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CASSAVA (*Manihot esculenta crantz*): AN AFFORDABLE ENERGY SOURCE IN DAIRY RATIONS

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ABSTRACT: *The current paper explores the evidence that exists on the potential use of cassava plant (Manihot esculenta Crantz) as an energy source for dairy cattle. Several studies have proven cassava roots, leaves and processing residues to be an important ruminant animal feed resource. Cassava root chip and meal are a potentially good rumen fermentable energy for dairy cows in the tropics. The vegetative parts of cassava are considered to be wastes since human beings grow cassava for its tubers. Feeding trials with cattle have shown cassava hay to have a dry matter intake levels DMI of around 3.2% of BW) and a digestibility (71%). The hay also contains tannin-protein complexes that may be a good source of rumen un-degradable protein that will be available to the animal post-ruminally. It has also be shown that supplementing 1-2 kg/head/day of cassava to dairy cattle may go a long way in reducing feeding costs and significantly increasing milk quality and quantity produced. Cassava hay was also noted to be anthelminthic and therapeutic since it contains condensed tannins. Condensed tannins have been proven to reduce gastrointestinal nematodes. Use of cassava as a substitute of maize in dairy rations can significantly lower the feed costs in smallholder dairy farms in cassava producing countries like Mozambique. It was concluded that cassava is potentially an affordable substitute for conventional energy source for small scale dairy farmers.*

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INTRODUCTION

Availability of animal feed is one of the greatest constraints to the expansion of the livestock industry in developing countries. Apart from the high and fluctuating costs and some of the ingredients used in mixed feeds, notably cereal grains are in high demand for human consumption (Oguntimein, 1988). The cassava products and by-products can be good alternative source of carbohydrate and protein for conventional feed ingredients.

In Mozambique cassava roots and leaves are widely grown mainly as a staple food. The main cassava products are the green leaves used as vegetable; the roots used fresh or dried for flour, roasted as a *gari* or for beer brewing. Cassava supplies roughly 30% of all calories consumed in Mozambique, making it the Country's most important food security crop (Donovan et al., 2011). In northern Mozambique, cassava commercialization centers on trade in dried flour, while in the south a prepared cassava-based convenience food called *rale* accounts for the bulk of marketed cassava product.

Due to the high productivity of cassava, either per unit of land or unit of labor, its products are generally priced lower than most crops. In Mozambique the price of cassava averages at around 55% of the cost of wheat and 60% of the cost of maize (Donovan et al., 2011). The relatively low cost of cassava makes it an attractive crop with a lot of potential in the livestock feed industry. Although there is scientific evidence that support the potential of cassava as an important livestock feed, it use as such is not fully exploited (Anjos, 2007). It is estimated that only 4% of total cassava output is used as a livestock feed resource. The aim of this paper is to explore the potential use of cassava as a substitute for maize in dairy rations.

MATERIALS AND METHODE

Chemical and nutritional composition of cassava

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The crop is an important source of carbohydrate for humans and animals, having higher energy density than other root crops, 610 kJ/100 g fresh weight. Dried cassava root has energy density that is similar to cereals (Bradbury and Holloway, 1988, FAO, 1990). Cassava roots and cassava leaves are both used for animal feed (Buitrago, 1990, Dahniya, 1994). The general chemical composition of cassava roots and leaves is shown in Table 1.

Table 1 - Chemical composition of cassava roots and leaves (Buitrago, 1990)

Nutrient	Storage root		Leaves	
	Fresh weight basis (%)	Dry weight basis (%)	Fresh weight basis (%)	Dry weight basis (%)
Dry matter	35.00	100.00	28.00	100.00
Starch	30.21	85.10	16.23	39.00
Crude protein	1.10	3.10	6.80	24.00
Fat	0.47	1.30	1.80	6.50
Crude fibre	1.10	3.10	5.80	20.60
Ash	0.70	1.90	1.70	6.20
Calcium	0.10	0.33	0.43	1.50
Phosphorus	0.15	0.44	0.08	0.27

Cassava roots are rich in digestible carbohydrates, mainly in starch. Cassava starch granules are composed mainly of two polysaccharides, amylose (20%) and amylopectin (80%) (Sandoval, 2008). Therefore cassava roots are low in protein and fat. Cassava root has less than the recommended minimum limit in almost all essential amino acids, except tryptophan (FAO, 1990). Cassava leaves are much richer in protein than the roots, although the leaf contains a lower proportion of methionine than the root protein. Cassava is good source of dietary fibre, magnesium, sodium, riboflavin, thiamine, nicotinic acid and citrate (Bradbury and Holloway, 1988). Cassava however contains cyanogenic glycosides linamarin and lotaustralin in a ratio of 97:7 in all its tissues except for the seeds (Teles, 1995). Cassava is usually classified by farmers as being bitter or sweet depending on the levels of anti-nutritional factors therein. Cassava varieties with bitter taste are considered toxic (Chiwona-Karltun et al., 2004).

In order to reduce toxicity, improve palatability of cassava various treatment methods are applied. Such methods include, peeling, boiling, steaming, shredding, roasting, fermentation, however the most common practices is drying of the roots after chipping (Garcia and Dale, 1999). The majority of farmers in Southern Africa prefer to grow the bitter varieties of cassava as form of crop protection against pests. It is therefore imperative that cassava must me adequately processed or treated before use as an animal feed ingredient. Most cassava growing farmers in Southern Africa know various processing techniques such as heap fermentation of roots to reduce bitterness (Tivana et al., 2007).This method is useful when preparing cassava roots for use as animal feeds. Cassava roots and leaves can also be ensiled to produce a nutrient dense feed that is low in anti-nutritional factors (Eruvbetine, et al., 2003).

Use of cassava in as livestock feed

Studies from across Africa reveled that cassava could be used as a source of energy and protein for ruminants. In Kenya, Sanda and Methu (1998) evaluated the effect of substitution of maize by cassava in dairy Friesian, Ayrshire and their F1 cross cows reported that cassava products are good energy feed ingredient for dairy cows and it can totally replace maize meal in the concentrate diets for cows producing approximately 12 kg of milk per day. In addition no significant difference in vivo digestibility of either the dry matter or organic matter and the feed cost per ton were reduced.

Cassava roots

Another study on the potential use of cassava as an important livestock feed ingredient evaluated the effect of cassava root chip on milk yield in lactating Holstein-Friesian cows. The cows were fed *ad libitum* a ration consisting of roughage (dried Ruzi grass) and a cassava containing concentrate with inclusion levels ranging from 25 % cassava up to 55 %. The results showed that the levels of cassava root chip containing concentrate compared favorably with a conventional concentrate. There were no significant differences in the total dry matter intake, digestion coefficients of Dry matter and Organic matter, milk yield and milk composition. It was therefore concluded that cassava chips can be used in dairy cattle feeds with inclusion levels as high as 55% (Wachirapakorn et al, 2001).

In another study by Wanapat and Petlum (2001), a supplement ration containing a high level of 85 % cassava root chips was fed to peri-parturient dairy cows (one month before calving up to 13 weeks post-partum). It was concluded that high level of cassava chips in the concentrate resulted in increased milk yield quality yet the cost of the cassava based feed was 60% lower than a typical commercial product. In primiparous lactating Holstein cows, cassava scrapings included at 0, 25, 50, 75 or 100% levels in the diet had no significant effect on dry matter intake (kg, %BW and g/BW $^{kg0.75}$) However, milk yield, milk yield corrected for 3.5% fat, and fat yield decreased linearly by 20, 30 and, 1.15 g/day, respectively, when corn grain was replaced with cassava scrapings (Ramalho et al., 2006).

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Cassava leaves

Cassava leaves have been tested on ruminants either as silage or hay. In Tanzania Kavana *et al* (2005) found out that that dairy cattle fed cassava leaf silage produced more milk than the control group that received standard silage. Cows on the cassava leaf silage produced an average of 9.9 litres/cow/day compared with 7.6 litres/cow/day from cows fed a standard maize silage. Cassava foliage was included in silage at the following graded levels 0, 20, 40 or 60% and its effect on milk production and composition on fat quality of Holstein-Friesian cow milk was evaluated. It was observed that milk quantity and quality including milk urea content decreased linearly with increasing levels of cassava foliage silage in the diet ($P < 0.05$). However, γ-linolenic and palmitic acid concentration in milk increased with increasing proportions of cassava foliage silage in the diet. Cassava leaf silage proved not to have a significant effect on milk fatty acids, pH, density; milk protein, fat, lactose total solids and somatic cell counts (Modesto et al., 2009).

The effect of corn silage (CS) replacement by cassava's foliage silage (CFS) on the production and quality of milk were evaluated. The results indicated that No significant effect ($P>0.05$) was observed for the levels of replacement of CS with CFS for the variables: dry matter intake (kg/day and %BW), milk yield, 4% fat corrected milk production, fat, protein, lactose, total solids, N-urea, and acidity, which had average values of 25.42 L/day, 24.54 L/day, 3.78%, 3.13%, 4.55%, 13.25%, 18.91 mg/dL, and 1.67, respectively. Nevertheless, a decreasing effect ($P<0.02$) was observed on milk density with the increase in replacement level (Santos et al., 2009)

Cassava hay

A study was conducted to examine the supplementation level (0, 0.8 and 1.7kg DM/hd/d) of cassava hay in multiparous Holstein – Friesian crossbreds. Concentrate was supplement at the same level while urea-treated (5%) rice straw was offered *ad libitum* basis. The results revealed that supplementation of cassava hay could significantly reduce concentrate use resulting in similar milk yield (12.5, 12.12 and 12.6 kg/hd/d) and significantly enhanced 3, 5% Fat corrected milk (14.21, 15.70, 14.9 kg/day). Moreover, cassava supplementation increased milk fat and milk percentages (Wanapat et al., 2000a). In other study Wanapat et al. (2000b) reported that cassava hay contained high level of protein and minimal level of tannin at 3 months after harvest. According to Wanapat (2001), cassava hay contains 20 to 25% crude protein in the dry matter, and with very minimal HCN content. Feeding trials with cattle revealed high levels of Dry matter intake (3.2% of BW) and high Dry matter digestibility (71%). The hay contains tannin-protein complexes which could act as rumen by-pass protein for digestion in the small intestine. Therefore, supplementation with cassava hay at 1-2 kg/hd/d to dairy cattle could markedly reduce concentrate requirements, and increase milk yield and composition.

Twelve swamp buffaloes and Brahman cattle heifers (6 animals each) were randomly assigned to two treatments, control (grazing only) and supplementation of cassava hay at 1-kg dry matter per head per day (DM/hd/d), in a 2×2 factorial arrangement according to a cross-over design. As a result it was revealed that supplementation of cassava hay at 1-kg DM/hd/d significantly ($P<0.05$) improved the nutrition of both swamp buffaloes and Brahman cattle in terms of DM, organic matter (OM), protein and energy intake and digestibility, ruminal NH3-N and rumen ecology. Cassava hay CH should be recommended used as a protein source replacement a soybean meal in concentrates for a sustainable dairy production in the tropics (Kavana et al., 2005). The cassava hay had a significant effect on the parasitic infestation, in terms of lower egg counts (Granum et al., 2007)

The effects of cassava feed block

Experiment was conducted to investigate the effect of cassava hay (CH) incorporated in a high-quality feed block (HQFB) on feed intake, digestibility, rumen fermentation, milk production and milk composition in lactating dairy cows. There were three treatments: control (no supplementation of HQFB); HQFB (supplementation of HQFB without CH); and HQFB-CH (supplementation of HQFB with CH). Total dry matter intake and digestion coefficient of dry matter in the HQFB-CH treatment were higher than in the other groups. The concentration of NH_3-N, the pH and the microbial populations in the rumen did not differ between treatments. Milk yield in the two HQFB treatments were higher than in the non-supplemented treatment. Fat-corrected milk (3.5% FCM), percent milk fat and total solids in the HQFB-CH treatment were higher than for the other treatments (Koakhunthod et al., 2001).

Suksombat et al, 2006 evaluated 3 groups of cows fed concentrates containing the respective cassava pulp, 35%, 40%, and 45%. All cows were fed *ad libitum* grass silage and given free access to clean water. Dry matter intake (15.3 vs. 15.8 kg/d), milk yield (14.2 vs. 14.1 kg/d), milk composition and body weight change were unaffected ($P>0.05$) by the treatments. Their study indicated that 45% cassava pulp can be used in the concentrate for lactating dairy cows.

CONCLUSION

Studies from across Africa have revealed that cassava is a good alternative source of dietary energy for dairy cattle. Various parts of the cassava plant including leaves, stems and roots can be processed to produce a valuable dietary energy source for lactating dairy cows. Cassava has also been noted to be toxic as it contains cyanogenic glucosides, such as linamarin and lotaustralin, it also contains significant levels of tannins and hydrogen cyanide. The content of the aforementioned anti-nutritional factors in cassava is variable with different cassava cultivars. Farmers can however grow the less bitter types for livestock feeds or eliminate the anti-nutritional factors via a

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variety of processing methods. Cassava root chip and meal are a potentially good rumen fermentable energy for dairy cows. Cassava hay has also been concluded to have to have a dry matter intake and digestibility levels that are comparable to conventional energy sources. It was also concluded that the hay also contains tannin-protein complexes that may be a good source of rumen undegradable protein that will be available to the animal post ruminally. The cheap production cost of cassava therefore makes it a reasonably more cost effective substitute for conventional energy sources such as maize.

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