Yields and milk characteristics of Bunaji, Wadara and Friesian X Bunaji cows fed Dietary baobab fruit pulp meal under tropical environment

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Target Audience: Reproductive physiologist, Animal Scientist, Biotechnologist, Livestock Extension Agent, Dairy Industries

Abstract

The research was conducted at Dairy Research and Development Centre (DRDC) of Abubakar Tafawa Balewa University, Bauchi. The study was carried out to evaluate the effect of organic antioxidant (baobab fruit pulp meal) supplementation on milk production pattern of lactating Bunaji, Wadara and Friesian x Bunaji cattle. A total of 24 clinically healthy lactating cows on their first and second parity were used for the research. The experimental cows were allotted to four treatment levels: 0.00, 5.30, 10.60 and 15.90 kg/100kg diet (diet 0, diet 1, diet 2 and diet 3) baobab fruit pulp meal (BFPM) with six animals per treatment in a Completely Randomized Design. The treatments were administered once daily (10 to 20 minutes) before milking and lasted for 186 days. However, milking was done manually once daily (morning) at 7:30 to 8:30 am by the same collector consistently up to the end of the data collection as described above. Moreover, milk yield parameters (initial milk yield (IMY), peak milk yield (PMY), decline milk yield (DOY), total milk yield (TMY) and average daily milk yield (ADMY) (L/head/day) of the cow was recorded daily on record sheet and measured in litres using calibrated rubber buckets and the data was subjected to analysis of variance of SPSS software. The milk yield parameters differed (P<0.001) significantly and shared similar characteristics pattern, in both the main and in interaction effects. There was significant (P<0.001) difference on breed effect along milk yield parameters measured. The Friesian x Bunaji Crosses had recorded significant higher total milk yield (2,529.60 litres), followed by Wadara breed (1,737.24 litres) while Bunaji recorded the lowest (1,644.44 litres) yield respectively. Second parity had recorded higher total milk yield (2,018.71 litres) than first parity (1,897.21 litres). Experimental animals under diet 3 (15.90 kg/ 100kg diet) had produced large volume of total milk yield as compared to other treatment levels. The control group produced lower total milk yield. In conclusion, BFPM supplementations significantly improved milk production yield from (1,413.60 to 2,057. 16 litres). It is recommended that, under tropical conditions BFPM as organic antioxidants with high concentrations of vitamin C, could be supplemented in the diet of lactating cows up to 15.90 kg/100 kg diet in order to improve milk production performances under tropical conditions.

Keywords: organic antioxidants, physiological response, lactating cows, milk production yield, supplementation

Rendements et caractéristiques du lait des vaches Bunaji, Wadara et Friesian X Bunaji nourries avec de la farine de pulpe de fruit de baobab sous environnement tropical

Résumé

La recherche a été menée au Centre de Recherche et de Développement des produits Laitiers (CRDL) de l'Université Abubakar Tafawa Balewa, Bauchi. L'étude a été réalisée pour évaluer l'effet d'une supplémentation en antioxydants organiques (farine de pulpe de fruit de baobab) sur le modèle de production laitière des bovins Bunaji, Wadara et Friesian x Bunaji en lactation. Au total, 24 vaches en lactation cliniquement saines à leurs premières et deuxièmes mises basses ont été utilisées pour la recherche. Les vaches expérimentales ont été affectées à quatre niveaux de traitement : 0,00, 5,30, 10,60 et 15,90 kg/100 kg de régime (régime 0, régime 1, régime 2 et régime 3) de farine de pulpe de fruit de baobab (FPFB) avec six animaux par traitement dans un système complètement randomisé. Conception. Les traitements ont été administrés une fois par jour (10 à 20 minutes) avant la traite et ont duré 186 jours. Cependant, la traite était effectuée manuellement une fois par jour (matin) entre 7h30 et 8h30 par le même collecteur, de manière constante jusqu'à la fin de la collecte de données, comme décrit ci-dessus. De plus, les paramètres de production laitière (rendement laitier initial (RLI), rendement laitier maximal (RLM), rendement laitier en baisse (RLB), rendement laitier total (RLT) et rendement laitier journalier moyen (RLJM) (L/tête/jour) de la vache a été enregistrée quotidiennement sur une feuille d'enregistrement et mesurée en litres à l'aide de seaux en caoutchouc calibrés et les données ont été soumises à une analyse de variance du logiciel SPSS. Les paramètres de production de lait différaient de manière significative (P <0,001) et partageaient des caractéristiques similaires, à la fois dans la principale et dans la dans les effets d'interaction. Il y avait une différence significative (P <0,001) sur l'effet de la race en fonction des paramètres de production de lait mesurés. Les croisements Friesian x Bunaji avaient enregistré une production de lait totale significativement plus élevée (2 529,60 litres), suivis de la race Wadara (1 737,24 litres) tandis que Bunaji enregistrait respectivement le rendement le plus faible (1 644,44 litres). La deuxième parité avait enregistré un rendement total en lait plus élevé (2 018,71 litres) que la première parité (1 897,21 litres). Les animaux expérimentaux soumis au régime 3 (15,90 kg/100 kg de régime) avaient produit un volume important de rendement laitier total car par rapport aux autres niveaux de traitement. Le groupe témoin a produit une production laitière totale inférieure. En conclusion, les supplémentations en FPFB ont significativement amélioré le rendement de production laitière de (1 413,60 à 2 057,16 litres). Il est recommandé que, dans des conditions tropicales, le FPFB, en tant qu'antioxydant organique à forte concentration en vitamine C, puisse être complété dans l'alimentation des vaches en lactation jusqu'à 15,90 kg/100 kg de ration afin d'améliorer les performances de production laitière dans des conditions tropicales.

Mots-clés : antioxydants organiques, réponse physiologique, vaches en lactation, rendement laitier, supplémentation

Introduction

Dairy cattle are breed of animals developed primarily for production of milk to nourish their young ones. When excess milk is harvested, the surplus will be used for household consumption and marketing activities (Kubkomawa, 2017). Under tropical condition, environmental factors (rainfall, ambient temperature, solar radiation, relative humidity, wind speed) influence milk production (Gantner *et al.,* 2017). Milk production and yields are the product of animal genetic (genetic makeup) and environmental interactions (season, nutrition, disease) upon quantity and quality of feed the animal can utilize (Habeeb *et al*., 2018; Ozoje, 2018). The number of parities of a particular individual animal can also affect milk yield and composition. According to Alphonsus *et al.* (2011) milk yield and composition increases with increasing number of parity and is probably depend on breed, management and climatic factors. Therefore, milk is a nutrient rich food produced by the mammary gland of the mammals. It contains several nutrients including carbohydrates, lipids, proteins, minerals, vitamins etc. in a balanced form for building up and maintaining human and animal body. It is considered as almost nature's perfect food. The adaptable but low yielding (0.5 to 1.5 litres of milk per day) of indigenous cattle have been used for centuries as a source of meat, milk and fibre in the tropical zones (Kosta *et al*., 2012). During thermal stress conditions, the antioxidant system of the dairy cow requires dietary antioxidant supplementations via water and or feed, to properly deal with the formation of excessive reactive oxygen species (Fadime, 2017). Antioxidant is a natural or man-made substance that may prevent or delay cell damage. Furthermore, antioxidants play a significant role in the body's defence system against reactive *et al* oxygen species. Moreover, baobab fruit pulp meal and organic selenium are one of the important feed derived antioxidants. The pulp meal is a nutritious feed supplements but grossly underutilized food resources with great potential for enhancing the antioxidant status and productivity of milking cows under tropical environment (Fadime, 2017). It increases feed intake, milk yield, improve metabolism and was effective in alleviating thermal stress in ruminants Okunlola *et al*., 2015). In recent time attention is shifting from the use of synthetic antioxidants to fight free radicals and other reactive oxygen species produced in body fluids and tissues of animal. This brought about a renewed interest in the use of organic antioxidant products that are viable and physiologically safe to improve health and performance in lactating cattle under thermal stress environment.

Under stress conditions, thermal and emotional factors would signal the hypothalamus and central nervous system of the lactating cow to alter feed intake and hormonal functions. Subsequently, increase in heat production, causes rapid declines in milk yield and fertility (Prathab *et al.,* 2017). However, under higher ambient temperature, gross reduction in blood levels of ascorbic acid (AA) (vit. C) in lactating animal will occur resulting in decrease endogenous synthesis of AA molecules, leading to insufficiency of the compound in the animal cells and tissues then, oxidative stress will set in, manifested by very low milk production and its composition in lactating cows due to poor dry matter intake especially under tropical environment where temperature-humidity index is always high (Alejandro *et al.,* 2014; AL Reyada *et al*., 2016). During lactation, mammary epithelial cells exhibit a high metabolic rate and thus produce large amounts of reactive oxygen species. In this condition, there will be decrease in blood superoxide dismutase, catalase activities and reduced glutathione concentration results in oxidative impact to macromolecules (Sharma *et al.,* 2011). The balance between cellular oxidant and antioxidant is critical with an imbalance causing oxidative stress and damage to cellular lipids, proteins and deoxyribonucleic acid (DNA). According to Sharma *et al.* (2011), oxidative stress can also affect animal health and the quality of their products such as milk and meat. Antioxidant supplementations in ruminant diet represents a useful tool to sustain redox homeostasis when the ruminants are exposed to oxidative stress (Ranjan *et al.,* 2012; Okunlola *et al.,* 2015). Improving the oxidative status of ruminants will play an important role in delivering high-quality milk and milk products to consumers to enhance wellbeing and improve livelihood nutritional security. This is basically achieved through the supplementations of organic antioxidants like baobab fruit pulp meal in the diets of lactating cattle under tropical environment to ameliorate year-round production of free radicals (Yang and Chan Li., 2015). This will ensure adequate and quality milk production per lactation per animal per day that will guarantee sufficient protein supply to the ever-increasing human population. According to Fadime, (2017) the major interest on BFPM relies in its ascorbic acid content. In particular, BFPM represents a single most important and highly valuable natural sources of AA that contained (150 to 499 mg/100g) in comparison to other vegetable fruits (strawberry 46 mg/100 g, apple 6 mg/ 100 g and orange 46 mg/ 100 g) that are generally considered best source of ascorbic acid and is approximately six times more than the content of AA in orange. Therefore, AA is vital, strong, least toxic and water-soluble antioxidant nutrient present in BFPM. The free radical scavenging activity of AA is due to its low oxidation-reduction potential (Matsui, 2012). Furthermore, it is an essential dietary nutrient required as a co-factor of many enzymes and antioxidant property which has beneficial effects in ameliorating oxidative stress and low milk yield. In view of these, the research is apparently designed towards filling that existing information gap which is imperative to the dairy industry.

Materials and Methods

Experimental site

The research work was conducted at Dairy Research and Development Centre (DRDC), Gubi Campus, Abubakar Tafawa Balewa University, Bauchi, along Ningi-Kano Road. Bauchi is in the North-East geo-political zone and lies within Northern Guinea Savannah. The DRDC is 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 (ATBIA, 2022).

Experimental animals, diet, duration and design

A total of 24 clinically healthy lactating cows in their first and second parity weigh between 200-400 kg, of 3-7 years old. They were under normal body condition scores (BCS) of 3 to 3.5 respectively. Three genotypes were used (100 % Bunaji, 100 % Wadara and 50 % Friesians × 50 % Bunaji) with two breeds per group making six animals, allotted to four experimental treatments (0.00, 5.30, 10.60 and 15.90 kg/100 kg diet) and were fed in the morning to each experimental cow (from first week of January to first week of July, 2022) once daily (10 to 20 minutes) before milking for the whole period of the trial that lasted for186 days. The quantity of supplemented diet offered to the experimental animals were based on milk production yield (½ kg of concentrate to 1 litre of milk produced per cow per day respectively) and laid in a completely randomized design. Presented in 2x3x4 (2 parity, 3 breeds and 4 dietary levels) factorial arrangement in a completely randomised design (CRD). Tag numbers were used for identification of the experimental animals. What was the composition of the diet?

Management of the experimental animals

The experimental animals were maintained under similar condition of feeding, housing and management. The animals graze on pastures during wet season (Guinea grass, *Digiteria exilis*, *Stylosanthes hamata)* and fed crop residues during dry season (Corn stovers, Rice straw, Groundnut haulm). Herd health management programme like medication, vaccines, deworming and acaricides spray against external parasites were carried out as at when due. But deworming against internal parasites (tape worms, liver flukes) and vaccinations against endemic diseases such as contagious bovine pleura pneumonia and haemorrhagic septicaemia were often carried out after six months. While acaricides spray against external parasites (ticks, mice, mange, flies) usually occurred forth nightly. Fresh and clean drinking water was provided *ad libitum* in a water trough. Salt lick was also available for licking as mineral source (Nacl 96 %, wood ash 1 %, bone meal 1 %, Fish meal 1 %, blood meal 1 %).

Data Collection

Milk collection procedures

The data variables investigated include; milk production yield parameters. The milk samples (100 ml) were collected three times at two months interval for analysis. Milking was done manually once daily (morning) at 7:30 to 10:30 am by the same collector consistently up to the end of the data collection. Milk production yield (L/head/day) of the cows was recorded daily on record sheet and measured in litres using calibrated rubber buckets.

Milk production parameters

The parameters considered include; initial milk yield (L), peak milk yield (L) decline off yield (L) total milk yield (L), average daily milk yield (L).

Determination of milk parameters

The daily milk yield collected from birth to about 60 to 80 days is referred to as initial milk yield from then the milk yield will be steadily remains constant from 80 to 140 days. This is termed as peak milk yield, then the yield continually to decline up to 0 level, a situation referred to as decline off yield. The total milk yield is the summation of all milk collected over the period of data collection. While the average daily milk yield is a total milk yield divided by number of data collection days.

Statistical analysis

Data generated were subjected to analysis of variance (ANOVA) using the General Linear Model procedure of statistical package for social sciences (SPSS, 2009) version 16.0. Where significant difference was observed, means were separated using Tukey pairwise comparison method (Tukey, 1991).

Results

Main effects

The result on the effects of breed, parity and diet on dams supplemented with varied levels of BFPM on milk yield characteristics of some lactating cows was presented in Table 1. There was significant ($P<0.001$) difference between breeds on milk yield characteristics with Friesian x Bunaji crosses recoded higher initial milk yield, peak milk yield, drying off yield and average daily milk yield (IMY, PMY, DOY, TMY and ADMY) followed by Wadara and Banaji breed in that order respectively. Based on parity, second parity (SP) was significantly ($P<0.001$) higher in term of milk yield than the first parity (FP) in all milk yield characteristics investigated. According to treatment levels, diet 2 (10.60 kg/ 100 kg) was statistically ($P<0.001$) significant and higher in milk yield (2414.28 litre) while control was the lowest (1413.60 litre) statistically.

Interaction effects

There was significant ($P<0.001$) interaction effect between breed and parity on milk yield characteristics and was presented in Table 2. There was a linearly increase in IMY, PMY and DOY as parity advances for second parity (SP) and was significantly ($P<0.001$) higher across the breed. The Friesian x Bunaji crosses recoded the highest milk yield in all variables while Bunaji was significantly the lowest. The interaction effects between breed and diet were tabulated in Table 3. with Friesian-Bunaji and Bunaji have the highest IMY recorded on diet 2 (10.60 kg/ 100 kg) while Wadara under IMY was higher on supplemented diet 1 (5.30 g/100 kg). Consequently, on IMY, PMY and DOY, The Friesian-Bunaji crosses, Wadara and Bunaji breed were significantly (P<0.001) higher under diet 2 (10.60 kg/100 kg). The interaction effects between parity and diet and three-way interactions on breed, parity and diet were presented in Table 4. and Table 5. The (first parity) FP was significantly higher (P<0.001) in IMY and PMY on diet 2 (10.60 kg/100 kg), while DOY on diet 3 (10.90 kg/100 kg). However, SP recorded significantly (P<0.001) higher milk yield characteristics on diet 2 (10.60 kg/100 kg) than other treatment levels. On three-way interactions, FP was significantly (P<0.001) different in IMY, PMY and DOY on diet 3 and 2 along the breeds. However, SP was significantly (P<0.001) higher in IMY, PMY and DOY on diet 1, 2 and 3 along the breed respectively, with Friesian x Bunaji crosses produced higher yield (4.47 litre) at SP.

Discussion

Breed

Highly significant (P<0.001) difference was observed along breed on milk yield characteristics in the current study. The Friesian x Bunaji cross-breds recorded highest in TMY (L) of 2,529.60 While 1,737.24; and 1,975.32 was recoded for Wadara and Bunaji. Similarly, the Friesian x Bunaji cross-breds had produced higher milk yield than other two indigenous breeds (Bunaji and Wadara) across milk yield traits (IMY, PMY, DOY, TMY and ADMY) respectively. Alphonsus *et al*. (2011) reported that, the superiority of Friesian x Bunaji cross-breds over the pure Bunaji and Wadara agreed with the principle of heterosis in animal breeding where by offspring of crosses are expected to perform above the average of the two parents. Furthermore, the current research findings were supported by Kro *et al.* (2020) who reported that Holstein Friesian crossbred cows are one of the high yielding categories of cattle in India, in an article titled effect of parity on the yield, fat and SNF content of milk in Holstein-Friesian crossbred cows. This was also in agreement with research conducted by Osei-Amponsah *et al.* (2020) on cattle crossbreeding for sustainable milk production in the tropics where they compared milk yield production of the local cattle breeds and cross-breds of Ghana. The milk yields increased dramatically in the F1 crosses with Jersey and Friesian cattle. In a similar vent, Galukande *et al.* (2013), 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 % *Boss 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 indigenous breeds could be linked to increase in the number of *Boss taurus* genes in the cross-bred cow for up to 50 or 75 % resulting in to hybrid vigour and breed complementarity termed heterosis. According to Osei-Amponsah *et al.* (2020), crossbreeding exploits additive and non-additive allele gene effects, leading to improvements, that allows higher milk production yields and early age of calving of cows. Furthermore, in the tropical wet and dry climatic zone of Uganda, increasing the percentage of *Bos taurus* genes beyond 75 % had resulted in lower milk yields than what observed in the 50 % crosses. The F2 in this climatic zone performed significantly lower than the F1. The low milk yield production by local breed 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 fund. In a contrary development, a report by Abbaya *et al.* (2020), had shown that Bunaji was superior in milk yield by 1.92 kg compared to other Nigerian indigenous breeds (Rahaji (1.35 kg), Adamawa (1.33 kg) and Sokoto gudali (1.66 kg) during let dry season under tropical environment). The superiority of Bunaji in milk yield according the report was because of it milk production potential, good appetite, better psychological and physiological adaptation to changing climatic factors in the hot climates, the breed's thermos-tolerance qualities enable it to have high feed intake. This assumption was earlier supported by a study conducted by Akpa *et al,* (2006) and Alphonsus *et al.,* 2011 respectively. In another development, according to Nuru (2022) The Wadara breed produced higher milk yield per lactation (1,217 kg) with average of 4.7 kg on daily milk yield basis compared to Bunaji (1,015 kg) with average of 4.0 kg on daily basis under tropical climate respectively. The breed effect discrepancies on milk yield production could be attributed to stage of lactation, individuality, season of sample collection, level of nutrition and disease condition of the animals.

Parity

On parity effect, there was significant (P<0.001) difference, where milk yield increased with increasing numbers of parity. In current study, second parity recorded higher milk yield than the first parity. This result was supported by previous studies reported by Rios-Utrera *et al*. (2013); Timarah *et al.* (2020 and Sabek, *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 secretary cells in the udder, increase feed intake and efficient protein and energy metabolism.

Treatment levels

Significant (P<0.001) difference was observed on treatment levels on milk yield respectively. Diet 2 (10.60 kg/100 kg) was significantly higher for TMY (2,414.28 L) as compared to other treatment levels. This agrees with Okunlola *et al.* (2016) who used BFPM on goats' diet at 0 %, 10 %, 20 % and 30 %. The milk yield was highest when BFPM was fed at 20 % inclusion in the diet and control was the least. Whereas milk yield of goats fed baobab at 10 or 30 % inclusion was not significantly different. The superior performance of diet 2, compared to other treatment levels could be linked to bioavailability of antioxidants contents of vitamin C, better digestibility, minerals and medicinal components of the meal. And possibly increasing BFPM levels more than (10.60 kg/100 kg diet) might interfere with the digestibility and possibly nutrients absorption of the basal and test diet. It could likely also due to the action of certain anti-nutrition factors (phytate). The current result 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. The higher milk production recorded in the current study could be attributed to an improvement in the immune system and antioxidant activities of the BFPM. Two- and three-way interactions effect on breed, parity and diet was also observed and had shown same behaviour as depicted in the main effects. However, enhancement of the body antioxidative capacities by BFPM results in reducing the destructive activities of reactive oxygen species on macromolecule thus, resulting in to more milk yield production.

Conclusion

From the current study it has been concluded that, supplementation of BFPM in the diet of lactating cows under tropical environment had significant effect in increasing milk yield from 1,413.60 litres in the control to 2,414. 28 litres. The Friesian x Bunaji lactating cows produced higher

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

Parameters	IMY (L)	PMY (L)	DOY (L)	TMY (L)	ADMY (L)
Breed					
BJ	1.17^{c}	1.81^{c}	1.44^{b}	1644.44^{b}	8.84^{c}
WD	1.28^{b}	1.92^{b}	1.47^{b}	1737.24^{c}	9.34^{b}
FRxBJ	1.57^{a}	2.90^{a}	2.33^{a}	2529.60^{a}	13.60^{a}
SEM	0.01	0.01	0.02	0.04	0.01
P. value	0.001	0.001	0.001	0.002	0.001
Parity					
FP	1.29	2.06	1.68	1897.21	1.68
SP	1.43	2.50	2.08	2018.71	2.00
SEM	0.01	0.01	0.02	0.04	0.01
P. value	0.001	0.001	0.001	0.003	0.001
Diet (kg/100 kg)					
0.00	1.15^{d}	1.46^{d}	1.19^{c}	1413.60^{d}	7.60^{c}
5.30	1.42^{b}	2.22^{c}	1.88^{b}	2050.44^{c}	11.04^{b}
10.60	1.54^{a}	2.75^{a}	2.20^{a}	2414.28^{a}	12.98^{a}
15.90	1.25^{c}	2.40^{b}	1.88^{b}	2057.16^{b}	11.06^{b}
SEM	0.01	0.01	0.02	0.04	0.01
P. value	0.002	0.001	0.001	0.001	0.001

BFPM= baobab fruit pulp meal, L= litre, IMY= initial milk yield, PMY= peak milk yield, DOY= decline off yield, TMY= total milk yield, ADMY=average daily milk yield, 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 ≤ 0.05

Table 2: Interaction effect of breed and parity on dams supplemented with varied levels BFPM on milk yield characteristics of some lactating cows

Parameters	BJ		WD		FR x BJ			
	FP	SP	FP	SP	FP	SP	SEM	P. value
IMY (L)	1.03^{b}	1.29^{a}	1.25^{b}	1.35^{a}	1.60^{b}	1.66^{a}	0.01	0.001
PMY (L)	1.74^{b}	1.93^{a}	1.86^{b}	2.13^{a}	2.60^{b}	3.45^{a}	0.01	0.001
DOY (L)	1.39^{b}	1.61^{a}	1.36^{b}	1.79^{a}	2.28^{b}	2.84^{a}	0.03	0.001

BFPM= baobab fruit pulp meal, L= litre IMY= initial milk yield, PMY= peak milk yield, DOY= decline off yield, BJ= Bunaji, WD= Wadara, FRxBJ= Friesian x Bunaji, FP= first parity, SP= second parity, 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 effect of breed and diet on dams supplemented with varied levels of BFPM on milk yield characteristics of some lactating cows

Parameters	BJ				WD				FR x BJ					
	0.00	5.30	10.60	15.90	0.00	5.30	10.60	15.90	0.00	5.30	10.60	15.90	SEM	P. value
IMY (L)	1.15^{b}	1.06^{b}	1.32^{a}	1.09^{b}	1.16^{c}	1.41^{a}	1.38^{a}	1.26^{b}	1.14^{c}	1.71^{b}	2.01^{a}	1.65^{b}	0.02	0.001
PMY (L)	1.60^{c}	1.73^{b}	2.04^{a}	1.98^{a}	1.28^{a}	2.03^{c}	2.43^{a}	2.22^{b}	1.56^{d}	2.83^{c}	4.02^{a}	3.69^{b}	0.01	0.001
DOY (L)	1.37^{b}	1.28^{b}	1.71^{a}	1.64^{a}	1.00^{b}	1.71^{a}	1.83^{a}	1.76^{a}	1.23^{d}	2.67^{b}	3.48^{a}	2.87^{b}	0.05	0.002

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

Table 4: Interaction effect of parity and diet on dams supplemented with varied levels of BFPM on milk yield characteristics of some lactating cows

Parameters	FP				SP					
	0.00	5.30	10.60	15.90	0.00	5.30	10.60	15.90	SEM	P. value
IMY (L)	1.08^{c}	1.22^{b}	1.56^{a}	1.30^{b}	1.22^{d}	1.57^{a}	1.58^{a}	1.37^{b}	0.02	0.001
PMY (L)	1.36^{d}	1.98^{c}	2.58^{a}	2.34^{b}	1.59^{d}	2.42^{c}	3.08^{a}	2.92^{b}	0.01	0.001
DOY (L)	1.12^{c}	1.66^{b}	1.92^{a}	2.02^{a}	1.29^{c}	2.11^{b}	2.76^{a}	2.16^{b}	0.03	0.001

BFPM= baobab fruit pulp meal, L=litre, IMY= initial milk yield, PMY= peak milk yield, DOY= decline off yield, FP= first parity, SP= second parity, SEM= standard error of mean, abcd; means within the same row followed by different superscripts are significantly different at P-value ≤ 0.05

Table 5: Interaction effect of breed, parity and diet on dams supplemented with varied levels of BFPM on milk yield characteristics of some lactating cows

Breed	Parity	Diet	IMY (L)	PMY (L)	DOY (L)
BJ	FP	0.00	1.15^{d}	1.53^{c}	1.34^{b}
		5.30	1.77^{b}	1.69^{b}	1.27^{b}
		10.60	1.23^{c}	1.89^{a}	1.28^{b}
		15.90	1.96^{a}	1.87^{a}	1.68^{a}
	SP	0.00	1.15^{d}	1.66^{d}	1.41^{b}
		5.30	1.35^{b}	1.77^{c}	1.30^{b}
		10.60	1.41^{a}	2.20^{a}	2.15^{a}
		15.90	1.23^{c}	2.09^{b}	1.60^{b}
WD	FP	0.00	1.04^{d}	1.23^{d}	1.90^{a}
		5.30	1.37^{b}	1.77^{c}	1.31^{d}
		10.60	1.44^{a}	2.29^{a}	1.72^{b}
		15.90	1.15^{c}	2.15^{b}	1.53^{c}
	SP	0.00	1.28^{c}	1.34^{c}	1.11^{c}
		5.30	1.44^{a}	2.29^{b}	2.10^{a}
		10.60	1.31^{c}	2.57^{a}	1.95^{b}
		15.90	1.37^{b}	2.30^{b}	2.12^{a}
FRxBJ	FP	0.00	1.05^{d}	1.34^{d}	1.11^{c}
		5.30	1.52^{c}	2.47^{c}	2.39^{b}
		10.60	2.01^{a}	3.56^{a}	2.76^{a}
		15.90	1.80^{b}	2.99^{b}	2.86^{a}
	SP	0.00	1.23^{d}	1.78^{c}	1.35^{c}
		5.30	1.91^{b}	3.19^{b}	2.93^{b}
		10.60	2.01^{a}	4.47^{a}	4.20^{a}
		15.90	1.50^{c}	4.38^{b}	2.87^{b}
		SEM	0.02	0.02	0.07
		P. value	0.001	0.001	0.001

BFPM= baobab fruit pulp meal, L= litre, IMY= initial milk yield, PMY= peak milk yield, DOY= decline off yield, 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 ≤ 0.05

(2,529.60 litres) milk yield, followed by Wadara (1,737.24 litres) breed respectively. Second parity was significantly higher (2,018.71 litres) than first parity (1,897.21 litres) in milk yield. The BFPM should be supplemented in the diet of lactating cows as antioxidants without deleterious effect up to the rate of 10.60 to 15.90 kg/100 kg diet in order to improve milk production and reduce negative effects of heat stress under tropical environment.

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