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Effects of Milled Maize Stalks on the Productive Response of Grazing Dairy Cows

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ABSTRACT

The productive response of grazing dairy cows was evaluated, using milled corn stalks in the diet. The study was developed in two different settings, in Ecuador (Costa and Sierra regions). On the coast farm (29.1 ha), cows grazed on Bermuda grass (*Cynodon nlemfuensis*) and Guinea grass (*Panicum maximum*) with several types of legumes (*Lysicarpus, Centrosema, Desmodium, Galactia*), supplemented with corn stalks cv. INIAP 125. The animals received 0.46 kg beginning at 3 kg, and milled maize stalks in 30 and 28-day periods, respectively (M-30 and M-28), and control without stalks for 36 days (M-0). The farm in the other region (14.2 ha) had 23 cows grazing on Kikuyo grass (*P. clandestinum*) and *ryegrass*-white clover (*L. perenne* and whole maize stalks and *T. (*60-70% ripe grain), at a rate of 18 kg green/cow/day for 48 days; and balanced supplement, at a rate of 0.5 kg/ milk liter, after the fourth kilogram, along with minerals. In both cases the forage had effects ($P < 0.05$) on cow response. In the Sierra area, the increase was 1.68 kg/cow, and in the coast, it was 1.1 and 2.5 kg/cow). Maize stalks served as a nutritional complement for poorly consumed grass areas in both regions; milk production/animal was increased, and the costs were reduced.

Key words: *associated pastureland, bovine, bulky feeds, environment, costs*

INTRODUCTION

Several experiments in grazing conditions made in the Latin American tropic, and in the high tropical areas in Latin America and Australia indicate that unfertilized *graminaceae* do not exceed volumes of 5-7 t/DM/year (Milera *et al*,. 2013), and it has poor-average nutritional quality, due to low protein contents (5-7%), which affects consumption, digestibility and animal response (Minson, 1981; Van Soest *et al*., 1991; Guevara, 1999; Pérez Infante, 2010; Milera *et al*., 2013).

That situation may be improved with the inclusion of milled stalks from maized and *Pennisetum*, delivered in the troughs, mixed to form a whole ration with the supplements, in order to increase lactation energy and improve overall feed consumption. It was reported in papers on dairy tropical Australian cows, by Kerr and Cowan (1991), and by Cowan (2995), in the Atherton Plateau area (high tropic); they described feeding strategies in dairy herds in the region, relying on grazing, on green grass and milled stalks, like corn. The bio-economic responses were high.

It coincides with Pérez (2010) for milled forage systems in the tropic; and by Camerón (2012); and Pulido *et al*. (2010) for temperate climate using forage complementation with maize, alfalfa and other grain and oleaginous stalks presented in different ways. The bio-economic advantages of supplementary feeding with mixed stalks in the troughs, and increased milk production are evident.

Accordingly, the purpose of the study was to evaluate the response to milled maize as a whole plant with grains, delivered in troughs to dairy cows under associated grazing (low tropic in Costa, and high tropic in Sierra) in Ecuador.

MATERIALS AND METHODS

Enclosures of 0.25 ha were used as replicas of African Bermuda grass (*C. nlemfuensis*) and naturalized Guinea grass (*P. maximum*) were used, on grayish brown soil with medium natural fertility and slightly acidic, located on 0°49'south latitude, and 80° west longitude, 15 meters above sea level. Sprinkler irrigation was applied after every use, during the research period. The land occupation time was 1-2 days, and variable resting times were applied, according to the condition of the grassland, and the time elapsed since the last use.

The maize area cv. INIA 125 (choclo white) for chopping was 3.2 ha, planted with whole soil preparation, minimum fertilization with urea, and low sprinkling irrigation. The cows (Holstein-Gyr and Brown Swiss-Gyr), between 3-4 months of lactation, were given maize (INIAP 125), harvested mechanically, and supplied in the troughs at a rate of 20 kg of fresh forage. The M-0 stage (no maize), the forage was milled in the same quantity/cow, from an area of *Pennisetum* spp.

The Cotopaxi dairy farm is located between 0º 9´79´´ south latitude, and 78º 68´28´´ west longitude, at 306 meters above sea level. It is a small farm of 14.2 ha, with 23 Holstein cows, and Holstein-Creole, with lactations between 2-4 months, grazing on kikuyo associations. The technique used was rational grazing. Occupation time was 1-2 days; the cows were given stalks from giant white maize, whole plant cut at the onset of maturation (60-70% of maturation grain in troughs, at a rate of 18 kg of green stalks/cow/day, over the 48 days of the local dry season, plus milk supplement at a rate of 0.5 kg/kg of milk, after the fourth kilogram of milk and mineral supplement.

Animals and design

Both studies included cows between 430 and 512 kg of live weight; the stocking rate was 1.09 cows/ha in the Costa region, and almost 1.86 cows/ha in the Sierra. The Costa study applied the total mixed ration technique; the table designed by Pérez (2010) about animal quality and response was used (Table 1).

To measure milk production effects, the records from every unit were used. For field use, the resting and occupation indicators during the period, and daily milk production were used as well. Variance analysis with animals as replicas in the two study periods, using SYSTAT 11.2, and the Duncan test (1995) for difference signification between means. Cost estimates were made to milk kg, according to the Luening techniques (1998).

RESULTS AND DISCUSSION

Milk production systems based on grazing (Table 2), with improved and native tropical graminaceae associations (fair-average quality), according to Pérez´s table (2010). They were complemented with milled maize stalks, as a total mixed ration with the supplement, had significant differences in both periods ($P < 0.05$), and values of up to 2.5 kg/cow superiority, regarding the animals without maize. The assumption that these systems offer a little explored productive potential in the low tropical areas of Latin America (Lascano, 2000; Cowan, 2005; Pérez, 2010; Guevara, 2015).

Pulido *et al*. (2010); Elizalde (2015); Mezzadra (2015) and Mulliniks *et al*. (2015) point that the improvements observed in the efficiency of primary milk and beef industries, can meet the current demands of foods for humans, and even future requirements. Hence, cattle farmers must keep cost-effectiveness and durability of the systems. One critical requisite (Mezzadra, 2015) is the kind of cows used, with lower requirements of energy and other nutrients, due to their low live weight. It also coincides with the study of Brown-Gyrolando cows in Costa, and smaller animals in Cotopaxi, from New Zealland Holstein genes, and Creole, both used on the location farm.

Dairy crossbred cows (European and Zebu), have dairy production records consistent with their potential to make efficient use of grass and forages. They can also overcome the 10 kg/cow/day with little supplementation based on milled forages (García López, 2033; Pérez, 2010). In addition to it, the grassland use values for lactating cows in the Costa study were between 41 and 52%.

In practice, some factors, like species, quantity and quality of forage supplied might have affected the dairy potential in systems with feeding techniques like the one used in Sierra (Callow, 2004; Díaz *et al*., 2012; Milera *et al*., 2013; Guevara, 2015). In that sense, other authors, like Kerr and Cowan (1991), Cowan (2005; Pulido *et al*., (2010); and Cucumbo *et al*. (2013), claim that it relies on the energy supply for lactation-fattening, conferred by maize stalks and biological nitrogen supplied by legumes, which is transferred to temperate *graminaceae*, and their protein conversion. Accordingly, it has a decisive effect on whole ration consumption, and increases animal dairy yields.

Maize stalk-based systems have high production levels, measured at experimental and commercial stations in the temperate areas of the Americas, ranging between 6 500 and 16 600 kg/ha/year, depending on the kind of forage, intensification of the system, and the lands used, with ballico-clover in spring and summer, and forage in winter; thus contributing to increased production and proper economic results (Pulido *et al*., 2010; Pérez *et al*., 2013).

Maize is an energy-rich forage resource, though it does not provide enough proteins and minerals, so it is not recommended to be used as a single feed. However, it has been observed to increase dry matter consumption and milk production of grazing animals of Region X, in Chile (Klein *et al*., 1993). Similarly, Callow (2004), and Cowan (2005), for dairy systems in the high tropical areas in Australia, used cow supplements during grazing. It also coincides with remarks on forage use, like maize and sorgo stalks in cattle grazing systems in the United States, which may help cut down costs (Mulliniks *et al*., 2015).

Grazing (2004) found that the types of maize stalks and supplementation with grains had important effects on the response of dairy grazing cows. Besides, the highest ration timely combined for ruminating fiber and amylaceous carbohydrates, improved dairy yields, using the milled forage. It relates to the supply of fermentable fiber. It was demonstrated at the South New Wales University, in Australia.

All this may have explained cow response in the high tropic study in Cotopaxi (Table 3), that was significantly higher ($P < 0.05$), in 1.68 kg/cow/day, than the study without maize stalks. Although the response differential was not so broad, as in the Costa case, it was stable during the 48 days of the study. Perhaps the differences in this case are less, due to the better kikuyo and ryegrass-clover associations with higher metabolizable protein and energy contents, and greater digestibility of dry matter at similar reshoot ages, and with no availability limitations (Graznin, 2004; Callow, 2004; Lowe *et al*., 2010; Mc Donalds *et al*., 2015).

The previous has been demonstrated in comparative trials between *graminaceae* and associations with temperate and tropical legumes, by Minson (1981), with differences in more than 10 units, higher digestibility per cent in temperate areas. Moreover, Callow (2004), and Cowan (2005), in high tropical dairy systems, in northern Australia, corroborated the advantages of *graminaceae* associations, like kikuyo, dactylo, ryegrass-clover cv. safari, and other legumes from high temperate areas, for more nutritional milk production, in comparison to reports by low tropical experimental stations and real systems, using graminaceae and legume associations, complemented with different kinds of forage (Pérez, 2010; Milera *et al*., 2013).

The costs of the Costa study averaged USD $0.29/kg of milk for the supplementation periods (M-30 and M-28), compared to the USD $0.35/kg of milk, when production was reduced without stalks mixed with supplement M-0, as control. In Sierra, the costs were reduced to USD $0.08/kg of milk, when corn was used, regarding the USD $0.23 from the other, against the USD $0.31, which may have owed to higher dairy yield, and a greater combination of variable/animal expenses over that stage (Luening, 1998; Mezzadra, 2015).

Dairy crossbred cows (European and Zebu), have dairy production records consistent with their potential to make efficient use of grass and forages. They can also overcome the 10 kg/cow/day with little supplementation based on chopped forages (García López, 2003; Pérez, 2010). Additionally, the values for grassland use in the Costa study were observed between 41 and 52%. Some factors are known to alter that potential (Díaz *et al*, 2012; Milera *et al*., 2013), and in addition to Kerr and Cowan (1991, Cowan (2005), and Comerón (2012) claim that it is caused by energy supplied by maize stalks for lactation-fattening; as well as biological nitrogen from legumes and other digestible nutrients, which have effects on whole ration consumption, and increased milk yields.

Lascano (2000) made reference to it, concerning forage-based diets supplied in the troughs, and for grazing on associations, in Colombia. It is also effective for grazing on *graminaceae* supplemented with legumes and balanced supplements in barns, during the dry season in Cuba (Milera *et al*, 2013).

In other trials in tropical areas, Pedro Infante (2010) concluded that in grass and legume associations for crossbred Holstein-Zebu cows, more than 9.0 kg of milk/cow/day, and more than 2 000 kg/cow/year, were achieved. Annual yield values accounted for 2 100-2 400 kg/ha, and a significant reduction of milk costs.

Mulliniks *et al*., (2015), highlighted that increased grain prices (corn and other grains, and oleaginous plants) have increased lands for cattle raising. Accordingly, more cost-effective technologies have turned into non-conventional, and harvest stalks, whole plant forage, and distilled products, are widely used. Their contents are varied as well (starch, gross fiber, NDF, and metabolizable energy), but the amounts used have a reasonable impact on milk yields.

McDonalds *et al*., (2015) reported that the plant´s individual components have different digestible fiber types, with values between 30 and 40%; a daily supply of 25-30 kg ensure high consumption and better selection of the plant parts eaten by the ruminants. It coincides with Van Soest (1991) and Arroquy (2015) on the advantages of neutral detergent fiber, based on the quality of the forage milled, and preserved or fresh, with which 15-20% concentration of these stalks used as whole mixed ration (MTR) supplied to dairy cows (or even fattening) showed important results in terms of the grass and other supplements added to the diet.

Other important effects were found in some studies on whole ration consumption, reduction of metabolites linked to ketosis and animal shape, in the midterm, to the next lactation period, when the grass associated with several high quality forages were ready (Cowan *et al*., 2003; Bargo *et al*., 2003; Kellaway and Harrington, 2005; Noro *et al*., 2011; Pérez Prieto *et al*., 2011; Cucunubo *et al*., 2013 Arroquy, 2015; Mezzadra, 2015).

Other important effects that may have influenced on these responses, in relation with the presence of legumes, might have been linked to an increase in the rate of rumen protein production, which is improved with fermentable fiber and nitrogen. Besides, it provides greater consumption and better milk yields, in comparison to grazing-balanced feed-only diets, according to Pulido *et al*. (2010) and Schobitz *et al*., (2013). Moreover, the beneficial effects of the diets have been reported in several experiments and cow syndrome recovery cases, where the favorable effects are reflected in the reduction of ketosis, subclinical and acute ruminal acidity, and abomasum displacement problems in high performance cows (Pulido *et al*., 2010; Pérez Nieto *et al*., 2013; Ruíz Albarrán *et al*., 2011; Wittwer, 2013; Scobitz *et al*., 2013; Cucunubo *et al*., 2013; McDonalds *et al*., 2015).

CONCLUSIONS

The use of whole plant milled maize forage to provide nutritional complementation with balanced supplementation to grazing cows, both in Sierra and Costa dairy farms, Ecuador, favored whole ration consumption, and milk production was increased significantly above 2 kg/cow/day, compared to the period without forage consumption.

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Table 1. Suggestions on pasture quality when availability is not a limit

Consumption %LW	ME Mcal/kgDM	BP %	Classification and definition	Milk prod. kg
3.3	2.4	>16	Excellent: green leafy pasture, highly fertilized with short rotations (less than 20 days) Guinea species	> 17
3.0-3.3	2.2-2.4	13-16	Very good: green even leafy pasture, almost always fertilized with 20-30 day rotations	12-17
2.7-3.0	2.0-2.2	10-13	Good: young pasture, mixed with ripe pasture, 20-30 day rotations	6-12
2.2-2-7	2.8-2.0	7-10	Average: uneven pasture beginning to ripe, +30-day rotations	2-6
2.1-2.4	1.6-1.8	4-7	Bad: ripe uneven pasture, +40-day rotations, maintenance diet	0
2.1	1.6	< 4	Very bad: very ripe and dry pasture, weight losses	Weight losses

Table 2. Effects of maize forage inclusion on cows grazing on *graminaceae*-legume associations in the dry low tropical areas in Manabí, for milk production (kg), and their cost/kg (USD)

Indicators	M-30	M-28	M-0 (Control)	E.S ±	Sig.	C. V(%)
T. resting	22-26	22-26	22-26	-	-	-
T. occupation	1-2	1-2	1-2	-	-	-
Daily milk production	238[a]	227[b]	203	5.61	6.73	14.3
Milk production/c/d (kg)	11.6	10.2	9.1[b]	0.19	0.51	9.6
Milk production/ha (kg)	12.3	11.1[b]	8.8	0.14	0.28	12.5
Cost/kg	0.29	0.29	0.35	-	-	-

Table 3. Effect of maize forage allowance on cows grazing on *graminaceae*-legume associations in the high Cotopaxi tropic, for milk production (kg), and cost/kg (USD)

Indicators	M-48	M-0 (Control)	E.S ±	Sig.	C. V(%)
T. resting	25-35	25-32	-	-	-
T. occupation	1-2	1-2	-	-	-
Milk production/cow/day (kg)	18.72	17.04	0.35	*	13.1
Milk production/ha/day (kg)	19.95	18.26	0.52	-	-
Cost/kg	0.23	0.31	-	-	-

1Estimated production, not from the records; * differences from P < 0.05