

## Nutritional and economical efficiency of three biosilages from agroindustrial wastes in beef cattle

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In dairy discarded steers was evaluated the nutritional and economical efficiency of three biosilages from agroindustrial wastes: bagasse and leaves of *Saccharum officinarum* (sugar cane), leaves of *Musa sp.* (plantain) and fruit of *Psidium guajava* (guava), submitted to solid state fermentation with three microbial preparations (T1 based on whey, T2 bovine feces and T3 with the mixture of both), also a control treatment with *Axonopus scoparius* (purple fodder) grazing. Treatments 1, 2 and 3 had 24.90, 21.97 and 26.1 % dry matter; 13.00, 12.84 and 13.43 % crude protein; 30.56, 33.52 and 22.58 % crude fiber; 65.11, 60.49 and 70.11 % of lactic acid concentration; pH 4.60, 4.80 and 4.70 and ammonia nitrogen concentration of 3.05, 7.11 and 5.50 %, respectively. In a completely randomized design with three replications, 12 steers with an average initial live weight of  $232.25 \pm 5.12$  kg were used. Animals consumed 3.07 kg/animal/d of dry matter. Best results were attained with whey silage, with a daily live weight increase of 0.50 kg, feed conversion, 6.76 and an economical profitability of 37 %. Also, there were significant differences ( $P \leq 0.01$ ) between treatments. It is suggested that with this technology the nutritional quality of agroindustrial wastes can be improved and used in cattle fattening. Silage supply biologically activated with whey improves live weight gain, and mitigates environmental pollution.

Key words: *biosilage, solid state fermentation, activator, whey, bovine feces*

One of the greatest challenges that our society must face in the future is hunger eradication and malnutrition. The Food and Agriculture Organization (FAO) has considered this defy as the first development objective of the millennium. According to reports of this organization, it is estimated that 925 million people suffered chronic hunger in 2010 (FAO 2010).

There are financial restrictions for importing cereals and protein sources for animal feeding, which even compete against human feeding (Aranda 2000). Thus, the search for new feeding alternatives is a first priority task).

In this context science must promote the necessary development towards the active search for new production approaches guaranteeing greater efficiency to face the increasing feeding security problems in poor countries (FAO 2010).

By their volume and composition, agroindustrial wastes are an alternative to face feed shortage. According to López (2008), Ecuadorean guava production, which is one of the inputs used in this research, is of 1.604 metric tons as average. In this item Pastaza province is outstanding as the highest producing, with 34 %. Also, wastes of fallen and not usable fruits are estimated in 10 to 15 %.

Regarding plantain leaves (another residual employed in this study), each adult plant after harvest, generate between 5 and 15 kg of plant material, with an interesting protein content from 12 to 15 %, although with lignified fiber and tannins of 2 to 4 % (Álvarez 2010). In Ecuador 170897ha of plantain are cultivated with a sowing density of

1 800 plants/ha (MAGAP 2009). Therefore, the great amount of residuals created by this agricultural activity can be calculated.

Brizuela *et al.* (2007) refer that one of the most promising methods for non-conventional protein production is the solid state fermentation (SSF) from lignocellulosic residues. In the first place, this is determined by the great volumes of residues produced in the world and in second place, by the advantages of the SSF system regarding conventional submerged fermentations. The cited authors state that sugar cane and its agroindustrial wastes are used in the production of protein enriched animal feed by SSF.

In the Institute of Animal Science of Cuba feeds as Saccharina (Elías *et al.* 1990) and Bagarip (Pedraza *et al.* 1995) have been obtained. These feeds outstand by their applications as partial replacements of traditional feeds and as dietetic supplements for some animals.

The silage offers the possibility of guaranteeing feeds during the seasons of high production for their preservation for their future use, especially in shortage periods. The silage can be preserved for months and even for years. Also, it can be used at any time, especially during drought periods (Anon 2004a). The same source declares that among the technological innovations allowing the increase of milk yield has been the feeding management of dairy cows, in which outstands the incorporation of maize silage in the rations.

According to Kneifel *et al.* (2000), many acid-lactic bacteria have the capacity of fermenting different carbohydrates. Another benefit cited by different

researchers is that during carbohydrate fermentation, the pH decrease in the intestine inhibits the growth of potentially pathogen bacteria, generating beneficial effects in the host (Gauthier 2002).

The objective of this study was to use the contaminating organic wastes of *Saccharum officinarum* (sugar cane) bagasse, non marketable fruit of *Psidium guajava* (guava) and *Musa sp.* (plantain) foliage, through the application of SSF and microbial preparations from whey and bovine feces, to fed fattening cattle. With this application it is also intended to mitigate environmental pollution.

### Material and Methods

The study was divided in three stages: 1) 9 d for the preparation and evaluation of the pre-ferment; 2) 21 d for the ensiling process and 3) 90 d for the feeding test in steers (15 d for adaptation and 75 of real test).

1) *Preparation and evaluation of the pre-ferment.* In a 200 L metallic tank, water, urea, salt, mineral, molasses and bio-accelerator (whey, bovine feces or whey + bovine feces) were placed according to table 1. The mixture was homogenized and covered with a lid for 88 h, at environmental temperature (21°C). Every four hours pH as fermentative variable was measured with a portable digital potentiometer.

Human consumption water was maintained at rest for 2 h. The commercial urea contained 46 % nitrogen and 85 degrees Brix the molasses. The composition of the commercial mineral salt was 9 % calcium, 10 % phosphorus and various micronutrients. In addition to the whey, a waste of unsalted fresh industrial cheese, fresh feces from bovines stabled in the shade were used. The mineral salt was composed of 9 % calcium, 10 % phosphorus, 4 % magnesium, 0.50 % sulfur, 24 % chlorine, 0.50 % potassium, 16 % sodium, 6000 mg zinc, 100 mg iodine, 750 mg copper, 50 mg cobalt, 5000 mg iron, 3000 mg manganese and 40 mg selenium.

2) *Ensiling process.* When the pH of the pre-

ferments was stabilized at 4.50, the silage was prepared. For that, each pre-ferment was mixed with the waste material (bagasse and leaves of sugar cane, plantain leaves and guava fruit), whose bromatological composition is presented in table 2. This material was chopped with an electric machine in 3-5 cm pieces. The proportion of the mixture was one liter of pre-ferment plus three kilograms of chopped wastes, according to the formula of table 3. These mixtures were placed in the wooden silo, box type, with a volume of 1 m<sup>3</sup> each. They were crushed to eliminate the presence of oxygen. Once full and crushed the silage, it was hermetically sealed with a black polyethylene plastic and above this some weight (stones and sand) was placed. The fermentation process lasted 21 d according to a previous study of Díaz (2002).

The sugar cane bagasse was immediately collected, after passing through a juice extractor machine and transported to the research place. Sugar cane leaves were picked up from a close plantation. They were green, healthy, complete and in good condition. Plantain leaves were in a similar way and were collected from plants using machete cut. Guavas were picked up from the soil. They were ripe fruits which fell from trees, in good condition and of different sizes. The soil from where the waste materials came was mud clayish, characteristic of the Ecuadorean Amazonia.

At the opening of the silage, samples were taken in triplicate, with the help of subsection tweezers to different parts of the silo. All the sampling was carried out in the morning hours. Samples were stored in amber color glass bottles with hermetic lids. They were refrigerated until their analysis for 8 h, as maximum. Microbiological indicators (total mesophyllous fungi and total mesophyllous anaerobic bacteria) (Petrifilm 2005) and fermentative indicators (pH, lactic acid, acetic acid, butyric acid and ammonia) (Lees 1995), were determined as variables.

Table 1. Pre-ferment formulas for the three types of biosilages

Biosilage (Code)	Water (%)	Urea (%)	Molasses (%)	Mineral salt (%)	Whey (%)	Bovine feces (%)
1 (B1)	45.0	1.0	20.0	1.0	33.0	
2 (B2)	45.0	1.0	20.0	1.0		33.0
3 (B3)	45.0	1.0	20.0	1.0	16.50	16.50

Table 2. Bromatological composition of the waste material used for the silage

Waste material	Dry matter (%)	SD	Crude fiber (%)	SD	Crude protein (%)	SD
Sugar cane bagasse	52.27	3.50	49.23	1.95	4.55	1.10
Sugar cane leaves	27.88	2.85	45.19	2.08	4.95	0.94
Plantain leaves	22.72	3.05	40.15	2.28	9.56	1.67
Guava	15.06	1.80	36.42	2.00	5.65	0.82

Table 3. Formula for the silage

Component	Pre- ferment	Sugar cane bagasse	Sugar cane leaves	Plantain leaves	Guaba
Percentage	25.00	31.50	19.50	19.50	4.50
Proportion	1.00	1.26	0.78	0.78	0.18

In addition crude protein and crude fiber were established according to AOAC (1995). *In vitro* digestibility (in ruminal fluid) and net energy were calculated as indicated by Guevara (2001).

3) *Steer fattening*. Twelve crossbred Holstein steers of 2 years of age, with an average initial live weight of  $232.25 \pm 5.12$  kg were distributed in completely randomized block design with three replications per treatment. Three treatments were established with the biosilages and one control integrated by steers fed *Axonopus scoparius* (purple fodder). A coproparasitic analysis was realized to the animals through flotation techniques, Mac Master, sedimentation and migratory (Thiempont 1993). Afterward they were wormed with ivermectine at 1 % with a dosage of 1 mL/50 kg LW. Later they were adapted to *ad libitum* silage for two weeks. In the 75 subsequent days biosilage was supplied once daily, at 8:00 a.m., in individual feeding troughs arranged in the paddock. Later on animals grazed the rest of the day in a paddock with *Axonopus scoparius* (purple fodder). For this a rope 2.50 m long was applied from the animal's neck to the stake anchored to the soil. The second month 3 m long of rope were established and in the last 15 d, 3.50 m.

The average dry matter consumption of forage was of 7.86 kg/animal/d. It was determined according to the method of Haydock and Shaw (1976), calculating the grazing area with two place changes per day. All animals of the test consumed in this way the forage, even the animals of the control group. Weight control was carried out at 30, 60 and 75 d of trial.

In this stage, initial, monthly and final live weight of steers, monthly and total feed consumption (in dry matter, organic matter and crude protein), feed conversion, cost/benefit (profitability) and unit cost of the product (\$/kg) were determined.

Statistical analysis. ADEVA was applied, and for mean separation Duncan's (1955) test ( $\alpha \leq 0.05$  and  $\alpha \leq 0.01$ ) was carried out.

### Results and Discussion

The pH performance curve is set out in figure 1, where it is demonstrated that the pre-ferment based on whey started with a value of 4.70 and had no variation during the first 12 h. From hour 20 it started to decrease to 4.60 and later to 4.50 from hour 24 henceforth. Subsequently it was maintained stable. That is, there were no changes in the value staying in the time. In this way the biological and biochemical balance were attained.

On the other hand, the pre-ferment based on bovine feces started with pH 8.10 and continued with irregular decrease, with slight peaks of rises until decreasing to 4.50 at 72 h of fermentation.

The mixed pre-ferment started with pH 5.50 and rise to 6.20 at hour 8. In this moment there was a constant and regular decrease until its stabilization in 4.50 at 68 h of fermentation.

In the pH curve influenced the biological competition for its establishment in the medium among ammonifier and lactic acid bacteria, homo and heterofermentative and their biochemical products. This is evidenced in the peak and decrease sequence shown in figure 1. Finally, the pH decreased to a stable value of 4.50 at 80 h of fermentation. Seemingly, this is due to the prevalence of lactic acid bacteria and consequently to the production of lactic acid and other organic acids.

In studies of Ayavaca (1999) at an average temperature of 13.36 °C and with the use of bovine feces as bioaccelerator of the pre-ferment an initial pH of 6.55 and maximum of 8.55 at 25 h were recorded for obtaining finally a pH of 4.83 at 96 h of starting the process. Under these conditions the desirable acidity and the stability of the process was attained.

This pH decrease, according to the fermentation time, could be the consequence of the acid production, as the lactic and the short chain fatty acids (SCFA) which inhibit or eliminate the microorganisms growing at more neutral pH (García *et al.* 2005). Valiño *et al.* (1994) indicated that the organic acids produced by the microorganisms during fermentation and the NH<sub>3</sub> resulting from urea hydrolysis affect pH. At the end of the ensilage a product of sticky consistency is obtained, with ripe fruit smell, dark coffee color, which is of great acceptance for the animals. The fermentative phenomena produced in the different silages are reflected in the pH values shown. The silage of best odor, palatability and acceptance by the animals is the one prepared with the addition of pre-ferment based on whey; followed by the mixed silage (whey and feces) and finally the pre-ferment based on the addition of bovine feces. According to Ojeda (1991) this situation is due to the odor that affects palatability. Also this author supports that in silages with high contents of dry matter as those attained in this study, need a higher pH to achieve the stabilization of the ensiled mass. This is really confirmed since there were no changes in the ensilage at the opening of the silo as in its utilization.

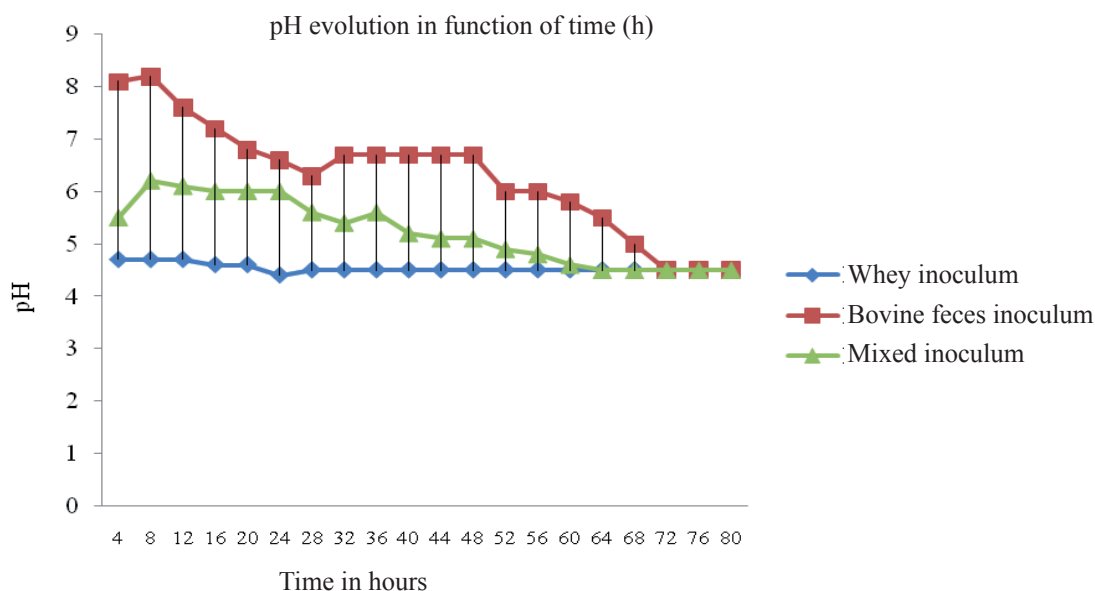


Figure 1. pH dynamics throughout the fermentation time of the microbial activators

Ramos *et al.* (2007) reported pH values of 4.76 and 5.85 in the final product of sorghum and rice polishing, respectively, figures which are similar to those of this paper. Table 4 shows the bromatological composition of the biosilages, where it can be seen that the treatment with highest percentage of crude protein (CP) was de biosilage prepared with mixed (13.43 %) pre-ferment. It followed the one activated with whey (13.00 %) pre-ferment and lastly, that made with the addition of pre-ferment from bovine feces (12.84 %).

Ayavaca (1999) reported similar values for the protein (12.18 %). In a study Guilcapi (1981) registered 7.40 % CP. Ramos *et al.* (2006) found values for CP of 18.13, 18.86, 19.13 and 19.70 % for sacchamaize, sacchacitrus and sacchapolishing, respectively. These figures are higher than those of this experiment, since from their origin they have higher nutritive components.

Ramos *et al.* (2007) reported crude protein values of 19.08 % and 19.18 %, which are higher to those found in this experiment. Possibly this could be due to the

fact that they used substrates with greater availability of nutrients.

The treatment with lowest amount of crude fiber was the biosilage enriched with mixed pre-ferment (22.58 %), followed by that made with whey (30.56 %), and finally was that containing bovine feces (33.52). On comparing these values with those of initial CF of the raw material (42.75 %), there was great decrease on the order of 14 %. According to criteria of Ayavaca (1999), this is possibly due to the biochemical transformations mediated by enzymatic groups during fermentation, since cell compounds and hydrolyzable carbohydrates are transformed into organic acids and alcohol. This author refers that in a similar study he obtained 17.07 % of CF. However, Guilcapi (1981) found a CP on the order of 31.5 %, a value which is similar to that obtained in this study.

On comparing the results of this study with other investigations, it is concluded that fermented sugar cane with different ingredients (leucaena, sweet potato, maize, soybean with maize without any inoculum

Table 4. Bromatological composition of the three biosilage types and of the control treatment

Components	Purple fodder	SD	Biosilage whey	SD	Biosilage feces	SD	Biosilage mixed	SD
Humidity (%)	86.14	2.76	75.10	0.90	78.03	1.82	73.9	1.74
Dry matter (%)	13.86	1.92	24.90	0.88	21.97	1.02	26.10	1.08
Crude fiber (%)	42.88	1.03	30.56	0.54	33.52	0.61	22.58	0.45
Crude protein (%)	9.30	0.34	13.00	0.23	12.84	0.34	13.43	0.27
Lactic acid (%)			65.11	2.13	60.49	1.97	70.11	2.01
Acetic acid (%)			32.30	0.99	36.06	1.02	28.40	0.93
Butyric acid (%)			2.59	0.21	3.45	0.31	1.49	0.11
NH <sub>3</sub> (% of total N)			3.05	0.05	7.11	0.09	5.50	0.07
pH			4.60	0.20	4.80	0.21	4.70	0.19

and with inoculum) through solid state fermentation showed CP values of 11.50 to 16.30 % (Valdivié *et al.* 1997), figures which are similar to those of this experiment.

Regarding the dry matter, the highest value corresponded to the treatment with mixed pre-ferment (26.10 %), followed by that containing whey (24.90). In the last place was that prepared with pre-ferment based on bovine feces (21.97 %).

Ramos *et al.* (2006) reported values of 35.56 % for Sacchamaize, 34.94 % for Sacchasorghum, 34.75 for Sacchacitrus and 35.25 % for Sacchapolishing, products of SSF that had additional components to those used in this study. Ramos *et al.* (2007) found similar figures of DM for Sacchasorghum and Sacchapolishing 37.72 and 38.45 %, respectively.

There was an adequate NH<sub>3</sub> concentration with values between 3.05 and 7.11 % which agrees with normal figures obtained in silages of this type (Fernández 2012). Silage consumption, expressed in DM, was of 3.27 kg/animal/d for the treatment with biosilage with pre-ferment based on whey, followed by the mixed, with 3.03 kg daily and afterwards by that of feces with 2.92 kg/d, and finally by the control treatment (only grazing), with 2.62 kg/animal/d. These values evidenced highly significant differences ( $P \leq 0.05$ ) between treatments (table 5).

The silage constitutes an excellent feed, although

precautions must be taken for its use. For that reason consumption field trials must be realized with the animals and turn to the laboratory. Silages are mainly used in dairy cows. According to Maynard *et al.* (1995) it must be considered that the cow must ingest it, at least, six hours prior to milking to avoid the transmission of unpleasant odors to the milk. These authors recommend supplying the following amounts of silage per day and per animal: for dairy cows, from 25 to 30 kg, and for fattening calves from 5 to 6 kg per 100 kg live weight. The maximum ration must not be attained before 12 months of age.

In regard to live weight gain of steers in the evaluation period (75 d), animals of the control treatment (grazing) gained 0.13 kg/animal/d, while those of the treatment based on silage with whey, 0.50 kg/animal/d. Meanwhile, with the mixed silage (whey + feces) 0.23 kg/animal/d was attained. Finally, with the silage based on bovine feces, total gain was of 0.18 kg/animal/d. There were significant differences ( $P \leq 0.05$ ) between the means of the treatments. The best result was obtained with the treatment with whey (table 6).

Anon (2001) reported that with animals from 2 to 3 years of age, healthy but skinny due to feeding deficiency, submitted to fast fattening, there was a daily gain of approximately 1 kg until slaughter.

Anon (2004a), on evaluating *Pennisetum*

Table 5. Effect of four biosilage treatments with different bioaccelerators and the control treatment on DM consumption of steers

DM consumption	Treatments				C.V (%)	EE ±
	Grazing	Whey	Feces	Mixed		
0-30 days	76.20 <sup>d</sup>	89.93 <sup>a</sup>	82.28 <sup>c</sup>	86.95 <sup>b</sup>	0.72	0.01
30-60 days	82.80 <sup>c</sup>	106.07 <sup>a</sup>	93.89 <sup>b</sup>	94.10 <sup>b</sup>	5.32	0.01
60 -75 days	37.50 <sup>d</sup>	49.46 <sup>a</sup>	42.99 <sup>c</sup>	46.47 <sup>b</sup>	0.29	0.01
Total 75 days	196.5 <sup>c</sup>	245.45 <sup>a</sup>	219.16 <sup>b</sup>	227.53 <sup>b</sup>	2.07	0.01
Average kg./day	2.62 <sup>c</sup>	3.27 <sup>a</sup>	2.92 <sup>b</sup>	3.03 <sup>b</sup>	2.07	0.01

<sup>abc</sup>Means with different letters differ statistically at  $P < 0.05$  (Duncan 1955)

DMC: dry matter consumption

CV: coefficient of variation

EE: experimental error

Table 6. Effect of four biosilage treatments with different bioaccelerators and the control treatment on live weight gain in steers

Weight gain	Treatments				C.V (%)	EE ±
	Grazing	Whey	Feces	Mixed		
0-30 d	3.33 <sup>b</sup>	13.33 <sup>a</sup>	3.67 <sup>b</sup>	8.00 <sup>b</sup>	14.90	0.01
30-60 d	4.67 <sup>b</sup>	16.00 <sup>a</sup>	4.67 <sup>b</sup>	6.67 <sup>b</sup>	18.75	0.01
60-75 d	2.00 <sup>b</sup>	8.00 <sup>a</sup>	5.00 <sup>ab</sup>	2.67 <sup>b</sup>	18.46	0.05
Total 75 d	10.00 <sup>b</sup>	37.33 <sup>a</sup>	13.33 <sup>b</sup>	17.33 <sup>b</sup>	12.05	0.01
Average (kg/d)	0.13 <sup>b</sup>	0.50 <sup>a</sup>	0.18 <sup>b</sup>	0.23 <sup>b</sup>	13.06	0.01

<sup>abc</sup>Means with different letters statistically differ at  $P < 0.05$  (Duncan 1955)

CV: coefficient of variation

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*purpureum* (king grass) ensiled with broiler feces in the fattening of young bulls, obtained a daily gain of 0.42 kg/d/animal, with higher silage consumption than in this study. Also reported results from a research conducted for the fattening of young bulls with silage of pig feces with molasses, sorghum straw and protein supplements, where average live weight gains of 1.36 kg/animal/d were found. This could be due to higher average consumption of silage, from 8.30 kg/animal/d, unlike what was registered in this study, which were 3.07 kg/animal/d.

In a similar way were reported the results of a trial realized in Northern Ireland with fattening oxen of the Shorthorn breed which were only fed with silages containing 21 % dry matter with 13.90 % CP. There were daily live weight gains of 1.25 kg with an average consumption of 5.70 kg silage/d.

Carnevali *et al.* (2002) reported average daily live weight gain of 0.60 to 0.74 kg in males and of 0.47 to 0.57 in females. They used molasses supplementation and urea for grazing bovines, with average CP content of the pastures of 9.50 %.

López *et al.* (2008) indicated that on supplying silage *ad libitum* to the animals, plus 1 kg/animal/d of cotton pellets (42 % CP) and later, 1.20 kg of sunflower pellets (35 % CP) obtained live weight gains of 0.63 kg/d and 0.68 kg/d, respectively. Daily consumption of dry matter per animal was of 9.10 kg. Therefore, there was always higher consumption regarding the remaining investigations and, thus, higher yield.

A better way of fattening steers and young bulls is the mixing of concentrates with the silage. This allows a uniform ration for all the animals, avoiding that the most aggressive achieve the consumption of more concentrates, as it occurs when the concentrate is spread over the silage. The concentrate could be composed of rice bran, cake of palm coconut, plus mineral additives (Anon 2004b).

It must be also taken into account that the use of

stubble with urea improves the productive indices. In a ration with available resources in the farm and that increases the crude protein values. In lactating cows, milk production can be increased up to 40 %. In fattening steers, gains of up to 0.34 kg per day can be reached (Anon 2004b)

Regarding feed conversion (table 7) obtained in this study, it was less efficient that that of the control treatment (grazing), with a value of 22.37, without differing statistically from that obtained with the treatment based on feces (20.98) and from the mixed (15.06), but it did differ regarding the most efficient, obtained in the treatment based on whey (6.76). The average of all treatments was 16.29 kg of feed, for obtaining 1 kg of meat or of live weight.

Olivo (1994) registered feed conversions between 10.51 and 10.56, on supplying hen feces plus molasses as supplement. Both are less efficient regarding the whey, and more efficient with respect to the remaining treatments. On analyzing results, it can be indicated that the use of supplementation with silage based on whey in the fattening of young bulls is more efficient, since the best final live weights were attained and the highest daily and total live weight increase.

Through the economical analysis the cost/benefit (C/B) was calculated. In the biosilage treatment with whey, there was an indicator of 1.37. This represents that for every dollar invested there was a profitability of 37 cents (37 %), which was reduced to 1.19 when mixed silage was used. The lowest profitability was registered with the biosilage treatment activated with pre-ferment based on bovine feces and with the control treatment with 1.13 and 1.10 of C/B, respectively.

It is concluded that by the biosilage process activated with pre-ferments multiple benefits are attained. The nutritional value of poor quality materials is improved by increasing the protein and

Table 7. Effect of four biosilage treatments with different bioactivators and the control treatment on the feed conversion (FC) in beef cattle fattening

Treatment	Feed conversion <sup>1</sup>			
	0-30 days	30 -60days	60-75 days	Total 75 days
Grazing	26.25 <sup>a</sup>	17.94 <sup>a</sup>	22.92 <sup>a</sup>	22.37 <sup>a</sup>
Whey	6.99 <sup>b</sup>	6.84 <sup>c</sup>	6.45 <sup>b</sup>	6.76 <sup>b</sup>
Feces	23.79 <sup>a</sup>	27.34 <sup>a</sup>	11.80 <sup>a</sup>	20.98 <sup>a</sup>
Mixed	10.99 <sup>b</sup>	14.85 <sup>b</sup>	19.35 <sup>a</sup>	15.06 <sup>a</sup>
Average	17.00	16.74	15.13	16.29
CV %	13.18	9.65	15.62	7.86
EE	0.05	0.01	0.05	0.05

<sup>abc</sup>Means with different letters in each variable differ at P<0.05 (Duncan 1955).

<sup>1</sup>Feed conversion (feed conversion in kg od DM/ kg of liveweight gain). VC Variation coefficient.

EE: Experimental error

making them more digestible for bovines; there is a suitable technology, applicable and promising, useful for the fattening of discarded bovines from dairy cattle raising and contributing to mitigate environmental pollution through a better use of agroindustrial wastes. The best treatment corresponded to the biosilage prepared with the addition of pre-ferment based on whey, since it generated greater live weight gain (0.50 kg), better feed conversion (6.76) and the highest profitability (37 %).

It is recommended further research on activated biosilages with pre-ferments through the use of other types of wastes and microbial inocula for testing them as feeding alternatives in ruminants.

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