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Short Communication
Growth Performance of Dekalb White® Egg-Laying Pullets fed Discard Corn Grain

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Abstract
Objective: This study was conducted to assess the growth performance of Dekalb White® egg-laying pullets fed discard corn grain. **Materials and Methods:** A total of 1,416 one-day-old Dekalb White® egg-laying pullets were placed according to a completely randomized design for 16 weeks. The two treatments were: a control diet with yellow corn (T0) and the substitution of 50% of conventional corn by discarded corn grain (T1). **Results:** The use of discarded corn grain in the pullet diets did not show notable changes ($p>0.05$) in body weight, mortality, feed intake, feed conversion ratio and flock uniformity (1-16 weeks). In addition, the dietary use of discarded corn grain reduced the diet cost and feed consumed cost by the pullets. **Conclusion:** The use of discarded corn grain as a partial substitute for conventional cornmeal reduces the pullet feed cost, without depressing the performance during 16 weeks of rearing.

Key words: Growth performance, discard corn, pullet, feed cost, chicken egg

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Chicken egg is one of the most consumed foods and is rich in amino acids, energy, essential trace elements and vitamins. In Central America, per capita consumption is estimated at 300 eggs[1]. However, to guarantee a good egg production and economic viability, it is necessary to have a correct management of the pullets that ensure the genetic expression of the future laying hen. In this sense, nutrition directly influences the flock uniformity and pullet performance, which affects the production and egg weight from week 18[2].

It is known that feeding constitutes between 60-70% of the total production costs in raising broilers; therefore, diets must be formulated from raw materials and by-products of cereals and grains rich in protein, lipids and energy[3]. Thus, research has focused on replacing cornmeal by available alternative feeds rich in essential nutrients, which do not affect the growth performance of birds at different production stages[4]. Specifically, in corn producing countries, part of this cereal is harvested for seed banks through the selection process; in this process, some corn seeds are considered discarded because it does not meet the optimal parameters to be a viable seed such as size, shape and mechanical damage[5].

Discarded corn grain could be an alternative feed resource to poultry because its chemical composition is similar or better than that of imported conventional corn, mainly in terms of protein and amino acids, although this chemical composition will depend on the corn variety[5]. Montes and Castillo[6] showed that the use of discard corn grain, partially replacing conventional corn in laying birds from week 38-52 reduced the diet cost and the cost of producing an egg and production and egg quality remained unchanged. Furthermore, Elvir *et al.*[7] reported that the increasing inclusion level of discarded corn in diets improved the body weight and feed intake, without affecting the feed conversion ratio of broilers, also improved the breast yield, without modifying the other edible portions. To our knowledge, there are no previous studies on the dietary use of discarded corn grain as a partial substitute for conventional cornmeal in laying pullets diet. Therefore, the objective of this study was to evaluate the growth performance of Dekalb White® egg-laying pullets fed discard corn grain.

MATERIALS AND METHODS

All the procedures adopted in carrying out this experiment were approved by the Pan-American Agricultural School, Zamorano, San Antonio de Oriente, Honduras and conducted in accordance with the Guidelines for Experimental Animals. The study was conducted in January-April/2019 at the Poultry Research and Training Center of the Pan-American Agricultural School (Zamorano), located in Valle del Yegüare at 32 km of the Tegucigalpa road to Danli. The place is 800 m above sea level with an average temperature of 26°C.

A total of 1,416 one-day-old Dekalb White® replacement laying pullets were placed for 112 days according to a completely randomized design with two treatments and 12 replicates. The experimental treatments consisted of a basal diet and the substitution of 50% of conventional cornmeal by discarded corn grain meal. The diets to supply the nutritional requirements of the genetic line under study in the starter (0-8 weeks), grower 1 (9-12 weeks) and grower 2 (13-16 weeks) phases were formulated (Table 1). For the

Table 1: Ingredients and nutritional contribution of pullet diets

	Experimental diets					
	Starter (1-8 weeks)		Grower 1 (9-12 weeks)		Grower 2 (13-17 weeks)	
Ingredients (%)						
Cornmeal	53.74	26.87	60.34	30.17	57.73	28.86
Discard corn grain	0.00	26.87	0.00	30.17	0.00	28.87
Soymeal	33.16	33.16	25.85	25.85	23.48	23.48
Wheat bran	6.13	6.13	9.10	9.10	13.16	13.16
African palm oil	2.28	2.28	0.00	0.00	1.01	1.01
Premix[1]	0.20	0.20	0.20	0.20	0.20	0.20
Common salt	0.35	0.35	0.35	0.35	0.35	0.35
Biophos	1.61	1.61	1.61	1.61	1.44	1.44
$CaCO_3$	2.05	2.05	2.05	2.05	2.22	2.22
DL-methionine	0.19	0.19	0.16	0.16	0.12	0.12
Choline chloride	0.12	0.12	0.12	0.12	0.12	0.12
L-Lysine	0.00	0.00	0.05	0.05	0.00	0.00
Mycofix Plus 5.0	0.12	0.12	0.12	0.12	0.12	0.12
Coccidiostat	0.05	0.05	0.05	0.05	0.05	0.05
Cost (USD/t)	372.09	316.96	338.56	276.66	325.75	266.52

[1]Each kg contains: Vitamin A: 10×10^6 U.I., Vitamin D3: 1.5×10^6 U.I., Vitamin K3: 2100 mg, Vitamin E: 10,000 mg, Thiamine: 800 mg, Riboflavin: 2500 mg, Pantothenic acid: 10,000 mg, Pyridoxine: 2500 mg, Folic acid: 250 mg, Biotin: 100 mg, Vitamin B12: 15 mg, Manganese: 60000 mg, Copper: 8000 mg, Iron: 60000 mg, Zinc: 50,000 mg, Selenium: 200 mg, Iodine: 800 mg, Cobalt: 500 mg, Antioxidant: 125,000 mg

formulation of the diets, the chemical composition of imported yellow corn and discarded corn grain, as well as recommendations reported by Castillo[6] was considered to select the level of inclusion of discarded corn grain.

Each replicate consisted of a pen with a wood chip bed and 9.96 pullets m^{-2}. Feed and water were offered *ad libitum* in hopper feeders and dual automatic waterers, respectively. The temperature and ventilation inside the house were controlled by gas brooders, curtain and fans. The ship was disinfected according to environmental quality standards. The pullets were vaccinated against Newcastle, Bronchitis, Gumboro, Coryza and Cholera diseases.

In each experimental phase (starter, grower 1 and grower 2), the indicators of the growth performance were determined. Viability was determined as the difference between the initial number of birds and recorded mortality. The feed intake was calculated using the offer and reject method. The feed conversion ratio was calculated as the amount of feed ingested for a gain of 1 kg of body weight. The initial and final weight of each stage was measured on a Mettler Toledo® IND226 industrial balance with precision±1.00 g, respectively. Uniformity according to the ±10 method was calculated.

To determine the cost of the experimental diets, the cost of conventional cornmeal ($ 260.16/t), discard corn grain($ 50/t), soybean meal ($ 492.68/t), vitamins and minerals premix ($ 2601.62/t), common salt ($ 107.72/t), African palm oil ($ 731.70/t), choline chloride ($ 2,154.47/t), DL-methionine ($ 4479.60/t), L-lysine ($ 2,688.21/t), calcium carbonate ($ 130.08/t), wheat bran ($ 66.7/t), dicalcium phosphate ($ 894.31/t), mycotoxin sequestrant ($ 8,871.95/t) and coccidiostat ($ 8871.95/t) were taken into account. The average diet cost was considered in the different production phases (starter, grower 1 and grower 2) to determine the feed consumed cost.

The results were expressed as Mean±SEM. An unpaired student's-t test was performed using SPSS 17.0 (SPSS Inc., Chicago, IL, USA). P values <0.05 were taken to indicate significance.

RESULTS AND DISCUSSION

Table 2 shows the growth performance of white egg-laying pullet fed with discarded corn grain. The initial and final body weight, feed intake, feed conversion ratio, uniformity and mortality did not show significant differences between treatments (p>0.05). However, the feed consumed cost decreased significantly (p<0.05) in the discarded corn grain group.

Mortality during 16 weeks was not affected by the use of discarded corn grain (Table 2), thus, this feed by-product is safe and can be used in poultry diets, which was verified by other studies when they used this by-product in the diets of laying hens and broilers[6,7]. Also, one of the purposes of this study was to determine whether the inclusion of discarded corn grain substituting 50% of conventional corn in pullet diets would influence body weight and uniformity, as the fundamental objectives of this productive stage.

In this sense, discarded corn grain has more protein and essential amino acids than conventional corn, such as methionine, threonine, tryptophan, arginine, isoleucine, leucine and valine[7]. Thus, the use of this by-product can guarantee a correct balance of amino acids in diets, which is essential for body development, intestinal health and viability of the flock[8]. Elvir *et al.*[7] found that the inclusion of discarded corn grain contributed more tryptophan in the diets, which benefited the feed intake and weight gain in broilers, however, our results did not show notable difference for these indicators, perhaps because pullets are slow-growing birds and require less protein and amino acids for growth. Authors like Arrazola *et al.*[9] have recommended alternative feeding strategies to reduce stress and improve animal welfare, without reducing body weight. It should be noted that this feed by-product, available in corn products countries, is wasted or is used to feed ruminants, these results demonstrate that this feed can replace imported conventional corn without depressing the main productive indicators of white egg-laying pullets.

Table 2: Effect of discarded corn on the growth performance of replacement laying pullets (1-16 weeks)

	Treatments			
Items	Control	Discarded corn grain	SEM±	p-value
IBW (g)	31.22	31.47	0.223	0.690
FBW (g)	1211.94	1230.76	24.351	0.590
FI (g)	4573.07	4608.83	42.378	0.840
FCR	3.88	3.84	0.099	0.782
Mortality (%)	0.84	0.92	0.029	0.625
Uniformity (%)	80.00	83.61	2.176	0.237
Cost of FC (USD/pullet)	1.58	1.32	0.038	<0.001

IBW: Initial body weight, FBW: Final body weight, FI: Feed intake, FCR: Feed conversion ratio, FC: Feed consumed

On the other hand, a flock of pullets is uniform when most of the birds are close to their average weight[10]. The results showed that the uniformity was equal to and higher than 80% (Table 2), which was in accordance with the indications of the genetic house[11]. In this sense, Hidalgo *et al.*[10] reported that a non-uniform body weight increases age at first egg and decreases egg uniformity in laying hens. In this sense, Mesa *et al.*[12] found no variations in body weight and uniformity when they used alternative feed-in pullet diets. In general, the uniformity problems that affect the entire flock are due to zoo technical situations, environmental influences and infectious diseases[13]. Importantly, flock uniformity increases between 12 and 16 weeks, due to fiber-rich diets that balance consumption and pullet body weight[2].

Another interesting result is that the discarded corn grain has a much cheaper purchase cost than conventional corn (50 vs 260.16 USD/t). In all production stages, an 18% reduction in the diet cost was achieved (Table 1). Thus, as the results were similar between treatments, the feed cost of the pullet was reduced by $ 0.26. Similar results were reported in previous studies, when discarded corn grain was used in broiler diets and a significant reduction was found in the diet cost and to produce 1 kg of body weight, carcass and breast[7]. Other studies have recommended the use of corn and wheat by-products replacing the original raw materials to reduce the production costs of birds[4]. In this sense, Martínez *et al.*[2] and Guzmán *et al.*[14] have shown that the partial substitution of corn for alternative feeds, including wheat bran, oat husk, sunflower husk, pea husk, rice husk, soybean husk and sugar beet pulp was used to lower the pullet production cost. Furthermore, Diarra *et al.*[15] reported that a higher inclusion level of starch-rich cassava meal gradually decreased the diet cost without depressing the growth performance of the birds. Considering the results obtained, the discarded corn grain could be a viable alternative to reduce the feed cost, with higher emphasis for medium and small producers. Moreover, this scientific work completes a cycle of studies with the dietary use of discarded corn grain in the most important productive objectives (broilers, laying hens and pullets) of the poultry industry. In addition, it could be the starting point for the use of this feed by-product in the diets of other poultry species. However, other studies are necessary to determine if this feed product can totally replace conventional corn.

CONCLUSION

From the results, we recommend the use of discarded corn grain as a substitute for 50% of conventional cornmeal to reduce the feed cost of the Dekalb White® egg-laying pullets, without depressing growth performance during the 16 weeks of rearing.

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