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Original

Performance Evaluation of Chopped Maize Rachis as Bedding for Dekalb White® Replacement Layer Pullets

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ABSTRACT

Background: The material used for poultry bedding is an important factor for breeders, since it requires elements that provide comfort to the birds and do not depress the production potential.
Aim: To evaluate the performance of chopped maize rachis as poultry bedding for Dekalb White® replacement layer pullets (1-16 weeks).
Methods: A completely randomized experimental design with two treatments and 12 repetitions under the same experimental conditions, was conducted for 112 days to 1.416 one-day old sexed Dekalb White® replacement layer pullets. The productive performance was determined in the 1-4, 5-8, 9-12, and 13-16 week periods, and in week 16; uniformity was calculated according to two methods.
Results: The utilization of chopped maize rachis did not reduce (P>0.05) live weight, food consumption, food conversion, and mortality throughout the productive phases evaluated. Uniformity, according to the ±10 method, showed no significant differences between the treatments (P>0.05); however, based on the standard weight method of the genetic line, the utilization of chopped maize rachis raised the batch's uniformity (P<0.05).
Conclusions: The use of chopped maize rachis as an alternative for bedding does not reduce the productive performance of starter pullets (until week 16). Additionally, according to the standard weight method of the genetic line, the uniformity found in the pullet batch reared on chopped maize rachis was better, though no significant changes were observed with the ±10 method.

Key words: productive behavior, batch homogeneity, pullet, maize rachis, bedding (Source: *AGROVOC)*

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INTRODUCTION

Aviculture is one of the ever-growing agricultural activities thanks to implementation of new feeding techniques, genetic breeding, and better health, bringing up benefits to modern consumers in terms of quality and safe products, which, in turn, are efficient, innovating, and affordable (FAO, 2019). In that sense, the meat and eggs from birds are considered the most commonly eaten foods worldwide (Scanes, 2007), being Latin America, one of the most important clients (Koppel *et al*., 2016).

On the other hand, egg production includes management of the genetic baseline of replacements and future layers, phased feeding, and ownership conditions. Particularly, proper management of replacement chickens ensures high production and quality of eggs from the eighteenth week of life on. The goal is that the chicks reach an efficient zootechnical performance during their growth, which allows them to express the genetic potential of layers, and generate income (García *et al*., 2016).

Rearing pullets on bedding up to the beginning of the laying stage is a technology widely used internationally (Kheravii *et al*., 2017). One of the main challenges of this activity is to provide the birds with dry, easy to handle bedding, to prevent lacerations on the legs and chests. Humidity is known to stimulate bacterial growth, unpleasant smell, and flies, causing stress to animals, which limits the productive potential (Teixeira *et al*., 2015). Besides, at the end of this stage, the bedding material can be used as a direct fertilizer, animal food, and substrate to make compost. The most frequently used materials for bedding are rice hulls, zeolite, sugar cane bagasse, wood shaving, and others (Valdivié and Ortiz, 2006).

One of the most widely used materials is wood shaving, due to its characteristics and management of confined animals, providing comfort and adequate isolation. The main disadvantage of this material is the little accessibility in some regions, which increases the purchasing and productive prices. The poultry industry is looking at other ways to replace the use of wood shaving due to its economic disadvantages. Hence, the utilization of low-cost available materials, which can be an alternative without jeopardizing the productive performance, such as chopped maize rachis (Teixeira *et al*., 2015), could reduce the cost of production (Kheravii *et al*., 2017).

Quite a few countries produce high quantities of corn, thus generating a considerable volume of maize rachis as product residue or subproduct. This material is used to make compost, as the organic matter for poor soils, and as biofuel (Basso *et al*., 2017). In that sense, Martínez (2018), demonstrated that the use of chopped maize rachis as an alternative to wood shaving for bedding helped keep the productive performance of broilers, producing considerable income. However, few studies have referred to the utilization of this subproduct as bedding for slow-growing birds.

The aim of this research is to evaluate the performance of chopped maize rachis as poultry bedding for Dekalb White® replacement layer pullets (1-16 weeks).

MATERIALS AND METHODS

Location of the study and geo-climatic conditions

The experiment took place at the Center for Poultry Research and Training, Pan-American Agricultural School Zamorano, km 32, between Tegucigalpa and Danlí, Honduras. The mean annual temperature is 24 °C, average precipitation is 1 100 mm, and the area is located at 800 meters above sea level.

Animals, experimental design, treatments

A completely randomized experimental design with two treatments and 12 repetitions was conducted for 112 days to 1 416 one-day old sexed Dekalb White ® replacement layer pullets. The treatments consisted in two types of materials for bedding, a treatment of wood shaving, and another based on chopped maize rachis. The rachis was crushed using a hammer mill (2.54 cm particle size grains).

Experimental conditions

Each repetition consisted in two 5.92 m^2 pens (1.6 x 3.7 m), containing 59 pullets each, at a rate of 9.96 birds/m^2. The food and water was supplied *ad libitum* in hoppers, and automatic dual trough, respectively. The diet was formulated at the feedstuff plant belonging to Zamorano Pan-American School of Agriculture, considering the requirements described in the manual for the genetic line utilized (Table 1). In addition to it, the birds were not regrouped at any time.

Table 1. Composition and contribution of the diet of replacement layer pullets (1-119 days)

Ingredients (%)	Start (1-8 weeks)	Growth 1 (9-12 weeks)	Growth 2 (13-16 weeks)
Corn meal	53.74	60.34	57.73
Soybean meal	33.16	25.85	23.48
Wheat bran	6.13	9.1	13.16
Plant oil	2.28	-	1.01
Premix[1]	0.2	0.2	0.2
Salt	0.35	0.35	0.35
Biofos	1.61	1.61	1.44
$CaCO_3$	2.05	2.05	2.22
DL-methionine	0.19	0.16	0.12
Choline chloride	0.12	0.12	0.12
L-lysine	-	0.05	-
Mycofix Plus5.0®	0.12	0.12	0.12
Salinomycin	0.05	0.05	0.05
Nutritional contribution (%)			
ME, kcal/kg	2 850	2 750	2 750
Crude protein	20.50	18.00	17.25
Calcium	1.05	1.05	1.10
Available phosphorus	0.45	0.45	0.42

Lysine	1.13	1.00	0.90
Methionine-cysteine	0.83	0.70	0.67
Threonine	0.78	0.68	0.64
Tryptophan	0.25	0.20	0.20
Isoleucine	0.89	0.76	0.72
Valine	0.98	0.86	0.82

[1]Each kg contains: vit. A, 10 x 10^6 I.U.; vit. D_3, 1.5x 10^6 I.U.; vit. K_3, 2 100 mg; vit. E, 10 000 mg; thiamine, 800 mg; riboflavin. 2 500 mg; pantothenic acid, 10 000 mg; pyridoxine, 2 500 mg; folic acid, 250 mg; biotin, 100mg; vit. B_{12}, 15 mg; manganese, 60 000 mg; copper, 8 000 mg; iron, 60 000 mg; zinc, 50 000 mg; selenium, 200 mg; iodine, 800 mg; cobalt, 500 mg; antioxidant, 125 000 mg.

The house was previously disinfected according to the environmental quality standards. Gas heating and power saving bulbs were used during the first 14 days of age; curtains were placed to control temperature and lighting. The pullets were vaccinated against Newcastle, Bronchitis, Gumboro, Coryza, and Cholera (Dekalb, 2014).

Productive indicators

All the indicators of productive performance were determined in different periods: 1-4 weeks, 5-8 weeks, 9-12 weeks, and 13-16 weeks. The mortality of replacement layer pullets was determined by the number of dead animals from the total number at the beginning of the experiment. The starting and final weights were measured individually, using a digital Mettler Toledo scale, IND 226, with a ± 0.1 g precision. Total food consumption was calculated according to the supply-rejection method. Food conversion was calculated as the amount of food ingested, representing 1 g of live weight gain (LW). Uniformity was calculated according to the ±10 method (Zuidho *et al*., 2015), and the standard weight (Martínez *et al*., 2011). The bedding height was determined in week 16, using a 20-cm Amiga® ruler.

Statistical analysis

The results are expressed as mean and ± SE. A T-student test was performed in two separate samples, using SPSS 17.0 (SPSS Inc., Chicago, IL, USA), to indicate the significant differences, $p<0.05$ values were used. Mortality was determined by comparison of proportions, using COMPRAPRO 1.0® software.

RESULTS AND DISCUSSION

Table 2 shows the effect of the bedding type on the productive performance of replacement layer pullets, during the first 4 weeks of life. The utilization of chopped maize rachis did not have a significant influence ($P>0.05$) on the live weight of the young birds, or accumulated consumption, food conversions, and mortality.

Table 2. Effect of bedding type on the productive performance of replacement layer pullets (1-4 weeks)

	Poultry bedding			
Indicators	**Wood shaving**	**Chopped maize rachis**	**SE±**	**P**
Starting live weight (g)	31.22	34.45	0.220	0.466
Final live weight (g)	197.90	200.41	2.437	0.475
Total consumption	537.57	573.23	23.774	0.300
Total conversion	3.23	3.40	0.143	0.408

Mortality (%)	1.56	1.17	0.156	0.090

The first days of life are the most critical days for the birds, since they are more prone to suffer gastrointestinal disorders associated to different situations, such as environmental stress and ownership (García *et al*., 2019). Moreover, this stage is characterized by greater growth of their digestive organs and the immunological system. Therefore, the management conditions are the ones defining the productive performance of pullets, as well as those of the future layer. As part of productive conditions, bedding is a pivotal factor to birds raised on flooring (Jasper *et al*., 2015).

Poultry breeders have always tried to use more convenient bedding in productive systems (Valdivié and Ortiz, 2006). In that sense, chopped maize rachis is a subproduct of that plant, which in many places has no practical use. Hence, the results showed that chopped maize rachis has a fibrous structure which cushions the birds' legs, without causing harm. To our knowledge, this is the first study done on chopped maize rachis to rear replacement chicks, so this might be an effective alternative in poultry production.

Furthermore, this novel type of bedding can absorb enough water (Martínez, 2018) to keep the pens dry, which is important to reduce and eliminate the presence of moss or mycotoxins (Paredes, 2011), which has been corroborated by the low mortality observed in this study (Table 2). Also important, the tabulated productive indicators are similar to the values referred to in the manual of this genetic line in particular (Dekalb, 2014). A previous experiment comparing chopped maize rachis to wood shaving used to rear broilers showed similar results, thus confirming the efficacy of this bedding for pullets.

Besides, Table 3 shows that the use of chopped maize rachis as bedding material did not depress the productive performance of replacement layer pullets significantly (P>0.05), during the starting-growth stage.

Table 3. Effect of bedding type on the productive performance of replacement layer pullets (5-8 weeks)

	Poultry bedding			
Indicators	**Wood shaving**	**Chopped maize rachis**	**SE±**	**P**
Starting live weight (g)	197.90	200.41	2.437	0.475
Final live weight (g)	491.58	484.82	5.860	0.424
Total consumption (g)	1 502.21	1 955.08	51.784	0.199
Total conversion	5.13	5.64	0.209	0.099
Mortality (%)	1.43	1.84	0.334	0.395

The importance of the starting-growing stage for the poultry industry is known, since it represents and adjusting growth period, and the structural components of the adult hens are generated. Accordingly, it is essential to observe the good practices in replacement rearing (Grandía *et al*., 2016). The results show that in the transition stage between starting (1-6 weeks)

and growth (7-12 weeks), the birds were not affected by the utilization of the this bedding type (chopped maize rachis).

According to El-Lethey *et al*. (2003), during this transitional stage, it is important to offer optimum management conditions to the birds, in order to reduce stress-related factors, and reduce possible enterobacterium-related diseases. Additionally, Jones, Donnelly, and Dawkins (2005) reported that mismanagement during this productive stage has a life-lasting negative impact on digestion and nutrient uptake, which generates higher productive costs and economic losses when the laying stage is reached (Tsiouris, 2016). This research confirms that the use of chopped maize rachis as bedding for pullets, does not cause any morbilethality in the birds, whose productive performance is similar to the optimum criteria of genetic guidelines (Dekalb, 2014).

The utilization of chopped maize rachis as bedding did not indicate any negative evidence between the treatments (P>0.05) for the final live weight of the pullets, which also included total consumption, food conversion, and mortality in 9-12 weeks old replacement layer pullets (Table 4).

Table 4. Effect of bedding type on the productive performance of replacement layer pullets (9-12 weeks)

	Poultry bedding			
Indicators	**Wood shaving**	**Chopped maize rachis**	**SE±**	**P**
Starting live weight (g)	491.58	484.82	5.860	0.424
Final live weight (g)	888.81	867.75	9.893	0.146
Total consumption (g)	1547.83	1490.70	58.741	0.499
Total conversion (g/g)	3.91	3.90	0.155	0.949
Mortality (%)	0.58	0.40	0.295	0.654

Some research has concluded that the moisture of poultry bedding is a determining factor that causes stress, and determines the productive characteristics of the birds. Also, Valdivié and Ortiz (2006), reported that poultry bedding should withstand the compression that comes as a result of animal growth. Thus, the specific weight of the material is an important factor to consider for use during 16 weeks throughout the developing stage. These results confirm that chopped maize rachis has favorable characteristics to be considered for poultry bedding, which is important to prevent lacerations and affectations on the legs that may lead to a decline in the birds' genetic expression (Rehman *et al*., 2017).

In that sense, Atencio *et al*. (2010) found similar results by comparing the productive performance with the use of different poultry bedding, such as river sand, wood shaving, and rice hulls. Moreover, Valdivié and Elías (2003), and Ortiz, Valdivié and Elías (2004), found no calluses on the metatarsus and chest blisters in broilers, on coffee-bean husks, sugar cane bagasse, and sugar cane bagasse+ashes, as bedding; their productive results did not show any remarkable differences (P>0.05) from the rice hulls.

Table 5 shows that maize rachis used as poultry bedding did not change (P>0.05) the productive performance significantly during the last stage of growing chicks (16 weeks old).

Table 5. Effect of bedding type on the productive performance of replacement layer pullets (13-16 weeks)

	Poultry bedding			
Indicators	**Wood shaving**	**Chopped maize rachis**	**SE±**	**P**
Starting live weight (g)	888.81	867.75	9.893	0.146
Final live weight (g)	1 211.94	1 187.63	16.543	0.310
Total consumption (g)	980.43	844.56	66.329	0.162
Total conversion (g/g)	3.06	2.67	0.221	0.220
Mortality (%)	0.981	1.806	0.325	0.087

According to Lara and Rostagno (2013), the stressing factors or the low body condition, delayed egg production and/or the eggs were below the commercial weight. In that sense, bedding compressing has been generated by the accumulation of liquid and solid wastes from production, during the 16 weeks of rearing. Also, Paredes (2015) said that the poultry bedding must guarantee less compression and moisture to avoid fungi and mycotoxins proliferation, to the end of development.

At this stage, fibrous diet and the permanence of these non-amylaceous carbohydrates in the cecum cause an increase of cecal morphometry, greater calcium, water, and electrolyte absorption, and less humid feces (Pérez and Dohigo, 2017). Studies using wood shaving and rice hulls as bedding in the development stage, showed similar results in terms of lethality and live weight, before the beginning of laying (Valdivié and Ortiz, 2006). Damage was not observed in the growing pullets using chopped maize rachis during rearing.

Table 6 shows the effect of the bedding type on the productive performance of replacement layer pullets, during the first 16 weeks of life. In the starting, growing, and developing stages, the utilization of chopped maize rachis did not decrease (P>0.05) the productive performance of pullets significantly; besides, the height of the bedding remained unmodified.

Table 6. Effect of bedding type on the productive performance of replacement layer pullets (1-16 weeks)

	Poultry bedding			
Indicators	**Wood shaving**	**Chopped maize rachis**	**SE±**	**P**
Starting live weight (g)	31.22	34.45	0.220	0.466
Final live weight (g)	1 211.94	1 187.63	16.543	0.310
Total consumption (g)	4 568.04	4 507.57	103.68	0.659
Total conversion (g/g)	3.84	3.69	0.089	0.839
Mortality (%)	1.13	1.31	0.098	0.239
Bedding height (cm)	6.73	7.75	0.408	0.090

A proper body condition as a result of adequate management of nutrition, biosafety, medications, and bedding, produces less stress in the animals, and therefore, fewer related-diseases and growth delay (Jasper, 2015). The results showed that the chopped maize rachis utilized as poultry

bedding throughout the replacement stage (up to 16 weeks), is a new viable and effective alternative. Another important data in Table 6 is that the bedding height remained unchanged (P>0.05). Teixeira *et al*. (2015) said that the bedding height indicates resistance to compression Uneven, dusty bedding with low porosity may lead to a reduction in height, which confirms that this material is resistance to the compression caused by growing animals, without harming the legs (Kaukonen, Norring, and Valros, 2016).

Uniformity according to the ±10 and standard weight methods are shown in figure 1. Chopped maize rachis indicated no remarkable differences between the treatments (P>0.05); however, uniformity based on standard weight rose significantly (P>0.05) compared to wood shaving.

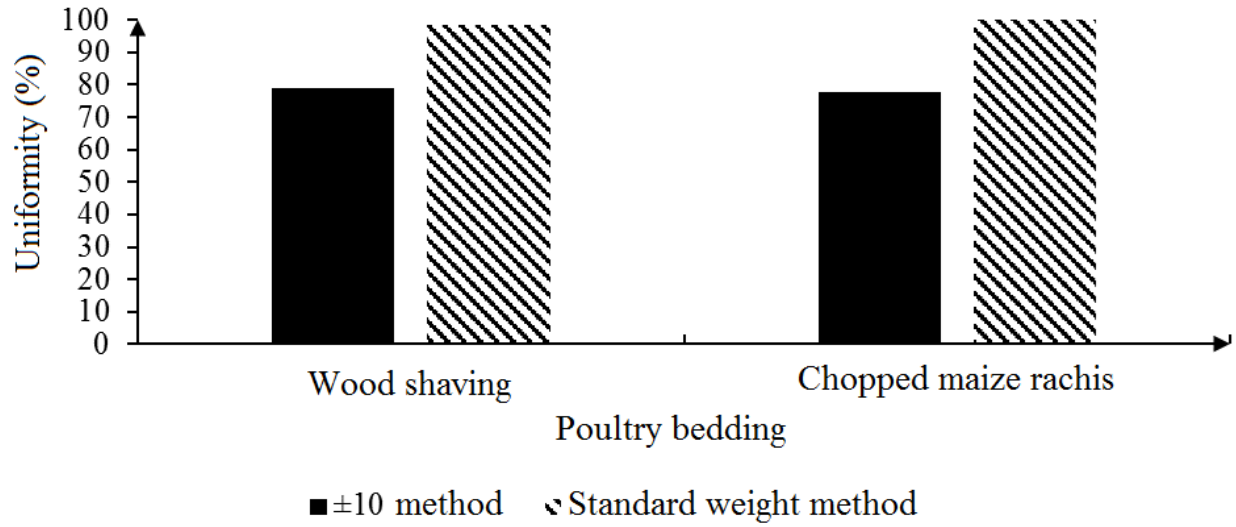

Figure 1. Effect of poultry bedding on uniformity, according to the ±10 method (SE± 2.351; value of P 0.740), and the standard weight method (SE± 0.427; value of P <0.001) of replacement layer pullets

In that sense, Zuidhof *et al*. (2017) said that a heterogeneous batch may cause a delay in laying, low production of eggs, and egg weight variability. In that sense, bedding made of alternative material (chopped maize rachis) did not hinder the uniform growth of the pullets, which may also favor the synchronization of sexual maturity and egg production. Also, Liu *et al*. (2017) reported that the most critical stage of uniformity is when the replacements are young animals, because they are exposed to different stressing agents, with little metabolic and immunological development. Gous (2018), mentioned that proper uniformity is over 80%. According to figure 1, the results showed lower percentages in relation to the ±10 method (78.99 vs 77.77).

Many authors overlook the relation between the live weight of the batch and the standard live weight of the genetic line. The main problems concerning uniformity, according to the standard weight method, are associated to zootechnical situations and infectious diseases affecting all the mass (Martínez *et al*., 2015). Based on the manual of the genetic line used, the birds reared on chopped maize rachis had an average weight close to the manual requirements for 16 weeks,

which confirms that this new bedding type (chopped maize rachis) maintains batch homogeneity and proper live weight throughout the productive stages.

CONCLUSIONS

The alternative use of chopped maize rachis as bedding did not limit the productive performance of replacement layer pullets during the growing stage. Additionally, according to the standard weight method of the genetic line, the uniformity of the pullet batch reared on chopped maize rachis bedding was better, though no significant changes were observed with the ±10 method.

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AUTHOR CONTRIBUTION

Conception and design of research: MV, YM. Data analysis and interpretation: AD, MV, Y. Redaction of the manuscript: AD, YM.

CONFLICT OF INTERESTS

The authors declare no conflict of interests.