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Short Communication

Effect of Chihua Pumpkin Residue (*Cucurbita argyrosperma)* in Ruminal Gas Production and Digestibility *in vitro*

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ABSTRACT

This study was conducted to evaluate the effect of chihua pumpkin (*Cucurbita argyrosperma*) residue in ruminal digestibility and gas production in an *in vitro* assay. Four treatments were evaluated: a control using a standard diet for ruminants elaborated with corn stover, corn grain and soybean meal, and three experimental diets with 10, 20 and 30% dry residue of chihua pumpkin instead of corn stover. Dry matter digestibility and gas production was determined at 24 h of incubation in ruminal fluid obtained from two Holstein cows with a ruminal cannula. Randomized block experimental design was used as and a comparison of means was performed by the Tukey test. The results indicated that dry matter digestibility was significantly increased ($P \leq 0.05$), while gas production tended to decrease ($P \leq 0.1$) with the addition of residue of chihua pumpkin. Under the conditions of this study, it was concluded that the residue of chihua pumpkin could be an environmentally friendly and ecological alternative for feeding ruminants that can be incorporated into the diet as much as 30% of the ration. However, this study was limited to an *in vitro* assay; *in vivo* studies are necessary to evaluate the potential of chihua pumpkin´s residue in the productive performance of ruminants. It would also be appropriate to evaluate the intake behavior, productive performance and nutritional status of animals fed with different forms of processed residue of chihua pumpkin.

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Authors' Contributions
BEV and MMCG executed the study and performed the chemical analysis. MRM conceived and designed the study and wrote the article.

Key words
Vegetable waste, Agricultural waste, Alternative feeds, Fiber digestion, Ruminants.

A key issue for sustainable development of animal production is the efficient use of resources, using feedstuffs that do not compete with human and reducing waste (Wadhwa and Bakshi, 2013). This coupled with the high cost of grains and an increasing demand for meat and milk for human consumption, makes it necessary to search for new alternatives for feeding livestock that positively affect health and productive performance of animals, while reducing production costs. Thus the waste of fruits and vegetables is an ecological and economically viable option to fulfill this purpose. Every year a lot of this waste is generated worldwide and Mexico is no exception. One example is the crop residue of chihua pumpkin (*Cucurbita argyrosperma*) (ChP). According to the SIAP (2015), in 2014 37,872 hectares of chihua pumpkin were harvested for its seeds in México, generating about 644,000 tons of fresh waste. Seeds of chihua pumpkin have high commercial and economic value, while the rest of the fruit is discarded once seeds have been collected. Studies with other pumpkins indicate that *Cucurbita maxima* has potential as animal feed because of its nutritional value (Halik *et al*., 2014). Furthermore, it has been shown that pumpkins as *Cucurbita maxima, Cucurbita moschata* and *Cucurbita pepo* have antioxidant potential due to the content of carotenoids, tocopherols and polyphenols in pulp and peel (Kim *et al*., 2012; Lozicki *et al*., 2015). Razzaghzadeh *et al*. (2007) suggest that silage residue of *Cucurbita pepo* can replace up to 60% of the forage ration without a negative affects in productive performance of fattening buffaloes. However, to our knowledge, there are no studies that indicate the effect of pumpkins in ruminal fermentation. Therefore, the objective of this study was to evaluate the effect of the residue of ChP on ruminal digestibility and gas production in an *in vitro* assay.

Materials and methods

The care and handling of animals from which ruminal fluid was obtained was performed in accordance with the guidelines of Mexican Council of Animal Care (SAGARPA, 1999).

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Table I.- Ingredients and chemical composition of experimental diets.

Ingredient (%)	Chihua pumpkin in diet (%)			
	0	10	20	30
Corn stover	70	60	50	40
Chihua pumpkin dry residue	0	10	20	30
Ground corn	16	18	18	18
Soybean meal	12	10	10	10
Urea	1	1	1	1
Minerals	1	1	1	1
Composition				
Dry matter, %	90.8	90.4	89.9	89.5
Crude protein, %	14.8	14.3	14.5	14.7
Neutral detergent fiber, %	47.1	45.6	44.5	43.2
Acid detergent fiber, %	30.9	30.7	30.5	30.4
Ether extract, %	2.5	2.6	2.7	2.7
Gross energy, Mcal/kg^{-1} DM	3.15	3.7	3.6	3.5

In accordance to nutrient requirements of small ruminant: Sheep, goats, cervids and new world camelids (NRC, 2007).

ChP residue samples were collected from the experimental field of Colegio de Postgraduados Campus Campeche, Mexico, after seed collection. ChP residue (pulp and peel) was dried in an oven at 60°C for 96 h, ground and stored at room temperature (25°C) until analysis. The *in vitro* study was conducted at the Laboratorio de Nutrición Animal del Postgrado en Recursos Genéticos y Productividad-Ganadería del Colegio de Postgraduados, Campus Montecillo, Estado de México, México.

Four treatments were evaluated: a control using a standard diet elaborated with ingredients commonly used in rations for sheep, and three experimental with 10, 20 and 30% dry residue of ChP instead of corn stover. Ingredients and nutritional composition are presented in Table I. Dry matter (DM), crude protein and ether extract were performed according to AOAC (2000). Neutral detergent fiber (NDF) and acid detergent fiber (FDA) were performed according to Van-Soest *et al.* (1991). Gross energy was determined in a bomb calorimeter (Parr, Mod 1241; oxygen pump model 1108). Dry matter digestibility (DMD) (Tilley and Terry, 1963) and gas production (GP) were assesed by water displacement (Fedorak and Hrudey, 1983) at 24 h of incubation in ruminal fluid from two, three years old ruminally cannulated Holstein cows, fed with alfalfa hay and commercial concentrate.

A randomized block experimental design was used. The results were analyzed with the GLM procedure of SAS 9.0 (2002) and the comparison of means was by the Tukey test (Steel and Torrie, 1988).

Results and discussion

The results are shown in Table II. After 24 h of *in vitro* incubation of diets, DMD increased significantly ($P \leq 0.05$), NDF digestibility decreased and ADF digestibility remained unchanged. GP tended to decrease ($P \leq 0.1$) with the addition of residue ChP. The decrease in NDF digestibility with increasing the DMD may be due to degradation of other non-fibrous carbohydrates. According to Zhang *et al.* (2013), pulp powder of *Cucurbita moschata* has high sugar content (44% of dry product), and is a source of a heteropolysaccharide composed of four different monosaccharides with important antioxidant and pharmacological properties. Such carbohydrates could be quickly fermented in this study. In addition, the antioxidants contained in the residue of ChP could increase the DMD. Hino *et al.* (1993) found that ruminal digestion of cellulose and other fibrous components increased when tocopherol and α-β-carotene were added in *in vitro* ruminal cultures, stimulating cellulolytic activity of rumen bacteria. Also, because of high content of NDF, ChP could improve ruminal characteristics and microbial fermentation, avoiding rumen discoloration. According with Alhidary *et al.* (2017) rumen color of lambs fed with diets containing less of 30% of NFD is lighter than those fed with more NDF.

Table II.- Effect of chihua pumpkin (*Cucurbita argyrosperma*) residue on gas production and digestibility of dry matter, neutral detergent fiber and acid detergent fiber after 24 h of *in vitro* incubation.

Item	Chihua pumpkin in diet (%)				SEM[1]
	0	10	20	30	
DMD, %[2]	47.3±2.05^{c}	45.1±1.84^{c}	53.9±1.26^{b}	57.4±1.67^{a}	1.73
NDF digestibility, %	75.1±1.18^{a}	71.1±1.66^{bc}	73.2±2.04^{ab}	70.1±0.79^{c}	1.15
ADF digestibility, %	39.5±1.02	37.7±2.20	41.4±0.88	38.3±0.78	1.29
GP, mL/g^{-1} DM[3]	245.9±9.52^{a}	229.9±12.48^{b}	233.0±19.77^{b}	231.2±10.93^{b}	13.76

[1]Standar error of mean; [2]Means with different letter in the row are statistically different ($P \leq 0.05$); [3]Means with different letter in the row tend to be statistically different ($P \leq 0.1$).

Theoretically, there is a close relationship between DMD and GP, which indicates that microbial biomass is improved and methane production is reduced with substrates with higher DMD per gas unit and, therefore, could be considered of a better nutritional quality (Posada-Ochoa *et al.*, 2014). In this study methane production was not assessed; however, there was a significant increase in DMD and a tendency to decrease GP by effect ChP in the diet, so ChP residue could decrease methane emissions.

It should be noted that there are few studies on the effect of pumpkin on productive performance. Razzaghzadeh *et al*. (2007) indicate that up to 60% forage silage ration can be replaced by pumpkin (*Cucurbita pepo*) without negative effects on gain weight of buffaloes; however, further studies evaluating the use of pumpkin in the diet of animals are necessary.

Conclusions

Under the conditions of this study, ChP residue could be an environmentally ecologic alternative for feeding ruminants, and can be incorporated into the diet as much as 30% of the ration. Because this study is limited to an *in vitro* assay and there are no previous studies, *in vivo* and *in vitro* studies are necessary to evaluate the potential of ChP residue in ruminal fermentation, productive performance of ruminants, and possibility methane reduction. It would be appropriate to evaluate the feed intake behavior, productive performance and nutritional status of animals fed with different forms of processing of ChP.

Statement of conflict of interest

Authors have declared no conflict of interest.

References

Alhidary, I.A., Abdelrahman, M.M., Aljumaah, R.S., Alyemni, A.H., Ayadi, M.A. and Al-Saiady, M.Y., 2017. *Pakistan J. Zool.,* **49**: 1847-1855. http://dx.doi.org/10.17582/journal.pjz/2017.49.5.1847.1855

AOAC, 2000. *Official methods of analysis*, 17th ed. Association of Official Analytical Chemists, Washington DC.

Fedorak, P.M. and Hrudey, S.E., 1983. *Environ. Technol. Lett*., **4**: 425-432. https://doi.org/10.1080/09593338309384228

Halik, G.D., Lozicki, A., Kozoirzebska, A., Dymnicka, M. and Arkuszewska, E., 2014. *Anim. Sci*., **53**: 103-110.

Hino, T., Andoh, N. and Ohgi, H., 1993. *J. Dairy Sci.,* **76**: 600-605. https://doi.org/10.3168/jds.S0022-0302(93)77380-4

Kim, M.Y., Kim, E.J., Kim, Y.N., Choi, C. and Lee, B.H., 2012. *Nutr. Res. Pract*., **6**: 21-27. https://doi.org/10.4162/nrp.2012.6.1.21

Lozicki, A., Koziorzebska, A., Halik, G., Dymnicka, M., Arkuszewska, E., Niemiec, T. and Bogdan, J., 2015. *Anim. Feed Sci. Technol*., **206**: 108-113. https://doi.org/10.1016/j.anifeedsci.2015.05.012

NRC, 2007. *Nutrient requirements of small ruminants-sheep, goats, cervids, and new world camelids*. National Academy Press, USA.

Posada-Ochoa, S.H., Ramírez-Agudelo, J.F. and Rosero-Noguera, R., 2014. *Agron. Mesoam*., **25**: 141-150. https://doi.org/10.15517/am.v25i1.14214

Razzaghzadeh, S., Amino-jabalkandi, J. and Hashemi, H., 2007. *Ital. J. Anim. Sci*., **6(Suppl. 2)**: 575-577. https://doi.org/10.4081/ijas.2007.s2.575

SAGARPA, 1999. *Official Mexican Standard NOM-062-ZOO-1999, Technical specifications for production, care and use of experimental animals*. Official Gazette Specifications, pp. 1-45.

SAS, 2002. *SAS user's guide*, Version 9.0. SAS Institute, Inc, Cary, NC, USA.

SIAP, 2015. *Servicio de Información Agroalimentaria y Pesquera*. Available at: http://www.siap.gob.mx/cierre-de-la-produccion-agricola-por-cultivo/ (Accessed 5 Jun, 2016).

Steel, R.G.D. and Torrie, J.H., 1988. *Bioestadística: Principios y procedimientos*, 2nd edn. McGraw-Hill, México.

Tilley, J.M.A. and Terry, R.A., 1963. *J. Br. Grassl. Soc*., **18**: 104-111. https://doi.org/10.1111/j.1365-2494.1963.tb00335.x

Van-Soest, P.J., Robertson, J.B. and Lewis, B.A., 1991. *J. Dairy Sci*., **74**: 3583-3597. https://doi.org/10.3168/jds.S0022-0302(91)78551-2

Wadhwa, M. and Bakshi, M.P.S., 2013. *Utilization of fruit and vegetable wastes as livestock feed and as substrates for generation of other value-added products*. FAO, the United Nations.

Zhang, Y., Chen, P., Zhang Y., Jin, H., Zhu, L., Li, J. and Yao, H., 2013. *Int. J. Biol. Macromol*. **62**: 574-581. http://dx.doi.org/10.1016/j.ijbiomac.2013.09.044