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RESEARCH ARTICLE

Associations between Milk Yield, Parity, Physiological Status and Certain Serum Biochemical Properties of Friesian x Bunaji Cows

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ABSTRACT

The study was conducted at National Animal Production Research Institute (NAPRI), Shika, Kaduna State, Nigeria to determine the effect of parity and stage of lactation on milk yield, and relationship between serum constituents and milk yield of Friesian x Bunaji cows. The cows were classified according to their days in milk production (DIM) and physiological status and parity number. The daily milk yield records were used to determine average daily milk yield in litres (l). Records of parity and days in milk for selected animals were collected from records kept at dairy programme unit of NAPRI. Whole blood was collected from each animal through its jugular vein prior to feeding in the morning and serum was separated to determine certain serum constituents. Commercial kits were used to determine total protein (Tp), albumin, total cholesterol, glucose, aspartate aminotransferase (AST), alanine amino-transferase (ALT), alkaline phosphatise (ALP), calcium, phosphorus according to standard procedures. Globulin and albumin/globulin were calculated. The milk yield of cows in second parity was significantly higher ($P<0.05$) than cows in first parity. The stage of lactation had no significant effect ($P>0.05$) on the milk yield of cows in early and mid-lactations. There were significant differences ($P<0.05$) in the selected serum electrolytes (calcium and phosphorus), enzymes, total protein and cholesterol of lactating and dry (pregnant) Friesian x Bunaji cows. A significant ($P<0.01$) positive correlation was obtained between serum cholesterol and milk yield. A low positive correlation for serum phosphorus and serum albumin:globulin ratio while negative correlations were obtained for AST, ALT, ALP, Calcium, Tp, serum glucose. Parity significantly ($P<0.05$) affected milk yield. DIM did not significantly ($P>0.05$) influence milk yield. An increase in serum cholesterol would positively determine milk production of Friesian x Bunaji cows.

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INTRODUCTION

Traditionally, selective breeding in livestock was aimed at improving the genetic potential of indigenous breeds of animals to enhance their productivity (Williams, 2005). The diversity of phenotype displayed by the various breeds of livestock is controlled by an equally broad genetic diversity, which provides opportunity for the selection of animals with superior performance in specific desirable traits such as milk yield. According to Naqvi (2007), conventional animals breeding programs depend on selection based on phenotypic traits, whereby traits which can be measured directly and animals with superior performance in the traits are used as breeding stock; where the traits is limited, such as milk production, progeny test schemes have allowed the genetic merit of the sex which do not display the trait to be estimated.

The productivity of indigenous tropical breeds of cattle is generally low, with late maturity, wide calving interval and low milk yield (Isaac and Olutogun, 2007) and attempts have been made to improve their productivity by introducing exotic cattle breeds in form of bulls' semen to increase milk yield. The Bunaji breed has been used in cross breeding programmes in National Animal Production Research Institute (NAPRI) Nigeria. The Holstein Friesian, an exotic breed is high milk producing dairy cattle breed (Maule, 1990). The high productivity in dairy enterprise is a function of both inherent efficiency of the cow and the application of the knowledge which has been accumulated as the result of research on dairy production. With the limitation placed on the introduction of exotic breeds of cattle into the country, it has become necessary that the genetically potential of the crosses of exotic and indigenous cattle breeds must be evaluated to enhance the purpose to which they were kept on the farm.

The objectives of this study is thus to determine the effect of parity and stage of lactation on milk yield, compare certain serum parameters relevant to milk production in dry (pregnant) and lactating cows, to determine if there are linear relationships with the serum parameters and milk yield.

MATERIALS AND METHODS

Study location

The study was conducted at the dairy cattle section of National Animal Production Research Institute (NAPRI) Shika, Zaria. This is located at latitude 11^0 15'N, and longitude 7^0 32'E at an altitude of 667m above the sea level and found within the Northern Guinea Savannah ecological zone of Nigeria. The wet season is usually from April through October and rainfall averages between 102 – 203 mm (Microsoft® Encarta premium, 2009). The prevailing vegetation of tall grass and big trees are of economic importance during both the wet and dry seasons.

The study was undertaken in the month of June, 2012. The average rainfall was about 120.6 – 146.2mm in the data collection period. Relative humidity ranged from 93.75 to 95.25 maximum and 43.13 to 61.75 minimum. Ambient temperature was between 22.5 and 35.6^{o}C. Average wind speed within the data collection period was mostly 7 to 10 knots and 11 to 16 knots signifying gentle or moderate breeze (Nigerian Meteorological Agency). Rearing of large and small ruminants, various types of poultry and cultivation of grains and vegetables are carried out in these areas.

Experimental Animal and Management

The experimental animals were fifteen female Friesian x Bunaji crosses. The experimental animals were housed in stalls. The cows were ear tagged for identification and record keeping purpose. The animals were grazed on mixed pasture under the close supervision of herdsmen for about 7 to 8 hours daily. Two kilograms of concentrate mixture (87% dry matter, 15% crude protein and 55%total digestible nutrients) fortified with a mixture of minerals were offered to each animal daily. Feed and water were supplied *ad libitum*. Regular dipping of the animals using an acaricide, (Amitix®) was carried out.

The cows were classified according to their days in milk (DIM) and physiological status (Mohebbi – Fani *et al.*, 2005); and parity number. Ten cows were in lactating (five in early lactation, five were in mid lactation) while five were dry, pregnant cows. The days in milk were: Early lactation $\leq$ 70 days; mid lactation 71 – 140 days. The physiological status was classified as lactating and dry (pregnant) cows. Parity was described as first (1) and second parity (2). Five cows were in first parity, five cows were in second parity).

Sample and data collection

Cows were hand – milked twice daily (morning and evening) commencing three to five days postpartum. The daily milk yields was recorded in litres (l) and measured using a calibrated measuring cylinder. Average daily milk yield was calculated,

Average daily milk yield = Total milk yield/ Number of days in milk

Two kilogram of concentrates was offered to each animal before milking served as conditioning for milk let - down. Records of parity and days in milk for selected animals were collected from records kept at dairy programme unit of NAPRI.

About 10ml of blood were collected from each animal through its jugular vein prior to feeding in the morning, into a plain sample bottle that was free of anticoagulant once a week for two weeks. Collected blood samples were transported immediately to the laboratory for analysis. The samples were centrifuged to separate the serum. The serum glucose was determined immediately after serum collection. The remaining blood serum was stored in bijou bottles at – 20^0C in a refrigerator pending biochemical analysis for other serum parameters. The following parameters were analysed according to standard procedures:

Total protein was determined using a commercial kit, *LABKIT®-biuret, colorimeter method*.

Albumin was analysed using a commercial kit, *LABKIT® containing Bromoscresol green colorimeter method*. The globulin values were determined by subtracting the value of albumin obtained from the value of the total protein obtained per sample. The albumin/globulin value was obtained by computing the ratio of their individual values. The total cholesterol was determined using a commercial kit, *LABKIT® CHOLESTEROL CHOD-POD, Enzymatic–Colorimetric.* Glucose value was determined using a commercial kit, AGAPPE® and analysis was carried out immediately the serum was harvested as the value change with time. Aspartate aminotransferase (AST) was determined using a commercial kit, LABKIT® GOT/AST MDH – NADH, Kinetic UV. Alanine aminotransferase (ALT) was determined using a commercial kit, LABKIT® GPT/ALT LDH – NADH Kinetic UV.Alkaline phosphatase (ALP) was determined using King – Armstrong method. Calcium and phosphorus were determined by automation using Audicom® electrolyte analyser.

Statistical Analysis

Data was analyzed using the General Linear Model (GLM) procedure of SAS (2002). Means were separated using square error of means (SEM). Pearson correlation of SAS (2002) was used to determine linear relationships between the serum chemistry parameters and milk yield.

RESULTS AND DISCUSSION

Effect of stage of lactation and parity on milk yield

The milk yield of cows that were less than 70days in lactation were not significantly ($P > 0.05$) different from cows which had been lactating for 71 – 140 days (Table 1). Parity influenced the quantity of milk yield (P<0.05). This is similar to previous reports (Nili – Ravi Buffaloes, Afzal*et al*., 2007; Sahiwal cattle, Tahir*et al*., 1989, Bajwal *et al*., 2004) that milk yield was lower in the first parity than in subsequent parities. This could be as a result of increase in the number of secretory cells of the alveoli and size of mammary gland.

In Table 2, there were significant (P<0.05) differences in the concentrations of serum electrolytes (Ca and P) of the lactating and dry Friesian x Bunaji crosses. The concentration of serum enzymes, AST and ALP were significantly (P < 0.05) higher in the dry cow than in the lactating cows, however the physiological status did not significantly influence concentration of ALT in this study. Blood constituents such as serum protein, albumin, AST, ALT and cholesterol levels have been reported (Otto *et al.*, 2000; El – Sherif and Assad, 2001) to be affected by physiological status of cows. In this study, AST was significantly (P<0.05) higher in lactating cows than in dry, pregnant cows. Ling *et al.* (2003) also reported that AST was low in dry periods but increased during day 117 and 151 of lactation in Estonian Holstein cows. However, the enzyme has been reported (Yildiz *et al.*, 2005) to increase in concentration during the dry period in cows. The serum enzymes, AST and ALT, create the structural components of the body of the foetus in pregnant animals, hence are important for pregnancy. According to Milinkovic – Tur *et al*. (2005), the activities of aminotranferases (such as AST and ALT) in the blood are associated with implantation, embryo survival, growth, uterine carbohydrate metabolism, amino acid metabolism and glycogen deposition.

Serum calcium was significantly (P<0.05) higher in dry (pregnant cows) than in the lactating cows. This is because after calving and lactation commence, hypocalcemia is inevitable as a result of tremendous challenge to the cow's ability to maintain calcium homeostatis (Carlos *et al*., 2013).

A significant (P<0.05) difference was observed between the serum total protein, albumin, and cholesterol of lactating and dry Friesian x Bunaji cows in this study. This is similar to the findings of Antunovic *et al.*(2002) in ewes. El – Sherif and Assad (2001) reported that physiological status of cows significantly affects serum protein, albumin and cholesterol levels). However, Yildiz *et al.* (2005) reported that total proteins and albumin were not affected in the gestation period.

There were significant (P<0.05) differences in the concentration of serum cholesterol. The total serum cholesterol was lower in dry cows. According to Yildiz *et al.* (2005), serum cholesterol levels decrease in the dry period and towards the end of gestation. This is because a decline in cholesterol level during the dry period indicates a rise in nutrients demand of the developing foe in the uterus and that the hormonal level of estrogen with thyroxin played a vital role in reducing the cholesterol level during pregnancy (Hagawane *et al*., 2007). Several authors have also reported low concentration of cholesterol at end of pregnancy (in Friesian cows, Tainturier *et al*., 1984; in buffaloes, Bekeova *et al*., 1987; and in goats Krajnicakova *et al*., 2003).

Table 1: Effect of Days in milk and parity on milk yield of Friesian x Bunaji crosses

	Average daily milk yield (l)	SEM
Stages of lactation		
≤ 70days	31.50 ± 5.00	4.39
71-140 days	30.00 ±7.19	
Parity		
1	13.83 ±5.31[b]	4.39
2	26.33 ±5.24[a]	

[ab]Means with different superscripts in the same column and for the same factor/ variable were significantly different (P<0.05).

Table 2: Serum electrolytes and enzymes of lactating and dry Friesian x Bunaji cows

Parameters	Lactating cows	Non-lactating cows	SEM
Ca(mm1/1)	4.79 [b]± 0.03	4.92[a]±0.04	0.02
P(mmol/l)	3.92[a] ±0.16	3.51[b]±0.23	0.13
ALT (IU/L)	28.70±1.74	28.40±2.46	1.42
AST(1U/L)	73.80[b]±3.49	80.80[a]±4.92	2.85
ALP(IU/L)	89.50[b] ±12.88	132.60[a] ±18.21	10.52

[a,b]Means in the same row with different superscript differs (P<0.05) significantly, Key: Calcium (Ca), Phosphorus (P); Aspartate Amino Transferase (AST); Alanine AminoTranferase (ALT); Alkaline Phosphatase (ALP).

Table 3: Mean of serum biochemical constituents for both lactating and dry Friesian x Bunaji cows

Parameters	Lactating cows	Non-lactating cows	SEM
Tp (g/dl)	10.49 [b] ± 0..19	11.10 [a] ±0.29	0.16
Alb (g/dl)	3.68 [b] ±0.24	4.30 [a] ±0.34	0.20
Gl (g/dl)	6.87±0.19	6.80±0.19	0.16
Alb / Gl	0.55±0.14	0.63±0.14	0.12
Glucose (mmol,l)	6.56±0.19	6.56±0.26	0.15
Ch (mg/dl)	8.61±0.60[a]	7.06±0.84[b]	0.49

[ab]Means in the same row with different superscript differs (P<0.05) significantly, Key:Total protein (Tp); Albumin (Alb); Globulin (Gl); Albumin:Globulin ratio (Alb:Gl); Cholesterol (Ch).

Table 4: Correlation between the selected serum chemistry parameter and milk yield in the Friesan x Bunaji cows

Serum Chemistry Parameters	Milk yield (l)
Ca(mmo1/1)	-0.298±0.280
P(mmol/l	0.189±0.499
ALT (IU/L)	-0.238±0.392
AST(1U/L)	-0.122±0.664
ALP(IU/L)	-0.426±0.114
Tp (g/dl)	-0.234±0.402
Alb (g/dl)	0.212±0.449
Gl (g/dl)	-0.312±0.258
Alb / Gl	0.244±0.381
Ch (mg/dl)	0.504±0.055[**]
Glucose (mmol)	-0.311±0.259

P≤ 0.01.[**]highly significant correlation

Key Calcium (Ca), Phosphorus (P); Aspartate Amino Transferase (AST); Alanine AminoTranferase (ALT); Alkaline Phosphatase (ALP);Total protein (Tp); Albumin (Alb); Globulin (Gl); Albumin:Globulin ratio (Alb:Gl); Cholesterol (Ch).

The serum glucose level in this study was above the normal (1.9 – 3.8mmol/l) range for cattle (Kaneko *et al.*, 1997). There was significant (P<0.05) difference between serum glucose of lactating and dry cows which may be due glucoses being an insensitive index of energy status as it is under strong hormonal control (Herdt, 2000).

There was a highly significant (P <0.01) positive relationship between the milk yield and serum cholesterol concentration indicating that the higher the milk yield the higher the serum cholesterol concentration. The result may be attributed to the stage of lactation of the cows,Yaylak *et al.*(2009) reported that serum cholesterol levels was high in cows in DIM of 70 – 140. Ling *et al.* (2003) also reported that serum cholesterol levels were low in early lactation and increased gradually to peak at mid lactation. Ruegg *et al.* (1992) have also reported significant relationship between serum cholesterol level and milk yield.

Negative correlations were reported for serum AST, ALT, ALP, total protein, Ca, and glucose in this study. Mohebbi–Fani *et al.* (2005) reported a similar result on lactating Friesian cows where there were no significant, negative correlations between milk yield and serum glucose, total proteins, and albumin. A low non-significant positive correlation was reported for serum phosphorus and serum albumin: globulin ratio.

Conclusion and recommendations

The stage of lactation in this study did not significantly influence the milk yield of Friesian x Bunaji cows in early and mid – lactation, while the quantity of milk yield was significantly influenced by the parity of Friesan x Bunaji cows. Milk yield was higher in the second parity than the yield of cows in the first parity. The physiological status of the Friesian x Bunaji cows influenced the serum constituents such as total protein, albumin, cholesterol, calcium, AST and ALP. Serum cholesterol concentration had a significant positive relationship with milk yield of the Friesan x Bunaji cows indicating that the higher the serum cholesterol level, the higher the expected milk yield of Friesan x Bunaji cows. Further study could be extended to the late lactation stage and higher parity to evaluate their effect on milk yield.

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