Original Article. May-August 2018; 8(2): 59-67. Received: 2018/01/ 21 Accepted: 2018 /03/02.

http://dx.doi.org/10.21929/abavet2018.82.5

Use of poultry by-products as a protein source in the preparation of ruminant diets

Aprovechamiento de subproductos avícolas como fuente proteica en la elaboración de dietas para rumiantes

Cabrera-Núñez Amalia* amacabrera@uv.mx **Daniel-Renteria Iliana** ilidaniel@uv.mx **Martínez-Sánchez César** cesamartinez@uv.mx **Alarcón-Pulido Sara** saalarcon@uv.mx **Rojas-Ronquillo Rebeca** rebrojas@uv.mx **Velázquez –Jiménez Saw** velazquez@uv.mx

[1]Faculty of Biological and Agricultural Sciences, University of Veracruz. Tuxpan, Mexico * Responsible author and correspondence: Cabrera - Núñez Amalia. Faculty of Biological and Agricultural Sciences of the University of Veracruz; Tuxpan-Tampico Highway Km. 7 ½, University Colony, Tuxpan, Veracruz, Mexico, CP 92890.

ABSTRACT

The objective of this work was to evaluate the effect of poultry by-products, on the weight gain and yield of the carcass, under a stabling system. 30 Cebu x Suizo heifers, weighing approximately 300 kg and 30 months of age were used, which were assigned, to a completely randomized design in three treatments. The treatments were the following: T1, (control) energy concentrate; T2, energy concentrate + 30% poultry manure and T3, energy concentrate + 30% poultry meal. The composition of the energy concentrate was based on ground sorghum, corn grain, wheat bran, ground bales and salt blocks of minerals. Each treatment was offered twice a day at a rate of 3% of the live weight for 90 days. The average daily weight gain ($p \leq 0.05$) was .964, 1.04, 1.15 kg/animal, respectively. A significant effect ($p \leq 0.05$) was observed on the percentage of yield of the channel of 47.02; 49.08 and 52.03 %, for T1, T2, and T3, respectively. The results indicate that supplementation based on poultry meal promoted a higher productive-yield in heifers supplemented under a stabling system.

Keywords: poultry by-products, diets, protein, ruminants.

RESUMEN

El objetivo de este trabajo fue evaluar el efecto de los subproductos avícolas, sobre la ganancia de peso y rendimiento de la canal, bajo un sistema de estabulación. Se emplearon 30 novillonas Cebú x Suizo, con un peso aproximado de 300 kg y 30 meses de edad, que fueron asignadas, bajo un diseño completamente aleatorio en tres tratamientos. T1 (testigo) concentrado energético; T2 concentrado energético+ 30% pollinaza y T3 concentrado energético + 30% de harina de ave. La composición del concentrado energético se basó en sorgo molido, maíz en grano, salvado de trigo, paca molida y sal mineral. Cada tratamiento se ofreció dos veces al día a razón del 3% del peso vivo durante 90 días. El promedio de ganancia diaria de peso ($p \leq 0.05$) fue 0.964, 1.04, 1.15 kg/animal, respectivamente. Se observó un efecto significativo ($p \leq 0.05$) sobre el porcentaje de rendimiento de la canal de 47.02; 49.08 y 52.03 %, para T1, T2 y T3, respectivamente. Los resultados indican que la suplementación a base de harina de ave promovió un mayor rendimiento productivo en las novillonas suplementadas bajo un sistema de estabulación.

Palabras clave: subproductos avícolas, dietas, proteína, rumiantes.

INTRODUCTION

One of the main factors that contribute today to maintain the quality of the environment, is the use of by-products of animal origin; so it is a priority to look for alternative nutritional sources that reduce costs without adversely affecting production. Agroindustrial activities generate waste that can be reincorporated into the food chain, after physical-chemical treatment (Castañeda *et al*., 2010).

Within the last report made by INEGI-Mexico (2010), it was analyzed that of the livestock products (Table 1) those obtained from cattle report an annual production of 665 thousand tons/year, mainly in some regions where livestock that is practiced is intensive type; a part of the byproducts obtained is destined for export, mainly due to the high quality of the product (Abdul-Kalil *et al*., 2006). The pigs are produced in 28 states of the country through intensive and extensive farms; as well as 500 thousand tons of by-products of this species, which are used annually for national consumption. With respect to sheep and goats, the average national production is 10,000 and 11,000 tons/year respectively, in this case the farms are extensive and they are carried out in 28 of the 32 entities of the country; there is only a slight deficit in the production of goats, which is covered by the import. The national production of consumer birds represents 30,000 to 40,000 tons/year, being one of the most technified in the country. Most of these farms are located in areas close to urban centers that consume most of this production (Gutiérrez *et al*., 2013).

Table 1. Livestock by-products in Mexico

Animal Species	By-products	Use
Commercial flocks.	Feces, viscera, feathers, bones	manure, meal, poultry manure
Bovines	Feces, milk	Bovine manure, fertilizers, serums
Ovine	Feces	Ovine manure, fertilizers
Rabbits	Feces	Rabbit manure, fertilizers
Fishes	Bones, skin	Meal

On the other hand, the existing deficit in the production of grains and the relative abundance of agricultural waste, make these along with other organic waste and livestock by-products become an acceptable and low-cost nutritional alternative that can be used in the feeding of ruminants as a source of non-degradable protein in rumen (Gómez, 2006).

An answer to this situation is found in the poultry industry, which is the source of a great miscellany of by-products with an enormous nutritional potential, which is evident as long as the transformation technologies applied propitiate the bioavailability of its nutrients. Thus, the use of organic waste generated by this industry can contribute to the nutrient reduction cost in balanced feed for the preparation of ruminant diets (Ockerman *et al*., 2005)

Poultry manure

The intensive poultry production establishments have a high production of poultry waste that is commonly used as fertilizer. At present, the use of such excrement (manure) for the feeding of ruminants has spread. Poultry is understood as the set of feces and urine of birds, plus food remains, feathers, eggs and absorbent material. They are characterized for being materials of low energetic value and high in proteins, fiber and minerals. The protein is presented with a high proportion of non-protein nitrogen, so its use is exclusively for the feeding of ruminants (Brunton, 2012).

There are substantial differences in the chemical composition of these materials depending on their origin, requiring a chemical analysis prior to use. The information related to the use of the carcass for meat animals, indicates that these could participate in the diet at levels of up to 30-40%, although there is a history of inclusions of 60-70% in animals with lower requirements.

On the other hand, dairy cattle with intermediate to low production should not exceed 25-30% of consumption, reducing factors to 10-15% in high production females. In addition to the aforementioned, it should consider, on the one hand, the probable contamination of these products with chemical substances (anabolics, antibiotics, etc.); and on the other hand, the possibility of contamination with pathogenic organisms, mainly *Salmonella ssp*. In this regard, the recommendations of different bibliographic sources indicate the possibility of silage of this material type, with the following advantages: low cost, decrease of potentially pathogenic organisms, greater palatability and decrease of preparing undesirable flavor (Pearson and Dutson, 2008).

Poultry meal

In this context, poultry meal is a poultry by-product considered a source of protein with high biological value, a digestibility coefficient of 82 % and adequate chemical composition; besides providing minerals and vitamins, mainly B12; achieving some markedly deficient amino acids in plant proteins (Wisman *et al*., 2006). Considering its nutritional characteristics, it has reduced cost (poultry meal costs only about two thirds of the cost of other animal proteins) and its availability in large quantities. The inclusion of this protein source in commercial diets for ruminants would contribute to a significant reduction of the production price, while allowing the use of a good quality by-product (Bishop *et al*., 1995).

The poultry meal obtained from byproducts of poultry slaughter, it is an original product, which includes to a greater or lesser extent viscera and digestive, bone, blood, heads and lean tissues and fat. The flours are obtained by heating, grinding and drying of warm-blooded land animals and slaughterhouse by-products, waste rooms and supermarkets to which part of the fat is usually extracted; it must be practically free of hairs, feathers, bristles, horns, hooves and digestive contents. This manufacturing process includes i) grinding to facilitate homogeneous thermal processing, ii) firing (at 133 °C for 20 'at 3 pressure bars) to sterilize the product and melt the fat and iii) sedimentation and separation of the poultry fat part.

Most industries extract fat by pressure, so that the average content in the meal (12-15 %) is quite high, similar to the meal from United States of America; but superior to those of French origin, where the fat is extracted almost completely with organic solvents. Degreased meal is more palatable and easy to preserve, but it has a significantly lower energy value, (order 600 kcal/kg). In addition, and depending on the process used, the pepsic digestibility of these defatted meals can be compromised (Orskov, 1995).

The meal of bird is a raw material very used in diets for cattle of fattening, reducing the costs of formulation of diets. Meat and bone meal is considered one of the first options as a source of phosphorus, due to the high cost of inorganic sources of this mineral. The content of poultry meal provides phosphorus and calcium, contributing to the supply of minerals necessary for the diet of bovines, presenting a considerable variability in its chemical composition, based on protein, fat and ash (Gómez, 2009).

The main variation factors of the final product are the heterogeneity of the initial product, the commercialization of mixtures of meat from different species and the fat extraction system. Poultry meals are good sources of protein and essential amino acids with an adequate quality-price ratio; however, they have a low content of tryptophan, which is also little available. Overheating (> 140 °C) reduces the availability of amino acids, especially lysine, and can reduce the energy value of fat.

About 50 % of the protein is considered unpleasant in the rumen, but the variability is very high. As an international standard, it is considered that a meal is of good quality when it is above 65% of proteins (but 50% is also commercial), with a humidity that ranges between 6-12% (at higher humidity it ferments and produces aflatoxins and below it affects the quality of the proteins) and a fat content below 12%. With reference to salt, for optimum qualities the maximum is 3% (Ockerman and Hanen, 2005).

Among the main drawbacks to its use are its great variability, low palatability in case of rancidity of fat, the high risk of microbial contamination and the possibility of adulterations. Meals with a high content of fat or ground very finely present problems of caking, so they flow with difficulty through the hoppers, accumulate in dead zones of the conveyors and they are caked in silos and cells. On the other hand, coarse grinding with the presence of bone pieces and other gross particles can reduce the use of phosphorus and possibly calcium and make sampling difficult, while at the same time worsening the appearance and quality of the granule (Williams *et al*., 2007). The problem presented by this product is usually associated with rancidity and palatability.

On the other hand, quality control must allow detecting fraud and classifying suppliers. It is also important to control moisture, insoluble ash in HCl, quality of fat and protein (digestibility in pepsin); as well as the freshness of the original raw material (biogenic amines, ammoniacal nitrogen), bacteriology and the degree of heat treatment received (solubility of the crude protein). High levels of protein indicate a higher proportion of meat and less bone and, as a consequence, higher protein quality (Castañeda *et al*., 2010).

The objective of this study was to carry out an investigation to evaluate the response to the addition of a poultry by-product to whole-grain diets destined for stabled fattening heifers.

MATERIAL AND METHODS

This investigation was developed in a commercial ranch of the North of Veracruz state, in the municipality of Platón Sánchez, geographically located in the meridians 21° 16 "north latitude and 98 ° 22" west longitude, at a height of 60 meters above the level of the sea (m a.s.l) and average annual temperature of 19-36 °C.

30 Cebu x Suizo heifers were used, weighing approximately 300 kg and 30 months of age, which were assigned under a completely randomized design in three treatments. T1 (control) concentrated without poultry by-product; T2 concentrated + 30% poultry manure and T3 concentrated + 30% poultry meal. The composition of the energy concentrate was based on ground sorghum, corn grain, wheat bran, ground bale, mineral salt with 11% crude protein and 70% TDN (Total digestible nutrients. The nutritional values were analyzed by the method of Van Soest and Wine (Ockerman and Hanen 1995).

The energy concentrate was stirred daily according to treatment in the following proportions (T1 = 100% concentrated), (T2 = 70% concentrated + 30% poultry manure) and (T3 = 70% concentrated + 30% poultry meal). This was supplied in dry matter twice a day at a rate of 3% of live weight (NRC, 2007) during the 90 days that the experiment was developed; the consumptions of food corresponded in average to 10.5 kg/animal. The rations were offered in 3 stages, which were initiation, transition and finalization. The initiation stage lasted 8 days and the ration was made up of 21% forage from ground star hay (*Cynodon plectostachium*) ground and 79% concentrated feed. The transition stage lasted 8 days and it was made up of 15% forage and 85% concentrate; while, for the 74-day completion stage, 11% forage and 89% concentrate were supplied. The management of the animals consisted of vaccination, deworming, identification and application of vitamins A, D and E intramuscularly. The variations in the weight of the animals were recorded in fortnightly periods. Once the fattening period was over, the animals were slaughtered in the TIF (Federal Inspection Trace) refrigerator, determining the cold carcass yield (RCF).

The data were processed in the statistical package SPSS version 10, through the analysis of variance and the differences between treatments were detected by the Duncan test. The level of significance was 5%.

RESULTS AND DISCUSSION

The nutritional values analyzed (Table 2) by the method of Van Soest and Wine (1994), fulfilled the nutritional recommendations indicated by the National Research Council (NRC, 2007), with 11-18% of Crude Protein (PC) and 70% of Total Digestible Nutrients (TDN) for heifers with weight between 300-350 Kg. Determining that the experimental rations made from aviary by-products in the present work contained different levels of protein (manure and poultry meal), which they expected an unequal growth of the animals according to the treatment.

Table 2. Nutritional composition of the diets used in the stabled heifers

Indicator (%)	T1	T2	T3
Crude protein	11.0	18.3	18.5
Ether extract	1.2	1.3	1.0
Extract of oxygen free	65.58	63.52	65.26
Crude fiber	6.6	5.6	5.4
Ashes	6.22	5.24	5.32
Total of degestible nutrients	70.10	70.13	70.25

The productive performance of the animals in the different treatments (Table 3), in relation to the total weight gain / day, was significantly higher ($p \leq 0.05$) in the groups that received avian by-products with respect to the control (.964; 1.04 and 1.15 kg, for T1, T2 and T3, respectively). Also, the heifers of the study that received only the supplement based on energy nutrients, had lower accumulated weight gain; compared with the treatments supplemented by avian by-products (T2 and T3), which had a significantly higher response ($p \leq 0.05$) to the addition of manure and poultry meal (86.8, 94.3 and 104.0 kg, for T1) , T2 and T3, respectively).
The difference in food consumption resulted in the consumption of T1 animals consuming 14.6 Mcal. of metabolizable energy / day; whereas the animals of the supplement + poultry meal (T3) treatment consumed 23.8 Mcal, equivalent to a difference of 40% that is reflected in the same proportion of the live weight gain between treatments. These differences were due to a better nutritional intake and the effect on the rumen of the inclusion of a true source of protein, with an adequate balance of amino acids on feed intake and live weight gain (Stewart and Bryant, 2008).
The age at which heifers were slaughtered (Table 4) and the quality of the nutritional supplementation influenced most of the carcass characteristics; this behavior was observed in the present study, registering a yield of 52.03% for the hot carcass yield, which was higher due to the effect of adding 30% of the poultry meal to the daily diet supplied (T3).

Table 3. Productive parameters in farmed heifers and supplemented with poultry by-products

Indicator (%)	T1	T2	T3
Initial weight (Kg)	291.3 a	309.7 a	307.2 a
Final weight (Kg)	378.1 a	404.0 b	411.2 b
Kg. cattle/animal 90 days/group	86.8 a	94.3 b	104.0 b
Gain of weight/day (Kg)	.964 a	1.04 b	1.15 b
Consumption of the concentrate (Kg)	11.343 a	12.120 a	12.336 a

Table 4. Characteristics of the carcass in heifers stabled and supplemented with poultry by-products

Indicator (%)	T1	T2	T3
Age at slaughter (Months)	30 a	30 a	30 a
Weight at slaughter (Kg)	378.1 a	404.0 b	411.2 b
Hot carcass weight (Kg)	177.96 a	198.1 b	214.08b
Yield of carcass weight (%)	47.02 a	49.08 b	52.03 b
Degree of classification	Commercial	Standard	Select
Distribution of the fat (marbled)	Little covered	Covered	Fatty
Color of the carcass	Dark red	Light red	Cherry red
Score for classification	4	3	2

In the evaluations of the carcasses visibly and tactilely (Table 4), it was determined that the distribution of fat on the carcass surface and thickness in the eye area of the loin were slightly moderate in those females that received a supplementation based on poultry manure and meal, reaching a standard and select classification degree for the carcass (T2 and T3). With regard to marbling, it was located at the level that was little covered, covered and fatty for the T1, T2 and T3 respectively; while the color of the carcass remained with a dark, light and cherry red color. Muscularity (muscular profile and costal eye area) did not show statistical differences in favor of a treatment, although the supplemented animals showed a better silhouette (straight vs. slightly concave profiles of the control).

CONCLUSIONS

The supplementation based on 30% of poultry by-products (manure and poultry meal), promoted a better productive performance in farmed heifers, achieving weight gains of up to 1.0 kg / day. In the same way, balanced supplementation with optimal levels of protein and energy in the diet, significantly improved the quality of the carcass, obtaining yields greater than 52.30%, surpassing the control and giving it a high degree classification. In this context, poultry meal is a poultry byproduct considered a source of protein with high biological value. Taking into account their nutritional characteristics and their availability in large quantity; the inclusion of this protein source in commercial diets for ruminants would contribute to a significant reduction in the production price; allowing at the same time the use of a good quality poultry by-product.

BIBLIOGRAPHY

ABDUL-KALIL HPS, Siti-Alwani M, Mohd-Omar AK. 2006. Chemical composition, anatomy, lignin distribution and cell wall structure of Malaysian plant waste fibers. *BioResources* 1(2):220-232.

http://ojs.cnr.ncsu.edu/index.php/BioRes/article/view/BioRes_01_2_220_232_AbdulKahlil_SM_Chemical_Composition_Mayalsian_Plant_Fibers/128

BISHOP CD, Angus RA, Watts SA. 1995. The use of feather meal as a replacement for fishmeal in the diet of Oreochromis niloticus fry. *Bioresource Technology*. 54: 291-295. https://doi.org/10.1016/0960-8524(95)00146-8

BRUNTON EW. 2012. Animal waste management an industry perspective. *American Society of Agricultural.* ISSN 2151-0040; DOI: 10.13031/ISSN.2151-0032.

CASTAÑEDA FEA, Monrroy AVJ. 2010. Métodos de procesamiento de subproductos agrícolas para elevar su valor nutricional. Centro de ganadería, Colegio de posgraduados. Chapingo, México. ISBN 978-607-715-083.

GÓMEZ AR. 2006. Harinas de origen animal. En: Shimada AS, Rodríguez FG, Cuaron JA (Ed.). Engorda de ganado bovino en corral. Consultores en Producción Animal, S. C. México. ISBN 6071701228.

GÓMEZ AR. 2009. Harinas de origen animal. En: Shimada AS, Rodríguez FG, Cuaron JA (Ed.). Engorda de ganado bovino en corral. Consultores en Producción Animal, S. C. México. ISBN 6071701228.

GUTIÉRREZ F, Rojas A, Dormond H, Poore H, WingChing R. 2013. Características nutricionales y fermentativas de mezclas ensiladas de desechos de piña y avícolas. Agron. Costarricense 27(1):79-89. ISSN 2215-3608.

INEGI. 2010. Instituto Nacional de Estadística, Geografía e Informática. Anuario Estadístico por entidad federativa, México. ISBN-13: 978-0309317023.

MADRID A. 1999. Aprovechamiento de los subproductos cárnicos. 1ª ed. Madrid España. Edit. Acribia, pp. 35-43. ISBN 978-84-200-0856-1.

NACIONAL RESEARCH COUNCIL (NRC). 2007. Requerimientos Nutritivos para rumiantes en Engorda. 7th Edition Natl. Acad. Washington. D.C. p. 11-34. ISBN 13: 978-0309317023.

OCKERMAN HW, Hanen CL. 2005. Industrialización de subproductos de origen animal. Editorial Acribia. Zaragoza; España. p.123-234. ISBN: 9788420007519

ORSKOV ER. 1995. In: Better utilization of crop residues and byproducta in animal feeding: Research Guidelínes. 1. State of Knowiedge (Preston TR, Kossila VL, Goodwin J, Reed S, eds.). FAO Animal Production and Health No 50, pag. 163-184. ISBN 978-92-5-107452-7.

PEARSON AM, Dutson TR. 2008. Edible Meat By-products Advances in meat research. *Elsevier Applied Science*. Vol. 8. ISSN 2076-3417.

RIQUELME VE. 1994. Suplementación estratégica con subproductos alimenticios. Acribia, España. ISBN: 978-84-200-0897-4.

STEWART CS, Bryant MP. 2008. The rumen bacteria. In: The rumen Microbial Ecosystem. Edited by P.N. Hobson. Elsevier Science Publishers Ltd. London, England. P 21-76.

VAN SOEST PJ. 1994. Nutritional Ecology of the Ruminants. Second Ed. Cornell Univ. Press, Ithaca, NY, 476 pag. ISBN 080142772X.

WILLIAMS SE, Tatum JD, Stanton TL. 2007. The effects of muscle thickness and time on feed on hot fat trim yields, carcass characteristics and boneless subprimal yields. *Journal of Animal Science;* 67 (10): 2669-2676. ISSN 0021-8812.

WISMAN EL, Holmes CE, Engel RW. 2006. Utilization of poultry by-products in poultry rations. *Poultry Science.* 37: 834-838. ISSN 0032-5791. DOI: 10.3382/ps.0370834.