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EVALUATION OF CALCIUM SOAP IN THE DIET FOR MILK PRODUCTION IN RED SOKOTO GOATS

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Abstract
The study was conducted to evaluate the performance of lactating Red Sokoto goats fed calcium soap produced in Nigeria. Twenty-four lactating Red Sokoto goats of average liveweight of 26.53±1.47 kg were balanced for parity and stage of lactation and then randomly allocated to three dietary treatment groups in a completely randomized design (CRD). The treatments were: Treatment A (control ration without calcium soap), B (ration with 50 g of calcium soap), and C (ration with 100 g of calcium soap). Six hundred (600 g) was offered to each animal as a supplement to *Digitaria* grass hay. Feed intake was measured daily and the goats were milked twice a week and the daily milk yield estimated for 26 days. The results indicated that the

inclusion of calcium soap reduced the intake of the supplement while the intake of hay and total dry matter were increased ($P<0.05$) at higher level of inclusion. The daily milk yield of the goats increased with dietary level of calcium soap but the increase was not significant ($P>0.05$). Milk total solids were significantly ($P<0.05$) higher in goats fed calcium soap. It is concluded that calcium soap can be fed up to 100 g in the diet of lactating Red Sokoto goats to enhance total dry matter intake and increase in milk production.
***Keywords**: Calcium soap, Feed intake, Goats, Milk composition, Milk production*

Introduction

The importance of quality of feed offered to ruminant cannot be overemphasized. For an example, energy is very critical for milk production by dairy animals (Morand-Fehr and Sauvant, 1978). In developed countries, therefore, calcium soap (calcium salt) developed from the saponification of calcium with palm oil fatty acids, is used as standard energy supplement for dairy animal feeding to enhance milk production. Inclusion of calcium soap in the diet has increased milk production in cows (Schauff and Clark, 1992) and goats (Teh *et al*., 1994) in quadratic manner with level of inclusion, but not in sheep (Casals *et al*., 2006).Feeding trial with the use of palm oil in the diet to increase milk production in goats has been reported (Otaru *et al*., 2020) but none reported to the best of our knowledge on the production and use of calcium soap in Nigeria for the enhancement of milk yield. Production of calcium soap in the country will be of immense value to dairy farmers because it reduces excessive use of soluble carbohydrate in the diet and the associated problems. A pilot study was therefore embarked upon to domesticate the production of calcium soap in Nigeria and evaluate its effects on the performance of the indigenous goat breed, the Red Sokoto goat.

Materials and Methods

Laboratory production of calcium soap

About 107 kg of calcium soap was produced by reacting or saponifying calcium oxide with palm oil fatty acids according to the procedure outlined by O. R. Momoh (personal communication, August 20, 2014). Molds of the calcium soap were pulverized and sieved into fine powder before being mixed with the diets.

Diets and dietary Composition

Three iso-nitrogenous diets (diets A, B and C) were formulated to contain 16% crude protein and varying levels of calcium soap as shown in Table 1.

Table 1: Ingredient and Chemical composition of experimental diets

Ingredients, % (as fed)	Diet A	Diet B	Diet C
Maize grain	31.50	23.17	14.84
Maize offal	15.75	14.36	11.26
Wheat offal	15.75	14.36	11.26
Cotton seed cake	34.00	38.30	44.50
Calcium Soap	0.00	8.33	16.66
Bone meal	2.00	1.00	1.00
Common salt	1.00	0.50	0.50
	100.00	100.02	100.02

Chemical Composition, % (DM basis)	Diet A	Diet B	Diet C	D. smutsii hay
Dry matter	94.66	93.50	94.31	94.60
Crude protein	16.93	15.66	15.93	6.64
Ether extract	11.22	15.69	16.86	5.10
Crude fibre	14.84	9.82	10.64	32.34
Neutral detergent fibre	28.36	28.49	33.68	62.90
Acid detergent fibre	17.78	13.25	16.47	43.06
Nitrogen-free extract	43.49	43.75	41.11	42.59
Ash	8.18	8.58	9.77	7.93
Gross energy, GE (MJ/kg)	16.50	19.12	20.67	15.67
Metabolizable Energy, ME (MJ/kgDM)*	10.86	12.75	13.66	10.32

*Estimated from GE determined with a bomb calorimeter following Garrett *et al*. (1959) recommendation of: 100 Mcal GE = 76 Mcal DE = 62 Mcal ME = 35 Mcal NE.

Animals' experimental design and management.

Twenty-four lactating Red Sokoto goats of average liveweight of 26.53 ± 1.47 were balanced for parity and stage of lactation and allocated to three dietary treatment groups of A, B and C in a completely randomized design (CRD). The animals were each housed in an individual feeding pen fitted with a feeder and a water container. The quantity of daily ration to feed to the goats to ensure consumption of 50 g (for diet B) and 100 g (for diet C) of calcium soap based on the proportions of the soap in the two formulated diets (Table 1) was estimated to be 600 g/head. At the point of feeding, 550 g of ration B was taken and 50 g of calcium soap was added and mixed thoroughly. Similarly, 500 g of ration C was taken and 100 g of calcium soap added and mixed. An amount of 600 g of *Digitaria simutsii* hay was fed to each of the animals after the supplement was fed. Clean and fresh water was provided every day for the animals *ad libitum*.

Milking

The study lasted for 40 days including an initial adjustment period of 14 days. After the adjustment period, milking of the goats was commenced and done twice a week for 26 days or almost 4 weeks. The kids were separated from their dams overnight between 17.00 h and 18.00 h and rejoined with their dams after milking the following morning at between 7.00 h – 8.00 h. The quantity of milk collected each of the days were multiplied by a factor of 2 as supported by the findings of Bencini *et al*. (2003). Milk samples were taken from randomly selected 5 does in each treatment for milk composition determination.

Chemical and statistical analyses

The feed samples proximate principles, milk total solids and protein (AOAC, 1980), feed neutral detergent fibre (NDF) and acid detergent fibre (ADF) (Goering and Van Soest, 1970) and milk fat (Gerber, 1960) were determined according to the outlined procedures. The Gross energy (GE) content of the diets was determined using oxygen bomb calorimeter (Model E2K, South Africa). Data on daily dry matter intake of feed and daily milk yield were subjected to analysis of variance for repeated measures using PROC MIXED procedure (SAS, 2002). PROC GLM procedure (SAS, 2002) was used for the analysis of milk composition. CONTRAST

statement of SAS (2002) was used to separate the means and the differences between least squares means were declared significant at P<0.05.

Results and Discussion

The least squares means of feed intake, milk yield and composition are presented in Table 2.

Table 2: Least squares means of daily milk yield and milk composition of Red Sokoto goats fed diets containing different levels of palm oil calcium soap

Parameters	Diets			SEM	Level of significant difference		
	A	B	C		A vs B	A vs C	B vs C
Dry matter intake (g)							
Hay	336.38	328.50	447.46	30.27	NS	*	*
Concentrate	534.37	524.78	519.30	7.10	NS	NS	NS
Total Dry matter	870.75	853.29	966.76	31.81	NS	*	*
Total DMI (g/KgW$^{0.75}$)	72.72	78.10	77.01	2.91	NS	NS	NS
Milk Yield							
Daily milk yield (ml)	535.78	552.32	582.32	54.35	NS	NS	NS
Efficiency of milk production (yield, ml/g Feed)	0.61	0.65	0.61	0.06	NS	NS	NS
Efficiency of milk production (yield, ml/kg Feed DM)	610	650	610	60	NS	NS	NS
Milk Composition (%)							
Total Solids	10.20	15.35	13.79	1.10	**	*	NS
Fat	3.25	3.19	2.59	0.59	NS	NS	NS
Protein	2.97	3.41	3.78	0.30	NS	NS	NS

* = P<0.05; ** = P<0.01; NS = Not significant (P>0.05).

Although the concentrate DM intakes were similar, they decreased across treatments as the level of calcium soap in the diet was increased. The taste or palatability problem of calcium soap or calcium salt normally depresses its intake by animals (Schauff and Clark, 1992). The intake of hay was highest in the goats which received 100 g calcium soap and was improved (P < 0.05) by 33 – 36% compared to the control group and those that received 50 g calcium soap. The goats fed 100 g calcium soap had lower gut fill with the lower consumption of the soap and thus compensated for the lower intake of the soap with higher consumption of the grass hay. This agrees with similar response by lactating Granadina goats fed basal diet of long alfalfa hay supplemented with concentrate containing different contents of protected fat rich in polyunsaturated fatty acids (PUFAs) (Sanz Sampelayo *et al.*, 2002). The total dry matter intake was also increased by 11 – 13% (P < 0.05) by the treatment and followed the same pattern as the intake of the grass hay. This disagrees with results of Schauff and Clark (1992) who observed decrease in DMI and those of Souza *et al.* (2014) with no changes in DMI because they used total mixed ration (TMR) as opposed to separate feeding of the concentrate and grass hay employed in this study.

The daily milk yield of the goats ranged from 536 to 582 ml for goats in the control group and the 100 g calcium soap group, respectively. Although the daily milk yield was not significantly (P> 0.05) affected by the treatment as was also reported on cows (Schauff and Clark, 1992), goats (Teh *et al.*, 1994) and ewes (Casals *et al.*, 2006), there was a trend of increase in milk yield across the treatments as the feeding level of calcium soap was increased. The ability of calcium soap to elicit high milk production was not marked because the goats were already in mid lactation when the study commenced and it coincided with when decline in milk yield might have set in due to apoptosis and influence of hormones occasioning gradual partitioning of nutrients for milk production away from the mammary gland to the body tissues (Capuco *et al.*, 2003). The efficiency of milk production was apparently similar among the treatments, but numerically, diet B or offering 50 g of calcium soap was the most efficient as consumption of 1 kg DM of the diet produced the most milk of 650 ml. The milk of the does offered the calcium soap at 50 g per head per day showed 50% superiority (P<0.01) in total solids content over those in the control group. The means of milk fat and protein percentages were similar (P>0.05)

among treatments but while the content of milk fat decreased, that of protein increased with increase in dietary calcium soap.

Conclusion

It is concluded that calcium soap can be fed up to 100 g in the diet of lactating Red Sokoto goats to enhance higher total dry matter intake and 9% superiority in milk production over the control. For efficiency of milk production, feeding 50 g to the goats was apparently the best. Being a pilot study in Nigeria, there is a need to re-evaluate the procedure of producing the calcium soap, and to ensure the acquisition of quality calcium oxide for the production.

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