Journal of Agricultural Science and Technology A 5 (2015) 214-217
doi: 10.17265/2161-6256/2015.03.010

# The Use of Coffee Pulp as a Potential Alternative Supplement in Ruminant Diets

Amalia Cabrera Núñez, Iliana Del Carmen Daniel Rentería, Miguel Ángel Lammoglia Villagómez, Pablo Elorza Martínez, César Enrique Martínez Sánchez, Sara Aida Alarcón Pulido and Rebeca Rojas-Ronquillo

*School of Biological and Agricultural Science, University of Veracruz, Tuxpan Veracruz 92860, Mexico*

**Abstract:** The study was conducted to evaluate the use of dried industrial coffee pulp in diets as supplement for ruminants. Two diets were formulated: A and B with 30% coffee pulp content each and different concentrations of carbohydrates (milled corn, corn bran, molasses, alfalfa hay) and fibrous residues (corn stubble, sugar cane mash) as ingredients. The dried coffee pulp was subjected to proximate analyses, whilst the two diets were subjected to nutritional and microbiological analyses. The results of the proximate analyses showed that the dried coffee pulp has 18% crude protein (CP), 33.6% crude fibre (CF) and total digestible nutrients (TDN) content of 63.8%. Diets A and B had the similar mean values for CP, CF and TDN (17%, 4.3% and 75.6%, respectively). The microbiological results showed that the two diets had the same minimal values for *Escherichia coli*, *Salmonella* spp. and coliform bacteria, which were all within the normal allowed values. The results indicate that dry coffee pulp in diets could be supplemented to ruminants for supporting milk and meat production without any adverse effect on their health.

**Key words:** Coffee pulp, ruminants, supplement.

## 1. Introduction

From the economic point of view, coffee has been one of the most profitable crops for many years in Latin America as well as in other areas in the world. It is interesting to point out that even if the productivity has been increasing, the method used to process the coffee fruit has not seen any major change over the years [1, 2]. However, due to a myriad of problems, such as disposal problems of this by-product and ensuing environmental pollution, this material has received a greater attention than in the past. Many strategies for use of coffee pulp has been proposed, like being used as compost, growth medium and fuel [3-7]. Use of coffee residue as component in animal feed has been reviewed by several authors [2, 7-10].

Coffee pulp is an agricultural by-product, which is found between the husk and the grain or seed, and also called mesocarp. It is a layer of spongy cells with an approximate thickness of 5 mm, and it is obtained during coffee harvesting season [6, 11].

To take advantage of coffee pulp in animal feeding systems in commercial quantities, it is necessary to use processing methods, such as drying and silage making, and to calculate appropriate feeding portions and formulation of nutritional blocks [8, 9]. The methods should be chosen to maintain and improve the nutritious value of the pulp without excessively increasing the final product cost [4].

The use of coffee pulp in animal diets is feasible. Because in the first place, there is the long harvest season of seven months to guarantee a sufficient and constant supply of the product [12]; and secondly, the composition of the coffee pulp itself has a high crude protein (CP) content for animal improvement [13].

The inclusion of coffee pulp into nutritious diets for ruminants could be a viable alternative, as enormous quantities of coffee pulp is produced in the whole world and this will reduce production costs of milk and meat, particularly in developing countries [6, 14].

The objective of this work was to formulate a

**Corresponding author:** Rebeca Rojas-Ronquillo, professor, research fields: food biotechnology and dairy science. E-mail: rebrojas@uv.mx.

well-balanced diet for ruminants using industrial coffee pulp.

## 2. Materials and Methods

This study was carried out during November 2013 in the coffee-growing zone of the center of Veracruz, México, located between the geographic coordinates on latitude 19°54′00″ and longitude 96°92′75″ to an altitude of 1,460 m above sea level, with an average temperature of 20 °C, relative humidity of 75% and rainfall of 2,510 mm. A semi-experimental lot of *Coffea arabica* L. (Arabica coffee)—a traditional variety which has been established in March 1999 with a sowing density of 1,200 trees/ha was used.

Coffee pulp samples for this study were obtained from 200 kg of fruit from the plantation. The fruits were pulped using a roll mill (Gordon model A). The pulp was placed on a concrete floor in the morning (8:00 h), picked up in the afternoon (16:00 h) with the purpose of letting it drain and dried under the sun for 240 d.

Ten samples of 1 kg (raw material) each were randomly taken from different points of 100 kg of the dry total coffee pulp obtained to use in this study. Afterwards, they were mixed again, two samples of 1 kg were gathered in plastic bags and then they were identified and sent to the bromatology laboratory for proximate chemical analyses, where the following were evaluated: CP, crude fiber (CF), dry matter (DM), total ashes, ether extract, nitrogen free extract, digestible energy and metabolizable energy.

The diets were formulated using carbohydrates (milled corn, corn bran, molasses, alfalfa hay) and fibrous residues (corn stubble, sugar cane mash). A pre-mix of commercial vitamins and minerals were used. The dried coffee pulp was used as a source of protein. Two diets were formulated using the results of the proximate chemical analysis (PCA) and the nutritional requirements were recommended by the National Research Council (NRC) [15] for ruminants in their reproductive stage. Diet A was made with dry coffee pulp (30%), milled corn (25%), corn stubble (14%), sugar cane mash (15%), corn bran (12%), molasses (2%) and pre-mix of commercial vitamins and minerals (2%). Diet B was made with dry coffee pulp (30%), milled corn (29%), corn stubble (4%), sugar cane mash (6%), alfalfa hay (26%), molasses (3%) and pre-mix of commercial vitamins and minerals (2%).

Microbiological analyses were done using the techniques of the Association of Official Analytical Chemists (AOAC) [16].

## 3. Results and Discussion

The fodders and other feed sources with 7%-9% and 11%-12% protein are classified as regular quality and good quality, respectively [17]. Adequate CP values have been identified between 10.7%-11.58% to coffee pulp [18], and these values agree with other reports [3, 7, 19]. The average CP and energy values (Table 1) obtained in this study (18% and 9.61 kJ/kg, respectively) were higher than values obtained in previous studies. The dehydrated pulp for 240 d used in this study would not restrict milk production in cows, because they need 11%-17% of CP [14].

The DM of 74.4% for dehydrated coffee pulp observed at 200 d [20] was superior to the average value 69.16% obtained in this study (Table 1). This variation may be due to climatic conditions, because during the study period, there was light rain, so pulp was picked up before 16:00 h.

**Table 1 Nutritional values of dry coffee pulp.**

| Quantified values (%) | Data ($x^b$ ± SD) (g)[a] |
|---|---|
| Dry matter | 69.16 ± 0.31 |
| Crude protein | 18.12 ± 0.66 |
| Ether extract | 5.71 ± 0.02 |
| Crude ash | 16.63 ± 0.41 |
| Crude fiber | 33.63 ± 0.06 |
| Nitrogen free extract | 15.89 ± 0.02 |
| Total digestible nutrients | 63.75% |
| Digestible energy | 8.36 KJ/kg (2.0 kcal/kg) |
| Metabolizable energy | 9.61 KJ/kg (2.3 kcal/kg) |

[a]Results expressed for 100 g from sample; $x^b$: average value from the essays made by triplicate; SD: standard deviation.

A desirable quality in feed materials, particularly for coffee pulp, is of a high content of ash to provide appropriate levels of minerals which are required in animal diet [21]. Possibly, there are differences between the average values of total ash 16% in this study and 14.7% obtained by other authors [11], who dried their pulp for 200 d. This could be due to the 240 d used for drying coffee.

It can be observed from Table 2 that the two diets formulated with 30% coffee pulp, fibre residues and carbohydrates were well balanced. This can be seen from the chemical analyses results, where the diets were balanced in energy (isocaloric) and protein (isonitrogenous). The energy and protein levels in this study satisfy the requirements for milk and meat production in ruminants, in agreement with NRC [15] values.

The microbiological analyses of the two diets in Table 3 showed that the levels of *Salmonella* spp., *Escherichia coli* and total coliform were in the allowed ranges by the regulation [22]. This implies that these diets are suitable to be used as ruminant nourishment; although it is important to notice that coffee pulp may contain high levels of caffeine and tannins, and this components may cause toxic effect in feeding animal [2, 7]. In order to apply the diets suggested in this study, caffeine and tannin amounts most be measured before. There are some alternatives to diminish the quantity of caffeine and tannins in coffee pulp, like fermentation [2], which can be easily used in case of silage preparation.

**Table 2 Nutritional values of diets A and B.**

| Quantified values (%) | Diet A | Diet B |
|---|---|---|
| Humidity | 12.24 | 11.88 |
| Crude protein | 17.18 | 17.03 |
| Ether extract | 6.49 | 8.14 |
| Crude ash | 7.88 | 7.78 |
| Crude fiber | 4.26 | 4.76 |
| Nitrogen free extract | 62.23 | 61.17 |
| Total digestible nutrients | 75.58 | 75.34 |
| Metabolizable energy | 13.84 MJ/kg | 13.88 MJ/kg |

**Table 3 Microbiological analyses of diets A and B.**

| Parameters | Diet A | Diet B |
|---|---|---|
| Coliform bacteria totals | < 1.8 MPN/g | < 1.8 MPN/g |
| *Escherichia coli* | < 10 CFU/g | < 10 CFU/g |
| *Salmonella* spp. | 0 CFU/25 g | 0 CFU/25 g |

MPN: most probable number; CFU: colony forming unit.

## 4. Conclusions

It can be concluded that dried industrial coffee pulp can be included in diets for ruminant livestock as a source of protein to support meat and milk production without any adverse effect on health due to microbial contamination, as there were within acceptable levels.

## References

[1] Jarquin, R., González, J. M., Braham, J. E., and Bressani, R. 1973. "Coffee Pulp and Parchment: Part II, Using Coffee Pulp in Ruminant Feeding." *Turrialba* 23: 41-7. (in Spanish)

[2] Habtamu, L. D. 2014. "A Critical Review on Feed Value of Coffee Waste for Livestock Feeding." *World J. Biol. Biol. Sci*. 2 (5): 72-86.

[3] Pandey, A., Soccol, C. R., Nigam, P., Brand, D., Mohan, R., and Roussos, S. 2000. "Biotechnological Potential of Coffee Pulp and Coffee Husk for Bioprocesses." *Biochem. Eng. J*. 6 (2): 153-62.

[4] Adams, M., and Ghaly, A. E. 2007. "Maximizing Sustainability of the Costa Rican Coffee Industry." *J. Clean. Prod*. 15 (17): 1716-29.

[5] Pierre, F., Rosell, M., Quiroz, A., and Granda, Y. 2009. "Chemical and Biological Evaluation of Coffee Pulp Compost in Caspito Andres Eloy Blanco, Lara State, Venezuela." *Bioagro*. 21 (2): 105-10. (in Spanish)

[6] Mussatto, S. I., Machado, E. M., Martins, S., and Teixeira, J. A. 2011. "Production, Composition and Application of Coffee and Its Industrial Residues." *Food Bioprocess Tech*. 4 (5): 661-72.

[7] Murthy, P. S., and Naidu, M. M. 2012. "Sustainable Management of Coffee Industry by-Products and Value Addition—A Review." *Res. Conser. Recy*. 66: 45-58.

[8] Tavares, A. A., Pereira, M. N., Tavares, M. R., and Chaves, M. L. 2005. "Performance of Holstein-Zebu Cows under Partial Replacement of Corn by Coffee Hulls." *Sci. Agric*. 62 (2): 95-101.

[9] Noriega-Salazar, A., Silva-Acuña, R., and García de Salcedo, M. 2008. "Review: Use of Coffee Pulp in Animal Feed." *Zoot. Trop*. 26 (4): 411-9. (in Spanish)

[10] Nurfeta, A. 2010. "Feed Intake, Digestibility, Nitrogen Utilization and Body Weight Change of Sheep Consuming Wheat Straw Supplemented with Local Agricultural and Agro-Industrial by-Products." *Trop.*

*Anim. Health Pro*. 42 (5): 815-24.

[11] Brahman, J. E. 1979. "Coffee Pulp in Other Species." In *Coffee Pulp: Composition, Technology and Utilization,* edited by Brahman, J. E., and Bressani, R. Ottawa, Canada: International Development Research Centre, 51-4.

[12] Ranganna, S. J. 1986. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products.* New Delhi, India: Tata McGraw Hill, 13-6, 26-30.

[13] Potter, S. G., Moya, A., Henry, P. R., Palmer, A. Z., Becker, H. N., and Ammerman, C. B. 1985. "Sugarcane Condensed Molasses Solubles as a Feed Ingredient for Finishing Cattle." *J. Anim. Sci.* 60 (3): 839-46.

[14] Williams, R. T. 2002. "Biochemistry of Phenolic Compounds." In *Biochemistry of Phenolic Compounds*, edited by Harbone, J. B. London, UK: Academic Press, 205-48.

[15] National Research Council (NRC). 1996. *Nutrient Requirements of Beef Cattle,* 7th ed. Washington, D.C. USA: The National Academic Press, 25-48.

[16] Horwitz, W. 1990. *Official Methods of Analysis of the Association of Official Analytical Chemists,* 15th ed.. Arlington, VA, USA: Association of Official Analytical Chemist (AOAC).

[17] Ramos, M., González, N., Ramírez, C., and Sánchez, F. 2000. "Antioxidant Activity of Coffee Pulp and Derivates." In *Proceedings of the VI Scientific Technical Conference of the National Experimental University of Tachira.* (in Spanish)

[18] Cabezas, M. T., Fores, A., and Egaña J. I. 1978. "Use of Coffee Pulp in Ruminant Feeding." In *Coffee Pulp Composition, Technology and Utilization,* edited by Braham, J., and Bressani, R. Ottawa, Canada: International Development Research Centre, 25-38.

[19] Negesse, T., Makkar, H. P. S., and Becker, K. 2009. "Nutritive Value of Some Non-conventional Feed Resources of Ethiopia Determined by Chemical Analyses and an *in Vitro* Gas Method." *Anim. Feed Sci. Tech*. 154 (3-4): 204-17.

[20] Leng, R. A., Preston, T., and Rosales, M. 1988. "Metabolic Limitations on the Use of Sugar Cane and Its Derivatives for Growth and Milk Production in Ruminants." In *Proceedings of the Workshop Seminar on Intensive Animal Production Systems and Renewable Energy with Tropical Resources,* 18-25.

[21] Agricultural Food and Research Council (AFRC). 1999. "Nutrient Requirements of Ruminant Livestock." In *Proceedings of the 5th International Congress Nutrition*, 113-7.

[22] Norma Oficial Mexicana NOM-110-SSA1. 1994. "Preparation and Dilution of Food Samples for Microbiological Analysis." *Official Journal of the Federation (México)* 11: 16. Accessed August 10, 2014. http://www.diario-o.com/dof/1995/10/16/ss_16oct95.htm. (in Spanish)