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Research Article

Evaluation of the Partial Substitution as a Protein Source of Soybean Cake by Soldier Fly Larvae Meal (*Hermetia illucens*) in the Feeding of Commercial Line Hens in the Laying Period

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Abstract

48 laying birds were housed, to which a control treatment with 100% soybean cake was applied, and three additional treatments with replacement by 20, 40 and 60% soldier fly larva meal respectively, with twelve birds per treatment, six repetitions per treatment and two birds per cage for each experimental unit. The duration was seven weeks, of which the first two were for adjustment and adjustments, and the remaining five for trial.

The results showed that the best weight gain for the hens was presented in the treatments with 60 and 40% substitution, probably due to the level of fat present in the larva meal. On the other hand, the percentage of laying was better in the control treatment and in descending order the diets with 20, 40 and 60% respectively. Finally, the lowest feed cost for the production of 1 kilogram of egg was for the treatment with 100% soybean cake and at an ascending level the treatment with 20, 60 and 40% respectively.

Keywords: *Layers; Soldier Fly; Larvae*

Introduction

With the growth of the world population, the current demand for animal protein should grow by 70% by 2050, which implies greater animal production and therefore a greater amount of protein sources to feed them, therefore it is necessary to venture in the production of other alternative sources of protein that are of high nutritional value, low cost and environmental impact and in which insects are presented as the best alternative given their high production per unit area, short time in their production cycle, high nutritional value and low production costs [1].

According to Andrew Vickerson, Enterra's Chief Technology Officer, there are several benefits to insect protein, and Enterra hopes that food manufacturers will be eager to consider this eco-friendly protein alternative. "Insects are a natural food source for poultry," he says. "Other sources of protein used in animal feed include fishmeal, which causes the depletion of fish stocks, or soymeal, which requires many inputs and acres of land, which could be used for the production of food for humans" [2].

In the wake of the transmissible spongiform encephalopathies (TSE) crisis, also known as mad cow disease, the European food industry has lived without meat protein and animal meal since 2000. According to the association's position paper on use of insect proteins in animal feed, "IPIFF believes that insects will soon constitute a reliable alternative or addition to the fishmeal feed formula for aquacul-

ture: the nutritional characteristics of insects (protein content, amino acid profile, level of digestibility) are in fact comparable to those of fishmeal products, which makes them a relevant substitute or addition in the diet of certain species of fish (trout or Atlantic salmon, for example) or shellfish and shrimp [3].

Plant-derived protein is a key ingredient in the feed of farm animals around the world.

Most of the experiments published to date have been carried out with broilers, chickens fed with house fly larval meal. The results showed that house fly larvae can be added at approximate dietary levels of 25% DM, without any negative effect on weight gain (BWG), feed intake (FI) and feed efficiency. That suggests that larval meal can efficiently replace other protein sources, such as soybean meal, fish meal, and peanut cake [4].

V Maurer., *et al*. [5] carried out a feeding test with partially defatted meal of dried *Hermetia illucens* larvae, in groups of Lohmann Selected Leghorn laying hens (four groups, 10 hens/group). The experimental diets H12 and H24 contained 12 and 24 g/100g of *Hermetia* flour, replacing 50 or 100% of the soybean cake used in the control feed, respectively. After three weeks of feeding experimental diets, there were no significant differences between the feeding groups with respect to performance (egg production, feed consumption). There was a trend (P = 0.06) to a lower albumin weight in the H24 group; the weight of the yolk and the shell was not different. There were no mortality or signs of health disorders in the experimental groups.

M Bejaei and K Cheng [6] conducted a 14-week trial to evaluate the effects on egg quality in three experimental diets 0%, 10% and 18% of dried soldier fly larvae, replacing soybeans. for chickens to free range. Weight gain, feed intake, egg production, egg weight, feed conversion, health and wellness parameters, blood biochemistry and hematology, excreta microbiota, tract mass digestive system, the thickness and thickness of the shell, the internal quality of the egg, sensory evaluation, the data were analyzed by ANOVA of least squares. The results of the study as in the one obtained in the present investigation indicated that the control hens had significantly better egg production and conversion than the hens fed with 18% soldier fly larvae, probably due to the higher fat content, the presence of chitin, they conclude that ifs the digestibility of soldier fly meal is improved, it can completely replace soybean cake in the diet of laying hens.

Secci G., *et al*. [7] tested the effect of replacing 100% soybean meal with meal from soldier fly larvae in the diet of Lohmann brown classic chickens for 21 weeks, at the end of the test, the eggs were characterized, the hens fed with soldier fly larvae meal produced eggs with a yolk ratio than the soy-fed group. The fatty acid profile was also determined, and the composition was almost similar in the two diets, the diets with soybean meal. Soldier flies contained 11% less cholesterol than those fed soy. These results suggest that soldier fly meal is an adequate total substitute for soybean meal in diets for laying hens, therefore it seems viable and a sustainable alternative to the vegetable protein source.

Methods

Three isoprotein and isoenergetic diets were formulated according to the requirements of the Commercial Line.

This test was carried out at the Sena CLEM facilities in Tuluá, which consisted of the partial substitution of the protein provided by the soybean cake for that contained in the soldier fly larvae (*Hermetia illucens*) meal, which was cultivated at starting from specimens of larvae collected from animal manure, larvae that were introduced to a mosquito net where they completed the pre-pupal and pupal stage until they reached the birth of the adult fly, which, right there inside the mosquito net, completed its reproduction stage by performing oviposition. The eggs were collected and sown in a substrate rich in nutrients where the larval stage developed until L4, L5 and pre-pupa, at which time it was harvested, slaughtered, sanitized and dehydrated in an automatic dryer at 60 degrees centigrade for 24 hours until achieving a humidity level of 10%. Once dry, it was manually ground and stored in plastic bags and airtight jars with lids.

Starting from the larva meal, the food mixing process was carried out with a weekly frequency for the four treatments, in which the level of substitution of the soybean cake as a source of protein was 0, 20, 40 and 60% for treatments T0, T1, T2 and T3 respectively; Said food was supplied in an amount of 130 g per bird in the morning; Consumption was not measured because, in no case were there representative residuals to measure. In addition, 48 hens of the commercial Lohman Brown line with twenty weeks of laying were used and placed in twenty-four cages, for a total of two hens per experimental unit, six repetitions per treatment and four treatments in total. The birds were placed in cages alternately to avoid contact between experimental units as well as the possible mixing of the different feeds.

The shed with capacity for 500 birds is located on the grounds of the Seine CLEM of Tuluá with an altitude above sea level of 960m, a rainfall of 1200 mm and an average temperature of 24 degrees Celsius.

The production week began on Tuesday, the day on which analysis of the previous seven days was carried out, beginning with the weighing of the animals, counting, weighing and classifying the eggs. This activity was carried out during the seven weeks of the trial between August 28 and October 15, 2018; the first two weeks were used as a period of accustoming and to make adjustments to reduce possible variables. Finally, the information per cage and per week was collected individually in the laying records designed and used in the poultry unit.

Results and Discussion

Parameters	Treatment 0	Treatment 1	Treatment 2	Treatment 3
Weight increase gr	0,160	0,140	0,180	0,220
Percentage of posture%	93,02	92,18	88,41	84,64
Conversion x kg of eggs	2,19	2,31	2,5	2,52
Cost of food $ kg	1402	1354	1306	1258
Cost per kg of egg $	3056	3114	3174	3132

After doing the statistical analysis, it can be deduced that there are significant differences in the weight gain of the hens, where, as already mentioned, there is a progressive increase in weight as the level of substitution increased, representing 60% of the maximum figure. It can be inferred that the greater amount of soldier fly meal produced a better increase in body weight due to its high level of fat, which is around 30%, which makes it very important as a caloric source.

The feed conversion has decreasing figures, that is to say better, in the treatments 0, 1, 2.3 respectively. These results are in accordance with the percentages of position that are also decreasing and follow the same origin; surely these results are due to the better nutrition achieved with higher levels of soy cake. For this test, soybean cake provided homogeneity as raw material, protein with better digestibility and lower values in fat that are presumed negatively interfered by fat accumulation in the posture but, positively, in the increase in body weight.

The data from the analysis show significant differences between treatment 0, the best, and treatment 1; These two in turn have a significant difference with treatment 2 and 3, which are similar to each other.

The percentage of laying has a decreasing value as the level of substitution is increased despite the fact that the levels of soldier fly larva meal theoretically have the same level of protein, and that balancing was made to balance the materials. premiums on all diets. Significant differences and decreasing figures are presumed to be initially due to lower digestibility of larval meal protein; on the other hand, not all larvae had the same degree of development, some were even in the pre-pupal stage, which increases chitin levels. The washing and purification process represents a possible cause since it is possible that after washing contaminants remain.

To compare the production costs of 1 kg of egg, we started from the difference in the price of the kilo of soy cake and larva meal, each valued at $ 1,900.00 pesos and $ 1,000.00 pesos respectively, as well as the difference in cost of other raw materials for each treatment. It is observed that the lowest price per kg of feed is the one with the highest level of substitution and so on until reaching the most expensive with 100% soybean cake, however when this information is crossed with the conversion, the production cost per kg of egg changes the order of the treatments, because although treatment 3 is the one with the lowest price feed, it also has the worst conversion.

Conclusion

Hermetia illucens soldier fly larva meal is a viable alternative to be used as a raw material in the feeding of laying birds, thus reducing dependence on imported raw materials; the production cost is feasible to be reduced by improving, massifying and making the production process more technical.

In the first place, there is a large amount of products and by-products of the agricultural and livestock industries that can be used as raw materials in the feeding of this species, however, for future tests the difference that may exist in the composition must be studied. of larva meal when using the different substrates in larval feeding. In the same way, it is necessary, for each case, to find the optimal level of body protein at different harvest ages, during the larva stage, and thus be able to take advantage of the stage of development where there is more and better quality of this component of the nutrition.

Regarding the level of technification of the process, the one that is most efficient for harvesting, slaughter, disinfection, drying and grinding must be found. All the improvements made will surely result in a decrease in the conversion rate and percentage of laying due to the use of better protein levels, better processing of raw materials used as food, with a beneficial impact on the environment, less loss of nutritional quality due to excess temperature and time of exposure of the larva to hot water during slaughter; Likewise, the contamination of the larva by residues of the used food caused by deficiencies in the cleaning and disinfection technique will be reduced.

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