



**INFLUENCE OF ORGANIC ANTIOXIDANT FOR MILK YIELD AND  
SERUM BIOCHEMISTRY IMPROVEMENT IN LACTATING COWS:  
A PANACEA TO FOOD INSECURITY IN NIGERIA**

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**ABSTRACT**

The research was conducted to evaluate the effect of organic antioxidant (baobab fruit pulp meal) supplementation on milk yield and serum biochemistry improvement in lactating cows as panacea to food insecurity in Nigeria. A total of 16 clinically healthy lactating Bunaji cows on their first and second parity were used for the research. The experimental cows were allotted to four dietary levels: 0.00, 5.30, 10.60 and 15.90 kg/100kg diet of baobab fruit pulp meal with four animals per treatment in a Completely Randomized Design (CRD). The treatments were administered once daily before milking and lasted for 120 days. Milk yield was measured and recorded on daily basis from the experimental animals throughout the period of the study. Blood samples (10 ml) were collected once from the experimental cows via jugular venipuncture using 18-gauge needle mounted on 20 ml syringe for biochemical analysis using standard laboratory procedures. The data collected were subjected to analysis of General Linear Model of SPSS software. The result revealed that, milk yield parameters differed ( $P < 0.05$ ) significantly. 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 control group. The result further indicated a significant ( $P < 0.05$ ) difference on serum biochemistry indices of the experimental cows. In conclusion, baobab fruit pulp meal supplementations significantly improved milk production yield from (1,413.60 to 2,057.16 litres). Based on the result of this study, it is recommended that, baobab fruit pulp meal 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 without deleterious effect.

**Keywords:** Organic, Antioxidants, Lactating-cows, Milk Yield, Supplementation

**INTRODUCTION**

Nigeria has a significant gap between its milk production and consumption (MLD, 2025). The country has a large cattle population, but majority are prone to poor nutrition and oxidative stress leading to very low milk yields (Adamu *et al.*, 2023). The average milk yield for a traditional cow in Nigeria is very low, typically ranging from 0.5 to 2 litres per day (MLD, 2025). This is in stark contrast to modern dairy breeds (like Friesians), which can produce 20 to 30 litres daily under proper management. Nigeria's annual milk production is estimated to be between 600,000 and 700,000 tonnes (MLD, 2025). This falls far short of the national demand. The low domestic production and high demand create a large deficit that is filled by imports. Nigeria's annual milk demand is approximately 1.6 to 1.7 million metric tonnes. Since local production only covers about 35 % of this demand. This import dependency costs Nigeria a significant amount of money, with the country spending around \$1.5 billion annually on importing milk and other dairy products, primarily in powdered form (MLD, 2025). The high import bill and low export value highlight Nigeria's position as a minor player in the global dairy market. While countries like New Zealand are major global exporters, Nigeria is a large importer, with its trade balance in dairy products heavily in the negative.

Cellular damage in mammary gland tissue impairs milk synthesis. Energy is diverted from milk production to support immune and repair functions. Oxidative stress can reduce feed intake and nutrient utilization efficiency, further limiting milk output. Baobab fruit pulp is a naturally concentrated source of compounds that can promote animal health and feed intake. The pulp is an exceptionally rich source of Vitamin C (ascorbic acid), with concentrations reported as high as 150 to 499 mg per 100 g (Hamzah



*et al.*, 2023). This is a remarkable concentration, up to ten times greater than that found in oranges. This is a critical factor, as Vitamin C is a powerful antioxidant known for its ability to fight infections and protect cells from damage. The research is aimed at feeding organic antioxidant to lactating for milk yield and serum biochemistry improvement: a panacea to food insecurity in Nigeria

## **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 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, 2024).

### **Experimental Animal, Management and Design**

A total of sixteen (16) lactating Bunaji on first and second parity were used for the study. The cows weighed between 200 and 300 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 four 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 % as control, 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 once daily in the morning before milking to each experimental cow for the period of three months (December to February). 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 manually once in a day (7:30 to 10:30 am). The collection procedure was performed by the same collector for consistency. Milk yield (L/head/day) characteristics are Initial milk yield (IMY), Peak milk yield (PMY), Total milk yield (TMY) and Average daily milk yield (ADMY). The milk yield 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 30- 60 days of lactation, depending on breed and management (Galukande *et al.*, 2023).
- Peak milk yield (L): This was measured as steady yield of milk from 60-120 days of lactation, depending on breed and management (Galukande *et al.*, 2023).
- 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.*, 2024)
- 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.*, 2024).

#### **Blood Sample Collection and Analysis**

Blood samples (10 ml) were collected at the end of the experiment (8:30 am to 9:30 am) from the Experimental cows via jugular venipuncture using 18-gauge needle mounted on 20 ml syringe. The samples for serum biochemistry and liver function test were collected (5 ml each) into heparin free bottles and allowed to coagulate at room temperature (21 °C-30 °C). The supernatant serum was decanted and stored in a freezer at a temperature of -20 °C until assay for biochemical analysis using standard laboratory procedures as described by (AOAC, 2010) at chemical Pathology Laboratory of the Abubakar Tafawa Balewa University Teaching Hospital, Bauchi.



### Serum Biochemical Indices and Liver Function Test

The serum biochemistry indices analysed were glucose, total protein, urea nitrogen, creatinine, and determined by spectrophotometric automated chemical analyzers (Ogunsanmi, 2002), while liver function parameters were aspartate aminotransferase, alanine aminotransferase, glutathione peroxidase, malondialdehyde, and superoxide dismutase and determined by spectrophotometric-linked reaction method (Cheesbrough, 2004).

## RESULTS AND DISCUSSION

### Proximate Composition of Baobab Fruit Pulp Meal

Table 1 shows proximate composition of baobab fruit pulp meal. Dry matter 89.00 %, Crude protein 2.26 %, Crude fibre 4.90 %, Ether extract 0.49 %, Ash 4.93 %, Nitrogen Free Extract 87.42 %, and Ascorbic acid 377.00 mg/100g.

**Table 1:** Proximate Composition of Baobab Fruit Pulp Meal

Compound	Concentration (%)
Dry matter	89.00
Crude protein	2.26
Crude fibre	4.90
Ether extract	0.49
Ash	4.93
Nitrogen free extract	87.42
Vitamin C (mg/100g)	377.00

Table 2 shows the results of the anti-nutritional substances present in the baobab fruit pulp meal. Tannin 0.60 mg/100g, Oxalate 0.48 mg/100g, Phytate, 1.63 mg/100g, Alkaloid 0.70 mg/100g and Trypsin inhibitor of 1.80 mg/100g.

**Table 2:** Anti-nutritional Factors of Baobab Fruit Pulp Meal

Compound	Concentration (mg/100g)
Tannin	0.60
Oxalate	0.48
Phytate	1.63
Alkaloid	0.70
Trypsin inhibitor	1.80

### Effect of Parity and Diet on Milk Yield Characteristics of Lactating Cows Fed Diet Supplemented with Varying Levels of BFPM

The result on the effect of parity and diet on milk yield characteristics of lactating cows fed diet supplemented with varied levels of BFPM is presented in Table 3. The result indicated that, second parity was higher ( $P < 0.05$ ) in IMY, PMY, TMY and ADMY compared to first parity. The values for IMY, PMY, TMY and ADMY were higher ( $P < 0.05$ ) in lactating cows fed 10.60 kg/100 kg BFPM diets.

In current study, second parity had higher milk yield than the first parity. This result was also supported by previous studies Rios-Utrera *et al.* (2023) 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.*, 2024)

Lactating cows fed 10.60 kg/100 kg baobab fruit pulp meal diet had higher ( $P < 0.05$ ) total milk yield (2,414.28 L), as compared to other baobab fruit pulp meal diets. This agrees with Okunlola and Olorunnisomo (2016) who supplemented baobab fruit pulp meal in goats' diet at 0 %, 10 %, 20 % and 30 %, respectively. The milk yield was higher when baobab fruit pulp meal was fed at 20 % inclusion as compared to control. However, milk yield of goats fed baobab fruit pulp meal at 10 or 30 % inclusion



was not significantly different. The superior performance of lactating cows fed 10.60 kg/100 kg baobab fruit pulp meal diet compared to other baobab fruit pulp meal diets could possibly be linked to bioavailability of antioxidants contents of vitamin C, better digestibility as well as possible minerals and medicinal components of the meal. And perhaps, increasing baobab fruit pulp meal diets more 10.60 kg/100 kg in the diets of lactating cows might interfere with the digestibility and possibly nutrients absorption of the basal and test diet. This could likely also due to the action of certain anti-nutrition factors (phytate).

**Table 3:** Effect of Parity and Diet on Milk Yield Characteristics of Lactating Cows Fed Diet Supplemented with Varied Levels of BFPM

Parameters	IMY (L)	PMY (L)	TMY (L)	ADMY (L)
<b>Parity</b>				
FP	1.29 <sup>b</sup>	2.06 <sup>b</sup>	1897.21 <sup>b</sup>	1.68 <sup>b</sup>
SP	1.43 <sup>a</sup>	2.50 <sup>a</sup>	2018.71 <sup>a</sup>	2.00 <sup>a</sup>
SEM	0.01	0.01	0.04	0.01
P. value	0.001	0.001	0.003	0.001
<b>BFPM (kg/100 kg)</b>				
0.00	1.15 <sup>d</sup>	1.46 <sup>d</sup>	1413.60 <sup>d</sup>	7.60 <sup>c</sup>
5.30	1.42 <sup>b</sup>	2.22 <sup>c</sup>	2050.44 <sup>c</sup>	11.04 <sup>b</sup>
10.60	1.54 <sup>a</sup>	2.75 <sup>a</sup>	2414.28 <sup>a</sup>	12.98 <sup>a</sup>
15.90	1.25 <sup>c</sup>	2.40 <sup>b</sup>	2057.16 <sup>b</sup>	11.06 <sup>b</sup>
SEM	0.01	0.01	0.04	0.01
P. value	0.002	0.001	0.001	0.001

SEM- standard error of mean, abcd; means within the same column followed by different superscripts are significantly different at P-value  $\leq 0.05$ , BFPM- baobab fruit pulp meal, IMY- initial milk yield, PMY- peak milk yield, DOY- decline off yield, TMY- total milk yield, ADMY- average daily milk yield, SP- second parity,

**Effect of Parity and Varied Levels of BFPM Diets on Serum Biochemistry of Lactating Cows**

The results of the effect of parity and diet supplemented with varied levels of BFPM on serum biochemistry indices of lactating cows is presented in Table 4. The result revealed that, glucose, total protein, urea nitrogen was similar ( $P > 0.05$ ) for parity. Glucose, total protein, urea nitrogen, were higher ( $P < 0.05$ ) in lactating cows fed 10.60 and 15.9 kg /100 kg BFPM diets. Creatinine in lactating cows fed BFPM diets was similar ( $P > 0.05$ ).

The serum parameters in cows fed 15.90 kg/100 kg BFPM diets were significantly higher compared to control and BFPM dietary and 5.30 kg/100 kg, respectively. The linear increase of serum biochemistry of the experimental cows as concentrations of BFPM diets increases, is an indication of an improvement in nutrient utilization and health. Moreover, Wafa and El-Nagar (2024) reported lower values of serum biochemistry (total protein, glucose) for lactating cows fed control diet, coenzyme Q10 and L-Carnitine compared to the values obtained in the current experiments. The values of blood biochemical indices are within the normal ranges for lactating cows. This shows that, the BFPM diets used were effective and have biological value. There were higher ( $P < 0.05$ ) values for glucose, total protein, urea nitrogen, while Creatinine was similar ( $P > 0.05$ ). The concentration of the serum blood metabolites recorded in the present study was in agreement with the normal range values of blood biochemistry recorded previously in cattle (Mikulkova *et al.*, 2024). In contrary, Soliman (2023) reported cows treated with zinc sulfate, vitamin E and selenium injection or both, did not differ in serum urea nitrogen and creatinine concentrations compared to control. The current study was in agreement with Alhidary *et al.* (2025) who observed significant increase in the serum concentrations of glucose, total protein, urea nitrogen in sheep fed diets supplemented with selenium and vitamin E. It vital to note that serum-biochemistry are the main determinant of the animals’ environmental and nutritional adaptation as well as welfare (Mikulkova *et al.*, 2024).

**Table 4:** Effect of Parity and Diet on Serum Biochemistry Indices of Lactating Cows Fed Diet Supplemented with Varied Levels of BFPM

Parameters	Glucose (%)	TP. (g/dL)	Urea N. (mg/dL)	Creatinine (mg/dL)
<b>Parity</b>				
FP	68.89	16.73	18.70	1.94
SP	68.65	16.81	18.65	2.18
SEM	2.02	0.70	0.22	0.41
P. value	0.17	0.71	0.32	0.11
<b>BFPM (kg/100 kg)</b>				
0.00	50.58 <sup>c</sup>	10.26 <sup>c</sup>	14.79 <sup>c</sup>	1.56
5.30	67.34 <sup>b</sup>	14.57 <sup>b</sup>	17.72 <sup>b</sup>	1.77
10.60	78.37 <sup>a</sup>	20.97 <sup>a</sup>	20.72 <sup>a</sup>	1.91
15.90	78.79 <sup>a</sup>	21.29 <sup>a</sup>	21.47 <sup>a</sup>	2.99
SEM	2.85	0.99	0.30	0.57
P. value	0.002	0.001	0.001	0.69
Reference values	37.107	6-28	10-30	0.5-3.5

SEM- standard error of mean, abcd; means within the same column followed by different superscripts are significantly different at P-value  $\leq 0.05$ , BFPM- baobab fruit pulp meal, TP- total protein, UR- urea nitrogen, FP- first parity, SP- second parity,

**Source:** Adeyemi and Soetan, (2018); Regmi and Pande (2018)

#### Effect of Breed and Varied Levels of BFPM Diets on Liver Functions of Lactating Cows

The results of the effect of parity and diet supplemented with varied levels of BFPM on liver functions of lactating cows is presented in Table 5. The result showed that, ALT, MDA and SOD were similar ( $P > 0.05$ ) for parity. The ALT, MDA and SOD were higher ( $P < 0.05$ ) in lactating cows fed 10.60 and 15.9 kg /100 kg BFPM diets. The AST and GPx were higher ( $P < 0.05$ ) in lactating cows fed 15.90 kg/100 kg BFPM diet.

The serum parameters in cows fed 15.90 kg/100 kg BFPM diets were significantly higher compared to control and other dietary levels. The linear increase of the values for liver functions as concentrations of BFPM diets increases, is an indication of an improvement in the animal health and efficient utilization of the nutrients. There were higher ( $P < 0.05$ ) values for AST, ALT, GPx, MDA and SOD. The concentration of the serum blood metabolites recorded in the present study was in agreement with the normal range values for liver enzyme activities recorded previously in cattle (Mikulikova *et al.*, 2024). The current result was in agreement with Alhidary *et al.* (2025) who observed significant increase in the serum concentrations of AST, ALT in sheep fed diets supplemented with selenium and vitamin E. In addition, Soliman (2023) also observed that, buffalo calves fed high Se (8.54 ppm) had higher activity of plasma AST. Wafa and El-Nagar (2024) report on liver enzyme metabolites was in agreement with present study. However, AST differed significantly. Moreover, the AST, ALT, GPx, MDA and SOD are some of the most important antioxidant's defenses that have a major role in reactive oxygen species withdrawal from the cell (Wafa and El-Nagar, 2024). The BFPM supplementation increased the concentrations of total antioxidants in blood compared to control in lactating cows and this can act as a biomarker in manifesting the level of oxidative stress.

**Table 5:** Effect of Parity and Diet on Liver Function of Lactating Cows Fed Diet Supplemented with Varied Levels of BFPM

Parameters	AST (IU/L)	ALT (IU/L)	GPx (µg/ml)	MDA (µg/ml)	SOD (µg/ml)
<b>Parity</b>					
FP	96.73	16.46	876.86	10.64	174.57
SP	97.32	16.28	882.02	10.58	174.04
SEM	0.78	0.83	5.40	0.26	1.51
P. value	0.45	0.69	0.35	0.32	0.59
<b>BFPM (kg/100 kg)</b>					
0.00	81.93 <sup>d</sup>	10.83 <sup>c</sup>	805.06 <sup>d</sup>	7.81 <sup>c</sup>	153.42 <sup>c</sup>
5.30	93.12 <sup>c</sup>	15.52 <sup>a</sup>	870.89 <sup>c</sup>	9.23 <sup>b</sup>	168.16 <sup>b</sup>
10.60	103.59 <sup>b</sup>	19.04 <sup>a</sup>	904.32 <sup>b</sup>	12.09 <sup>a</sup>	186.29 <sup>a</sup>
15.90	109.45 <sup>a</sup>	20.38 <sup>a</sup>	937.49 <sup>a</sup>	13.31 <sup>a</sup>	189.34 <sup>a</sup>
SEM	1.10	1.17	7.64	0.36	2.13
P. value	0.001	0.001	0.002	0.001	0.001
Reference values	78-130	11-40	735-1450	6-23	142-280

SEM- standard error of mean, abcd; means within the same column followed by different superscripts are significantly different at P-value  $\leq 0.05$ , BFPM- baobab fruit pulp meal, AST- aspartate aminotransferase, ALT- alanine aminotransferase, GPx- glutathione peroxidase, MDA- malondialdehyde, SOD- superoxide dismutase, FP- first parity, SP- second parity.

**Source:** Adeyemi and Soetan, (2018); Regmi and Pande (2018)

## CONCLUSION AND RECOMMENDATION

Feeding organic antioxidant inform of baobab fruit pulp meal to lactating cows improved milk yield by 41.4 %. The diet has high bioavailability and low anti nutritional factors resulting to better blood metabolites.

Based on the result of this study, it is recommended that lactating cows will be supplemented with organic antioxidant inform of baobab fruit pulp meal up to 10.60 kg/100 kg diets without physiological effect for better performance. The diet can be used as biomarker to know the level of oxidative stress in cows

## REFERENCES

- Adamu, S., Abdulrashid, M., Zahraddeen, D. and Daudu, O. M. (2023). Yield and milk characteristics of Bunaji, Wadara and Friesian x Bunaji cows fed dietary baobab fruit pulp meal under tropical environment. *Nigerian Journal of Animal Production*, **50**(1): 83-96.
- Alhidary, I. A., Shini, S., Al Jassim, R. A. M., Abudabos, A. M. and Gaughan, J. B. (2025). Effects of selenium and vitamin E on performance, physiological response and selenium balance in heat-stressed sheep. *Journal of Animal Science*, **93**: 576–588.
- AOAC, (2010). Association of Official Analytical Chemists. Official method of analysis. 18<sup>th</sup> Ed. Virginia, USA, Washington D.C, AOAC Inc. Arlington.
- ATBIA (2024). Abubakar Tafawa Balewa International Airport, Bauchi. Annual metrological report Bulletin Pp 5-8
- Babayemi, O. J., Abu, O. A. and Opakunbi, A. (2024). **Integrated animal husbandry for schools and colleges**. First edition, positive press, Ibadan, Nigeria Pp. 12-264.
- Cheesbrough, M. (2004). **District Laboratory Practice in Tropical Countries**. Part 2 University Press, Cambridge, United Kingdom, pp 266-342.
- Ferreira, M. F. L Rennó, L. N., Rodrigues, I. I., Detmann, E., Paulino, M. F., Filho, S. C. V., Martins, H. C., Moreira, S. S, and Lana, D. S. (2024). Effects of parity order on performance, metabolic, and hormonal parameters of grazing beef cows during pre-calving and lactation periods. *BMC Veterinary Research*, **17**:3 11. 021-03019-0



- Galukande, E., Mulindwa, H., Wurzinger, M., Roschinsky, R., Mwai, A. O. and Sölkner, J. (2023). Cross-breeding cattle for milk production in the tropics: achievements, challenges and opportunities. In collaboration with: *National Animal Genetic Resources Centre and Data Bank, Entebbe, Uganda; BOKU–University of Natural Resources and Applied Life Sciences, Vienna, Austria; International Livestock Research Institute, Nairobi, Kenya and National Livestock Resources Research Institute, Kampala, Uganda.*
- Hamzah, R. U., Jigam, A. A., Makun, H. A. and Egwim, E. C. (2023). Antioxidant properties of selected African vegetables, fruits and mushrooms: A Review. doi: 10.5772/52771. Pp 1- 12.
- MLD (2025). Federal Ministry of Livestock Development of Nigeria: *Establishment, Mandate, and Analysis of Data Reporting on Milk Yield. A collaboration with National Dairy Policy. info.fmld.gov.ng/July, 2025.*
- Mikulková, K., Ilek, J. and Kadek, R. (2024). Glutathione redox state, glutathione peroxidase activity and selenium concentration in periparturient dairy cows, and their relation with negative energy balance. *Journal of Animal and Feed Sciences*, **2**(5): 19-26.
- Ogunsanmi, O. A., Ozegbe, P. C., Ogunjobi, D., Taiwo, V. O. and Adu, J. O. (2002). Haematology plasma biochemistry and whole blood minerals of the captive adult African grasscutter (*Thryonomys swinderianus*) *Journal of Tropical Veterinary Medicine*, **20**(1): 27-35.
- Ríos-Utrera, Á., Calderón-Robles, R. C. and Galavíz-Rodríguez, J. R. (2023). Effects of breed, calving season and parity on milk yield, body weight and efficiency of dairy cows under subtropical conditions. *International Journal Animal and Veterinary Advances* **5**(6): 226-232.
- Soliman, A. S. H. (2013). Impact of using antioxidant agents on reproductive performance and thermoregulation in Aberdeen Angus cows under new valley conditions. Unpublished M. Sc Thesis, Assiut University, Faculty of Agriculture, Department of Animal Production. Pp 4-75
- Wafa W. M., El-Nagar, H. A. (2024). Reproductive efficiency, milk production, health status, antioxidant capacity, lipid profile, and metabolic hormones of lactating cows treated with Coenzyme Q10 and L-Carnitine. *Journal Of Animal Health and Production*, **9**(4): 380-390.