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# Meals from woody forage plants and palm fruit in the diet of broilers

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## Abstract

The work was conducted at the Research Center Santa Lucía, of the University Institute of la Paz, from Colombia, with 240 broiler chicken of the Cobb Avían 48® breed in their finishing stage. The objective was to evaluate the productive and economic response when including alternative feedstuffs such as 10 % meal from woody forage plants and oil palm fruit in the conventional diet. A completely randomized design was used, with four treatments of three replicas each and 20 animals per replica. The treatments were: T0: 100 % commercial concentrate feed; T1: 10 % mulberry *Morus alba* (L.) meal and 90 % commercial concentrate feed; T2: 10 % *Gliricidia sepium* (Jacq.) Kunth meal and 90 % commercial concentrate feed; and T3: 10 % ground oil palm *Elaeis guineensis* (Jacq.) fruit and 90 % commercial concentrate feed. No significant statistical differences were found among the treatments for the variables: weight gain, intake, conversion index and viability. The weight gains (g/bird) fluctuated between 1 388,8 (T0) and 1 037,0 (T1). The incomes, net cash profit, profit margin, net profit per animal and benefit/cost (B/C) ratio, were higher in treatments T2 and T3. The viability was high in all the treatments. It is concluded that the inclusion of these meals from woody forage plants in the conventional diet of broilers is feasible, because the productive results are not affected, while the inclusion of oil palm fruit turned out to be the best economic alternative.

Keywords: intake, *Elaeis guineensis*, weight gain, *Gliricidia sepium*, *Morus alba*

## Introduction

Poultry production in Colombia has shown great development in the last fifty years, with an increase in broiler production of 4,8 % in 2015 (Avila, 2016); however, the feed production costs for this species (essentially concentrate feed) represent 75 % of the total exploitation costs. For such reason, the utilization of low-price and high-quality feedstuffs is essential for expanding the poultry industry (FAO, 2014).

In this sense, it is necessary to turn to medium- and low-scale production, which should improve efficiency in the feeding of their birds to obtain higher productivity and competitiveness. Regarding this, it is essential to utilize forages and alternative materials available in the region, without decreasing feed quality. These alternative materials include mulberry [*Morus alba* (L.) (Ustundag and Ozdogan, 2015)]; quickstick *Gliricidia sepium* (Jacq.) Kunth), which according to Francisco and Hernández (1998) is probably the most widely used multipurpose forage species, and oil palm [*Elaeis guinnensis* (Jacq.) fruit (Adrizal *et al*., 2011)].

Ly and Pok (2013) state that mulberry and *G. sepium* show good protein percentages, but contain antinutritional substances which limit the intake by the animals. According to Sundu *et al*. (2006), the inclusion of the oil palm fruit is safe up to, at least, in 40 % of the diet, which allows a balance in amino acids and metabolizable energy, improves birds' immunity and reduces pathogen bacteria, even when digestibility is reduced, due to the high diet fiber. The purpose of this research consisted in evaluating the productive and economic response when including alternative feedstuffs, such as the meal from woody forage trees and oil palm fruit at 10 % in the conventional diet.

## Materials and Methods

*Location*. The trial was conducted in the shed of the Research Center Santa Lucía, property of the University Institute of la Paz, located at km 14 of the road from Barrancabermeja to Bucaramanga, whose coordinates are 7° 04′ 03″ N and 73° 50′ 50″ W, with an altitude above sea level of 75 m, average temperature of 32 ºC, approximate annual rainfall of 2 830 mm and relative humidity of 80 %. The shed was equipped under the current biosafety regulations established by the Colombian Agricultural Institute (ICA for its initials in Spanish).

*Animals, treatments and experimental design*. Three hundred one-day old chicks of the

Cobb Avían 48® line were used, which were confined with a density of 40 animals/m². They had been vaccinated against Marek's, Newcastle and Gumboro diseases. On day 21, 240 broilers were weighed and selected, according to completely randomized design, in mixed lots, with a density of 7 birds/m², distributed in four treatments with three replicas each and 20 animals as experimental unit in each replica. The treatments were:

- Treatment T0: 100 % commercial concentrate feed.
- Treatment T1: 10 % mulberry meal + 90 % commercial concentrate feed.
- Treatment T2: 10 % *G. sepium* meal + 90 % commercial concentrate feed.
- Treatment T3: 10 % ground palm fruit+ 90 % commercial concentrate feed.

## *Experimental procedure*

*Elaboration of the meals*. In the case of mulberry, variety acorazonada of 80 days of age, it was cut at less than 30 cm of height, the leaves were taken, dehydrated under sunlight over cement floor on black plastic of 3 mm of thickness to be ground afterwards. In *G. sepium*, also with 80 days of age, the technique of milking the leaves from their branches was used and they were later dehydrated under sunlight during 72 hours over cement floor on black plastic of 3 mm of thickness and were ground later. The oil palm fruit was harvested mature, and was dried under shade over cement floor in a 20-m² area, on plastic, until it reached the point in which it could be ground in a mill without blocking it. Once the meals were ready, they were homogenized with the commercial concentrate feed during five minutes in a horizontal ribbon mixer, with capacity for 120 kg.

*Management and feeding*. The diets were adjusted daily according to the total weight of the broilers and the management charts of the category. The rations were supplied twice per day (6:30 a.m. and 7:30 p.m.). To stimulate voluntary intake, the feed found in the troughs was turned three times per day. A hopper feeder and an automatic water dispenser were used per replica.

*Chemical analysis*. Samples of 300 g were taken for each of the mixtures; they were labeled and sent to the bromatology laboratory of the National University of Colombia, Medellín campus, for the following analyses:

- Ash: direct incineration at 600 ºC, AOAC rule 942.05 (Thiex *et al*., 2012);
- Crude fiber: of the cooked disk crucible, AOAC rule 978.10;
- Moisture and other volatile matters: thermogravimeter at 103 ±2 °C, ISO rule 6496;
- Crude protein: Kjeldahl, rule NTC-4657 UNAL (2014).

The chemical composition of the mixtures is shown in table 1.

For determining the animal behavior, feed intake and mortality were controlled daily, and for the live weight they were weighed at the beginning of the experiment and every seven days during three weeks. From these records, the gain, feed conversion and viability percentage were calculated.

*Economic analysis*. For the economic analysis the forage cost, as well as drying and grinding, cost of commercial feed, depreciation of equipment and facility, labor, broiler value and slaughter were taken into consideration. The incomes were calculated in Colombian pesos from the current prices for the kg of broiler carcass and sale of chicken manure. The economic indicators were determined through the following formulas:

- Net cash profit (NCP): Incomes – Expenditures
- Profit margin (PM): (Incomes/Expenditures) x 100
- Benefit/cost (B/C) ratio: Incomes/Expenditures
- Net profit per animal (NPA): SV/A – C/A

*Where*:

- SV/A (Sale value per animal): Incomes/Final number of animals
- C/A (cost per animal): Expenditures/Final number of animals

*Statistical analysis*. Initially the exploratory analysis of the data (box diagrams) was carried out in order to determine the atypical data. Afterwards

Table 1. Bromatological composition of the diets (%).

| Indicator | T0 | T1 | T2 | T3 |
|---|---|---|---|---|
| Crude protein | 19 | 18,50 | 18,90 | 16,60 |
| Crude fiber | 5 | 4,70 | 4,50 | 5,30 |
| Ash | 8 | 5,65 | 4,65 | 4,45 |
| Moisture and other volatile matters | 13 | 11,80 | 11,20 | 11,10 |

T0 (Control), T1 (10 % *M. alba*), T2 (10 % *G. sepium*), T3 (10 % *E. guinnensis*).

descriptive statistics was used, then they were analyzed through an Anova after the variance homogeneity and normality assumptions were tested through Levene's and Kolmogorov-Smirnov tests, respectively. The work was done with significance value of 5 %. Multiple mean comparison was performed according to Bonferroni test. For the data processing the statistical software SPSS® version 23 was used.

## Results and Discussion

No significant statistical differences were found among the treatments (table 2) for the variables: weight gain, intake, conversion index and viability.

Similar results were reported by Panja (2013), who worked with male broiler chicks, three weeks old, with diets supplemented with 0,5; 1,0; 1,5 and 2,0 % *M. alba*, and no significant differences were found for feed intake, weight gain and feeding efficiency among treatments, although in that study higher live weight gains were obtained (2 679; 2 695; 2 521 and 2 530 g, for 0,5; 1,0; 1,5 and 2,0 %, respectively). The differences among the trials could have been given by the inclusion percentages of the forage species used. In this study they were higher than 10 %, while in the study conducted by Panja (2013) they did not exceed 3 % of the diet.

On the other hand, Solís-Barros *et al.* (2017) found higher gains than the ones in this study, with values of 3 060 g in heterozygous naked neck broilers fed with the inclusion in the concentrate feed of 3 % meal of *M. alba* leaves and 5 % toasted *Cajanus cajan* grain during 90 days. These animals did higher intake (8 616,4 g/bird) and had a lower conversion (2,31).

The results of this study also differed from those obtained by Santos *et al.* (2014), when studying the productive performance of heterozygous naked neck broilers of the breed T451N, with three living spaces (5, 10 and 15 $m^2$) and two diets (0 and 3 % meal of *M. alba* leaves) at 30 % of restriction. These authors found significant differences in the intake, weight gain ($p < 0,05$) and feed conversion ($p < 0,01$). The results indicated higher productive efficiency with 10 $m^2$/bird and diet with 3 % of mulberry leaf meal.

The same occurred with the results reported by Herrera and Díaz (2016), when comparing *M. alba* and *G. sepium* in diets of naked neck broilers. In this case, daily weight gain and intake (9 059,96 g) was higher for mulberry and the lowest values (8 557,045 g) in *G. sepium*, for which they recommend its inclusion up to 5 % in the diet. In turn, no differences were found in conversion among the diets, similar to this study, because the evaluated diets had an analogous nutritional composition.

Regarding the oil palm fruit, Ruiz-Posada *et al.* (2015) evaluated its utilization *ad libitum* and commercial concentrate feed in broiler chicken feeding in the finishing stage. These authors found that the growth rate did not show significant differences among treatments. The palm fruit showed good palatability and the technical results were satisfactory, which indicates that its utilization in broiler chicken feeding is viable.

On the other hand, Pushpakumara *et al.* (2017) used the palm fruit cake in the rations of broiler chicken to evaluate the increase of body weight, feed intake and feed conversion. In this sense, the weight increase was significantly lower ($p < 0,05$) in birds fed with diets that contained 20 % of palm fruit cake, compared with 5, 10 or 15 %. A significantly higher intake ($p < 0,05$) was observed in birds fed with diets that contained 15 % of palm fruit cake compared with the control. The broilers fed with 15 and 20 % of palm fruit cake showed a significantly higher conversion ($p < 0,05$) compared with the birds fed with 5 %.

Regarding the incomes, the net cash profit (NCP), profit margin (PM), net profit per animal

Table 2. Effect of the inclusion of woody forage meals and palm fruit on productive indicators of broiler chicken.

| Indicator | Treatment | | | | Significance |
|---|---|---|---|---|---|
| | T0 | T1 | T2 | T3 | |
| Weight gain (g/bird) | 1 388,8 ± 53,02 | 1 037,0 ± 171,23 | 1 190,81 ± 118,1 | 1 302,63 ± 52,84 | NS |
| Intake (g/bird) | 3871,3 ± 608,41 | 3494,0 ± 146,53 | 3297,22 ± 219,22 | 3482,28 ± 123,89 | NS |
| Conversion | 2,8 ± 0,279 | 3,4 ± 0,537 | 2,76 ± 0,136 | 2,67 ± 0,035 | NS |
| Viability (%) | 86,7 ± 15,27 | 91,7 ± 7,63 | 96,66 ± 5,77 | 95 | NS |

T0 (Control), T1 (10 % *M. alba*), T2 (10 % *G. sepium*), T3 (10 % *E. guinnensis*).

(NPA) and benefit/cost (B/C) ratio, were higher in the treatments where 10 % palm fruit and *G. sepium* meal was included (table 3).

Similar conclusions were reached by Rahman *et al*. (2010) when including palm oil meal (2, 3, 4, 5 %) in the diets of chicken. These authors found that the total cost of those treatments was lower than that of the control group based on concentrate feeds.

Anaeto *et al*. (2009) found that the feed costs decreased and the return rate was increased with the intensification of the substitution of concentrate feed by palm cake (0, 10, 20, 30 %).

There are also proofs about the economic possibilities of the meals from other forage trees when substituting the conventional diet based on concentrate feeds. In this sense, Islam *et al*. (2014) reported that 3,5 % mulberry leaf meal can be used to formulate a low-cost diet to produce broiler meat.

Zambrano *et al*. (2015) used mulberry meal in the diet of campero chicken and improved the economic yield of poultry farmers.

On the other hand, Dhakal *et al*. (2016) determined the effect of different percentages (0,25; 0,5 and 0,75 %) of *Nigella sativa* on the characteristics of the carcass and economic analysis of Cobb-500 broiler chicken and found that the best net profit was for 0,5 %, for which they recommended it as an efficient and economical feeding system.

## Conclusions

It is concluded that the inclusion of these meals from woody forage plants in the conventional diet of broiler chicken is feasible, because the productive results are not affected; while the inclusion of oil palm fruit turned out to be the best economic alterntive.

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Table 3. Economic indicators for the evaluated diets[1].

| Indicator | Treatment | | | |
|---|---|---|---|---|
| | T0 | T1 | T2 | T3 |
| Incomes ($) | 971 920,00 | 917 200,00 | 1 022 640,00 | 1 047 904,00 |
| Expenditures ($) | 623 066,40 | 591 562,18 | 591 946,00 | 602 955,33 |
| NCP ($) | 348 853,60 | 325 637,82 | 430 694,00 | 444 948,67 |
| PM (%) | 35,89 | 35,50 | 42,12 | 42,46 |
| SV/A ($) | 16 960,00 | 15 040,00 | 16 080,00 | 16 805,33 |
| C/A ($) | 11 982,05 | 10 755,68 | 10 205,97 | 10 578,16 |
| NPA | 4 977,95 | 4 284,32 | 5 874,03 | 6 227,17 |
| B/C | 1,56 | 1,55 | 1,73 | 1,74 |

[1] Colombian pesos.

Net cash profit (NCP); Profit margin (PM); Sale value per animal (SV/A); Cost per animal (C/A); Net profit per animal (NPA); Benefit/cost ratio (B/C).

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