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Effect Of Selected Fodder Intervention On Friesian Cow's Milk Quality In Smallholder Farms In Bomet, Kenya

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Abstract
This study explores the effect of diverse experimental diets on milk quality in Friesian dairy cows across Bomet County. It incorporated the use of a supplementary feed mixture with a dry matter content of 400 g/kg, comprising lucerne, greenleaf desmodium, sweet potato vines, and chicory. These ingredients were finely chopped and mixed in a ratio of 1:2:3:1. Supplementation was implemented at varying levels, denoted as T1 (0%), T2 (10%), T3 (20%), and T4 (30%), relative to the estimated daily dry matter intake of 4% of the live body weight of the dairy cow. The basal diet, consisting of Boma Rhodes with a dry matter content of 400 g/kg, was utilized. The study spanned nine weeks in each region, involving one week of backgrounding all animals, followed by a fourteen-day adaptation period and six weeks of comprehensive data collection. The research delves into the impact of milk quality outcomes resulting from diets with supplementation levels ranging from 10% to 30% in Friesian dairy cows. Notably, a significant difference in butter fat content was observed between animals fed experimental diet 1 and those on diets 2, 3, and 4 ($P < 0.05$), emphasizing the unique effect of diet 1 on milk fat composition. Conversely, diets 2, 3, and 4 demonstrated similar effects on butter fat content. Milk density also varied significantly between diet 1 and diets 3 and 4 ($P > 0.05$), indicating a distinct influence of diet 1 on milk density, while diet 2 showed a more analogous impact. Lactose percentage and crude protein content remained consistent across all diets, underscoring stability in these essential components. Although pH levels remained unchanged for diets 1, 2, and 4, diet 4 exerted a unique impact on milk pH compared to diet 3. Additionally, milk conductivity, Solid Not Fat (SNF), and Total Solid % displayed no significant differences across experimental diets, highlighting robust consistency in these parameters despite dietary variations. These nuanced findings offer valuable insights for dairy farmers and processors in optimizing nutritional strategies for enhanced product quality. The feeding trial involved twelve Friesian dairy cows, and the subsequent laboratory analysis, conducted at Egerton University, examined various milk quality parameters. The results provided specific details on butter fat content, milk density, lactose percentage, crude protein content, pH levels, conductivity, SNF, and Total Solid % for each experimental diet, guiding recommendations for optimal dietary supplementation and milk quality enhancement.

Key Word: *Zero Grazing Boma Rhodes lucerne, greenleaf desmodium, sweet potato vines, and chicory*

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I.Introduction

Around 11,000 years ago, the integration of milk into human nutrition emerged with the shift from hunting and gathering to farming in the Middle East. Initially, those herding cattle started fermenting milk to produce yoghurt and cheese as a way to break down lactose, an indigestible milk sugar for adults (Curry, 2013). In many low- and middle-income nations, smallholders play a significant role in milk production, contributing to the economic well-being of rural households (Jahroh et al., 2020). The global share of milk production from these countries has risen from 50% in 2011 to 53% in 2020 (OECD-FAO, 2021). Milk holds a crucial position in global diets (Kamana et al., 2014).

It comprises an intricate blend of both macro and micronutrients that functions as a significant store of minerals, fats, proteins, carbs, and important vitamins like riboflavin, calcium, and vitamin B12 (Dugum & Janssens, 2015). Among animal-source foods, dairy products are particularly economical in low-to-middle-income countries (LMICs) (Alonso et al., 2018; Muunda et al., 2021). Milk production is a crucial source of income for small-scale dairy farmers (Msalya, 2017).

Smallholder-driven production of milk creates jobs for people all along the dairy chain in addition to improving food and nutrition for the participating households. This includes roles for small-scale rural processors and intermediaries, thereby contributing to broader economic development (Hemme et al., 2010). As a heterogeneous mixture, milk can be divided into three phases: emulsifying (fat coagulated as globules), colloidal (containing casein, the main milk protein), and true solution (containing lactose, soluble whey proteins, as well as minerals) (Mehta, 2015).

II.Material And Methods

Description of the Research Area

The experiment occurred at the Olubutyo Dairy Cooperative Demonstration Farm in Tagiamin village, Bomet County, Kenya, located approximately 223 km from Nairobi. Bomet County, formed in 1992, has a population of 875,689 and covers 1,630.0 square kilometres. Bomet Town, the county seat, is accessible via the Narok-Kisii road. Bomet's climate features brief, warm, and cloudy summers, with long, cool winters. The average annual temperature ranges from 11.67°C to 26.11°C. The warm season lasts from March 13 to January 13, with daily average temperatures at 25.56°C. February is the hottest month. Summer, with an average daily high temperature of 22.78°C or less, spans from April 29 to August 29. July is the coldest month with an average lowest temperature of 11.67°C.

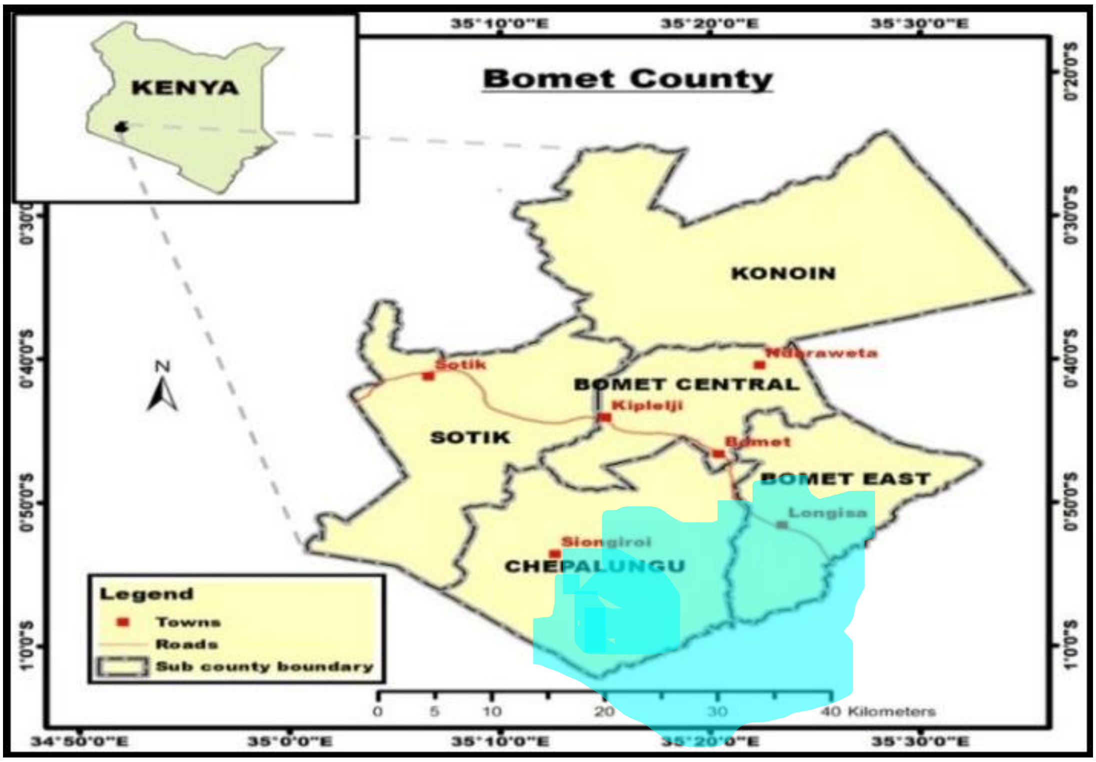

Figure 1: Bomet County map illustrating the study region, sourced from the Kenya Independent Electoral and Boundaries Commission (2012).

***Sampling and Fodder Production*:**

Twelve Friesian lactating cows, selected randomly based on consistent breed but varying lactation stages, weighing 400 kg ±100, were sampled from dairy farms in Bomet County. These cows were isolated in zero-grazing stalls, grouped in blocks, and subjected to similar dietary treatments. Concurrently, selected fodders (Boma Rhode, Lucerne, desmodium, sweet potato vine, and chicory) were established on a 1.2-acre land, employing standard procedures and fertilizers. The identified fodders were later utilized to create a supplementary feed mixture, chopped and mixed in a ratio of 1:2:3:1.

***Feed Preparation and Experimental Design*:**

The feed mixture, with a dry matter content of 400 g/kg, was supplemented at inclusion levels T1 (0%), T2 (10%), T3 (20%), and T4 (30%) of the estimated daily dry matter intake for twelve Friesian dairy cows, each weighing 400 kg ±100, at different lactation stages. The experimental diets were randomized and distributed independently in each block, with Boma Rhodes grass hay as the negative control. The feeding trial spanned nine weeks, with the first week for backgrounding, followed by a two-week adaptation period and six weeks of data collection. The quantity of the experimental diet varied for different inclusion levels.

***Management of Experimental Animals and Data Collection*:**

The experimental animals were isolated in specific zero-grazing stalls, dewormed, vaccinated, and tested for mastitis. Data on milk yield were collected daily after 14 days of adapting, at 06:00 hr and 15:00 hr. ANOVA was used in the statistical analysis to determine how different dietary treatments affected the amount of milk produced.

Laboratory Analysis

Milk quality was determined in the Department of Dairy and Food Science and Technology Laboratory at Egerton University in Kenya. A Lactoscan milk analyser, (Model Lactoscan MCC30, Milkotronic Ltd, Bulgaria) calibrated to the Kenya Bureau of Standards acceptable levels was used to analyse milk for ash%, total soluble solids%, solids-not-fat %, crude protein % and butter fat%, pH, conductivity, Lactose %, and milk density (Alaru, 2019).

***Experimental Diets and Statistical Analysis*:**

The dietary treatments included T1 (0%), T2 (10%), T3 (20%), and T4 (30%), with the experimental diets randomized and distributed independently in each block. Boma Rhodes grass hay served as the negative control. Statistical analysis involved ANOVA in a randomized complete block design (RCBD) using the SAS (2020) version 9.4 Statistical Package's General Linear Model Procedures. The model considered fixed effects such as treatment and random effects like block and block * treatment interaction.

H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$
H_a: $\mu i \neq \mu j$ for at least one pair i, j
Model:
$Y_{ij} = \mu + \theta_j + \tau i + \tau Bij + \varepsilon_{ji}$
where:
Y_{ij} is the random variable representing the response for treatment i observed in block j,
μ is a constant (which may be thought of as the overall mean)
θ_j is the (additive) effect of the j^{th} block {j= 1, 2,3}
τi is the (additive) effect of the i^{th} treatment {i = 1, 2,3,4}
τBij is the Interaction between i^{th} treatment and j^{th} block
ε_{ji} is the random error for the i^{th} treatment in the j^{th} block.
Fixed effects: Treatment
Random effects: Block, Block *treatment

III.Result

Table 1:Milk quality parameters using a Lactoscan for the experimental animals

	Parameter							
	Butterfat %	Density	Lactose %	Crude Protein %	Ph	Conductivity (mS/cm)	Solid not Fat %	Total Solid %
Diet								
1	6.7^a	1002.8^a	4.1^a	29.9^a	6.1^a	6.0^a	7.6^a	0.605^a
2	4.8^b	1001.8^{ab}	3.8^a	28.9^a	5.9^{ab}	6.0^a	7.1^a	0.5675^a
3	4.3^b	1001.5^b	3.7^a	28.8^a	5.79^b	5.1^a	5.1^a	O.565^a
4	4.9^b	1004.2^c	3.8^a	29.7^a	6.0^a	5.8^a	7.03^a	0.5858^a
SEM	0.5914	0.3536	0.1670	1.6715	0.0656	0.3695	0.2977	0.0261
P	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

a, b: means with the same superscripts in the column and raw are not significantly different (P>0.05).
SEM = standard error of the mean

Animals fed on experimental diet 1 differed significantly in terms of milk's butter fat content compared to those fed on diets 2, 3 and 4 at $P<0.05$. There was no significant difference between milk's butter fat content for the experimental animals fed on diets 2,3 and 4 at $P>0.05$. Milk density for experimental animals fed on diet 1 had no significant difference compared to that fed on diet 2 at $P<0.05$, though it differed significantly from those fed on diet 3 and 4 at $P>0.05$. Milk density for experimental animals fed on diets 2 and 3 had no significant difference at $P>0.05$ though it differed significantly from those fed on diets 1 and 4 at $P<0.05$. The milk density of animals fed on diet 3 differed significantly from those fed on diets 1 and 4 at $P<0.05$.

There was no significant difference in the lactose percentage of the milk from all the experimental animals fed with the four experimental diets at $P>0.05$. There was no significant difference in the crude protein content of the milk from all the experimental animals fed with the four experimental diets at $P>0.05$.

There was no significant difference in the pH level of the milk from animals fed on experimental diets 1,2 and 4 at $P>0.05$. pH levels for milk obtained from the experimental animals fed on diets 2 and 3 had no significant difference at P<0.05. However, there was a significant difference in pH level for animals fed on experimental diet 4 and those fed on diet 3 at P<0.05. There was no significant difference in milk conductivity levels across the four experimental diets. The percentage of Solid not Fat content of the milk produced by all the experimental animals had no significant difference at P>0.05. There was no significant difference in milk's Total Solid % level across all the experimental animals fed on the four diets.

IV.Discussion

The most significant finding is the difference in butter fat content between the animals fed experimental diet 1 and those fed diets 2, 3, and 4 (P < 0.05). This result indicates that experimental diet 1 had a distinct effect on the butter fat content of the milk. The lower fat content may have implications for the taste and texture of dairy products produced from this milk. There was no significant difference in butter fat content among the animals fed diets 2, 3, and 4 (P > 0.05). This suggests that these three diets had a similar impact on butter fat content, indicating that the specific composition of experimental diet 1 played a unique role in this regard.

The results indicate that milk density differed significantly between diet 1 and diets 3 and 4 (P > 0.05). This suggests that diet 1 had a distinct effect on milk density compared to diets 3 and 4. However, milk density did not significantly differ between diet 1 and diet 2 (P < 0.05), indicating that diet 2 had a more similar impact on milk density compared to diet 1. There was no significant difference in milk density between diets 2 and 3 (P > 0.05), but both differed significantly from diets 1 and 4 (P < 0.05). This could be due to the specific composition of these diets, which influenced milk density differently.

The study found no significant difference in the lactose percentage of milk across all four experimental diets (P > 0.05). This implies that the dietary variations did not impact the lactose content of the milk. A consistent lactose percentage is essential for maintaining the taste and texture of dairy products. Similarly, there was no significant difference in the crude protein content of the milk produced by animals fed with the four experimental diets (P > 0.05). This suggests that the diets did not have a significant effect on milk protein content. Consistent protein levels are essential for the nutritional quality of dairy products

There was no significant difference in pH levels for milk from animals fed diets 1, 2, and 4 (P > 0.05). This indicates that these diets did not have a significant impact on milk pH. Diet 2 and Diet 3 had similar effects on milk pH (P < 0.05). However, there was a significant difference in pH levels between animals fed diet 4 and those fed diet 3 (P < 0.05). This suggests that diet 4 had a distinct effect on milk pH compared to diet 3. Variations in milk pH can impact product quality, especially in cheese and yoghurt production.

No significant difference was observed in milk conductivity levels across the four experimental diets. This indicates that dietary variations did not affect milk conductivity, which is an important indicator of milk quality and udder health. Consistent conductivity levels are typically desirable in dairy farming.

The study found no significant differences in the percentage of Solid Not Fat (SNF) and Total Solid % across all experimental diets. Consistent SNF and Total Solid % levels are important for dairy product consistency and quality

V.Conclusion

In summary, the results of the milk quality analysis using Lactoscan suggest that while there were significant differences in butter fat content and milk density between certain diets, other milk components such as lactose percentage, crude protein content, milk conductivity, and SNF content remained relatively consistent across the dietary treatments. For dairy farmers, these findings may have practical ramifications and processors in optimizing milk quality and dairy product production. Overall, these findings highlight the nuanced effects of different diets on milk composition. The study suggests that specific dietary formulations can have a significant impact on butter fat content, milk density, and pH levels, which are key factors in dairy product quality. However, other components such as lactose, protein, milk conductivity, SNF, and Total Solid % remained relatively consistent across the dietary treatments. These insights are valuable for dairy farmers and processors aiming to optimize milk quality and dairy product production. Further research may be needed to understand the underlying mechanisms and their implications for product processing and marketability

VI.Recommendation

Given the significant impact of dietary composition on milk quality, it is essential to carefully consider the formulation of supplementary diets. Further research into the specific components of experimental diet 1 that affected butter fat content and milk density could provide valuable insights for optimizing feeding strategies. Continue to investigate the underlying mechanisms of how different diets affect milk composition. This can help refine dietary recommendations and understand the broader implications for the dairy industry. Continue to investigate the underlying mechanisms of how different diets affect milk composition. This can help refine dietary recommendations and understand the broader implications for the dairy industry.

Farmers are advised to conduct thorough cost-benefit analyses to assess the economic feasibility of higher supplementation levels, keeping in mind the potential plateau in milk yield beyond a certain point. Continuous monitoring and further research are encouraged to refine recommendations and accommodate the diverse conditions influencing Friesian dairy cow responses in different environments.

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