# Productive performance of grazing heterozygous naked neck fowls, with different vital spaces and *Morus alba* leaf meal included in the ration

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In order to study the productive performance of heterozygous naked neck fowls, with different vital spaces, a total of 144 fowls of T451N breed, without being sexed, from 1 to 91 d old were used. They were distributed according to a random blocks design, with a 3 x 2 factorial arrangement in six treatments: three vital spaces (5, 10 and 15 $m^2$) and two diets (0 and 3 % of *Morus alba* leaf meal), at 30 % of restriction. Weight gain, food conversion, carcass yield and its main cuts and abdominal fat deposition were evaluated. The space-diet interaction was significant in intake, weight gain ($P < 0.05$) and food conversion ($P < 0.01$). Results indicated a higher productive efficiency with 10 $m^2$/fowls. Regarding control diet (1.62 g/kg LW), the highest liveweight (3.15 kg) and the lower abdominal fat deposition (1.46 g/kg of LW) were obtained when including 3 % of mulberry leaf meal, regardless the vital space used. The vital space influenced on carcass yield and its main cuts (drumsticks+tighs and breast), which were superior within 10 and 15 $m^2$. It can be concluded that breeding grazing heterozygous naked neck fowls, fed with a diet with 3 % of mulberry leaf meal, at 30 % of restriction in 10 $m^2$ per fowl, improved productive performance.

Key words: *grazing rearing, mulberry, naked neck fowls, abdominal fat*

Global intake of avian products, especially from grazing fowls, has experienced a constant growth during the last years, tendency that will continue according to Kellems & Church (2010).

In developing countries, the rearing of fowls improved for pastures (country fowls) has also been retaken. These fowls are fed with tree forage species (mulberry, mucuna and leucaena), with high protein, vitamin and mineral contents, although the use of these sources is limited due to anti-nutritional factors they have and to the high fiber level (Olmo *et al*. 2012).

There are many different criteria about proper density for grazing fowls, which varies with very wide ranges, from 2 (Phillips *et al*. 2002), 4 (Fanático 2007) to 1.6 (Miguel *et al*. 2008). Soler and Fonseca (2011) change the concept and state 1 fowl in 10 $m^2$, which could be the closest to optimal density, considering that the fowl can take some food in freedom or semi-freedom. From this point of view, it has to be considered that the experience of how population density of fowls raised in cages influences not only on animal welfare and its productivity (Shim *et al*. 2012), but also on bone morphology of legs, increase of feather eating appearance and stress (Dawkins *et al*. 2004), and even on organoleptic quality of carcasses (Fanático 2007).

In spite of the importance of this topic, there is low amount of information about studies on the most proper stocking rate, type of fowl, feeding system, grazing system, type of grass and diet composition. The objective of this study was to measure the productive performance of grazing heterozygous naked neck fowls, with different vital spaces and mulberry leaf meal included in the ration.

## Materials and Methods

*Location, soil and sowing of plants*. The research was carried out at the Universidad Técnica Estatal de Quevedo, Ecuador, located at 01°06' SL and 79°29' WL, at 75 m o.s.l., with a mean annual temperature of 24.7 °C, 87 % of relative humidity, 2613 mm of precipitations, 886 h of annual heliophany and soil of clay, sand and lime.

San Agustín grass (*Stenotaphrum secundatum*) was used for grazing, which is a very accepted grass in Ecuador for being resistant to stepping and droughts. It is characterized by providing a good cover (98 %) and a higher amount of macro-fauna (insects, snails and worms). The soil was fertilized with humus from the Red Californian earthworm. According to reports from INIAP (Instituto Nacional de Investigaciones Agropecuarias) about the nutritional composition of this grass, its crude protein contribution is around 15.3 %, at 45 d of re-growth. Its lower level of lignin is 6.10 %, proper fibrous fractions (66 % of NDF and 35.4 % of ADF), with an energy value that ranges around 7.8 MJ/kg. The experimental area had 4320 $m^2$, divided into 6 replications (720 $m^2$). It was divided into two plots (360 $m^2$) and per diet (control and 3 % of mulberry leaf meal). This area, at the same time, was sub-divided into 9 paddocks with different dimensions (20, 40 and 60 $m^2$), which is proportional to three paddock/vital space (5, 10 and 15 $m^2$). Fowls had access to the grazing area after 28 days old, and remained grazing 20 d in each paddock. Six mobile metal cages (one/replication) of 12 $m^2$ were used. They were divided into six smaller compartments (2$m^2$) for keeping four fowls (experimental unit) per treatment. Each cage had a water trough and feeding trough. Each fowl was identified through a colored bracelet as a control measurement. Males had it in the right leg and females in the left. At 7:00 a.m., fowls were taken out of their cages and conducted to the corresponding paddock, where they remained until 5:00. p.m. At that time, they were taken back to their cages where they were fed according to the experimental treatment (0 or 3 % of mulberry leaf meal), at 30 % of restriction. The real food intake was controlled daily. Chemical composition (%) of mulberry leaf meal is: 92.81 DM, 24.78 CP, 2.96 Ca, 0.38 P, 39.54 NDF, 27.00 ADF, 17.5 of hemicellulose, 12.4 cellulose, 6.10 lignin and 8.74 MJ/kg ME. A commercial balanced food was used, based on maize-soy, according to recommendations of SASSO (2012). After 15 d old, the adaptation to diet started gradually, with 3 % of mulberry leaf meal. Table 1 shows the composition of the initial, growth and final diet (with mulberry or without it). They were calculated according to the animal category.

*Fowls*. A total of 144 heterozygous naked neck fowls of T451N breed, from a crossbreeding between T44N roosters and recessive SA51 hens (SASSO 2012), from 1 to 91 d old and both sexes were used. They were kept in cages located in an open sided building until they were 28 d old, moment in which they started to have access to the grazing area. Their weighing was carried out at the beginning and every 15 d. Weight gain and food conversion were calculated according to controlled food. At 13 weeks of age, a total of six fowls/treatment were weighed and sacrificed according to the methodology described by Sánchez (1990) in order to evaluate carcass yield, its main cuts (drumsticks+thighs and breast), edible viscera and abdominal fat.

*Laboratory Analysis*. Samples of grass and mulberry were analyzed in the Laboratorio de Servicios de Análisis e Investigaciones en alimentos (INIAP), in Quito, Ecuador, in order to determine the content of dry matter (odio a mILESDM) and crude protein (CP), according to AOAC (2006), and NDF, ADF, hemicellulose, cellulose and lignin, according to Goering and van Soest (1970). Experimental diets were sent to the lab for confirming the contribution of nutrients calculated for formulations through a proximal analysis.

*Experimental design and statistical analysis*. The experiment was carried out according to a random blocks design, with factorial arrangement (3 spaces x 2 diets) and six replications per treatment. For the statistical analysis of results Di Rienzo *et al*. (2012) was used. The mean values were compared using the test of Duncan

Table 1. Composition of experimental diets

| Raw materials, % | Initial (1-27 d) Mulberry meal, % | | Growth (28-63 d) Mulberry meal, % | | Finalized (63-91 d) Mulberry meal, % | |
|---|---|---|---|---|---|---|
| | 0 | 3 | 0 | 3 | 0 | 3 |
| Dry maize | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| Rice cone powder | 5.30 | 4.30 | 15.00 | 15.00 | 20.00 | 20.00 |
| Mulberry | 0.00 | 3.00 | 0.00 | 3.00 | 0.00 | 3.00 |
| Fish meal | 7.00 | 6.80 | 4.00 | 3.70 | 3.50 | 3.30 |
| Soybean Pasta de soya | 34.00 | 34.00 | 20.00 | 19.00 | 18.00 | 17.00 |
| Palm tree oil | 2.00 | 2.60 | 1.20 | 1.50 | 2.80 | 3.25 |
| Calcium carbonate | 1.50 | 1.30 | 1.40 | 1.50 | 1.30 | 1.00 |
| Biofos (Phosbic) | 1.20 | 1.20 | 1.20 | 1.20 | 1.20 | 1.20 |
| Iodine salt Crisal | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 |
| Premix Broiler | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Metionine | 0.02 | 0.20 | 0.20 | 0.20 | 0.22 | 0.22 |
| Lisine | 0.12 | 0.12 | 0.12 | 0.13 | 0.10 | 0.10 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Calculated analysis | | | | | | |
| Total Protein, % | 21.88 | 21.76 | 17.68 | 17.01 | 16.74 | 16.78 |
| EM ( MJ/kg) | 12.00 | 12.00 | 12.34 | 12.00 | 12.3 | 12.34 |
| Calcium, % | 1.07 | 1.05 | 0.96 | 0.96 | 0.86 | 0.90 |
| Total phosphoro, % | 0.78 | 0.70 | 0.63 | 0.64 | 0.62 | 0.65 |

A kg of food contains: vitamin supplement: vitamin A (10000 UI), vitamin D3 (2000 UI), vitamin E (10 mg), vitamin K 3 (2 mg), Thiamine (1 mg)-B1, Riboflavin (5 mg), Pyridoxine (2 mg)- B 6 ,Vitamin B12 (15 mg), nicotinic acid (125 mg), calcium pantothenate (10 mg), folic acid (0.25 mg), and Biotin (0.02 mg). Mineral supplement: mineral selenium: selenium (0.1 mg), Iron (40 mg), copper (12 mg), zinc (120 mg), Mg (100 mg), iodine (2.5 mg) and cobalt (0.75 mg). (INIAP), Quito, Ecuador

(1955) in the necessary cases.

## Results and Discussion

There was significant interaction in indicators (table 2) of intake, weight gain and total food conversion (P<0.05). Total intake differed (P < 0.05) among treatments and it was superior in 10 $m^2$ for 3 % of mulberry leaf meal. In the spaces of 5 and 15 $m^2$, there were no differences for this indicator between the two diets (0 and 3 % of mulberry leaf meal). There were differences in the total weight gain (P < 0.05) among treatments. In the 5 $m^2$, the two diets (0 and 3 % of mulberry leaf meal) differed among them and also regarding the others (P < 0.05).

The highest value was present in the control treatment in 10 m2. Total food conversion was lower in the control diet and with 10 $m^2$. The rest of the treatments and vital spaces did not differed for this indicator.

These results could be owed to that, in higher spaces, the fowls had higher availability of natural food and, therefore, they had higher intake than the fowls that were grazing in 5 $m^2$. The results achieved with 10 $m^2$/fowl, even with the diet restricted at 30 %, were higher than those informed by SASSO (2012).

Although there is not an agreement in the consulted literature about the vital spaces for feeding grazing fowls, studies pointed out by Soler and Fonseca (2011) suggest the space of 10 $m^2$/fowl, which coincides with the results of this research. However, results with broilers and country chickens, located in cages and fed with mulberry meal, confirm that levels superior to 5 % of its inclusion affect productive indicators, while the diet is increased. These results have been confirmed by studies carried out by Casamachín *et al*. (2007), who used Cobb-400 fowls in cages, with different levels of mulberry meal and indicated that inclusion levels of 5 % or lower showed a similar productive to control.

Chowdary *et al*. (2009), Simol *et al*. (2009) and Itzá *et al*. (2010) arrived to similar conclusions when they obtained unfavorable results in fattening broilers when including 5 % of mulberry leaf meal.

Cáceres *et al*. (2006) and Olmo *et al*. (2012) have used lower concentrations of mulberry leaf meal and different food combinations in grazing fowls with very good results. Fumero *et al*. (2010) pointed out that the chemical composition and acceptability of diets with low fiber levels can influence on the best use of mulberry meal for feeding fowls.

There were no significant interaction in carcass yield, drumsticks+thighs, breast and relative weights of edible viscera and abdominal fat; therefore, the main effects were presented. Table 3 shows effect of the diet on carcass yield and its main proportions in grazing naked neck fowls.

In general, fowls consuming 3 % of mulberry meal had higher liveweights, with lower deposition of abdominal fat within their carcasses. Olmo *et al*. (2012) pointed out that the content of crude fiber in mulberry leaf

Table 2. Interaction among studied factors in the productive performance of grazing heterozygous naked neck fowls

| Indicators | Mulberry, % | Vital space, $m^2$ 5 | 10 | 15 | Sign. SE (±) |
|---|---|---|---|---|---|
| Total intake, kg/fowl | 0 | 4.76[c] | 4.81[bc] | 4.90[ab] | 0.04* |
| | 3 | 4.78[c] | 4.93[a] | 4.83[abc] | |
| Total weight gain, kg/fowl | 0 | 2.21[d] | 2.67[a] | 2.53[bc] | 0.04 * |
| | 3 | 2.41[c] | 2.63[ab] | 2.63[ab] | |
| Food conversion | 0 | 2.08[a] | 1.83[b] | 2.00[a] | 0.04* |
| | | 2.00[a] | 2.00[a] | 2.00[a] | |

[abc] Different letters per indicator differ significantly at P < 0.05 (Duncan 1955).
*P < 0.05

Table 3. Effect of the diet on carcass yield and its main proportions in grazing naked neck fowls

| Indicators | Mulberry meal, % 0 | 3 | Sign. SE (±) |
|---|---|---|---|
| Liveweight, kg | 3.03 | 3.15 | 0.02** |
| Carcass yield , % | 75.27 | 74.29 | 0.95 |
| Drumsticks+thighs weight, g/kg LW | 168.0 | 165.0 | 2.54 |
| Breast weight, g/kg LW | 190.0 | 187.0 | 2.88 |
| Edible viscera weight, g/kg LW | 79.0 | 77.0 | 1.29 |
| Abdominal fat weight, g/kg LW | 15.50 | 14.0 | 0.41* |

*P < 0.05 ** P < 0.01

(14.26 %) could contribute to abdominal fat absorption. Savón (2005) reported that fiber in rations for fowls produces lipid and cholesterol absorption at intestinal level. This effect is caused by soluble fiber (peptine) and lignin (Salas *et al*. 2008, Pittaway *et al*. 2008 and Albetis 2010). Ayerza *et al*. (2002) related the presence of moderate and high levels of fiber in the diet to the reduction of cholesterol and low density lipo-proteins (LDL) within the blood flow. In this respect, Albert (2006) stated that mulberry meal has high solubility and low lignin levels (7.6 %). According to Endo *et al*. (1999) and Hara *et al*. (1999), cited by Martínez *et al*. (2010), these fat reducing effects could be caused by the presence of high levels of short chain fatty acids (SCFA), found in the caecum, because it is stated that it has hypocholestoremic (butyric, acetic and propionic acids) characteristics which work as inhibitors of the HMG-CoA reductase enzyme.

When analyzing the effect of vital space on carcass yield (table 4), liveweight did not differ among treatments but there was higher carcass yield ($P < 0.01$) in the groups with 10 and 15 $m^2$/fowl. This may have happened because the animals in larger spaces (10 and 15 $m^2$) had more possibilities of having food, regarding those in 5 $m^2$. Carcass yield values were similar to those informed by Pavlovsky *et al*. (2009) with naked neck fowls of 14 weeks old, with diets based on alfalfa meal.

Results suggest that T451N heterozygous naked neck fowls, from SASSO (2012), can be raised in grazing systems, with vital spaces of 10 $m^2$/fowl, supplemented with balanced food, or including 3 % of mulberry leaf meal within it, and at 30 % of restriction, without affecting productive performance, according to the standards of this breed, which are good carcass yield and its main cuts, and lower abdominal fat deposition.

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Table 4. Effect of space on the weight relative to liveweight (%) of carcass indicators of grazing heterozygous naked neck fowls

| Indicators | Spaces | | | Sig. SE (± |
|---|---|---|---|---|
| | 5 $m^2$ | 10 $m^2$ | 15 $m^2$ | |
| Liveweight, kg | 3.05 | 3.14 | 3.08 | 0.03 |
| Carcass yield , % | 71.54[b] | 76.53[a] | 76.27[a] | 1.17** |
| Drumsticks+thighs, g/kg LW | 161.0 | 168.0 | 170.0 | 3.12 |
| Breast weight, g/kg LW | 182.0 | 190.0 | 192.0 | 3.52 |
| Edible viscera, g/kg LW | 82.0 | 80.0 | 82.0 | 2.23 |
| Abdominal fat weight, g/kg LW | 15.0 | 14.0 | 14.0 | 1.50 |

[ab] Different letters within the same line differ significantly at $P < 0.05$ (Duncan 1955).

** P<0.01)

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