventional in poultry farming is growing, aiming at animal welfare and less aggression for laying hens (Berto et al., 2012). The conventional total food restriction, to reduce body weight by 25-30% has been the most used technique, mainly because it is easy to apply, is less costly, and results in satisfactory performance results (Souza et al., 2010).

However, this technique is challenged for leading laying hens to severe stress situations, compromising good animal welfare practices. According to Freitas et al. (2011) to be accepted by the poultry industry, the method should produce the necessary stimulus for mute induction, ensuring sufficient regression of the reproductive system and production and quality of eggs in the post-molting period similar to those obtained with the fasting method.

The use of foods rich in fiber and/or with the presence of antinutritional factors has been researched as an alternative method for fasting (Garcia et al., 2002). These methods involving grain supply are a trend in the industry since several studies show that they promote productive improvements in the post-molting period, especially cornmeal, which has its efficacy proven in several studies (Berto et al., 2012).

An ingredient with high potential for use are dry grains of the distillery with corn solubles, known as DDGS, this has a high amount of protein, amino acids, energy, phosphorus, other minerals and is rich in fiber (Shin et al., 2016), which can be a viable change for inducing poultry seedlings.

The production of laying hens in alternative systems to cage breeding is a reality in laying poultry, the *Cage-Free system,* if handled correctly, ensures the laying hens better welfare conditions, due to greater behavioral freedom than the conventional system. The insertion of new productive genetics is also an impact factor in production, seeking laying hens that ensure higher production with lower cost is essential nowadays. Valentim et al. (2019) comparing the production performance of two

categories of laying hens, the Black Laying hen Avifran breed and the Hisex Brown strain, reported that the Black Laying hen Avifran presented better performance when raised in alternative systems.

Therefore, because of the above, the objective was to evaluate ground corn and DDGS as alternative foods for seedling induced in Black Avifran laying hens reared in the Cage-Free system.

MATERIAL AND METHODS

The present research was carried out in the alternative poultry sector of the experimental farm of the Federal University of Mato Grosso, with a duration of 56 days, divided into two phases. The first phase of molt lasted 14 days, and the next phase was divided into two periods of 21 days in the post-molt. The project was submitted, analyzed, and approved by the ethics committee on the use of animals (CEUA), filed under number 23108.092960/ 2015-80.

We used 144 Black Avifranhens at 70 weeks of age, divided into three treatments and six replicates with 8 laying hens each, in a completely randomized experimental design. Daily the maximum and minimum temperatures were recorded, obtaining an average temperature of 26.7 and 34.5 °C, respectively. The experimental treatments were: T1 - partial quantitative food restriction; T2 - Ground corn; T3 - Dry grains of the distillery with corn soluble (DDGS).

The laying hens were reared in a cage-free system, on the floor, with the nest, being 1 mouth/laying hens, perch, and shavings bed. The accommodation was in boxing, with the dimensions of 2.77m x 2.22m (length x width) providing an area of 0.76 m²/laying hens. A decreasing light program was used, before the experimental period, so that in the 14 days of molting the laying hens had only the stimulation of natural light during the day and after the change period the light program was increasing until reaching 16 hours of light.

In the first 14 days, the laying hens of treatment 1 received 60 grams of feed each, and water at will, following the recommendations of the phase described by Rostagno et al. (2011), according to table 1. Treatments 2 and 3 received the test food and water at will after all treatments received the same diet as table 1. The nutritional composition of the natural matter of food is set in table 1.

Table 1 - Calculated and analyzed the composition of the diet used for the treatment with food restriction and Bromatological Analysis of DDGS and Corn.

Ingredients	Control	Iingredients	DDGS	Corn
Ground corn	61.98	Crude Protein	42.73	8.21
Soybean Meal	25.00	Ethereal Extract	1.66	5.07
Soybean Oil	1.52	Crude Fiber	18.37	2.60
Limestone	8.10	Mineral Matter	1.87	1.18
Common salt	0.50	Dry Matter	89.00	87.70
Dicalcium phosphate	1.10	Non-nitrogen extract	47.73	69.41
[1] Posture switch	1.80	NDT (estimated)	79.09	82.00
Total (kg)	100	Ca	0.13	0.02
		P	0.53	0.23

Nutrient (%)	
Metabolizable energy (kcal/kg)	2800.00
Crude protein (%)	19.46
Digestible lysine (%)	1.080
Digestible Methionine+Cystine (%)	0.94
Digestible tryptophan (%)	0.23
Digestible threonine (%)	0.68
Calcium (%)	3.07
Phosphorus available (%)	0.30
Sodium (%)	0.16
Crude fiber (%)	2.74

[1]Core composition: Calcium (mix) 80 g/kg, Calcium (max) 100 g/kg Phosphorus (min) 37 g/kg, Sodium (min) 20 g/kg, Methionine (min) 21.5 g/kg, Lysine (min) 18 g/kg, Vitamin A (min) 125000 IU/kg, Vitamin D3 (min) 25000 IU/kg, Vitamin E (min)312 IU/kg, Vitamin K3 (min) 20 mg/kg, Vitamin B1 (min) 20 mg/kg, Vitamin B2 (min) 62.5 mg/kg, Vitamin B6 (min) 37.5 mg/kg, Vitamin B 12(min) 200 mcg/kg, Folic Acid (min) 6.25 mg/kg, Pantothenic Acid (min) 125 mg/kg, Biotin (min) 1.2 5 mg/kg, Choline (min) 1700 mg/kg, Niacin (min) 312 mg/kg, Copper (min) 125 mg/kg, Iron (min) 680 mg/kg, Iodine (min) 8.75 mg/kg , Manganese (min) 937 mg/kg, Selenium (min) 3.75 mg/kg, Zinc (min) 500 mg/kg, fluoride (max) 370 mg/kg.

The laying hens, food and feed were weighed in each period to verify the consumption of food in the seedling, feed intake in the post-seedling, feed conversion by egg mass in the post-seedling, feed conversion per dozen in the post-seedling and percentage of weight loss. The average daily intake was calculated according to repetitions and treatments and the number of laying hens killed per week was considered, corrected by the methodology proposed by Sakomura and Rostagno (2007).

Also, the number of eggs produced was recorded daily to verify the variables: days to cease laying, percentage of posture before and after the seedling. To calculate the percentage of production, the total number of healthy, broken, cracked, shelled, shelled, and deformed eggs produced in the two experimental periods was used.

Feed conversion by mass was obtained by dividing the means of the performance variables feed intake into grams by egg mass in grams. The feed conversion per dozen was obtained by dividing the feed intake into kilograms in the total period by the dozen eggs produced in the total period. Viability was calculated from the total number of dead laying hens subtracted from the total number of laying hens housed, and the values were converted into percentage at the end of the experimental period.

At each end of the experiment cycle, the analyses of average egg weight, Haugh Unit (UH), specific gravity, albumen height, weight, and percentages of yolk, shell, and albumen were performed. To determine the average weight, the number of healthy eggs from each plot was collected. For the other analyses, at the end of the period, three eggs were chosen per random plot, excluding the dirty ones with problems in the shell (thin shell, deformities, cracked) and weighed individually.

After weighing, the specific gravity was determined by immersion of the eggs in saline solutions with density ranging from 1.070 to 1.095 g/cm³, with an interval of 0.005 g/cm³, duly calibrated using a densimeter (OM-5565, Incoterm).

After that, the eggs were broken for the analysis of albumen height, weight, and percentage of yolk, shell, and albumen. The height of the albumen was measured using a digital caliper. With the egg weight and albumen height data, UH was obtained by the formula:

In which: H = height of dense albumen (millimeters); G = gravitational constant of value 32; W = egg weight (grams), according to Brant et al., (1951).

The separation of the gems was done manually, being weighed individually. The shells, after washing in running water to remove residues from the albumen, were left at room temperature for 72 hours for subsequent weighing. The weight of the albumen was

obtained by the difference between the weight of the whole egg and the weight of the yolk and bark.

The color of the yolk was determined from the comparison with the color pattern scale Yolk Color Fan - DSM® (score from 1 to 15, ranging from light yellow to dark orange), where two samples of each repetition were used. These were placed on a flat surface, where their coloration was obtained immediately after the egg was broken.

Statistical analyses of the variables were performed using the statistical software Sisvar. The data were submitted to variance analysis (ANOVA) and the means compared by Tukey's test, α=0.05.

RESULTS AND DISCUSSION

No significant differences were observed ($p>0.05$) about; the percentage of posture during the change, posture percentage after changes, days to cease posture, and percentage of weight loss. Regarding food intake (g) and feed intake (g) the treatments differed statistically ($p<0.05$) as shown in Table 2.

Table 2: Performance of Black Avifran laying hens in the molting and post-molting period.

Parameters	Restriction	Corn	DDGS	CV%	p-value
Posture during molting (%)	17.66	18.41	22.82	15.33	0.326
Post-molting posture (%)	44.45	45.77	42.30	10.82	0.489
Days to cease posture	7.43	8.40	9.40	7.94	0.078
Food consumption (g/laying hens/day)	59.0[b]	69.0[a]	66.0[a]	11.41	0.045
Feed intake (g/laying hens/day) post-molting	78.60[b]	122.60[a]	119.60[a]	2.89	0.017
Mass conversion	2.11	2.11	2.08	4.75	0.059
Conversion per dozen	1.39	1.35	1.41	3.49	0.068
Weight loss (%)	6.17*	4.10*	5.12*	*	*

Means followed by different letters differ from each other in the same column by the Tukey test ($p<0.05$), CV= coefficient of variation; *Descriptive analysis.

Therefore, in the tested period (14 days) corn and DDGS presented similar results ($p>0.05$) to the partial restriction method, and these products may be possible substitutes for this method. Fiber is a limiting element in the digestion of food, so foods rich in this compound can induce molt, in which case DDGS and corn can cause the stress necessary for the seedling to be induced in laying hens.

Hussein (1996) concluded that the forced molt made in commercial laying hens requires, for its maximum efficiency, a body weight loss of 25%, however, the data of this experiment show that the use of restriction, corn, and DDGS resulted in lower

percentages being 6.17; 4.10 and 5.12% respectively, thus concluding that the 14 days of experimentation did not show the efficacy necessary for the best result of the seedling.

Scherer et al. (2009) used to diet with quantitative restrictions to induce seedlings and observed that the laying hens that had higher feed intake in the post-forced seedling period presented better weight, percentage of laying an egg mass during the second production cycle.

The treatments took between seven and nine days to cease the posture of the laying hens, according to Berto et al. (2012) with the fasting method, the posture stop occurs around eight days after the food withdrawal, corroborating the present research.

The significant results ($p<0.05$) related to food intake (g), feed intake (g) post-molting can be explained by the restricted feed supply, different from the access to corn and DDGS at will. Teixeira and Cardoso (2011) report that although the vast majority of scientific publications are directed to industrial laying hens, forced molting can also be practiced in alternative creations, a system in which this research was carried out.

Regarding egg quality in the post-molting period, except for yolk color, there was no difference ($P>0.05$) on the parameters evaluated, according to table 3.

Table 3: Characteristics of eggs of laying hens in the post-molting period induced by feeding with DDGS or corn,

Parameters	Restriction	Corn	DDGS	CV%	p-value
Egg weight	61.12	63.03	61.60	3.69	0.213
Yolk weight	15.34	15.89	15.61	3.00	0.423
Peel weight	5.45 [a]	5.18 [a]	5.72 [b]	4.31	0.048
Albumen weight	40.33	41.95	40.26	5.74	0.063
Specific gravity	1.089	1.091	1.092	0.28	0.123
Color of yolk	5.60[b]	8.80[a]	8.40[a]	5.81	0.035
% yolk	24.56	25.31	25.37	4.28	0.087
% peel	8.67	8.25	9.29	5.19	0.065
% albumen	66.77	66.42	65.33	2.28	0.078
Haugh Unit	100.09	104.07	97.57	5.07	0.092

Means followed by different letters differ from each other in the same column by the Tukey test ($p<0.05$), CV%= coefficient of variation; The color of the yolk was interfered ($P<0.05$) with the treatments used, and the color was lower in the treatment with partial quantitative food restriction.

This data corroborates those obtained by Mejia et al., (2011) who found that the increase in the duration of feeding diets containing 20% of DDGS increased the color of the yolk.

The specific severity was not influenced (P>0.05) by the addition of DDGS, however, in absolute values they can corroborate the results of Mejia et al., (2011), where the highest level of DDG presented lower values of specific severity. Teixeira & Cardoso (2011) report that hunger causes a depression of the immune state and, consequently, the occurrence of sanitary problems in laying hens and eggs destined for human consumption. Therefore, the use of alternative methods for this practice is justified.

According to Teixeira et al. (2014), molting methods involving short fasting periods associated with the subsequent supply of limited amounts of food or using nutritional restriction can provide a significant loss of body weight and effective productive return. Donalson et al., (2005) observed that laying hens submitted to the conventional seedling method produced eggs with higher weights than laying hens not induced to molting.

Cerbaro et al. (2014) compared food fasting to nutrient restriction about a basic diet for laying hens, using rice husks in the diet in 50 and 75%, the authors found a bodyweight loss of 25% at 20 and 10 days for diets with a dilution of 50 and 75%, respectively, concluding that dilution by up to 50% can be used for forced mute induction without causing severe stress, therefore, achieving greater well-being in production. Freitas et al. (2011) report that the inclusion of leucena hay in the seedling diet from 50% produces results similar to those of the fasting method and this alternative food may be an alternative way to the fasting method.

The results obtained prove that there was no major interference in diets with alternative foods on egg performance and quality, and therefore a viable way to replace the fasting method that causes damage to the well-being of laying hens.

CONCLUSION

The use of ground corn and DDGS can be used as alternative methods to partial quantitative feed restriction for the induced seedling of Black Avifran laying hens when reared in alternative systems *(Cage-Free),* without altering the performance and quality of eggs in the post-mute period.

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