



Global Advanced Research Journal of Agricultural Science (ISSN: 2315-5094) Vol. 6(2) pp. 026-030, February, 2017 Issue.
Available online <http://garj.org/garjas/home>
Copyright © 2017 Global Advanced Research Journals

Full Length Research Paper

In Situ Ruminant Degradability of Savoy Grass (*Panicum maximum*) Silages with Different Levels of Passion Fruit (*Passiflora edulis*) Peel Inclusion

Italo Espinoza Guerra¹, Mirian Medina Villacís¹, León Montenegro Vivas¹, Manuel Salcedo Sarmiento¹, José Macías Velíz¹, Mary Cifuentes Rojas¹, Marlene Medina Villacís^{2,3}, Alina Martínez Hernández³, Rosa Varas Giler¹ and José Romero Romero¹

¹Facultad de Ciencias Pecuarias. Universidad Técnica Estatal de Quevedo. Av. Walter Andrade. Km 1 ½ vía a Santo Domingo, C.P. 73. Quevedo, Los Ríos, Ecuador. (Faculty of Animal Sciences. State Technical University of Quevedo. Av. Walter Andrade. Km 1 ½ vía a Santo Domingo, C.P. 73. Quevedo, Los Ríos, Ecuador)

²Facultad de Ciencias de la Ingeniería, Universidad Técnica Estatal de Quevedo. Ave. Quito. Km 1 ½ vía a Santo Domingo de los Tsáchilas, C.P. 73. Quevedo, Los Ríos Ecuador. (Faculty of Engineering Sciences, State Technical University of Quevedo. C.P. 73(Ave. Quito. Km 1 ½ vía a Santo Domingo de los Tsáchilas, Quevedo, Los Ríos Ecuador).

³Universidad de Pinar del Río, Cuba. (University of Pinar del Río, Cuba).

Accepted 03 February, 2017

(Four levels of passion fruit peel (PFP) 10, 20, 30, and 40% inclusion in Savoy grass silage were evaluated to determine dry matter (ISDMD), organic matter (ISOMD) and inorganic matter (ISOMD) in situ ruminant degradability). In situ degradability technique in 10 x 20 nylon bags, of 50±3 pore size at 0, 3, 6, 12, 24, 48, and 72 incubation hours for three 500 ± 25 kg average weight bovine Brahman. A complete randomized block design was used. An increase in ISDMS disappearance as RCM (P <0, 05) with 40% level of addition was evidenced. Values of 60.22% in 72 hours of incubation were obtained. ISOMD values showed no difference between treatments (P>0.05) at 0, 3, and 48 incubation hours. Differences (P<0.05) were found at 6, 12, 24, and 72 incubation hours. The highest ISOMD disappearance value was attained at 72 hours of incubation in T4 (59, 46 %). DISMI showed no difference between treatments (P>0.05) at 0, 3, 6, and 72 hours of incubation. However, we found a different behavior (P<0.05) at 12, 24, and 48 hours of incubation. ISIMD at 72 hours of incubation was 69, 09 for T4. The highest percentage of degradation was attained with the addition of 40% RCM.

Keywords: fermentation, chemical and food science, agricultural waste.

INTRODUCTION

Grass and forage are the main source of food for bovine in

the tropics but forage production varies in quality and quantity throughout the year and directly affects cattle productivity. Peláez *et. al.* (2011). Animal production systems in the tropic develop basically, through pasturage with grass monocultures, generally having regular to low

*Corresponding Author's Email: iespinoza@uteq.edu.ec;
Tel: 59352951896

quality, mainly due to their high fiber content and low protein levels. (Carmona 2007). The highest limitation in bovine production in developing countries is the fluctuation of forage resources quantity and quality. (Posada y Noguera, 2005). Forage represents the most economical source for ruminant feeding, especially in the tropics where there are large land extensions allotted to cattle raising. In most tropical countries, the expansion of agricultural boundary reached its limit and the increase in animal husbandry nowadays depends, to a great extent, on production intensification and technification (Avellaneda et al. 2007).

In tropical regions, cattle herds graze on meadows where quantitative and qualitative production is distributed in two different periods: a rainy season and a dry season (Canesín et al. 2014). In the tropics and subtropics grass and forage are produced abundantly during the rainy season with values of up to 80% of annual production, what results in a loss of part of this food due to the impossibility for cattle to use it and also because of a decrease in its nutritional value as it ripens unused in the fields (Caraballo et al. 2007). The use of agroindustry waste in feeding ruminants is of great importance since a third of the waste produced in the world is intended for livestock. There is a great amount and variety of waste with different potentialities. However, most of these residues is lost or underused because of the lack of knowledge about their nutritional value or their limitations concerning animal's response, when included in the diet (Vieira et al. 1999). Using agroindustry by-products for such purposes contributes to address these potentially polluting wastes to better aims (Olivera et al. 2006).

To minimize these problems, the incorporation of tropical fruit residues can be promoted. These by-products generated in great volumes are great pollutants if they do not have an appropriate aim (Cándido et al. 2007). Caraballo et al. (2007) indicate that silage does not improve fresh forage nutritional value but it contributes to keep value thereof. According to Nussio et al (2002), in some places of the world, silage production provides 10 to 25% of forage for ruminants and represents a 2% global rate of additional food supply. To minimize these problems the use of such tropical fruits as passion fruit (*Passiflora edulis*) by product residues can be promoted. These by-products are generated in great volumes in the northern zone of Los Rios province and, when not used for appropriate aims, they contaminate the environment. Savoy grass could be added in ruminants' diet. On the basis of the antecedents presented, this research makes an attempt to prove that adding some levels of passion fruit peel residues can improve nutritional contribution (...) and Savoy grass silage in situ degradability

MATERIALS AND METHODS

The experiment was done in the Rumiología lab at La Maria experimental farm, belonging to Quevedo State Technical University, and located at Km 7, Road Quevedo – El Empalme, Mocache canton, Los Rios province, at 73 meters above the sea level height. The annual rainfall attaining 1690 mm. Four levels of inclusion of passion fruit peel residues (10, 20, 30, and 40%) in relation to Savoy grass were studied. In the preparation of experimental silages Savoy grass (*Panicum maximum*) from an already established plantation from La Maria experimental farm was used. The grass was cut manually at an age of 35 days, later it was ground in the forage saw. Passion fruit waste used in the experiment was collected at Tropifrutas juice enterprise in Quevedo city. Micro-silage were made using 4 inches PVC tubes of 30 cm height and 10 cm width which were sealed with a stopper in their lower part. A hosepipe was used to allow fluid release. Once micro-silage were prepared, they were filled-up and compressed with vegetative material. 3 kgs of Savoy grass previously ground to a ½ and 1 particle size. Before sealing, percentages of passion fruit peel (10, 20, 30 and 40%) were put in each silage. Later micro-silages were sealed with an upper stopper, screws were put to secure lid and sealed with a packing tape.

Once filled up, silages were stored for 35 days at room temperature, inside a storehouse with natural light (12 hours light – 12 hours darkness) without direct solar radiation. Silages were opened after 35 days of storage and samplings representing approximately 500 grains were taken from each one, having been silage material previously homogenized. Samples were put in a stove to 65°C for 48 hours and were ground in a Thomas Willy laboratory mill with 2 a millimeter screen. To each sample proximity analysis dry matter (DM), organic matter (OM), ashes (A), proteins (P), energy (E), neutral detergent fiber (NDF), acid detergent fiber (ADF), hemicellulose, lignin, calcium (ca), and phosphorus (P). Then, bags were filled up to evaluate in situ degradability in periods of 0, 3, 6, 12, 24, 48 and 72 hours. After the incubation period, an analysis of dry matter degradability (DMD), organic matter degradability (OMD) and inorganic matter degradability (IMD)

DM, OM, AND IM in situ digestibility was determined through the use of nylon bag technique. For this, three castrated and rumen fistulated bovine (Brahman) about 400 kg live weight were used. For each treatment, three bovine were used in each repetition. Seven nylon bags 10 x 21 cm and 53 mm pore size, each containing 10 gr of ground sample were used. Six bags were suspended on the rumen's ventral part, with a 0, 3, 6, 12, 24, 48, and 72

Table 1. *In situ* digestibility of dry matter in Savoy grass silages with different levels of passion fruit peel inclusion . La María farm, UTEQ 2014

Incubation Time (hours)	Treatments ¹				SME	Probabilities
	T1	T2	T3	T4		
0	14.17a	15.69 ^a	16.97 ^a	16.21a	0.42	0.4565
3	21.79a	22.06 ^a	23.69 ^a	23.63a	0.22	0.0761
6	26.62b	28.91 ^a	29.06 ^a	30.10a	0.17	0.0045
12	37.64c	40.74ab	40.49b	42.89a	0.19	0.0011
24	45.32b	48.03ab	49.48 ^a	51.67a	0.67	0.0065
48	52.45b	54.70ab	56.04 ^a	57.56a	0.25	0.0046
72	55.24c	56.54bc	58.59ab	60.22a	0.30	0.0094

SME – Standard Mean Error

^{abc}Rates with the same letters do not differ statistically, Tukey ($p \leq 0.05$). (¹T1 = Savoy grass 90% + 10% Passion fruit peel, T2 = Savoy grass 80% + 20% Passion fruit peel. T3 = Savoy grass 70% + 30% passion fruit peel . T4 = Savoy grass 60% + 40% Passion fruit peel

hours incubation sequence. Material disappearance at zero hour was estimated in the seventh bag without incubation in the rumen. It was washed in the same way as the rest. Dry matter (DM), organic matter (OM), and inorganic matter (IM) digestibility. During the test bovine were fed with savoye grass *ad libitum*. After this, bags were dried in a stove at 60 °C during 48 hours. To each bag residue DM, OM, and IM content was determined in each incubation period. Its percentage of disappearance was estimated by difference using Orskov and McDonald (1980) equation. Nonlinear parameters, as well as ISDMD, ISOMD, and ISIMD disappearance were calculated through SAS 2001 software package.

Statistical analysis

Nonlinear parameters, as well as ISDMD, ISOMD, and ISIMD disappearance were calculated through SAS 2001 software package. The values obtained in all variables were analyzed using a complete randomized block design. Turkey test was used for comparing averages under $P < 0.05$ probability levels.

RESULTS AND DISCUSSION

In situ dry matter degradability (ISDMD)

ISDMD values are presented in Table 1 and they do not show ($P > 0.05$) difference between treatments at 0 and 3 hours of incubation periods. Results at 6, 12, 24, 48, and 72 hours were different, T4 showing higher degradability at 72 hours (60,22%), followed by T3, T2, and T1 (58.59, 56.54 y 55.24%, respectively). It was seen that as the incubation time increases, an increase of DM disappearance is observed due to a greater time of contact of the sample with the rumen.

In situ organic matter digestibility (ISOMD)

ISOMD of the present study are shown in Table 2, where no differences can be seen among ($P > 0.05$) treatments at 0, 3, and 48 incubation hours, while a different performance ($P < 0.05$) at 6, 12, 24, and 72 incubation hours was shown. The highest Om disappearance value was shown at 72 hours of incubation in T4 (59, 46 %) followed by T3 (57,23%); T2 (54,49%); T1(53,15%)

In situ inorganic matter digestibility (ISIMD)

ISIMD values in this study are shown in Table 3, where no difference between treatments ($P > 0.05$) at 0, 3, 6 and 72 hours of incubation was observed. However a different behavior was found ($P < 0.05$) between treatments at 12, 24, and 48 hours of incubation. The highest IM disappearance at 72 hours of incubation was shown by T4 (69.09%) followed by T3 (65.92%), T1 (64.96%).

DISCUSSION

ISDMD results are higher than those found by Do Rego et al (2010), who obtained 36,66 to 50,78% MS disappearance in achiote inclusions in elephant grass silages, and higher degradability a longer incubation time. Carvalho *et al* (2008) observed the same behavior for MS soluble fraction through cocoa flour inclusion in elephant grass silages with more degradability a more incubation time).

Likewise Chizzotti et al (2005) studied the levels of inclusion of cotton seed in elephant grass silages and observed similar DISMS behavior. Junior et al (2006) obtained 59.9 % (DISMS for passion fruit peel residue (RCM) while Ferreira, Neiva, and Rodriguez (2004) showed values of 39,9% MS digestibility in elephant grass

Table 2. (In situ digestibility of Savoy grass silages organic matter with different levels of passion fruit peel inclusion. La Maria farm. UTEQ 2014)

Incubation time (hours)	(Treatments)				RSE	Probability
	T1	T2	T3	T4		
0	10.77a	11.89 ^a	13.50a	12.94a	0.32	0.1553
3	17.05a	17.38 ^a	19.57a	19.14a	0.21	0.0280
6	22.20b	25.58 ^a	25.35a	26.34a	0.16	0.0012
12	34.34b	36.94ab	37.71ab	39.73a	0.36	0.0224
24	42.72b	45.93ab	46.07ab	49.49a	0.45	0.0224
48	50.91a	53.04 ^a	55.42a	53.77a	0.53	0.1804
72	53.15b	54.79ab	57.23ab	59.46a	0.42	0.0209

RSE = rate standard error

^{abc} (Rates with similar letter do not differ statistically, Turkey(p≤0.05).

(¹T1 = Savoy grass 90% + 10% passion fruit peel, T2 = Savoy grass 80% + 20%ion Fruit peel. T3 = Savoy grass 70% + 30%passion fruit peel. T4 = Savoy grass 60% + 40% passion fruit peel)

Table 3. In situ digestibility of Savoy grass silages inorganic matter with different levels of passion fruit peel inclusion. Farm La Maria, UTEQ 2014

Incubation time (hours)	(Treatments)				RSE	Probability
	T1	T2	T3	T4		
0	36.28a	38.34 ^a	42.33a	41.70a	0.85	0.2058
3	48.44a	49.98 ^a	49.18a	51.90a	0.47	0.2383
6	51.75a	55.24 ^a	52.20a	53.80a	0.69	0.4568
12	56.23b	59.15ab	57.80b	61.53a	0.28	0.0071
24	58.48b	62.08ab	60.93ab	64.21a	0.37	0.0191
48	61.08b	64.10ab	64.83a	65.52a	0.32	0.0228
72	64.96a	66.98 ^a	65.92a	69.09a	0.48	0.1532

RSE = rate standard error

^{abc} (Rates with similar letter do not differ statistically, Turkey(p≤0.05).

(¹T1 = Savoy grass 90% + 10% passion fruit peel, T2 = Savoy grass 80% + 20%ion Fruit peel. T3 = Savoy grass 70% + 30%passion fruit peel. T4 = Savoy grass 60% + 40% passion fruit peel). For all the times, an increase on inorganic matter disappearance can be observed with the passing of incubation time)

silage. Reis (1994) obtained 48,25%, values lower than those obtained in this study at 72 hours of incubation) (Borges *et al* (2005) reported higher values for MS disappearance at 48 hours, RCM (64,29%). In passion fruit by products lower values were reported by Manoel, Banys, and (2003) who found an effective degradability for passion fruit peel residues (55,22% and for watermelon by products (54,3%). Vieira, Vasquez y Da Silva (1999) obtained high rates between 67 and 71% in MS disappearance in three residue passion fruit varieties: yellow, red and mixed.

These results are similar to those found by Schmidt *et al.* (2014) and Jarrige (1981), who state that forage ISOMD is tightly linked to cell walls, so that apparently indigestible forage organic matter depends, in essence, on the wall indigestible fraction. That is why forage digestibility differences are higher between varieties than those between species.

When comparing ISIMD values estimated for this study, with those presented by López *et al.*(2014) whose study about the nutritional value of pineapple stubble silages with raising urea levels showed results between 67,32 and 71,30 %, notably higher than the ones obtained by Sánchez and Soto, (1998) for such fresh forage as Estrella grass (53,8%) and Brachiaria ruzi (53,7%) The treatments evaluated show good digestibility, this indicates that their benefit to the ruminant could be greater than the one that can be expected from other tropical forages as Morera, Jaragua grass and Kikuyo Grass (Estrada *et al.* 1998)

CONCLUSIONS

Panicum maximum grass silage ISDMD at 72 hours was higher with the inclusion of passion fruit peel, mainly with 30 and 40% levels. *Panicum maximum* grass silage

ISOMD at 72 hours incubation time evidenced supremacy when compared to the treatment having the highest level of passion fruit peel inclusion (40%). The changes in ISIMD were evident at 0, 3, 6, and 72 incubation hours due to passion fruit peel inclusion. Adding passion fruit peel residues to Savoy grass silage had a positive impact on the ruminal environment. Savoy grass silage with 40% inclusion of passion fruit peel residue (T4) showed the highest values of dry matter digestibility and T3 showed the highest values for organic matter digestibility.

REFERENCES

- Avellaneda J, Gonzales S, Pinos J, Hernández A, Montañez O, y Ayala J (2007). Enzimas fibrolíticas exógenas en la digestibilidad in vitro de cinco ecotipos de Brachiaria. *Agronomía Mesoamericana*, 18(1), 11 - 17.
- Borges I, Rogério M, Silva A, Junior G, Neiva J, Rodriguez N, Do Carmo M (2005). Degradabilidade "in situ" da materia seca e fracoes fibrosas do subproduto do maracujá e do Capim elefante em ovinos. *Sociedad Brasileira de Zootecnia*.
- Cândido M, Neiva J, Rodriguez N, Ferreira A (2007). Características fermentativas e composição química de silagens de capimelefante. *Revista Brasileira de Zootecnia*, 36(5), 1489-1494.
- Canesin R, Berchielli T, Messana J, Baldi F, Pires A, Frighetto Reis y (2014). Effects of supplementation frequency on the ruminal fermentation and enteric methane production of beef cattle grazing in tropical pastures. *Revista Brasileira de zootecnia*, 43(11), 590-600.
- Caraballo A, Betancourt M, Florio J (2007). Efecto de la melaza, estado fisiológico del pasto y tamaño del material cosechado sobre el ensilado de pasto guinea (*Panicum maximum*, Jacq.). *Ciencia*, 15(1), 35-46.
- Carmona J (2007). Efecto de la utilización de arbóreas y arbustivas forrajeras sobre la dinámica digestiva en bovinos. *Revista lasallista de investigación*, 4(1).
- Carvalho G, Garcia R, Pires A, Detmann E, Pereira O, y Fernandes F (2008). Degradação ruminal de silagem de capim-elefante emurchecido ou com diferentes níveis de farelo de cacau 37(08), 1347-1354. *Revista Brasileira de Zootecnia*, 37(08), 1347-1354.
- Chizzotti M, Filho S, Leao M, Valadares R, Chizzoti F, Magalhaes K, y Marcondes M (2005). Casca de algodão em substituição parcial à silagem de capim- elefante para novilhos. *Revista Brasileira de Zootecnia*, 34(06), 2093-2102.
- Do Régo A, Cândido M, Duarte J, Pereira E, Feitosa J, y Rêgo M (2010). Degradação de silagens de capim-elefante contendo subproduto do urucum. , 41(3), 482-489. *Revista Ciência Agrônômica*, 41(3), 482-489.
- Ferreira A, Neiva J, y Rodriguez M (2004). Valor nutritivo das silagens de capim-elefante com diferentes níveis de subprodutos da indústria do suco de caju. *Revista Brasileira de Zootecnia*, 33(6), 1380-1385.
- Júnior A, Filho J, Eustáquio I, Tiesenhausen V, Rocha T, Cappelle E, Filho C (2006). Effects of different additives on the content of crude protein, ether extract and coefficient of digestibility of silage of passion fruit residue. *Ciencias Agropecuarias*, 31(3), 871-875.
- López M, Wing R, Rojas A, Rodríguez S (2014). Valor nutricional del ensilaje de rastrojo de piñna con niveles crecientes de urea. *Nutrición Animal Tropical*, 8(1), 1-20.
- Manoel A, Banys V, y Pereira R (2003). Degradabilidade da matéria seca dos subprodutos de polpa de frutas e soja extrudada. In: *40a Reunião anual da sociedade brasileira de zootecnia*. Santa Maria. Anais: Sociedade Brasileira de Zootecnia .
- McDonald P, Edwards R, Greenhalgh J, y Morgan C (2006). *Nutrición Animal. 6a edición*. Editorial Acribia.
- Nussio G, Paziani F, Nussio B (2002). Ensilagem de capins tropicais. *Sociedade Brasileira de Zootecnia*, 39, 60-90.
- Olivera R, Carminate R, González M, Pérez C, Viera G, Sáez S (2006). Valor nutritivo in vitro de ensilajes de hollejo fresco de cítrico (*Citrus sinensis*) con bagacillo de caña de azúcar (*Saccharum officinarum*) *Revista de producción animal*. *Revista de Producción Animal*, 18(2), 95-98.
- Orskov E, Deb Hovell FM (1980). Uso de la técnica de la bolsa de nylon para la valuación de los alimentos. *Producción Animal Tropical* 5: 213-233. *Producción Animal tropical*, 5, 213-233.
- Peláez A, Meneses M, Miranda A, Ayala MM, Crosby M, Loera O, Megías D (2011). Enzimas fibrolíticas producidas por fermentación en estado sólido para mejorar los ensilajes de caña de azúcar. *Agrociencia*, 45(6), 675-685.
- Posada S, Nogueira R (2005). Técnica in vitro de producción de gases: Una herramienta para la evaluación de alimentos para rumiantes. *Livestock Research for Rural Development*.
- Reis J (1994). Composição química, consumo voluntário e digestibilidade das silagens de resíduo do fruto de maracujá (*Passiflora edulis*, Sims f. *flavicarpa*) com capim-elefante (*Pennisetum purpureum*, Schum), cv cameroon e suas combinações. *Lavras. Composição química, consumo voluntário e digestibilidade das silagens de resíduo do fruto de maracujá (Passiflora edulis, Sims f. flavicarpa) com capim-elefante (Pennisetum purpureum, Schum), cv cameroon e suas combinações. Lavras: (pág. 50). Lavras: Universidad Federal Lavras.*
- Sánchez J, Soto H (1998). Estimación de la calidad nutricional de los forrajes del cantón de San Carlos. Componentes de la pared celular. *Revista Nutrición Animal Tropica*, 4(1), 7-19.
- SAS. (2001). Statistical Analysis System - SAS. System for Microsoft Windows: release 8.2. Cary: 2001. 1 CD-ROM. Raleigh, North Caroline, USA.
- Schmidt S, Nussio L, Queiroz OS, Zopollatto MF, y Daniel J (2014). Efectos del *Lactobacillus buchneri* sobre el valor nutritivo del ensilaje de caña de azúcar para el acabado de toros de carne. *Revista Brasileira de Zootecnia*, 43(1), 8-13.
- Tilley J, Terry R (1963). A two stage technique for the in vitro digestion of forage crops. *Journal of British Grassland Society*, 18, 104-111.
- Vieira C, Vasquez H, Da Silva J (1999). Composição Químico-Bromatológica e Degradabilidade In Situ da Matéria Seca, Proteína Bruta e Fibra em Detergente Neutro da Casca do Fruto de Três Variedades de Maracujá (*Passiflora* spp). *Revista Brasileira de Zootecnia*, 28(5), 1148 - 1158.