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Research Application Summary

Nutritive value of cooking melon from diverse processed products as energy source for livestock

Madibela, O. R.[1]*, Basutli, O.[1] & Masebu, H.[2]
[1]Department of Animal Science & Production, Botswana University of Agriculture & Natural Resources, P/Bag 0027, Gaborone, Botswana
[2]Department of Agricultural Engineering and Land Use, Botswana University of Agriculture & Natural Resources, P/Bag 0027, Gaborone, Botswana
***Corresponding Author:** omadibel@bca.bw

Abstract

Botswana is endowed with high diversity of both domesticated and wild plants despite its semi-aridness. The present study determined the nutritive value of diverse processed products from cooking melon *(Citrullus vulgaris)* with a view to use it as an energy source for livestock. Melon was fractionated into pulp and seeds (PS), outside cover (OC), outside cover and pulp (OCP) and left as whole melon (WM) and processed by a kitchen blender before drying under shade. Results showed that processed products have low dry matter (DM) content which were significantly different ($p<0.01$; 44.1, 37.9, 33.7 and 47.1%) for OCP, PS, OC and WM respectively. The low DM and high moisture content pose a challenge of processing and storage of melon products. Pulp and seed product have high energy which is highly degraded by rumen microbes. The high quality of the WM suggest that it may not be necessary to fractionate melon into different products.

Keywords: *Citrullus vulgaris*, crude protein, digestibility, diversity, gas production

Résumé

Le Botswana est doté d’une grande diversité de plantes, domestiques et sauvages, malgré sa semi-aridité. La présente étude a déterminé la valeur nutritive des divers produits traités de cuisson du melon (*Citrullus vulgaris*) en vue de l’utiliser comme une source d’énergie pour le bétail. Le melon a été fractionné en pulpe et les graines (PS), la couverture extérieure (OC), la couverture extérieure et la pulpe (OCP) et, le melon entier (WM) traité par un mixer de cuisine avant d’être sécher à l’ombre. Les résultats ont montré que les produits transformés ont une faible matière sèche (MS) qui étaient significativement différentes, respectivement ($p <0,01$; 44,1, 37,9, 33,7 et 47,1%) pour l’OCP, PS, OC et WM. La faible MS et haute teneur en humidité posent un défi de traitement et de stockage des produits de melon. Les produits issus de pulpe et de graines ont une grande énergie qui est fortement dégradé par les microbes du rumen. La haute qualité de la WM suggère qu’il n’est pas nécessaire de fractionner le melon en différents produits.

Mots clés : *Citrullus vulgaris*, protéine brute, digestibilité, diversité, production de gaz

Background

Profitability of farming among resource-limited smallholder farmers is eroded by high costs of production. For livestock farmers in the tropics and sub-tropics who rely on natural pasture, low quality of pasture during the dry season (Bakrie *et al.*, 1996) necessitate supplementary feeding, which comes with a cost. Though ruminants are able to utilize low quality feedstuffs due to the presence of micro-organisms in their rumen, the microbial protein produce do not meet nutrients requirements for production. Supplementation with proteins is necessary to meet micro-organism's requirements for nitrogen (Mathis *et al.,* 2006). Nitrogen is considered a limiting element in ruminant nutrition due to its role in the growth of micro-organism in the rumen (Karsli and Russell, 2002). Fermentable energy is needed to fuel the metabolism of such acquired nitrogen (Mathis *et al*., 2006), hence the need to concurrently supplement readily digestible energy from carbohydrates (Karsli and Russell, 2002). Most resource-limited farmers may not be able to afford these supplements for nitrogen or energy because most countries in sub-Saharan Africa do not produce molasses which provide readily fermentable energy. However, sub-Saharan Africa is endowed with plentiful natural resource, some which include domesticated crops. In Southern Africa, these biodiversity include melons, both domesticated and wild types (Knight, 1995). The fact that melons survive in harsh Southern Africa conditions means that they are adapted to drought conditions of water stress and high ambient temperatures (Kane, 2010). Identifiable types include the commonly eaten watermelon (*Citrullus lanatus;* magapu), the cooking melon (*Citrullus vulgaris;* marotse), seeds melon (sesoswane/egusi), wild type (kgengwe/Tsamma melons) and mutant of watermelon or cooking melon (mokatse). The fruits of these are always plentiful during the harvest season even during the drought years and offer opportunity for use as livestock feed. Due to availability of simple sugars, melon fruits will provide readily fermentable energy to livestock.

Literature summary

Feeding livestock is one of the most important and expensive part of successful agriculture. To keep costs low some farmers feed by-products from industries in order to reduce the cost of production. Due to limited supply, by-products are now becoming expensive because of high demand. Though maize is a valuable energy source for livestock, its use in sub-Saharan Africa in animal feeds creates competition with humans. Molasses can also be used as an energy source because it is easily fermentable but also contain significant quantities of trace minerals, such as copper, zinc, iron, manganese (McDonald *et al.,* 2011). Molasses in the urea-molasses block provide missing sugars and trace minerals and improve digestion of fiber in the rumen of livestock fed low quality forages (Thu and Aden, 2001). Unfortunately, most countries in sub-Saharan Africa do not produce sugar cane which often needs irrigation thus putting a strain in water resources. This makes drought-resistant crops like melon amiable alternatives. According to Penuel *et al.* (2013) in Nigeria more than 66,000 metric tons of melon seeds are produced annually. These seeds are used for oil production at subsistence level in Nigeria and other African and Middle East countries. Research indicate that it is only seed and seed cake that is used to feed livestock, especially poultry (Beshir and Babiker, 2009; Penuel *et al*., 2014) and the melon fruit as a source of water to livestock during the dry season, as it is the case in Tanzania (Kusekwa *et al.,* 1990; Shayo *et al.,*1996). In the Kalahari Desert wild-types of melon (Tsamma melons) are used by wildlife during the dry season probably supplying water and needed energy (Knight ,1995). There is, however, paucity of scientific information on the use of melon as source of energy for livestock. This study was designed to generate information on the nutritional value, especially energy content of different fractions of cooking melon from a smallholder farm near Botswana University of Agriculture and Natural Resources.

Study Description

Melons-cooking type, *Citrullus vulgaris,* were purchased from a smallholder farm at Bokaa Village on the outskirts of Botswana University of Agriculture and Natural Resources. Bokaa village is situated east of A1 Francistown road about 10km north of the university at 24^{o} 27'0" S and 26^{o} 1'0" E (http://www.maplandia.com). Melons were sliced and pieces selected in a completely random fashion into four (4) treatments. The slices were fractionated into pulp and seeds (PS), outside cover (OC), outside cover and pulp (OCP) or left as whole melon (WM) and processed by a kitchen blender before drying under shade. After drying samples were analysed at Botswana University of Agriculture and Natural Resources animal nutrition laboratory for proximate procedures according to AOAC (1997) and *in vitro* gas production using modified methods of Menke and Steingass (1988). Energy content was analysed on the gross samples and residues after in vitro degradation using bomb calorimeter to estimated degraded energy.

Results and Discussion

Results showed that processed products have low dry matter (DM) content which were significantly different ($p<0.01$; 44.1, 37.9, 33.7 and 47.1%) for OCP, PS, OC and WM, respectively. There was significant difference in ash ($p< 0.05$) between the treatments. The OCP contained high ash content (33.5%) with the least being in PS with 18.9% ash. However, crude protein (CP) varied significantly ($p<0.05$), being higher in the WM with 22.2% protein, followed by PS with 14.8% and lowest in OC (5.5%). Fibre components were different for neutral detergent fibre (NDF; $p<0.01$; 46.2, 37.4, 34.8 and 22.6%) for PS, OC, WM and OCP and acid detergent fibre (ADF; $p<0.05$; 36.1, 43.7, 29.4 and 22.4%) for PS, OC, WM and OCP, respectively. *In vitro* gas production was different ($p<0.05$) in the various products, with WM producing the highest gas (87.5ml/0.5g) and PS producing the least gas (60ml/0.5g). *In vitro* DM digestibility was similarly different ($p<0.05$). The OCP was highly digestible (80.5%) while PS was the least digestible (53.6%). Gross energy (GE) was significantly different ($p<0.05$) in the various products. Pulp and seed (PS) product had the highest GE (16.8 MJ/kg) followed by WM (15.4MJ/kg) and the least was observed in the OC with 13.9MJ/kg. *In vitro* degraded energy from different products were 11.3, 15.9, 12.0 and 13.6MJ/kg for OCP, PS, OC and WM, respectively.

The low DM (ranging from 34 to 47%) and high moisture content (Table 1) pose a challenge of processing and storage of products of melon. Conceptualized ideas for small-scale processing machinery are being discussed both by the nutritionists and engineers at Botswana University of Agriculture and Natural Resources. The pulp and seed (PS) product have high energy (17 MJ/kg) which is highly degraded/fermented (≈ 95%) by rumen microbes. Fermentable energy is needed by rumen bacteria to capture nitrogen from ammonia for their growth (Karsli and Russell, 2002). The Pulp and seed product also contain high protein content (15%; Table 1) and thus may need protection from rumen fermentation probably through heat treatment to avail protein to the lower tract of ruminants (Moshtaghi Nia and Ingalls,1992). The high quality of the whole melon suggest that it may not be necessary to fractionate melon into different products, which is a good thing since it will reduce costs of processing. However, water need to be extracted for keeping quality and for further processing. In such a case, drying will be hastened and the liquid may be concentrated and used in the same way as molasses or be used in cooking or baking. As molasses, the concentrate syrup can be used during ensiling of low energy forages to supply fermentable energy. Applicability of melon in human and livestock feeds is ideal since it is drought tolerant and its farming is wide spread and the technology is unlikely to be rejected. Further, research to document indigenous knowledge of melons, including the wild types is needed. This will create further research in breeding for different products which include human food and livestock feeds. Other studies that need to be undertaken should focus on comparing the nutritional value of melon fruits from the wild and the mutant one in case there are equally nutritious melons. This would lessen the burden on the cooking melon as food and/or feed.

Table 1. Least square means for chemical composition, in vitro degradable dry matter, in vitro degradable energy (% fresh basis), in vitro gas yield and gross energy of Outside Cover and Pulp, Pulp and Seeds, Outside Cover and Whole Melon.

Treatment	ADF[2]	ADL	NDF	CP	ASH	DM	TG (ml/0.5g sample)	GE (MJ/kg)	DE	IVDMD
OCP1	22.45	1.24	22.61	5.49	33.55	44.11	82.50	14.94	75.57	80.53
PS	36.14	3.89	46.17	14.84	18.93	37.19	60.00	16.81	94.60	53.65
OC	43.66	4.10	37.37	9.40	27.56	33.75	86.00	13.87	86.87	71.12
Whole melon	29.45	1.69	34.80	22.18	23.14	47.10	87.50	15.40	88.65	68.77
S.E	2.88	1.59	1.55	1.92	2.38	1.41	3.65	0.45	2.17	4.321
P- value	0.025	0.535	0.002	0.013	0.046	0.008	0.017	0.042	0.015	0.049
Effect	*	NS	**	*	*	**	*	*	*	*

[1]OCP = Outside cover and pulp; PS = Pulp and seeds; OC = Outside cover (rind); SE = standard error
[2]ADF = acid detergent fiber; ADL=acid detergent lignin; NDF= neutral detergent fiber; DM = dry matter content; TG = total gas yield; GE gross energy; DE = degraded energy; IVDMD= in vitro dry matter degradability.

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