

NUTRITION VALUATION OF THREE FEEDING ALTERNATIVES IN THE GROWING AND FATTENING OF PIGS (*Sus scrofa domestica*) NANEGAL-PICHINCHA

VALORACIÓN NUTRICIONAL DE TRES ALTERNATIVAS ALIMENTICIAS EN EL CRECIMIENTO Y ENGORDE DE CERDOS (*Sus scrofa domestica*) NANEGAL-PICHINCHA

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Abstract

The pigs' diet can be diverse, based on feed, kitchen waste, and crops' waste, which can be seen as an opportunity if known how to use this alternative feeding mechanism for this specie. In Ecuador various crops are produced and their waste can be used in pigs feeding, not as a unique source of nutrition but as a complementary diet. In this research done in Nanegal, in the North West of Pichincha, endemic crops were used such as banana (*Musa × paradisiaca*), white carrots (*Arracacia xanthorrhiza*), and sweet potato (*Ipomoea batatas*). An adaptation period is needed for the animals to be fed with crop's waste and they can reach superior consumption levels compared to animals only nurtured with feed, weight gains superior to 0,9 kgs per day, nutrition conversions of 3,4 and performance to the canal of 78% and a dorsal fat density of 25mm. **Keywords:** Nutrition, crops waste, banana, sweet potato, white carrot.

Resumen

La dieta de los cerdos puede ser muy variada; se utiliza balanceado, desechos de cocina y residuos de cosecha, lo que puede ser una oportunidad si se sabe cómo utilizar esta alternativa de alimentación para esta especie. En Ecuador se producen varios cultivos y sus residuos se pueden utilizar en su alimentación, no como una fuente única pero sí complementaria. En esta investigación realizada en el Noroccidente de Pichincha en la parroquia de Nanegal, se utilizó cultivos de la zona como son: banano (*Musa × paradisiaca*) zanahoria blanca (*Arracacia xanthorrhiza*), camote (*Ipomoea batatas*). Se necesita una etapa de adaptación de los animales para alimentarse con residuos de cosecha y pueden alcanzar consumos superiores a los animales alimentados únicamente con balanceado, ganancias de peso superiores a los 0,9 kg/día, conversiones alimenticias de 3,4 y rendimientos a la canal del 78% y espesor de grasa dorsal de 25 mm.

Palabras claves: Alimentación, residuos de cosecha, plátano, camote, zanahoria blanca.

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1 Introduction

According to (FAO, 2017), pork is the most consumed meat in the world, followed by the avian and then the bovine meats. The share of total consumption is around 43%, 33% and 23% respectively, with a small percentage (2%) for turkey meat. In 2013, there were 108 million tons produced worldwide, the largest producers are: China 57%, European Union 20%, USA 9%.

The Association of Pig Farmers of Ecuador (ASPE, 2016) reported that in 2013 the national production of pork was 117 708 MT, of which 74 980 MT were produced on technified farms, equivalent to 63.63% of the Domestic production, and 42 800 MT were produced in family farms or backyard equivalent to 36.36% of national production. The consumption of pork in 2007 was 7 kg/ person/ year, by 2013 increased to 10 kg/ person/ year, a 42% increase in 6 years.

Despite the increased consumption of meat in the country, producers are experiencing a crisis, according to Ram rez (2017), and one of the factors that is affected is food as the raw material, corn, is expensive according to the producers. For example, a quintal of corn costs USD 14.90, while in neighboring countries the value ranges from USD 7 to 13.

The feeding of pigs depends on the level of technification of the farms, in intensive systems, their feeding is based on balanced feed, and in familiar productive units or backyard, their food is varied and vegetable foods that do not qualify for marketing can be used, kitchen waste, by-products of the milling industry among the most important. According to (AGRYTEC, 2016) the main source of feed for swine in Ecuador is the balanced feed with a weighted average of 73%, followed by other foods category with 12.7%, whole grains or ground 8.6% and green fodder 5.3%.

This study evaluated three crop residues that are used to feed pigs in partial substitution of the balanced feed. Therefore, the objectives of the study were: to evaluate the response of the pigs to the three food supplements as an alternative source in each of the productive stages of the animal; the parameters evaluated were: consumption, weight gain, feed conversion, carcass yield and mm of dorsal fat.

2 Materials and Method

2.1 Population and sampling

The present investigation was carried out in the Nanegal parish, in the canton of Quito, in the province of Pichincha-Ecuador, located at a height of 1 199 masl, climatic conditions are; Warm subtropical-humid, the temperature oscillates between 16 and 24 Â° C, relative humidity average 90%, annual rainfall 2 086 mm.

The factor under study was feeding with crop residues as a complement to the pigs' balanced feed (Chart 1).

A completely randomized block design (DBCA) was used because the shed where the pigs were raised has a rectangular shape and on only one side has ventilation curtains, so this factor had to be blocked so that it does not affect the investigation. The results were analyzed in the INFOSTAT statistical program and a 5% LSD-Fisher test was used for the analysis of the averages.

Twelve male castrates of Landrace x Pietrain breeds were used, with an average weight of 29.6 kg and an age of two and a half months, where three pigs were distributed in each of the four treatments, and were housed in individual pens.

At the beginning of the investigation, a bromatological analysis was performed on the harvest residues used and the balanced feeds used (Chart 2).

The amount of food supplied to the animals was determined according to the Chart of consumption by age and weight recommended by the Brazilian Charts for Poultry and Pigs (Santiago Rostagno et al., 2005), for T1 they were fed only with balanced feed; in the treatments T2, T3 and T4 considered an inclusion of 60% of balance and 40% of crop residues was considered. The amount of balanced feed and crop residue was calculated every day by dividing it into two servings per day, the first being at 8 am and the second 4 pm. To determine the feed consumption before supplying the next ration, the feed residue was weighed. Consumption was determined by the following equation.

Where:

$$\text{Consumption of feed} = \text{Initial ration} - \text{residue} \quad (1)$$

The weight of the animals was recorded at 10 am every 8 days using a scale, to determine the weight gain of the different treatments the difference of weights was established;

Table 1. Different crop residues and balanced in pig feed.

Treatmento	Types of feed
T1	Balanced 100% Witnessed.
T2	Balanced 60 % + 40 % Green plantain (<i>Musa x paradisiaca.</i>)
T3	Balanced 60 % + 40 % White carrot (<i>Arracacia xanthorrhiza.</i>)
T4	Balanced 60 % + 40 % Sweet potato (<i>Ipomoea batatas.</i>)

Table 2. Proximal food analysis

Feed	MS %	P %	F %	C %	EE %	ENN %
Balanced	90,75	17,26	4,05	4,32	4,24	70,14
Green plantain	28,1	4,2	0,6	6,22	2,31	91,65
White carrot	28,5	2,24	1,36	5,61	1,73	94,27
Sweet potato	46,3	2,46	1,3	3,96	0,68	94,24

MS= Dry matter; P= Protein; F= Fiber; C= Ashes;
ENN= Non-Nitrogenous; EE= Ethereal Extracto.

Where:

$$\text{Weight gain} = \text{Initial weight} - \text{Final weight} \quad (2)$$

The feed conversion is the result of the calculation of the feed consumed divided for the weight increase of the pigs in each of the treatments.

Where:

$$\text{Feed conversion} = \frac{\text{Feed consumed}}{\text{Weight increase}} \quad (3)$$

The variable yield of the carcass was made once the animals reached commercial weight (approximately 100 kg) at 5 months of age. This variable is the ratio of the live weight of the animal and the weight after the slaughter and without viscera.

Where:

$$\text{Carcass yield} = \frac{\text{Alive weight} - \text{Vicara weight}}{\text{Alive weight}} \times 100 \quad (4)$$

The thickness of the dorsal fat was determined by placing the second and third cervical vertebrae, in this area a cut of 10 cm of width by 10 cm of length and 10 cm of depth was made, with the aid of a calibrator the amount of fat present in the cut was measured.

3 Results and discussion

3.1 CFeed consumption (CA)

The CA in the growing stage of the T1 and T4 registered better consumption, while T3 and T4 had

lower intakes. In the fattening stage, T4 continued to be the one with the best consumption, followed by T1, finally T2 and T3 with Lower consumption. Rostagno Santiago (2005) recommends consumption for initial stages of 1.04 kg/day, while growing 1.81 kg/day and for fattening 3.25 kg/day.

Works performed by Valdivie et al. (2009) determined that the consumption of raw green platina in shell can reach up to 4-5,9 kg in the fattening stage, also established that the inclusion rates of 30% of plantain in the diet of the pigs did not have a negative effect on the weight gain, on the contrary, inclusions of higher than 50% did affect the CA.

3.2 Weight gain (GP)

Pigs fed with the T1 and T2 obtained the best GP 1.07 and 1.04 kg/day, while T3 and T4 obtained the lower GPs in the following order: 0.94 and 0.91 kg/day. For De Blas (2006) it is possible to obtain weight gains in pigs between 0.9 and 1.0 kg/day, with improved genetics.

According to the Anon Swine Research Institute (2004), pigs fed only with platina had gains of only 0.56 kg/day. This is a result of the low protein content that determines a relatively poor supply of amino acids (Valdivie et al., 2009); For this reason Campadabal (2009) points out that energy foods such as cassava, plantains, and sweet potatoes should be supplied together with a source of protein.

Table 3. Consumption of balance feed and crop residues (kg/day) in different treatments

Treatments	Growth Kg/day	Fattening Kg/day
T1	1,83 a	2,58 b
T2	1,54 b	2,25 c
T3	1,52 b	2,31 c
T4	1,75 a	2,79 a
\bar{X} Kg/pig	1,66	2,48
CV %	2,56	1,84

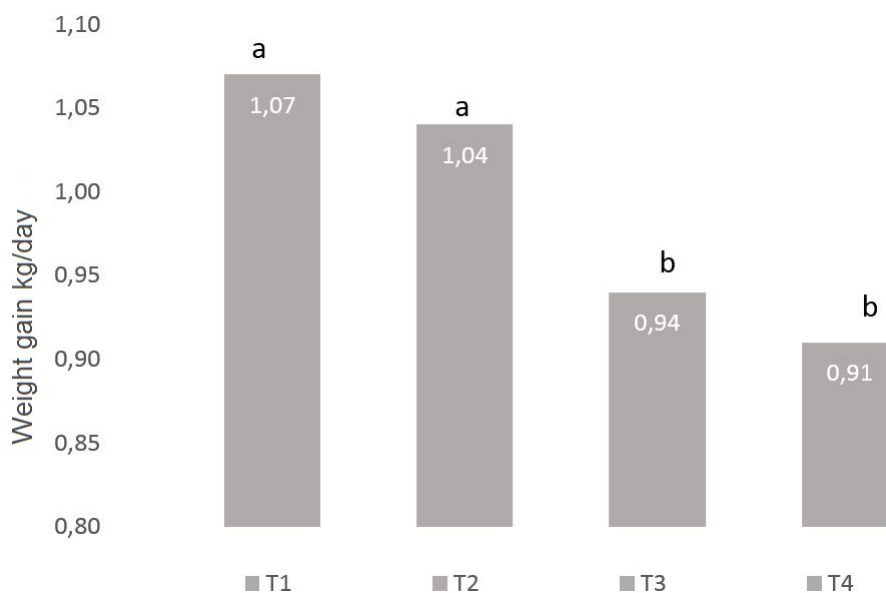


Figure 1. Weight gains (kg/day) in pigs fed for 10 weeks with crop residues. Own elaboration

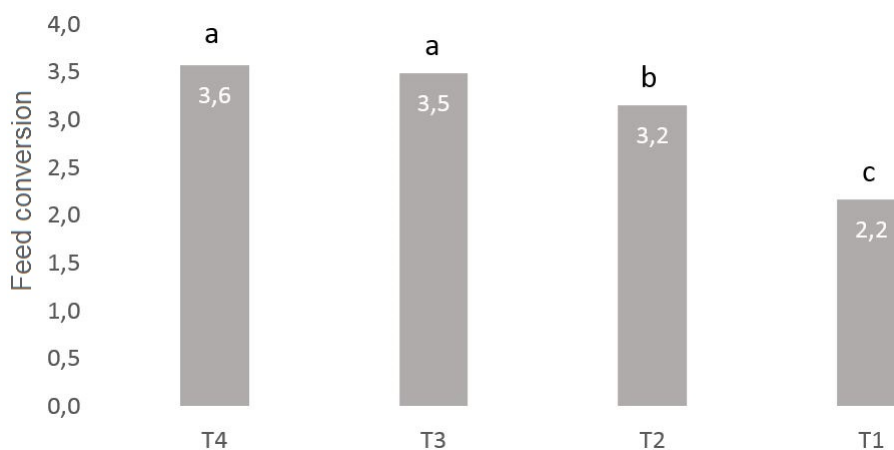


Figure 2. Feed conversion in pigs fed 10 weeks with crop residues. Own elaboration

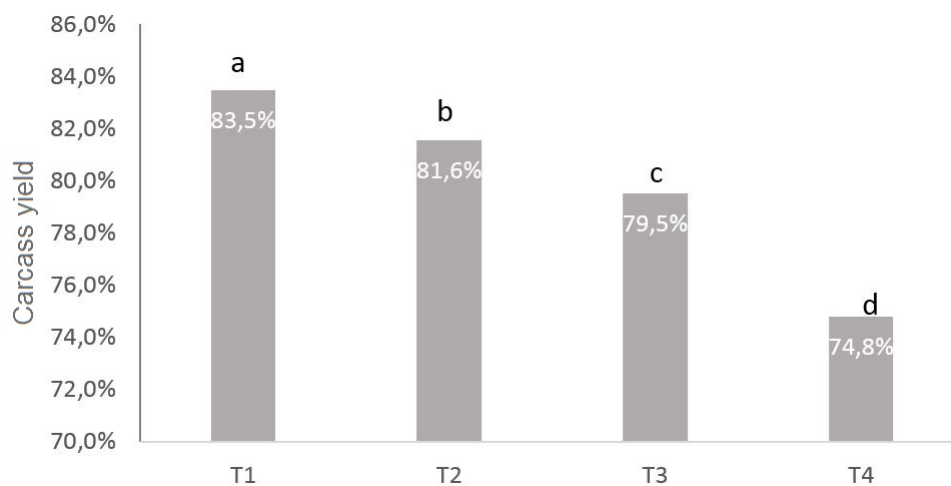


Figure 3. Carcass yield in pigs fed 10 weeks with crop residues.

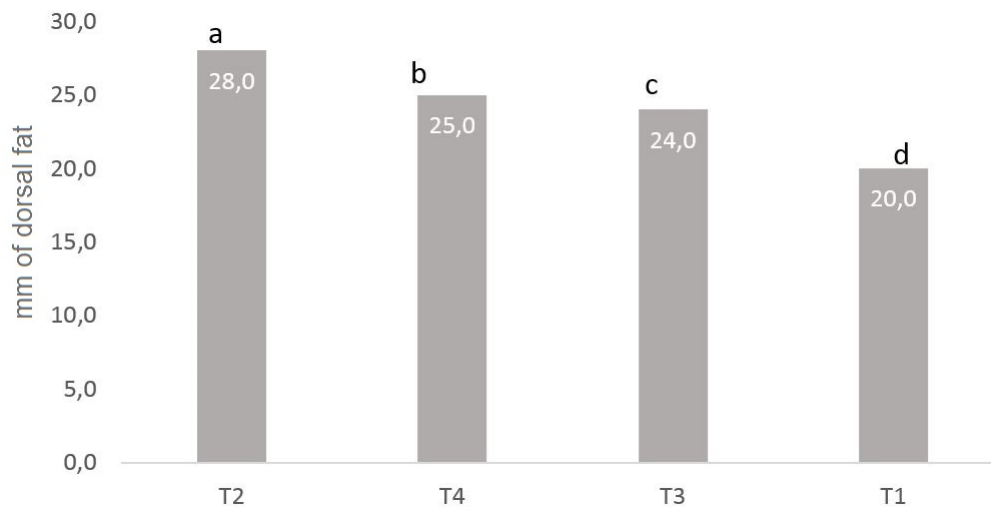


Figure 4. Dorsal fat (mm) in pigs fed 10 weeks with crop residues.

3.3 Feed conversion (conA)

The lowest ConA was obtained by the pigs fed with T1 obtaining 2.1; then the T2 fed pigs obtained 3.16 of ConA; the statistical behavior for T3 and T4 of CA were similar with 3.49 and 3.57 respectively.

For Silva (2010) pigs fed with 30% green plantains in their diet presented ConA of 2.52; While Garcia (2013) mentions that pigs fed banana leaf residues (*Musa spp*) including concentrates showed feed conversion of 2.99 when 15% were included in the diet, in this study ConA is lower since they used only 15% inclusion in the diet of the animals unlike our study where we obtained a ConA of 3.4 with an inclusion of crop residues of 40%.

3.4 Carcass yield (RC)

The T1 pigs obtained the best performance in the carcass yield, 83.5%, followed by T2 with 81.6%, then T3 with 79.5%, the lowest yield was obtained by T4 with 74.8%; Medel (2004) mentioned that the yield of the carcass increases with the age of slaughter, as it decreases the relative importance of the viscera, and showed increases of 0.5% for every 10 kg PV. For Marín & Mariscal (1997), pigs fed green or mature plantain silage showed 73.4% yields in pigs weighing 73 kg. of live weight.

3.5 Dorsal fat (GD)

The T2 pigs reached a higher GD of 28 mm, followed by the T4 with GD of 25 mm, then the T3 with a GD 24 mm, and the smaller one was the T1 with 20 mm, Medel & Mariscal (2004) determined that pigs with weights of 103 kg have 14 mm of dorsal fat and pigs with 125 kg have 18 mm of fat. (Angeles Marin et al., 1997) determined that pigs fed green or mature plantain silage had a GD of 27 mm. Dominguez (2008) established that pigs fed in the priming stage with orange silage accumulated up to 36 mm of dorsal fat.

4 Conclusions and recommendations

In this research the pigs fed with crop residues obtained a good feed conversion (CA) as in the case of T4 that was superior to T1. In the variable weight gain (GP) there was variation between treatments,

this is due to the low protein content that this type of food affects in the consumption of essential amino acids that the animal needs for its productive development, this was also reflected in the food conversion variable (ConA), where crop residues, despite good consumption, did not present a good weight gain, resulting in the highest ConA in T3 and T4.

As for the variable carcass yield (RC) behaved better the T1 that consumed 100% of balance feed and decreases in the pigs fed with crop residues, this is because these foods are rich in ENN, an excess in this nutrient at the end of the metabolism will become fat, this was evidenced in pigs fed with crop residues that obtained more dorsal fat (GD).

Pigs can consume crop residues but this should not be the single source of food but always complementary, in this research the green plantains, sweet potato and white carrot are feeds with high energy value but low protein concentration, which increases the amount of dorsal fat and decreases carcass yield if used at high levels.

Feeding pigs with crop residues is an option as long as these crops are from the area since the low content of dry matter can increase the cost of production in the pig farm.

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