Colegio de Postgraduados

Non-toxic *Jatropha curcas* L. residual paste as a protein supplement in poultry diets

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ABSTRACT

Objective: To evaluate the effect of the non-toxic residual meal from Mexican jatropha (*Jatropha curcas* L.) as part of a protein supplement in broiler chicken feed.

Design/methodology/approach: An experimental diet was designed by incorporating meal obtained from the non-toxic residual jatropha paste, which was administered to a group of 20 one-day-old Cobb 550 chicks. The chicks were weighed every three days, and their feed was adjusted weekly according to their development over a 28-day period. Another group of chicks, with the same number of individuals, characteristics, and follow-up, was fed a commercial diet for comparison purposes.

Results: The inclusion of non-toxic residual jatropha paste in the broiler chickens' diet produced similar performance to that obtained with the commercial diet.

Study limitations/implications: The scale of the experiment could affect the generalization of the results to a larger poultry population.

Findings/conclusions: The non-toxic residual meal from Mexican jatropha could be a viable and sustainable alternative for enriching poultry diets.

Keywords: Poultry feed; Production alternatives; Broiler chickens; Meal.

INTRODUCTION

Poultry farming in Mexico is in constant growth, driven by the demand for chicken meat as the main source of animal protein. In 2019, chicken meat production reached 909 thousand tons, representing 55% of the animal protein supply in the country (SIAP,

2019). This expansion calls for the search for sustainable alternatives in animal feed, where Mexican jatropha emerges as a viable option. This native Mexican plant, with high protein and lipid content in its seeds (Makkar, Becker, Sporer, & Wink, 1997), offers promising potential as a feed supplement for the poultry sector. The existence of non-toxic varieties of Mexican jatropha in Mexico (Martínez-Herrera, Siddhuraju, Francis, Dávila-Ortíz, & Becker, 2006) allows for the use of its residual meal as a protein supplement in poultry diets. This study analyzes the effect of non-toxic residual meal from Mexican jatropha on the growth of broiler chickens, contributing to the search for sustainable alternatives in poultry feed.

MATERIALS AND METHODS

Obtaining and processing inputs for the preparation of the experimental diet. The Mexican jatropha seeds, sourced from Papantla, Veracruz, were pressed to extract the oil. The residual meal was processed in an autoclave at 121 °C and 15 psi for 15 minutes to inactivate thermolabile antinutrients (Martínez-Herrera, Siddhuraju, Francis, Dávila-Ortíz, & Becker, 2006). The diet inputs (residual meal, corn, soy, wheat, sorghum, fish, and beef bone) were ground into a fine meal and then pelletized.

Toxicity. The residual meal was subjected to HPLC analysis to determine the content of phorbol esters, following the procedure described by Makkar (Makkar Harinder, Aderibigbe, & Becker, 1998).

Characterization of the diet inputs. The moisture, protein, and crude fiber content were determined according to Mexican official standards (PROYECTO de Norma Oficial Mexicana NOM-116-SSA1-1994, 1994) (Norma Oficial Mexicana NOM-F-68-S-1980, 1980) (NORMA Oficial Mexicana NOM-F-90-S-1978, 1979).

Experimental diet. The study compared the growth of chickens fed a commercial diet (Alpesur) and an experimental diet. The experimental diet was divided into three phases: pre-initial (week 1); providing 22% protein, initial (weeks 2-3); providing 20% protein, and finishing/final phase (week 4 onwards); providing 18% protein (Table 1).

The Pearson square method (Núñez González, Barcenas Mompeller, Mejías Caba, & Marrero García, 2020) was used to determine the quantity of each ingredient. Trouw Nutrition™ Axtra® PHY TPT 10,000 G phytase was added at 0.005% (200 g) to improve mineral absorption and eliminate phytic acid.

Experimental development. A total of 40 one-day-old Cobb 550 chicks were used. They were vaccinated against Newcastle disease on days 1 and 15. A shelter was established

Table 1. Elaboration of the non toxic formulation (%).

Inputs	Week 1 Pre-starter	Week 2 Starter	Week 3 Starter	Week 4 Fattening
J. curcas non- toxic	41.14	35.05	35.05	28.95
Beef bone flour	10.21	7.16	7.16	4.11
Wheat	42.21	45.26	45.26	48.30
Corn	3.21	6.26	6.26	9.31
Sorghum	3.21	6.26	6.26	9.31

with four blocks (two per group) of 1 m^2, with 10 chicks in each block, and the temperature was controlled using a heater. 100 W bulbs were used to maintain constant illumination.

Feeding program. The amount of feed was calculated for 20 chicks per group. The feeding program was developed over 28 days, increasing the amount of feed each week: week 1: 0.900 kg per day; week 2: 1.90 kg per day; week 3: 3.90 kg per day; and week 4: 5 kg per day.

Ethical management. The guidelines of NOM-051-ZOO-1995 (PROYECTO de Norma Oficial Mexicana NOM-051-ZOO-1995, 1996) were followed for the humane treatment of animals throughout the experiment.

RESULTS AND DISCUSSION

Toxicity of the residual meal. The HPLC analysis of the residual meal showed a phorbol ester content of 0.02 mg/g, confirming its non-toxic nature, which is consistent with previous studies (Makkar, Becker, Sporer, & Wink, 1997).

Nutritional content of the inputs. The residual meal from Mexican jatropha showed a protein content of 24.11% and a lipid content of 38.96%, standing out as a viable protein and energy source for chickens. In comparison, corn and sorghum, traditional ingredients, had lower percentages of protein (8.3% and 8.7%, respectively) and lipids (4.6% and 3.1%). Wheat provided 15.3% protein, and beef bone meal contributed 49.7%. These results indicate that Mexican jatropha can partially replace conventional inputs, offering an adequate nutritional balance and contributing to sustainability in poultry feeding.

Total and average daily feed consumption. The average feed consumption was similar in both groups during the 28 days of the study. Although the control group consumed more feed in the first week (0.303 kg compared to 0.266 kg in the experimental group), the differences narrowed by day 28, with totals of 2.769 kg and 2.316 kg, respectively. Neither group reached the theoretical consumption of 3 to 4 kg per chick (DANE (Departamento Administrativo Nacional de Estadística), 2015), and the differences were not statistically significant ($F=5.88$; $P=0.79$). The slight preference for the commercial diet may be attributed to palatability factors such as color and texture, as noted in previous studies (Nesseim *et al.*, 2019). Overall, the inclusion of Mexican jatropha did not negatively affect the amount of feed consumed by the chicks.

Increase in body mass. Figure 1 shows the increase in body mass of the chicks fed the experimental diet compared to those fed the commercial diet. The data indicate that both groups experienced similar growth throughout the study, with no statistically significant differences in average weight ($F=2.61$; $P=0.9$; $DF=2$).

During the 28 days of the study, both groups showed a consistent weight increase, with more pronounced gains starting from day 7, and by the end of the period, the average weights were similar. These results contrast with previous studies (Aguirre Jaramillo, 2011; Granda Paz, 2012), which reported lower weights due to the use of lower concentrations of Mexican jatropha (10%). In this study, the concentrations were higher (45% to 28%), which may have limited efficient metabolism and, consequently, body mass gain. Future research could evaluate intermediate concentrations to optimize growth and metabolic efficiency.

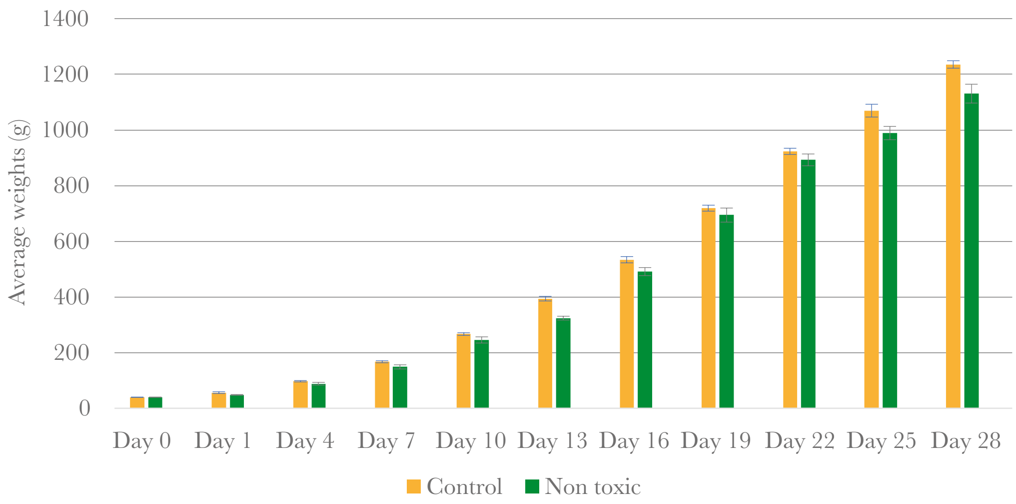

Figure 1. Average body mass gain.

Feed conversion ratio and productive efficiency factor. The results on the feed conversion ratio (FCR) for the groups fed the commercial diet and the experimental diet are presented in Table 2.

The data indicate that there was no significant difference in the feed conversion ratio (FCR) between the two groups ($F=6.39$; $P<0.05$; $GL=2$). This result suggests that the experimental diet is as efficient as the commercial diet in terms of feed conversion. Although optimal conversion ratios are considered to be below 1.8, the results of this study were higher: 2.24 for the group fed the commercial diet and 2.05 for the group with the experimental diet. The conversion ratios obtained in this study differ from those reported by Granda (Granda Paz, 2012) with a value of 1.50 and Aguirre (Aguirre Jaramillo, 2011), who achieved an efficiency of 1.48. The main difference lies in the concentrations of Mexican pinion or *J. curcas* seeds used: this study implemented higher levels (45% to 28%), while the aforementioned studies used a concentration of 10%. Various factors can influence conversion ratios, such as the genetics of the birds, the composition of

Table 2. Comparison of commercial and experimental diet.

Day	Commercial Diet	Experimental Diet
1	5.39±1.19	5.53±1.24
4	3.78±1.19	3.76±1.24
7	2.58±1.19	2.8±1.24
10	2.12±1.19	2.15±1.24
13	1.91±1.19	2.15±1.24
16	1.74±1.19	1.77±1.24
19	1.74±1.19	1.61±1.24
22	1.74±1.19	1.66±1.24
25	1.91±1.19	1.83±1.24
28	2.24±1.19	2.05±1.24

the feed, the feeding system, ambient temperature, and individual metabolic efficiency (Acres-Aviagen, A, 2014). When evaluating the productive efficiency factor (PEF), a better result was obtained from the group exposed to conventional feed, recording a value of 196.6, while the experimental diet group reached 184.2. The PEF is another important indicator that combines performance in terms of weight gain and feed efficiency, providing a comprehensive view of the productivity of the feeding system. Both groups achieved favorable PEF results, exceeding the threshold of 180 considered "excellent" in most national poultry farms (Ingalls Herrera & Ortiz Muñiz, 2006). This result is a positive indicator that the incorporation of Mexican pinion seeds in the diet does not negatively affect the productive efficiency of the chickens.

CONCLUSIONS

The results indicate that the non-toxic residual paste of Mexican *J. curcas* seeds or pinion seeds is a promising ingredient for broiler diets, without negatively affecting their growth, feed conversion, productive efficiency, or health. The performance was comparable to that of the commercial diet, with no significant differences in the weight of the chickens. This supports the viability of integrating Mexican pinion seeds or *J. curcas* seeds into poultry feeding, contributing to the diversification and sustainability of this industry.

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