



## PHYSIOLOGICAL EFFECT OF FEEDING ORGANIC ASCORBIC ACID ON MILK COMPOSITION AND MINERAL CONTENTS OF LACTATING COWS UNDER HEAT STRESS ENVIRONMENT

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### ABSTRACT

The study was carried out to evaluate the effect of organic ascorbic acid (baobab fruit pulp meal) supplementation on milk composition and milk mineral contents of lactating Bunaji, Wadara and Friesian x Bunaji cows under heat stress environment. The experiment was conducted at the Dairy Research and Development Centre (DRDC) of Abubakar Tafawa Balewa University, Bauchi. A total of twenty-four (24) lactating cows at early, mid and late lactation were used for the research. The experimental cows were allotted to four dietary treatment diets comprising: 0.00, 5.3, 10.6 and 15.9 kg/100kg diet of BFPM respectively with six animals per treatment in a Completely Randomized Design. The data generated was subjected to analysis of variance of SPSS software. The treatments were administered once daily after milking and lasted for 186 days. For laboratory analysis of milk composition and mineral contents, 100 mls of milk per cow was collected bimonthly. Protein was higher ( $P<0.05$ ) in Bunaji and Wadara breeds While milk fat was higher ( $P<0.05$ ) in Bunaji and Friesian x Bunaji breeds. Also, Total Solid was higher ( $P<0.05$ ) in Bunaji cows. Furthermore, Calcium and phosphorus were higher ( $P<0.05$ ) in lactating cows fed 10.60 and 15.90 kg /100 kg baobab fruit pulp meal. In conclusion, BFPM at 15.9 kg/100 kg inclusion in the diet of lactating cows improve milk composition and mineral contents than other diets. It is recommended that, under tropical conditions Supplementation of BFPM should be included in the diet of lactating cows as antioxidants up to the rate of 15.9 kg/100 kg diet without any deleterious effect.

**Keywords:** Lactating, Oxidative, Stress, Thermal, Heat.

### 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 (Magdi, 2015). During thermal stress conditions, the anti-oxidant system of the dairy cow requires dietary anti-oxidant supplementation via water and/ or feed, to adequately scavenge the excessive reactive oxygen species. The baobab fruit pulp meal is a nutritious feed with great potential for enhancing the anti-oxidant status and productivity of milking cows under the tropical environment (Bamalli *et*



*al.*, 2014), but grossly underutilized. It increases feed intake, milk yield, improve metabolism and is effective in alleviating thermal stress in ruminants (Bamalli *et al.*, 2014). In recent times, there has been shifting of interest from the use of synthetic anti-oxidants against reactive oxygen species produced in body fluids and tissues of animals to the use of organic antioxidants, which are viable, affordable and physiologically safe to improve health and performance of lactating cattle under the thermal stress environment (Prathap *et al.*, 2017).

(Ganaie *et al.*, 2013) had indicated that, heat stress was found to reduce the milk protein, fat, solids-not-fat (SNF) contents in dairy cows. Heat stress reduced short-chain fatty acids while increased the long chain fatty acids in the milk. It was observed that, there was reduction in percentages of total protein, fat casein, lactose, sodium, calcium, lactalbumin, short and medium-chain fatty acids, IgG and IgA for the first four lactations in Holstein heifers (Hammani *et al.*, 2015). Consequently, the elevated heat load index was correlated with decline in lactose, protein and fat concentration in milk. The mineral make-up of milk is crucial to the stability of the physio-chemical equilibrium. Heat stress can increase body temperature which may affect milk composition and mineral synthesis in mammary gland (ATBIA, 2022). (ATBIA, 2022) noted that, dietary manipulation can make huge impact in reducing the negative impact of heat stress on lactating cows on milk composition.

## **MATERIALS AND METHODS**

### **Experimental Site**

The research was conducted at Dairy Research and Development Centre (DRDC), Abubakar Tafawa Balewa University, Bauchi, Nigeria. Bauchi is in the North-East geo-political 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 (ATBIA, 2022).

### **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. weighed between 200 and 400 kg, and between 3-7 years old. The experimental animals were maintained under similar condition of feeding, housing and management. They comprised four treatment groups, with six animals per treatment group in a factorial arrangement under a Completely Randomized Design (CRD).

### **Experimental Diets and Duration**

The experiment had four treatment diets comprising of T1= 0% inclusion of BFPM, T2= 5.30% inclusion of BFPM, T3= 10.60% inclusion of BFPM and T4= 15.90% inclusion of BFPM all in kg/100 kg diet. The diets were fed in the morning to each experimental cow once daily before milking for the whole period of the trial (January to July, 2022). The quantity of supplemental diet offered were based on milk production yield ( $\frac{1}{2}$  kg of concentrate to 1 litre of milk produced per cow per day, respectively).



## **Data Collection**

### **Milk compositions and mineral analysis**

One hundred millilitres (100 mls) of milk per cow was collected bimonthly to examine for concentrations of protein, milk fat, solid non-fat, total solid, lactose and ash (%). Other parameters analysed were selenium, calcium, sodium, potassium, phosphorus and magnesium concentrations (mg/L). The milk compositions were analyzed using lacto-scan milk analyzer (Infitek Inc. Co, Ltd. Lixia District, Jinan, Shandong China, 2014 Bldg-3) while the mineral contents (selenium, calcium, sodium, potassium, phosphorus and magnesium) were determined using Atomic Absorption Spectrophotometer (SP-IAA320, Infitek Co. Ltd, West Aoti, Shandong, China. as described by (Franzoi *et al.*, 2019). The analyses were done at Biochemistry Laboratory of Abubakar Tafawa Balewa University Teaching Hospital, Bauchi.

### **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, 2009) version 16.0. Where significant difference was observed, means were separated using Tukey Pairwise Comparison method (Tukey, 1991).

## **RESULTS AND DISCUSSION**

### **Effect of Baobab Fruit Pulp Meal on Milk Composition**

The effect of breed, parity and diet on milk composition of lactating cows fed diet supplemented with varied levels of baobab fruit pulp meal (BFPM) is presented in (Table 1). Protein was higher ( $P < 0.05$ ) in Bunaji and Wadara breeds while milk fat was higher ( $P < 0.05$ ) in Bunaji and Friesian x Bunaji breeds. Total solid was higher ( $P < 0.05$ ) in Bunaji cows and the values for solid non-fat; lactose and ash were similar ( $P > 0.05$ ) in all the breeds. Protein, solid-non-fat, total solid, lactose and ash were similar ( $P > 0.05$ ) for both parity except fat ( $P < 0.05$ ). The values for protein, fat, solid-non-fat, total solid, lactose and ash were similar ( $P > 0.05$ ) in lactating cows fed BFPM diets. (Abbaya *et al.*, 2020) reported similar milk composition values with the current studies for Brown Swiss Holstein-Friesian, Simmental, Alpine Grey and Pinzgauer breeds. (Soliman, 2005) also reported lower fat and solid-non-fat values for Bunaji, Red Bororo, Sokoto Gudali and Adamawa Gudali but recorded higher protein %, respectively. The variation in milk composition observed in the present study could be attributed to genetic and non-genetics factors as well as stage of lactation.



**Table 1:** Effect of Breed, Parity and Diet on Milk Composition of Lactating Cows Fed Diet Supplemented with Varied Levels of Baobab Fruit Pulp Meal

Parameters	Protein (%)	Fat (%)	SNF (%)	TS (%)	Lactose (%)	Ash (%)
<b>Breed</b>						
BJ	3.23 <sup>a</sup>	3.49 <sup>a</sup>	8.87	12.40 <sup>a</sup>	4.97	0.68
WD	3.22 <sup>a</sup>	3.25 <sup>b</sup>	8.67	11.93 <sup>b</sup>	4.76	0.68
FRxBJ	2.99 <sup>b</sup>	3.41 <sup>a</sup>	8.42	11.83 <sup>b</sup>	4.74	0.69
SEM	0.07	0.05	0.15	0.16	0.13	0.01
P. value	0.02	0.01	0.85	0.05	0.11	0.22
<b>Parity</b>						
FP	3.09	3.47	8.61	12.01	4.74	0.68
SP	3.20	3.31	8.79	12.09	4.90	0.68
SEM	0.06	0.04	0.12	0.13	0.11	0.01
P. value	0.47	0.01	0.54	0.12	0.33	0.22
<b>BFPM (kg/100 kg)</b>						
0.00	3.01	3.19	8.74	11.94	5.01	0.69
5.30	3.16	3.56	8.72	12.28	4.86	0.69
10.60	3.28	3.34	8.72	12.06	4.77	0.67
15.90	3.13	3.45	8.43	11.93	4.72	0.68
SEM	0.08	0.06	0.17	0.19	0.15	0.01
P. value	0.08	0.14	0.35	0.65	0.69	0.23
Reference values	2.26-5.96	1.96-5.84	5.19-10.54	6.33-18.44	3.68-9.00	0.5-0.8

abcd; means within the same column followed by different superscripts are significantly different at P-value  $\leq 0.05$ , BFPM- baobab fruit pulp meal, SNF- solid non -fat, TS- total solid, BJ- Bunaji, WD- Wadara, FRxBJ- Friesian-Bunaji, FP- first parity, SP- second, SEM- standard error of mean,

Source: Soliman (2005); Desyibelew and Wondifraw (2019)



### **Effect of Baobab Fruit Pulp Meal on Milk Mineral Contents of Lactating cows**

The effects of breed, parity and diet on milk mineral contents of lactating cows fed diet supplemented with varied levels of BFPM is presented in (Table 2). The values for calcium, magnesium, potassium, sodium and phosphorus were similar ( $P > 0.05$ ) for all the breeds and parities. Calcium and phosphorus were higher ( $P < 0.05$ ) in lactating cows fed 10.60 and 15.90 kg /100 kg BFPM diet. Magnesium, potassium and sodium were higher ( $P < 0.05$ ) in lactating cows fed 15.90 kg/100 kg BFPM diets. In the present study lower milk calcium, sodium, magnesium was observed contrary to (Achi, 2020) who reported higher values for calcium, phosphorus, sodium, potassium and magnesium, respectively in Egyptian cattle. The current study was in agreement with (Abbaya *et al.*, 2020) who reported higher milk mineral contents of Bunaji, Rahaji, Adamawa Gudali and Sokoto gudali. The current study was also in agreement with (Achi, 2020) who reported significant difference for magnesium, potassium, sodium and phosphorus while calcium was ( $P > 0.05$ ) similar. The milk mineral contents for lactating cows fed 15.90 kg/100 kg BFPM diets had higher calcium, magnesium, potassium, sodium and phosphorus values. This could be a reflection of the effect of supplementation of vitamins which has a direct relationship to the mineral content of the milk (Bondan *et al.*, 2018). The BFPM supplementation on lactating cows was critical in the improvement of values of milk mineral contents that are pre-requisite for bone formation and approximately content (0.7 %), but more often, higher values indicate an abnormal condition of mammary gland (Rai, 2014).



**Table 2:** Effect of Breed, Parity and Diet on Milk Minerals Content of Lactating Cows Fed Diet Supplemented with Varied Levels of Baobab Fruit Pulp Meal

Parameters	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Phosphorus (mg/L)
<b>Breed</b>					
BJ	81.12	6.89	71.38	58.98	64.41
WD	82.03	7.15	71.45	60.73	66.38
FRxBJ	84.65	7.41	73.05	60.55	65.99
SEM	1.89	0.14	1.28	0.79	0.80
P. value	0.11	0.54	0.56	0.23	0.22
<b>Parity</b>					
FP	82.24	7.14	70.99	59.96	65.72
SP	82.96	7.07	73.08	60.03	65.30
SEM	1.55	0.11	1.05	0.65	0.65
P. value	0.46	0.08	0.89	0.14	0.33
<b>BFPM (kg/100 kg)</b>					
0.00	54.61 <sup>c</sup>	5.19 <sup>d</sup>	53.07 <sup>d</sup>	44.97 <sup>d</sup>	56.99 <sup>b</sup>
5.30	72.44 <sup>b</sup>	6.62 <sup>c</sup>	66.22 <sup>c</sup>	55.40 <sup>c</sup>	65.67 <sup>a</sup>
10.60	98.02 <sup>a</sup>	7.76 <sup>b</sup>	80.13 <sup>b</sup>	67.66 <sup>b</sup>	68.34 <sup>a</sup>
15.90	105.32 <sup>a</sup>	8.84 <sup>a</sup>	88.42 <sup>a</sup>	71.94 <sup>a</sup>	71.04 <sup>a</sup>
SEM	2.19	0.16	1.48	0.92	0.92
P. value	0.001	0.001	0.002	0.001	0.001
Reference values	40-120	3-13	40-75	35-75	40-80

abcd; means within the same column followed by different superscripts are significantly different at  $P\text{-value} \leq 0.05$ , BFPM- baobab fruit pulp meal, BJ- Bunaji, WD- Wadara, FRxBJ- Friesian-Bunaji, FP- first parity, SP- second parity, SEM- standard error of mean, Source: Soliman (2005); Kebede (2018)





## CONCLUSION AND RECOMMENDATION

In conclusion, baobab fruit pulp meal inclusion in the diet of lactating cows significantly improve milk composition and mineral contents by maintaining the values within normal range under tropical environment. It is recommended that, under tropical conditions Supplementation of baobab fruit pulp meal should be included in the diet of lactating cows as antioxidants up to the rate of 15.9 kg/100 kg diet without any deleterious effect.

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