(RESEARCH ARTICLE)

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Evaluation of milk quality from dairy cows fed maize (*Zea mays*) stover treated with chopped and mineralized groundnut (*Arachis hypogea*) and soybean (*Glycine max*) stover

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Abstract

This study evaluated the effect of upgrading the quality of maize stover (MS) on milk nutritive value. The study involved feeding MS improved using urea (U), chopped groundnut stover (cGS), chopped soybean stover (cSS), mineralized groundnut stover solution (mGS) and mineralized soybean stover solution (mSS) to lactating dairy cows. The feeding trial involved twelve (12) dairy cows in their second parity. Effect of supplementation with MS improved with U, cGS, cSS, mGS and mSS on milk quality was evaluated following on-station feeding trials. The study involved 2^2 factorial experiments within a Completely Randomised Design (CRD). Milk samples were analysed for protein, lactose, fat and solid not fat (SNF). Mean milk protein levels ranged from 3.52mg/ml to 3,73mg/ml (s.e=0.03) for milk from cows fed on MS improved using cGS and mGS respectively. Protein and Lactose were observed to be the least variable (3.64g/ml ±0.12, and 5.24g ±0.24 respectively). Average milk fat content was highest (4.78%, se=0.52) in milk from cows fed on UET treated MS and lowest (3.43%, se=0.52) in milk from cows fed on gGS protein based MS. Within legume type milk fat was higher(4.75%±1.99) in milk from cows fed on MS blended with mGS than that in milk from cows fed on MS improved with cGS (3.43%±1.99). Similar result was observed in milk fat from cows fed on MS improved with the use of soybean. Lactose in milk from cows fed on UET treated MS was highest (5.51g, se=0.061) and lowest (5.10g, se=0.061) in milk from cows fed on MS blended with cGS. Milk from cows fed on MS improved with mGS was higher (9.61p/cwt, se=0.14) in SNF and lowest (8.88p/cwt, se=0.14) in milk from cows fed on MS with cGS. The milk density values ranged from 32.65sg, se=0.53 for milk from cows fed on UET treated MS to 30.42sg, se=0.053 for milk from cows fed on MS blended with cGS. Milk components were higher when cows were fed on MS improved using mineralized legume stover solutions.

Keywords: Milk quality; Mineralized; Chopped; Maize; Groundnut; Soybean; Stover

1. Introduction

The nutritional value of livestock products has been acknowledged in human nutrition. For example, WHO/FAO (2003) [1] stated the following with regard to the use of animal products in human diet: "As diet becomes richer and more diverse, the high-value protein that the livestock sector offers improves the nutrition of the vast majority of the world. Livestock products not only provide high-value protein but are also important sources of a wide range of essential micronutrients such as iron and zinc, and vitamins such as vitamin A. For the large majority of people in the world,

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particularly in developing countries, livestock remains a desired food for nutritional value and taste." This statement is particularly true for Zambia where the per capita consumption of meat is only 2.4 kg per annum (Aregheore, 2010) [2]. In the advent of the HIV/AIDS pandemic, livestock has even become critical in that animal products provide specific nutrients that directly demobilize the progression of HIV to the AIDS condition. This is because these nutrients are associated with maintenance or enhancement of the immune system of the human body. Meat is a good source of high quality protein, micronutrients such as zinc, magnesium, selenium, iron and vitamins A, E, and B-complex (Ochetin, 1995 [3] and Speedy, 2002 [4]). Work by Speedy (2002) [4], revealed that milk is the most complete of all foods, containing all the constituents of nutritional importance to human beings. Eggs make a useful contribution to the daily intake of vitamin D, retinal, riboflavin, iodine, iron and protein. Thus, a combination of red meat, eggs and milk provides a complete diet to take care of all the necessary nutrients that would mitigate or keep the HIV at low levels and keeping a person healthy. Clearly, the importance of livestock from a nutritional point of view and the well-being of human beings cannot be overemphasized.

Many factors can influence milk composition. This is an important point to remember when evaluating the potential to improve a herd's milk composition and component yields. The major components of milk are water, fat, protein, lactose and minerals. Factors that influence composition are genetics and environment, level of milk production, stage of lactation, disease (mastitis), season and age of the cow. Farms that used genetic information (EBV) and phenotypes when selecting sires were higher ($p<0.05$) for milk fat percentage than farms that used only phenotypes and personal opinion (Rhone, 2008) [5]. Palmquist and Bealulieu (1993) [6], reported that, with increase in feeding of concentrate, there is also a reciprocating increase in milk protein components up to a point where if dry matter in the diet is more than 50% concentrate, the increase in starches shows a decrease in milk fat percentage. Feeding strategies that optimize rumen function also maximize milk production and milk component percentages and yield (Looper, 2012) [7]. Dairy breeds mostly used by dairy farmers show variations in fat, protein, lactose and ash. This shows the influence of breed on milk quality (MOAC, 2005) [8]. Work by Midou, Kibon, Moruppa and Augustine (2010) [9], indicated that the composition of milk varied for some components. There was seasonal variation ($p<0.05$) on calcium. Total solids (TS) and soluble nitrogen fats (SNF) were significant ($p<0.05$) as affected by season. Parity and season had no effect on cholesterol, magnesium and phosphorus. A study by Nyamushamba et al., (2014) [10], indicated that parity, year of calving, days in milk and age of calving affect yield and composition of milk of Red Dane cows in Zimbabwe. It was reported by Sutthisak et al., (2014) [11], that milk protein and SNF were found to be higher during rainy season than in the summer and winter seasons. Proper feeding significantly increased milk yield and to a certain extent, could alleviate the decline in milk components. Air temperature above $25^{o}C$ and humidity below 65% has effect on changes in milk fat, protein and lactose content. Milk yield, protein and lactose content are affected by the kind of supplemented green feed (Jonkus et al., 2004) [12]. Feed quality and quantity have been observed to show seasonal fluctuation, a trend which affects animal nutrition and performance. Dry seasons in Zambia and many other tropical countries are marked with periods of feed shortages resulting in general retardation in animal growth and production (Najib and Eng, 2013) [13]. A systematic critical appraisal of the establishment and management methods of improved pasture and fodder species is probably relevant in the promotion of better development and utilisation of the crop by dairy cattle in the small-scale farming systems (Najib and Eng, 2013) [13]. Milk composition is influenced by both season and regional location. This is due to changes in temperature and feed availability during different seasons. Development of different feeding systems according to season and region is needed to produce high quality and satiable milk production (Kitaeg et al., 2009) [14]. Pavel et al., (2011) [15], observed that milking period affects milk fat, making the fat percentage lower in the morning compared with the evening milking period. Seasonal differences in milk fat, protein and somatic cell count were significant.

It is against this background that a research project was carried out at the Batoka Livestock Research Centre in Choma district of the southern province of Zambia with an objective of assessing the effect of inclusion of legume stover on milk quality and nutritive value. The study specifically compared the nutritional composition of milk from cows fed on groundnut and soybean nitrogen based maize stover as well as the effect of stover processing methods on milk quality.

2. Material and methods

2.1. Research site

The research was conducted in Southern Province of Zambia. The province lies at an altitude range of 400- 1400 m above sea level. It has a mean annual temperature ranging from 14°C to 28°C. It receives an annual rainfall of 700 mm to 1000 mm .The soil type ranges from clay to sandy loam (Ministry of Agriculture, 2013) [16].

2.2. Methodology

2.2.1. Study 1. Treatment with urea

Dry maize stover was chopped using a stover shredder and treated using the Urea-Ensiling Technique (UET) before being offered to the cows. The standard method of urea treatment used in other developing countries which involves the making of a solution of urea using four (4) kg urea fertilizer feed grade (46%N) into sixty (60) litres of water and mixing this with one hundred (100) kg of stover was used. Pits were dug on raised ground for the purpose of the UET. The stover was chopped into 3-5 cm pieces, mixed with the urea solution using a watering can and buried into the pit, ensuring an air-tight environment using polythene plastic sheets and compacting. The stover and straw were ready for feeding in 21 days (3 weeks urea incubation period). Three kilograms (3 kg) of the feed was given to each cow per day in a 2^2 factorial experiment in a Complete Randomised Design (CRD). UET was taken as novel therapy or positive control and compared with the test therapies.

2.2.2. Study 2. Treatment with legume stover

The quality of maize stover was improved using mineralised and chopped legume stover [Groundnuts (*Arachis hypogea*) and Soybean (*Glycine max*)]. These feeds constituted test therapies. The feed ingredients (maize and legume stover) were all procured from local farmers. Three kilograms (3 kg) of the feed was given to each cow per day in a 2^2 factorial experiment in a Complete Randomised Design (CRD). Four rations were prepared on the basis of cereal type, legume type, source of nitrogen and method of processing of legumes as follows:

- Chopped Maize stover + mineralized Groundnut stover solution
- Chopped Maize stover + chopped Groundnut stover
- Chopped Maize stover + mineralized Soybean stover solution
- Chopped Maize stover + chopped Soybean stover

A similar number of animals fed on a commercial diet (dairy meal) were used as a positive control. Additionally, another similar number of animals that just grazed normally (no supplementation) were used as a negative control. Test diets were formulated such that they were iso – nitrogenous (same CP) and iso – energetic (same GE or ME). To ensure that the diets were iso-nitrogenous and iso-energetic, samples of cereal stover and legume stover were analysed for their GE and nitrogen content respectively before rations were compounded. Quantities of cereal and legumes (maize, groundnut and soybean stover) used were computed by simple proportion to equate the energy and nitrogen content in each feed based on the results of the proximate analysis. This was important for the data to be valid and reliable hence the conclusions and recommendations.

2.2.3. Mineralization of legume stover

Dry groundnut and soybean stover were tied into bundles each weighing 5 kg. Three (3) bundles of groundnut stover were completely immersed in 100 litres of water in a plastic drum of 210 litre capacity. The drum was covered with a tight lid. Another three (3) bundles of soybean stover were treated in a similar manner in another drum. The set up was left for five days to allow for mineralization to take place. A preliminary proximate analysis of samples revealed that a period of five (5) days was the optimum for mineralisation to be effective.

2.2.4. Ration formulation

Rations were prepared using the BLP 88 computer programme (1987) [17] to meet the nutrient requirements of dairy animals (NRC, 2001) [18]. Amounts generated from the ration formulation programme were measured using a scale. These were mixed by rolling and turning several times on polythene plastics spread on concrete floor using a garden fork in order to ensure consistence in the composition.

Two (2) types of rations were compounded: one comprising chopped cereal and legume stover. The other comprised chopped cereal stover and mineralized legume stover solutions. The mineralised legume stover solutions were sprayed on the measured quantities of chopped maize stover using a watering can and then turned several times using a garden fork on a concrete floor. To help bind the chopped (ground) legume stover to maize stover, as well as to improve palatability, molasses solution was sprinkled and mixed with all types of ingredients at compounding. All other ingredients were the same for the rations but only differed in the source of protein and processing method used. Feeds were then packed in 25 kg plastic bags in readiness for delivery to the feeding or milking parlour site where feeding was carried out.

2.2.5. Feeding trials

The feeding trials involved twelve (12) lactating dairy cows in their second parity arranged in a 2^2 factorial experiment within a Complete Randomized Design (CRD). The experimental units (dairy cows) were randomly selected using simple random numbers from the herd available at Batoka Livestock Trust Research Centre (BLTRC). Treatments (rations) were randomly allocated to experimental units (dairy cows) by picking lots using animal identities (Ear-tags and feed type) written on pieces of paper and placed in two separate urns (boxes). An adaptation period of five (5) days was allowed for each feed before data was recorded.

The feeding trial commenced by determining the optimum quantity of feed to be given to each animal. Quantities of four kilogram (4 kg), three kilograms (3 kg), two kilograms (2 kg) and one kilogram (1 kg) were tried over a period of seven (7) days. During the trial one kilogram (1 kg) of feed was found to be the appropriate quantity of feeding to appetite during supplementation since rejected quantities were much less.

The experimental cows were allowed to graze from seven (7) to twelve (12) hours and then brought to the milking parlour for milking each day. Each animal was offered one (1 kg) of the ration being administered at a given time (control or test therapy). The control or test treatments were supplements to the free grazing during times of feed shortage. The parameters used to test the effect of the treatments was feed intake. An adaptation period of seven (7) days was allowed for each feed before data was recorded. Data pertaining to feed intake was taken as the difference between feed offered and feed left in the feeding trough. Data was for each experimental unit were recorded on score sheets.

2.2.6. Statistical model

$Y_i = \mu + R_i + b(x) + \varepsilon_i$

Where Y_i = observed milk quality on individual cow of a given ith legume type.

μ = overall mean

R_i = effect of the ith legume type

$b(x) = b$ is the regression coefficient for initial feed intake used as a covariate

ε_i = random error component

2.2.7. Research design and data collection

The twelve (12) dairy cows were arranged in a 2^2 factorial experiment in a Complete Randomized Design (CRD). Daily feed intake was recorded on individual score cards identified by animal identity numbers from June 12, 2017 through November 09, 2017.

2.2.8. Statistical analysis

Data was analysed using the Statistical Analysis System on the General Linear Model computer. Treatment means were compared using the F-test (Table 3).

3. Results

3.1. Milk quality analysis

3.1.1. Protein content

Mean milk protein levels ranged from 3.52 mg/ml to 3,73 mg/ml (s.e=0.03) for milk from cows fed on maize stover whose quality was improved using chopped groundnut stover and that from milk for cows fed on maize stover whose quality was improved using solution from mineralized groundnut stover respectively (Table 2). However, though the means differed numerically the differences were not significant ($p > 0.05$) (Table 3). Results presented in Table 1 and Figure 1 show a general increase in protein level with a period of lactation within each feed type. The variance estimate for milk protein for feeds was 0.0144 mg/ml.

The total (crude) protein content of milk is determined by analyzing milk for nitrogen and multiplying by a factor of 6.38. The total protein percentage of milk is generally considered to be about 3.5, of which 94 to 95 percent is in the form of true protein (Davies et al., 1983 [19]; Jenness, 1985 [20]).

Table 1 Av. protein (mg/ml) content for milk from treatments

Treatment	Mean($\bar{y}$)	SD	SEM
MCGN	3.52		
MCSB	3.63		
MGNS	3.73	±0.12	0.03
MSBS	3.66		
UETM	3.68		

MCGN=Maize Stover + Chopped Groundnut Stover, MCSB=Maize Stover + Chopped Soybean Stover, MGNS=Maize Stover + Groundnut Stover Solution, MSBS=Maize Stover + Soybean Stover Solution, UETM=Urea Ensilage Treated Maize stover
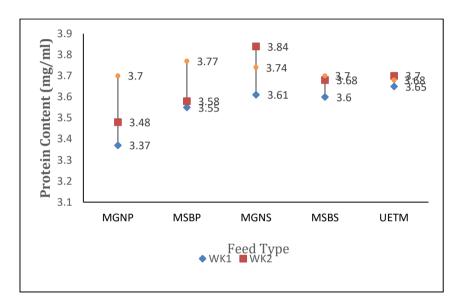

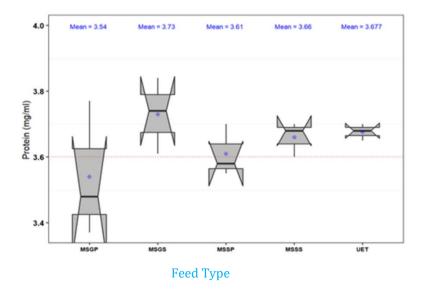**Figure 1** Weekly milk protein fluctuations by feed type

Figure 2 Effect of feed type on mean milk protein

Table 2 Effect of Feed Processing Method on Milk Protein (mg/ml)

Treatment	Mean($\bar{y}$)	SD	SEM
Mineralization	3.70	±0.10	0.03
Chopping	3.58		
UET	3.68		

UET=Urea Ensilage Treatment

Table 3 Analysis of variance for protein (mg/ml) content in milk from cows fed improved maize stover based feeds

Source of variation	df	Sum of squares	Mean square	F_{cal}	F_{tab}
Total	14	0.17			
Treatment	4	0.06	0.015	1.36	3.48
Error	10	0.11	0.011		

CV=3.30%

3.1.2. Fat content

Across feed type the highest average milk fat content (4.78%, se=0.52) was recorded in milk from cows fed on urea ensilage treated maize stover while the lowest (3.43%, se=0.52) was observed in milk from cows fed on maize stover that were improved using chopped groundnut stover (Table 4). Similarly, the differences were not significant (p>0.05) (Table 6). The variance estimate for milk fat for feeds was 3.960%.

Within legume type the milk fat was higher(4.75%±1.99) in milk from cows fed on maize stover blended with mineralized groundnut stover solution than that in milk from cows fed on maize stover improved with chopped groundnut stover (3.43%±1.99)(Table 4). A similar picture was observed in milk fat from cows fed on maize stover improved with the use of soybean (Table 4). There was a general decrease in milk fat with increase in days among all the samples from cows fed on the different feeds.
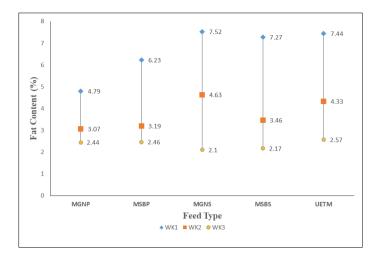
Table 4 Av. fat (%) content for milk from treatments

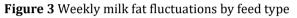| Treatment	Mean($\bar{y}$)	SD	SEM
MCGN	3.43		
MCSB	3.96		
MGNS	4.75	±1.99	0.52
MSBS	4.30		
UETM	4.78		

MCGN=Maize Stover + Chopped Groundnut Stover, MCSB=Maize Stover + Chopped Soybean Stover, MGNS=Maize Stover + Groundnut Stover Solution, MSBS=Maize Stover + Soybean Stover Solution, UETM=Urea Ensilage Treated Maize stover

Table 5 Effect of Feed Processing Method on Milk Fat (%)

Treatment	Mean($\bar{y}$)	SD	SEM
Mineralization	4.55	±0.85	
Chopping	3.70		0.28
UET	4.78		

UET=Urea Ensilage Treatment

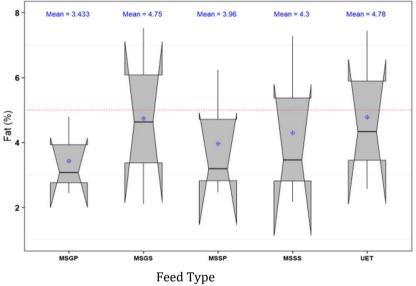**Figure 3** Weekly milk fat fluctuations by feed type

Figure 4 Effect of feed type on mean milk fat

Table 6 Analysis of variance for fat (%) content in milk from cows fed improved maize stover feeds

Source of variation	df	Sum of squares	Mean square	F_{cal}	F_{tab}
Total	14	55.74			
Treatment	4	3.86	0.97	0.19	3.48
Error	10	51.88	5.19		

CV=46.93%

3.1.3. Lactose content

Tables 7 and 8 show comparisons of levels of lactose content in the five (5) treatments used in the study. Milk from cows fed on urea ensilage treated maize stover reflected the highest (5.51 g, se=0.061) content of lactose, while milk from cows fed on maize stover blended with chopped groundnut stover was observed to contain the lowest (5.10 g, se=0.061) quantity of lactose. It was observed that the means for lactose content for the five (5) treatments did not differ significantly (p>0.05). When evaluated within each feed type results show a general increase in lactose content with period. The variance estimate for lactose content was 0.056 g.

Table 7 Av. lactose (g) content for milk from treatments

Treatment	Mean(ȳ)	SD	SEM
MCGN	5.10		
MCSB	5.24		
MGNS	5.31	± 0.236	0.061
MSBS	5.27		
UETM	5.51		

MCGN=Maize Stover + Chopped Groundnut Stover, MCSB=Maize Stover + Chopped Soybean Stover, MGNS=Maize Stover + Groundnut Stover Solution, MSBS=Maize Stover + Soybean Stover Solution, UETM=Urea Ensilage Treated Maize stover

Table 8 Effect of Feed Processing Method on Milk Lactose (g)

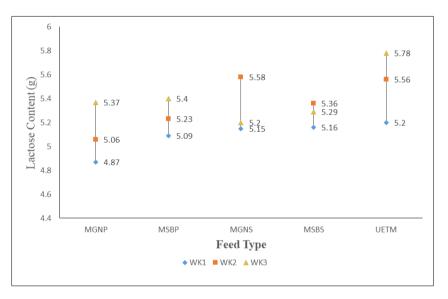| Treatment	Mean(ȳ)	SD	SEM
Mineralization	5.29	±0.25	
Chopping	5.17		0.080
UET	5.51		

UET=Urea Ensilage Treatment

Figure 5 Weekly milk lactose fluctuations by feed type

Table 9 Analysis of variance for lactose (g) content in milk from cows fed improved maize stover feeds

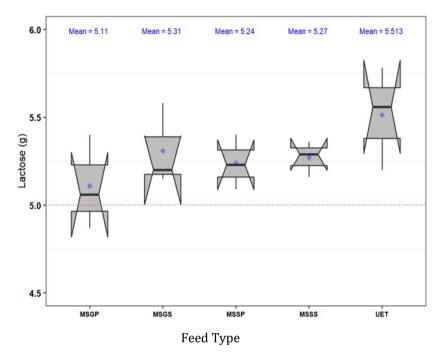| Source of variation	df	Sum of squares	Mean square	F_{cal}	F_{tab}
Total	14	7.38			
Treatment	4	0.39	0.098	0.14	3.48
Error	10	6.99	0.699		

CV=4.50%

Figure 6 Effect of feed type on mean milk lactose

3.1.4. Solid-Not-Fat (SNF) content

Results of the study indicated higher (9.61 p/cwt, se=0.14) Solid-not-fat levels in milk from cows fed on maize stover improved by blending with mineralized groundnut stover solution. The study further showed that milk from cows fed on maize stover mixed with chopped groundnut stover had the lowest (8.88 p/cwt, se=0.14) Solid-not-fat (Table 10). Levels among all the five (5) treatments did not differ significantly (p>0.05) (Table 12).

Table 10 Av. SNF (P/cwt) content for milk from treatments

Treatment	Mean(ȳ)	SD	SEM
MCGN	8.88		
MCSB	9.26		
MGNS	9.61	±0.54	0.14
MSBS	9.16		
UETM	9.38		

MCGN=Maize Stover + Chopped Groundnut Stover, MCSB=Maize Stover + Chopped Soybean Stover, MGNS=Maize Stover + Groundnut Stover Solution, MSBS=Maize Stover + Soybean Stover Solution, UETM=Urea Ensilage Treated Maize stover

Table 11 Effect of Feed Processing Method on Milk SNF (P/cwt)

Treatment	Mean(ȳ)	SD	SEM
Mineralization	9.39		
Chopping	9.10	±0.5	0.170
UET	9.38		

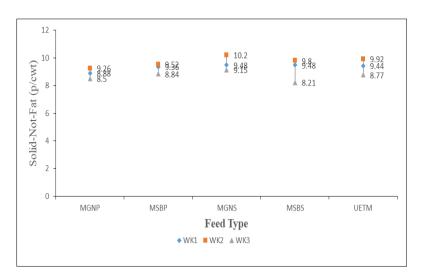UET=Urea Ensilage Treatment

Figure 7 Weekly milk SNF fluctuations by feed type
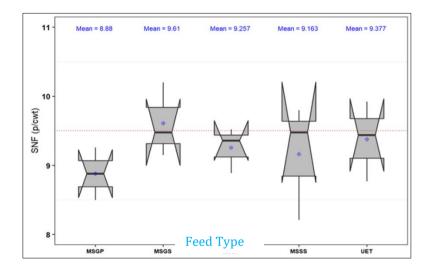

Figure 8 Effect of feed type on mean milk Solid Not Fat (SNF)

Table 12 Analysis of variance for SNF (P/cwt) content in milk from cows fed improved maize stover feeds

Source of variation	df	Sum of squares	Mean square	F_{cal}	F_{tab}
Total	14	4.01			
Treatment	4	0.88	0.22	0.70	3.48
Error	10	3.13	0.313		

CV=5.83%

4. Discussion

4.1. Effect of legume type on milk quality

Results of the current study are in consonance with those reported by Intisar et al (2012), [21] who observed a significant variation (p<0.05) in milk components among experimental groups attributed to type of feed and breed. Milk quality differences recorded among the effect of treatments were certainly related to the diets' nutrient contents, in particular the protein content which was higher in groundnut based diets and UET and lower in soybean based diets

(Table 1, Figs. 1 and 2). We can also explain this difference by several factors such as the biological variations among experimental units. The overall mean values of fat and SNF 4.528 and 8.754 percent observed by Sharma et al., (2001) [22], were in consonance with results of today's study. Similarly, Steinshamn (2010) [23] reported variations in milk quality on the basis of type of legume forage used. Cows on Red Clover diets yielded milk with lower milk fat and protein contents than cows fed on grasses and other legumes.

Results of the current study are in agreement with those of Garcia et al., (2005) [24], who reported previous studies in Thailand showing milk fat percentage levels for crossbred cattle ≥75% Holstein having milk fat values of 3.77%, with a protein content of 3.17 g/ml. This low level in fat content is a result of high temperatures and humid climate characteristic of tropical regions. This study used the Batoka crossbreed resulting from cross breeding of local cattle and the Holstein Friesian dairy breeds. This implies that the experimental units used in the current study had some percentage of *Bos indicus* influence which affects milk fat. Results of the study by Taneja (1999) [25], who used Sahiwal and Red Sindhi showed higher milk fat values (4.3-5.2% and 4.5-5.2%, respectively) than the values observed in today's study.

In the current study it was observed that milk fat was the most variable component (4.24% ±1.99) not only among feed types but also over time (Feeding period) (Table 4 and Fig 3). However, despite the observed numerical variations, levels of fat content did not differ significantly ($p > 0.05$) among treatments or sources of nitrogen. Factors contributing to variations in milk composition include species, differences between individuals within strain and differences in conditions affecting individuals. On all milk components, milk fat is the most influenced by dietary manipulation. Most changes in milk composition due to dietary manipulation are related to changes in ruminal-acetate-propionate ratio. Among the notable factors that influence milk composition are; plane of nutrition, forage to concentrate ratio, forage quality (e.g particle size), level and type of dietary fat.

Outcomes of this work are in agreement with those of Heinrichs et al., (2016) [26], who indicated that milk fat depression can be alleviated within 7 to 21 days by changing the diet. Milk protein changes may take 3 to 6 weeks or longer if the problem has been going on for a prolonged period.

Protein and Lactose were observed to be the least variable (3.64 g/ml ±0.12, and 5.24 g ±0.24 respectively). This lower difference in protein and lactose among treatments is indicative of suitability of groundnut and soybean stover as possible alternatives to the use of conventional sources of Nitrogen in dairy rations.

When evaluated across legume type fat, protein, SNF, FP and lactose contents were numerically higher in milk from dairy cows fed on groundnut stover based diets. However there were no significant ($p > 0.05$) differences among the treatments. In contrast density was numerically higher in milk from cows fed on soybean stover based diets. Similarly no significant ($p > 0.05$) differences were observed among the treatments. These results may be due to the differences in nutritive value of the materials used to improve the quality of maize stover.

4.2. Effect of processing method on milk quality

The outcomes of the study have shown a general common trend in protein level, fat percentage, lactose level, SNF, Milk Density and Milk Freezing point (FP). When evaluated within feed type, milk components were higher in milk from cows fed on maize stover treated with mineralized legume stover solutions than in that in milk from cows fed on maize stover treated with chopped legume stover.

In an evaluation of milk components between feed types, the study has revealed that milk from cows fed on maize stover treated with chopped soybean stover was higher in almost all milk components than that from cows fed maize stover treated with chopped groundnut stover. Conversely, milk components in milk from cows fed maize stover treated with mineralized groundnut stover solution were higher than milk components from cows fed on maize stover treated with mineralized soybean stover solution.

5. Conclusion

The study has revealed that milk protein, fat, lactose and solid-not-fat components were generally higher in milk from cows fed on maize stover improved using groundnut stover than milk from cows fed on soybean based rations. When evaluated across processing method today's study has indicated that milk from cows fed on maize stover improved with mineralized legume stover solution was superior in protein, fat, lactose and solid-not-fat components than that from cows fed on maize stover improved with chopped legume stover. Results of the current study have indicated that milk composition is clearly influenced by diet, specifically legume type. This study has revealed differences in the effect of

legume type on milk composition. Milk from cows fed on Urea based diet was superior in all milk components than that from both soybean and groundnut based diets. Though milk components differed numerically these differences were not significant ($p > 0.05$). Results of this study indicate that soybean and groundnut stover can be used interchangeably without adversely affecting milk composition. Smallholder farmers and animal nutritionists can positively influence the composition (nutritive value) of milk by improving the quality of maize stover with cheap and locally available legume stover in formulating dairy rations. Additionally the study has shown that improving the quality of maize stover using mineralized legume solutions is more effective in altering the milk quality on smallholder dairy farms. Finally, the potential of other legume stover other than those of groundnut and soybean should be evaluated.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no competing interests.There is no conflict of interest regarding the publication of this article.

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