



Effect of Breed, Parity and Dietary Selenomethionine Supplementation on Milk Yield Traits of Lactating Cows in the Tropical Savannah Zone

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Abstract

The study was conducted to evaluate the effect of selenomethionine (SeMet) supplementation on milk yield traits of 24 clinically healthy lactating Bunaji, Wadara and Friesian x Bunaji cows in their first and second parities. The lactating cows were allotted to four treatments corresponding to four dietary levels (0.00, 30.00, 60.00 and 90.00 mg/100 kg diet) of selenomethionine. There were six animals per treatment in a 3 x 2 x 4 factorial arrangement with a Completely Randomized Design. The data generated were subjected to analyses of variance with the SPSS software and the means were separated using Tukey's HSD. Friesian x Bunaji and second parity cows had higher ($P < 0.05$) initial milk yield, peak milk yield, drying milk yield, total milk yield and average daily milk yield. At 90.00 mg/100 kg diet of selenomethionine, total milk yield was higher. In conclusion, selenomethionine supplementation in the diet of Bunaji, Wadara and Friesian x Bunaji cows at 90.00 mg/100 kg significantly improved total milk yield (2,685.84 liters) compared to control diet (1,692.60 liters), respectively. It is recommended that, under tropical conditions, selenomethionine as organic antioxidants and constituent of glutathione peroxidase could be added at 90.00 mg/100 kg in the diet of lactating cows for improved milk yield without any adverse effect on their performance.

Keywords: Selenomethionine, cattle, Improvement, Milk, antioxidant, Wadara

Introduction

Milk is a nutrient rich food produced by the mammary gland of the mammals. It contains several nutrients including water, carbohydrates, lipids, proteins, minerals and vitamins in a balanced form for building up and maintaining human and animal body. During thermal stress, the antioxidant system of the dairy cow requires dietary antioxidant supplementation via water and or feed, to duly deal with the formation of excessive reactive oxygen species and improve milk yield. Antioxidants are natural or man-made substances that may prevent or delay cell damage and play a significant role in the body's defense system against reactive oxygen

species. Selenium (Se) has been recognized as an essential trace element which plays a major role as redox cofactor and catalyst in biological systems (Abdulrashid and Juniper, 2016) It is critically important as antioxidant, anti-inflammatory, and chemoprotective properties in the animal body. Organic selenium (selenomethionine) known as SeMet is a naturally occurring amino acid containing a selenium atom bound to methionine. It is however, an essential micro nutrient that is required for a number of biochemical processes in both humans and animals' body (Abdulrashid and Juniper, 2016). Some of the functions include enhancing antioxidant status in lactating cows, control of mastitis in dairy

herd, control of retained placenta, improve calf weight gain, improved immune system function, improve fertility and thyroid hormone metabolism (Salles *et al.*, 2014). Abdurashid and Juniper (2016) reported, it is a co-factor of the antioxidant enzyme (glutathione peroxidase, catalase, superoxide dismutase) in the body that counteract the damaging effects of reactive oxygen species and numerous peroxides that are known to manifest and increase in their destructive activity in tissues during thermal stress. Moreover, SeMet supplementation increases the expression of glutathione peroxidase enzyme, which plays a very important role in antioxidant defense in different tissues and is recognized as having anti carcinogenic and antiviral properties (Salles *et al.*, 2014). Improving the oxidative status of lactating cows will play an important role in delivering high-quality milk and milk products to consumers to enhance wellbeing and improve livelihood nutritional security (Prathap *et al.*, 2017). In view of the above, the research focused on selenomethionine supplementation for physiological improvement of milk yield performance of indigenous breed of lactating cows under tropical savannah zone, which is imperative to the transformation of dairy industry and food security.

Materials and Methods

Experimental Site

The research work was conducted at Dairy Research and Development Centre (DRDC), Abubakar Tafawa Balewa University, Bauchi, Nigeria. Bauchi is in the North-East geopolitical zone and lies within Northern Guinea Savannah, located between latitudes 9° 30' and 12° 30' North of the equator and between the longitudes 8° 50' and 11° 0' East of the Greenwich meridian. The rainfall ranges between 700 to 1,300 millimetres (28 to 51 inches) per annum. Consequently, rains

start in April/May and ends in October. It is usually hot and humid during the day in wet season. The range average daily temperature is 17 to 40 °C depending on the season. The average relative humidity also ranges from 16.5 to 75 % respectively.

Experimental Animal, Management and Design

A total of 24 lactating Bunaji, Wadara and Friesian x Bunaji cows at early, mid and late lactation were used for the study. The animals weighed between 200 and 400 kg, and were 3-7 years old. The experimental animals were maintained under similar condition of feeding, housing and management. The animals were allotted to the experimental treatments in a 3x2x4 factorial arrangement presented in a completely randomized design. The factors in the experiment were the genotypes (Bunaji, Wadara and their cross), parity (first and second) and SeMet Supplementation (0.00, 30.00, 60.00 and 90.00 mg/100 kg diets).

Experimental Diets and Duration

The Experiment had four diets with inclusion SeMet at (0.00, 30.00, 60.00 and 90.00 mg/100 kg diets) levels. The diets were fed in the morning to each experimental cow once daily before milking for the period of six months (January to July). The quantity of supplemental diet offered were based on milk production yield (½ kg of concentrate to 1 litre of milk produced per cow per day, respectively).

Data Collection

Milk collection procedure and yield characteristic

Milking was done in the morning manually and once in a day (7:30 to 9:30 am). The collection procedure was performed by the same collector for consistency. Milk yield

(Litre (L)/head/day) characteristics are: Initial milk yield, peak milk yield, drying milk yield, total milk yield and average daily milk yield of the cow was recorded daily on record sheet and measured in litres using calibrated rubber buckets. Milk yield characteristics were determined as follow:

Initial milk yield (L): This was measured as rising yield of milk from calving to about 60-80 days of lactation, depending on breed and management (Galukande *et al.*, 2020).

Peak milk yield (L): This was measured as steady yield of milk from caving to about 80-140 days of lactation, depending on breed and management.

Drying off yield (L): The quantity of milk recorded as the yield continually declined to 0 level (Galukande *et al.*, 2020).

Total milk yield (L): The total milk yield was measured as the summation of all milk collected over the period of the experiment (Babayemi *et al.*, 2014)

Average daily milk yield (L): This was measured as the total milk yield divide by the number of days of the experimental period (Babayemi *et al.*, 2014).

Statistical Analysis

The data generated were subjected to analysis of variance (ANOVA) using the General Linear Model procedure of Statistical Package for Social Sciences (SPSS, 2007) version 16.0. Where significant difference was observed, means were separated using Tukey Pairwise Comparison method (Tukey, 1991). The model for the analysis is thus;

$$Y_{ijkl} = \mu + B_i + P_j + D_k + (BP)_{ij} + (BD)_{ik} + e_{ijk}$$

Where:

Y_{ijkl} = Independent variables

μ = Overall mean

B_i = Effect of i^{th} breed (1, 2, 3)

P_j = Effect of j^{th} parity (1, 2)

D_k = Effect of k^{th} diet (1, 2, 3, 4)

$(B \times P)_{ij}$ = Interaction effects of i^{th} breed and j^{th} parity

$(B \times D)_{ik}$ = Interaction effect of i^{th} breed and k^{th} diet

e_{ijkl} = Random error

Results and Discussion

Effect of breed, parity and diet on milk yield characteristics of lactating cows fed diet supplemented with varied levels of selenomethionine

The result on the effect of breed, parity and diet on milk yield characteristics of lactating cows fed diet supplemented with varied levels of selenomethionine is presented in Table 1. Initial milk yield, peak milk yield, drying milk yield, total milk yield and average daily milk yield values were higher ($P < 0.05$) in Friesian x Bunaji cows. Second parity was higher ($P < 0.05$) for Initial milk yield, peak milk yield, drying milk yield, total milk yield and average daily milk yield compared to first parity cows. Initial milk yield, drying milk yield, total milk yield and average daily milk yield were higher ($P < 0.05$) in lactating cows fed 90.00 mg/100 kg selenomethionine diets. Peak milk yield was higher ($P < 0.05$) in lactating cows fed 60.00 and 90.00 mg/100 kg selenomethionine diets. The current findings were supported by Kro *et al.* (2020) who reported Holstein Friesian crossbred cows are one of the high yielding categories of cattle. Osei-Amponsah *et al.* (2020) also reported that milk yields increased dramatically in the F1 crosses with Jersey and Friesian cattle. In a similar vent, Galukande *et al.* (2020) reported that in all Ugandan climatic zones, cross-bred cows had higher milk yields, where the mean milk yield per lactation for cows with 50 % *Bos taurus* genes was 2.6 times higher than that of the indigenous cows. The reasons for better performance and higher milk yield produced by crosses in the tropical environment compared to local breeds could be linked to increase in the number of *Bos taurus* genes in the cross-bred cow up to 50 % resulting in to hybrid vigor and breed complementarity termed heterosis (Alphonsus *et al.*, 2011).

According to Alphonsus *et al.* (2011) the superiority of Friesian x Bunaji cows over Bunaji and other indigenous breeds agreed with the principle of heterosis in animal

breeding where offspring of crosses are expected to perform above the average of the two parents. The low milk yield production in local breeds of cattle under tropical conditions could be related to poor genetic potentials for milk production, harsh climatic variables, low nutrient contents of tropical forages and lack of genetic selection for high milk yield of indigenous breed due to, inappropriate government policies and inadequate funding (Galukande *et al.*, 2020).

The breed discrepancies on milk yield could be attributed to stage of lactation, individuality, season of sample collection, level of nutrition and disease condition of the animals. In this study, second parity had higher milk yield than the first. This result was also supported by previous studies (Ferreira, *et al.*, 2021) that, cows of first parity yielded less milk per lactation, per day and per calving interval and were less efficient than second, third and fourth parity. The disparity in milk yield based on parity could be attributed to the increase in body weight, milk secretory cells in the udder, increase in feed intake and efficient protein and energy metabolism (Ferreira *et al.*, 2021)

Effect of varied levels of selenomethionine diets on milk yield of lactating cows

Linear increase in milk yield of lactating cows in ascending order as selenomethionine diets increases, was also observed. Moreover, cows fed 90.00 mg/100 kg selenomethionine diet had higher total milk yield (2,685.84 L). While control diet fed to lactating, cows was lower in total milk yield (1,692.60 litre). This was in contrast with Achi *et al.* (2020), that reported 820.20, 751.20 and 835.80 litres of milk from cows that were fed diet containing selenium, vitamin E and selenium + vitamin E, respectively. Stockdale *et al.* (2011) indicated that, the more levels of selenomethionine

consumed, the more the milk yield produced. Deficiency of selenomethionine impairs the immune function, leading to a higher risk of heat stress and diseases like mastitis, resulting to lower milk yield. The result could perhaps be attributed to an improve in digestibility, immune system and antioxidant activities of the selenomethionine diets.

Moreover, two-and three-way interactions effect in breed, parity and diet was also observed and shown same behaviour as depicted in the main effects and presented in Tables 2 and 3. Enhancement of the body antioxidative capacities by SeMet had resulted in reduction of the destructive effects of reactive oxygen species in body cells and tissues, thereby improving milk production and yield. According to Ullah *et al.* (2020) the bioavailability of SeMet compound in the body tissues of lactating cows would result to an of increase of milk production performance by 24.8 %.

Conclusion

In conclusion, Friesian x Bunaji lactating cows had higher total milk yield (3,057.84 litres), followed by Wadara (1,975.32 litres) and Bunaji (1,636.80 litres) breeds. Moreover, second parity had higher total milk yield (2,455.20 litres) compared to first parity (1,934.40 litres). 90.00 mg/100 kg SeMet diets fed to lactating cows significantly improved total milk yield (2,685. 84 litres) compared to control diets (1,692.60 litres).

Recommendation

It is recommended that, selenomethionine be fed at 90.00mg/100 kg as organic antioxidant and component of the enzyme glutathione peroxidase in the diets of lactating Bunaji, Wadara and Friesian x Bunaji cows to improve physiological processes and milk yield without any deleterious effect.

Table 1: Effect of breed, parity and diet on milk yield characteristics of lactating cows fed diet supplemented with varied levels of selenomethionine

Parameters	IMY (L)	PMY (L)	DOY (L)	TMY (L)	ADMY (L)	CMP/kg diet (₦)
Breed						
BJ	1.13 ^c	1.83 ^c	1.44 ^c	1636.80 ^c	8.80 ^c	-
WD	1.45 ^b	2.20 ^b	1.66 ^b	1975.32 ^b	10.62 ^b	-
FRxBJ	2.09 ^a	3.62 ^a	2.51 ^a	3057.84 ^a	16.14 ^a	-
SEM	0.02	0.01	0.02	0.05	0.02	-
P. value	0.002	0.001	0.001	0.001	0.001	-
Parity						
FP	1.38 ^b	2.22 ^b	1.60 ^b	1934.40 ^b	10.40 ^b	-
SP	1.68 ^a	2.80 ^a	2.12 ^a	2455.20 ^a	13.20 ^a	-
SEM	0.01	0.01	0.01	0.02	0.01	-
P. value	0.001	0.001	0.001	0.002	0.001	-
Diet (mg/100 kg)						
0.00	1.36 ^d	1.81 ^d	1.38 ^d	1692.60 ^d	9.10 ^d	21.53
30.00	1.55 ^c	2.50 ^c	1.69 ^c	2135.28 ^c	11.48 ^c	17.07
60.00	1.62 ^b	3.02 ^a	2.02 ^b	2477.52 ^b	13.32 ^b	14.72
90.00	1.80 ^a	3.06 ^a	2.36 ^a	2685.84 ^a	14.44 ^a	13.57
SEM	0.02	0.01	0.02	0.05	0.02	-
P. value	0.001	0.002	0.001	0.001	0.001	-

IMY- initial milk yield, PMY- peak milk yield, DOY- drying off yield, TMY- total milk yield, ADMY- average daily milk yield, CMP- cost of milk production/ kg diet, L- litre, BJ- Bunaji, WD- Wadara, FRxBJ- Friesian x Bunaji, FP- first parity, SP- second parity, SEM- standard error of mean, abcd; means within the same column followed by different superscripts are significantly different at P-value \leq 0.05

Table 2: Interaction between breed and parity on milk yield characteristics of lactating cows fed diet supplemented with varied levels of selenomethionine

Parameters	BJ		WD		FR x BJ		SEM	P.value
	FP	SP	FP	SP	FP	SP		
IMY (L)	1.06 ^a	1.15 ^a	1.40 ^a	1.47 ^a	1.68 ^b	2.41 ^a	0.03	0.001
PMY (L)	1.67 ^a	1.10 ^b	1.92 ^b	2.43 ^a	3.07 ^b	3.97 ^a	0.01	0.001
DOY (L)	1.27 ^b	1.66 ^a	1.38 ^b	1.93 ^a	2.15 ^b	2.75 ^a	0.03	0.001

BJ- Bunaji, WD- Wadara, FRxBJ- Friesian x Bunaji, FP- first parity, SP- second parity, IMY- initial milk yield, PMY- peak milk yield, DOY- drying off yield, L- litre, SEM- standard error of mean, abcd; means within the same row followed by different superscripts are significantly different at P-value ≤ 0.05

Table 3: Interaction between breed and diet on milk yield characteristics of lactating cows fed diet supplemented with varied levels of selenomethionine

Parameters	BJ				WD				FRxBJ				SEM	P.value
	0.00	30.00	60.00	90.00	0.00	30.00	60.00	90.00	0.00	30.00	60.00	90.00		
IMY (L)	1.17 ^b	1.99 ^a	1.01 ^b	1.25 ^b	1.29 ^b	1.33 ^b	1.44 ^b	1.68 ^a	1.65 ^d	1.96 ^c	2.17 ^b	2.41 ^a	0.04	0.001
PMY (L)	1.42 ^d	1.72 ^c	1.98 ^b	2.21 ^a	1.55 ^d	2.11 ^c	2.55 ^a	2.49 ^b	2.47 ^d	3.10 ^c	4.15 ^b	4.35 ^a	0.01	0.001
DOY (L)	1.11 ^b	1.52 ^a	1.58 ^a	1.66 ^a	1.18 ^b	1.78 ^a	1.84 ^a	1.83 ^a	1.70 ^c	2.68 ^b	2.56 ^b	2.87 ^a	0.04	0.001

BJ- Bunaji, WD- Wadara, FRxBJ- Friesian x Bunaji, IMY- initial milk yield, PMY- peak milk yield, DOY- drying off yield, L- litre, SEM- standard error of mean, abcd; means within the same row followed by different superscripts are significantly different at P-value ≤ 0.05

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