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*Full Length Research Paper*

# Productive behavior of *Rhode Island Red* hens fed with *Cnidoscolus chayamansa*

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**It was compared the productive performance of *Rhode Island Red* hens fed with commercial feed or replacement of a portion of the corn and soy for flour *Cnidoscolus chayamansa* leaves. 240 hens (60 animals/group), between 10 and 18 weeks old, were used in a control group (commercial feed) and three experimental groups (3; 6 and 9% flour *C. chayamansa*). The animals were reared on floor, with access to 50 m$^2$ of grass *Stenotathum secundatum*/group, 6 hours/day. The diets had equal metabolizable energy content (10.83 MJ/kg) and crude protein (16.27%). Productive and nutritional indicators were calculated. The highest intakes were obtained in control (5028.50 g), 3% (4497.80 g) and 6% (4322.63 g) chayamansa C. inclusion. The highest end accumulated body weight was obtained in the control diets (1899 g) and 3% of *C. chayamansa* (1632.50 g). The lower conversion values were obtained in the control (2.65) and 3% of *C. chayamansa* (2.75). All diets covered the nutritional requirements. *C. chayamansa* increased the availability of calcium in the diet. Crude fiber did not exceed the permissible value, but increased from 2.61% in the control to 3.56% with 6% inclusion. It can replace 3% of the corn and soybean diet for *Rhode Island Red* hens in development and pre posture, for C. chayamansa and obtain productive behavior, consumption, conversion and efficiency of commercial balanced nutrients like.**

**Keywords:** Chaya, consumption, conversion, poultry, weight gain.

## INTRODUCTION

The high prices of corn and soybeans (ASERCA, 2015) influence the cost of feeding poultry, because these materials are the main ingredients of the commercial balance. This forces them to seek alternatives, to support poultry breeds without affecting sales prices (Herrera, 2014).

Some forage shrubs have been used in feed for laying hens and broilers as: *Morus alba* (Casamachin *et al*., 2007 and Herrera *et al*., 2014), *Moringa oleifera* (Abou *et al*., 2011 and Gadzirayi and Mupangwa, 2014), *Gliricidia sepium* and *Cajanus cajan* (Chakoma *et al*., 2004 y Sánchez, 2009) and *Leucaena leucocephala* and *Cnidoscolus chayamansa* (Aguilar *et al*., 2000 and

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Sarmiento *et al*. 2002). Although, the effects of *C. chayamansa* has not sufficiently evaluated in the under development hens feed and pre posture.

*C. chayamansa* (family *Euphorbiaceae*) is an endemic plant of the Maya region in the Yucatan Peninsula, where the inhabitants of the warm sub-humid zone of Mexico and Central America consume their leaves. *Cnidoscolus* genre has over 40 different species (CARDI, 2010 and James, 2012). It is a semi-woody, semi-perennial shrub, of medium size that tolerant adverse environmental conditions (Ross and Molina, 2002).

This shrub has high content of protein, fiber, potassium, vitamin C and calcium (Ross, 2003 and Cifuentes and Porres, 2014). However, Valenzuela *et al*. (2015) exposed that this plant has biologically active chemicals that reduce blood sugar levels and has antioxidant capacity, for its richness in phenolic groups. It appreciable amounts of tannins and saponins (Mordi and Akanji, 2012) were found. Castro *et al*. (2014) quantified high contents of hydrocyanic acid in its leaves, so they recommended the pretreatment of the leaves for use.

The leaf meal *C. chayamansa* could be used for the replacement of part of the corn and soybean diet hens under development *Rhode Island Red*. These birds have greater hardiness than commercial laying hens (Pampin, 2010 and Sarmiento, 2012). The evaluation of different levels of inclusion is necessary because its fibrous value and the presence of active ingredients, may limit its use to under development and pre posture hens. *C. chayamansa* including dietary under development and pre posture hens could maintain or improve consumer indicators, conversion, weight gain and efficiency in the utilization of nutrients in relation to the use of commercial feed.

The objective was to compare the productive performance of *Rhode Island Red* hens that were fed with commercial feed or replacement of part of corn and soybeans in the diet, for foliage meal of *C. chayamansa*.

## MATERIALS AND METHODS

### *Location*

The research was conducted in the province of Los Ríos, Republic of Ecuador, 01°06 'south latitude and 79°29' west longitude, 75 meters above sea level, with an annual average temperature of 24.70 °C, relative humidity 87%, annual average rainfall of 2613 mm, annual heliophany of 886 hours and clay loam soil.

Crops. *C. chayamansa* collecting and processing.

Each group had daily access to a pasture area with 50 m2, *Stenotathum secundatum* grass that was planted at random, with 8 kg/ha of pure germinable seed. The planting distance of *C. chayamansa* was 2x2 m between plants and rows. Forage area *C. chayamansa* and grazing area were fertilized with 35 kg of humus per hectare. The leaves of the shrub were collected every 45 days. The leaves were dried in the sun for three days then milled in a hammer mill, to produce flour.

### *Animals, design and experimental groups*

240 *Rhode Island Red* hens were used in the development and pre posture category, between 10 and 18 weeks of age. The animals were distributed a randomized block design in a control group (with commercial feed) and three experimental groups (with 3; 6 and 9% of *C. chayamansa* inclusion in the diet), with 60 animals per group.

The animals were adapted to diets, initial seven days (during the week $10^{th}$). The animals had access to water and food, 24 hours a day. It was fitted with a trough manual feeder and 60-watt light bulb, to each group. The rations were formulated according to the requirements for this phase of development and pre posture of animals (table 1).

Animals were housed in rustic installations. They were raised on floor, with a bed 15 cm chip. The area was divided with fences, to host animals of different groups. The animals accessed the area of *S. secundatum* for three hours in the morning and three hours in the afternoon.

The animals were vaccinated against New Castle, at 12 weeks of age against Avipox at 14 weeks of age against Avian Infectious Coryza, at 16 weeks of age.

The animals were weighed every 15 days, 7:30 hours before ingestion of food, to calculate the average daily gain, for phase and accumulated breeding. Voluntary consumption (supply-rejection) was measured, one twice a month. Conversion, as a result of food intake from body weight gain was calculated. The food balance for weight gain obtained was calculated.

### *Chemical analysis of food*

Dry matter (DM), crude protein (CP), metabolizable energy (ME), crude fiber (CF), calcium (Ca) and phosphorus (P) food were determined (AOAC, 2012). The chemical composition of flour of *C. chayamansa* was: 91% dry matter (DM), 20% crude protein (CP), 8.62 MJ/kg of metabolizable energy (ME), 15.60% crude fiber (CF), 0.71% calcium (Ca) and 0.30% phosphorus (P). The chemical composition of the pasture was: 24% of DM, 11.22% of CP, 9.12 MJ/kg of ME, 17.20% of CF, 0.46% of Ca and 0.27% of P.

### *Statistical analysis*

Data were analyzed by SAS software (Statistical Analysis System), version 9.3 (2013) to evaluate descriptive statistics (mean and standard deviation) and multiple range

**Table 1.** Composition of the diets for research group

| Ingredients (%) | Control groups | Experimental groups | | |
|---|---|---|---|---|
| | | I | II | III |
| Corn, flour | 58.66 | 56.60 | 56.60 | 55 |
| Soy, flour | 14 | 12.50 | 11 | 10 |
| *C. chayamansa*, flour | 0 | 3 | 6 | 9 |
| Fish, flour | 7 | 7 | 7 | 7 |
| Rice, powder | 9.40 | 9.40 | 9.40 | 9.40 |
| Di-calcium phosphate | 1 | 1 | 1 | 1 |
| Pre-mixture[1] | 0.16 | 0.16 | 0.16 | 0.16 |
| Calcium carbonate | 9 | 9 | 9 | 9 |
| Sodium chloride | 0.50 | 0.50 | 0.50 | 0.50 |
| Lysina | 0.15 | 0.15 | 0.15 | 0.15 |
| Methionine | 0.13 | 0.13 | 0.13 | 0.13 |

**Table 2.** Voluntary feed intake (g/animal) of *Rhode Island Red* hens in the category of development and pre posture, with the inclusion or not of *C. chayamansa* in the diet.

| Weeks of biweekly measurement | Control | 3% of inclusion | 6% of inclusion | 9% of inclusion | SE (±) | Signification (p) |
|---|---|---|---|---|---|---|
| 12 | 1475 [a] | 1052.80 [ab] | 944.30 [b] | 983.30 [b] | 38.50 | 0.0308 |
| 14 | 1295.50 [a] | 1114.50 [ab] | 1046.33 [bc] | 916 [c] | 42.34 | 0.0032 |
| 16 | 1068 [ab] | 1115.50 [a] | 1126.67 [a] | 1000 [b] | 51.20 | 0.0130 |
| 18 | 1190 [ab] | 1215 [a] | 1205.33 [a] | 1077 [b] | 48.67 | 0.0184 |
| Total | 5028.50 [a] | 4497.80 [ab] | 4322.63 [ab] | 3976.30 [b] | 69.80 | 0.0178 |

[a, b y c] Different letters in the super indicate that average rates differ significantly ($p<0.05$)

test of Tukey was used for comparison of averages, with the determining the standard error (SE) and the probability value (p), in the analysis of variance (ANOVA).

I, group with 3% of inclusion; II, group with 6% of inclusion; y III, group with 9% of inclusion.

[1] 1 Premix of vitamins and minerals, where 1.00 kg of feed contains the following vitamins: A (10000.00 IU), D3 (2000.00 IU), E (10.00 mg), K3 (2.00 mg), B1 (1.00 mg), B2 (5.00 mg), B6 (2.00 mg), B12 (15.00 mg), B3 (125.00 mg), B5 (10.00 mg), B9 (0.25 mg) and biotin (0.02 mg) and micro-mineral elements: selenium (0.10 mg ), Iron (40.00 mg), copper (12.00 mg), zinc (120.00 mg), Mg (100.00 mg), iodine (2.50 mg) and cobalt (0.75 mg).

## RESULTS

The higher consumption of food ($p<0.05$) were obtained in the control diet (5028.50 g) with 3% (4497.80 g) and 6% (4322.63 g) inclusion of C. chayamansa. The worst result was presented at 9% incorporation of this plant, in animal feed. The same trend occurred in the fortnightly measurements, where the increase of fibrous food in the diet, reduced voluntary intake (table 2).

The highest final live weight accumulated in raising ($p<0.05$) was obtained in the control diets (1899 g) and 3% inclusion of C. chayamansa (1632.50 g). Similarly, it happened with the total average daily live weight gain and the various measurements in breeding. The worst result was presented with 9% of the shrub in the diet (table 3).

The lower conversion values ($p<0.05$) were obtained in the control diet (2.65) and 3% inclusion of C. chayamansa (2.75) value increased with the incorporation of shrub (table 4). This was due to differences in the voluntary intake and body weight gain of the animals in each of the diets.

With food balance calculation it showed that all diets covered the nutritional requirements of animals in this phase of development, for the weight gain that was obtained (table 5). Although it is necessary to ensure appropriate balance of energy and protein in the diet, the increasing substitution of grains for flour *C. chayamansa* leaves. Using this shrub increased availability of dietary calcium. The difference in indicators research groups, not

**Table 3.** Productive performance of *Rhode Island Red* hens in the category of development and pre posture, with the inclusion or not of *C. chayamansa* in the diet.

| Indicadors | Control | 3% of inclusion | 6% of inclusion | 9% of inclusion | SE (±) | Signification (p) |
|---|---|---|---|---|---|---|
| Live weight accumulated, g | 1899 [a] | 1632.50 [ab] | 1428 [bc] | 1194.70 [b] | 41.50 | 0.023 |
| Weeks of biweekly measurement | Average daily liveweight gain (g) | | | | | |
| 12 | 35.53 [a] | 28.57 [ab] | 22.45 [bc] | 14.88 [c] | 1.20 | 0.0230 |
| 14 | 24.04 [a] | 23.04 [ab] | 21.12 [b] | 18.29 [ab] | 0.67 | 0.0001 |
| 16 | 33.93 [a] | 26.43 [a] | 30.04 [a] | 22.88 [a] | 1.60 | 0.0001 |
| 18 | 42.14 [a] | 38.57 [ab] | 35.55 [b] | 29.29 [ab] | 2.01 | 0.0001 |
| Throughout the breeding (56 days) | 33.91 [a] | 29.15 [ab] | 27.29 [bc] | 21.33 [c] | 1.90 | 0.0230 |

[a, b y c] Different letters in the super indicate that average rates differ significantly ($p<0.05$)

**Table 4.** Feed conversion of *Rhode Island Red* hens in the category of development and pre posture, with the inclusion or not of *C. chayamansa* in the diet.

| Weeks of biweekly measurement | Control | 3% of inclusion | 6% of inclusion | 9% of inclusion | SE (±) | Signification (p) |
|---|---|---|---|---|---|---|
| 12 | 2.60 [c] | 2.96 [cb] | 3.01 [b] | 4.27 [a] | 0.06 | 0.0001 |
| 14 | 3.44 | 3.45 | 3.54 | 3.58 | 0.08 | 0.0893 |
| 16 | 2.26 | 3.14 | 2.68 | 3.13 | 0.05 | 0.1891 |
| 18 | 2.02 [b] | 2.31 [b] | 3.03 [a] | 2.63 [ab] | 0.03 | 0.0100 |
| Total (56 days) | 2.65 [b] | 2.75 [b] | 3.02 [ab] | 3.33 [a] | 0.04 | 0.0013 |

[a, b y c] Different letters in the super indicate that average rates differ significantly ($p<0.05$)

because of the energy, protein or mineral concentration in diets. However, it might depend on the fiber content. Crude fiber values did not exceed the permissible values of requirements (4%), in any case, but rose 2.61% in the control group to 3.56%, with 6% incorporation of shrub in the diet.

## DISCUSSION

The higher feed intake, total and per fortnight, were obtained in the control diet, followed by 3% and 6% inclusion of *C. chayamansa* (table 2). These results agree with those of Aguilar *et al*. (2000) who they determined that the inclusion of forage *C. chayamansa* and *L. leucocephala* (10; 20 and 30%) in the diet of native chickens negatively affected the digestibility, feed intake and productive behavior of birds, with increasing the inclusion of the shrub. Birds fed *C. chayamansa* better than those fed *L. leucocephala* and the best behavior was observed with 10% of C. chayamansa behaved. With these results it was possible to demonstrate the need to regulate the content of fiber in the diet for the hens in development and pre posture, because the voluntary food intake is affected.

The accumulated final live weight, average daily gain of total body weight gain and higher body weight were obtained biweekly control diets and the lower value of inclusion (3%) of *C. chayamansa* (table 3). Sarmiento *et al*. (2002) fed broilers with *C. chayamansa* and obtained productive results and performance similar to the control channel (diet based on corn and soya), with the lowest value for inclusion in this bush (150 g/kg body weight) and they recommended that this shrub flour can be mixed with corn, up to 250 g/kg, to improve performance of broilers fed low protein diets. Donko *et al*. (2002) found the best results with the use of 25g/kg flour *C. aconitifolius* in broilers.

Lower values were obtained conversion control diet and with inclusion of 3% *C. chayamansa* (table 4). Abouelezz *et al*. (2011) evaluated the effects of dietary nutritional

**Table 6.** Food balance in the diet of *Rhode Island Red* hens in the category of development and pre posture, with the inclusion or not of *C. chayamansa* in the diet.

| Elements | Control | 3% of inclusion | 6% of inclusion | 9% of inclusion |
|---|---|---|---|---|
| Consumption/bird/day, kg DM | 0.09 | 0.08 | 0.08 | 0.07 |
| Contribution ME, MJ/kg | 10.88 | 10.88 | 10.80 | 10.78 |
| Requirement ME, MJ/bird/day | 10.87 | 10.87 | 10.87 | 10.87 |
| Difference ME, MJ | 0.01 | 0.01 | (0.07) | (0.09) |
| Contribution CP, g | 168.10 | 164.30 | 160.02 | 158.60 |
| Requirement CP, g | 160 | 160 | 160 | 160 |
| Difference CP, g | 8.10 | 4.30 | 0.02 | (1.40) |
| Contribution CF,% | 2.41 | 2.84 | 3.13 | 3.56 |
| Requirement CF,% | 4 | 4 | 4 | 4 |
| Difference CF,% | 1.59 | 1.16 | 0.87 | 0.44 |
| Contribution Ca,% | 3.68 | 3.73 | 3.78 | 3.84 |
| Requirement Ca,% | 1.50 | 1.50 | 1.50 | 1.50 |
| Difference Ca,% | 2.18 | 2.23 | 2.28 | 2.34 |
| Contribution P,% | 0.48 | 0.47 | 0.48 | 0.48 |
| Requirement P,% | 0.40 | 0.40 | 0.40 | 0.40 |
| Difference P,% | 0.08 | 0.07 | 0.08 | 0.08 |

meal inclusion leaves shrub *L. leucocephala* and *M. oleifera* in the behavior of *Rhode Island Red* hens. They found the best results in the conversion of eggs with the lowest value of inclusion the bush, in 10% of the diet. Herrera *et al*. (2014) used flour *M. alba* forage for food naked neck chickens grazing and obtained the best conversion, with 3% of inclusion, in line with the lower value of inclusion of roughage in the diet.

Diets covered nutritional requirements and the use of *C. chayamansa* increased availability of calcium, fiber and allowed to replace a major part of dietary protein (table 5). The favorable productive performance of the animals was justified by the nutritional value of *C. chayamansa*. Sarmiento *et al*. (2002 and 2003) studied the protein composition of the same genus plants (*C. aconitifolius*) and determined which has a higher concentration of essential amino acids to alfalfa and soybeans regarding only ranged from 0.416 to 0.641 for lysine and valine. They concluded that a fibrous food with ample opportunities for incorporation into livestock diets.

The rusticity of *Rhode Island Red* hens enable them to make a good use of pasture and compliment your diet and ensure a more natural breeding. In this regard, Abouelezz *et al*. (2012) and Abouelezz *et al*. (2014) conducted ethological studies and quality of eggs *Rhode Island Red* hens grazing, from 8:00 AM to 17:00 PM. They found that the animals made good use of the natural vegetation, to express a favorable productive performance. In addition, grazing allowed expressing his behavior in semi-liberty and staying in comfort during operation in backyard, by their degree of rusticity. However, it should be noted that the rustic hens have a higher utilization of the enhanced fiber.

## CONCLUSIONS

It proved to be possible to replace 3% of the corn and soybean diet for *Rhode Island Red* hens in development and pre posture for foliage meal of *C. chayamansa* and obtain productive behavior, consumption and conversion efficiency of use of nutrients similar to the use of commercial feed.

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