

## Milk yield and composition of lactating Friesian x Bunaji cows supplemented with dietary vitamin E and selenium

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### Abstract

Vitamins and minerals are essential in milk production of dairy cows. This is because these micronutrients are sometime neglected or deficient in the diet. Therefore, supplementation of feed grade vitamins and minerals need to be maximized for improved milk production in dairy cows. The study was carried out to evaluate the effect of selenium and vitamin E on milk yield and composition of Friesian x Bunaji lactating cows. Twenty lactating Friesian x Bunaji cows in their early lactation were used. The study consisted of four treatments with five animals per treatment in a Completely Randomized Design (CRD). Treatment I served as control without selenium or vitamin E supplementation, Treatment II was supplemented with 3 mg of feed grade selenium; Treatment III, with 20 mg of feed grade Vitamin E; and Treatment IV was administered a combination of 3 mg feed grade selenium and 20 mg of vitamin E. The treatments were given once a week, while the animals were given free access to feed and water provided ad libitum. The cows were fed the treatment diets once a week until calving and milked for 90 days. Milk yield and ash content were higher ( $P < 0.05$ ) for lactating Friesian x Bunaji cows fed Se + vitamin E supplemented diets than in other groups while milk composition properties were all similar ( $P > 0.05$ ). Magnesium (14.73 – 81.27 mg/l), potassium (1700.30 – 2449.80 mg/l) and phosphorus (1362.90 – 2151.50 mg/l) had higher ( $P < 0.05$ ) values milk mineral composition of Se, vitamin E and Se + vitamin E supplementation for Friesian x Bunaji cows. It can be concluded that vitamin and selenium supplementation improved milk yield and composition.

**Keywords:** Friesian x Bunaji, Selenium, vitamin E, milk composition

### Rendement du lait et composition des vaches de la Bunaji X Friesian, complétée par l'alimentaire de vitamine E et un sélénium



### Résumé

Les vitamines et les minéraux sont essentiels dans la production de lait de vaches laitières. En effet, ces micronutriments sont parfois négligés ou déficients dans le régime alimentaire. Par conséquent, la supplémentation de vitamines et de minéraux de qualité alimentaire doit être maximisée pour améliorer la production de lait chez les vaches laitières. L'étude a été réalisée pour évaluer l'effet du sélénium et de la vitamine E sur le rendement en lait et la composition des vaches de lactation X Bunaji X Bunaji. Vingt vingt allaitant des vaches de la Bunaji dans leur petite lactation ont été utilisées. L'étude consistait en quatre traitements avec cinq animaux par traitement dans une conception complètement randomisée (CCR). Traitement J'ai servi de contrôle sans supplémentation de sélénium ou de vitamine E, le traitement II a été complété par 3 mg de sélénium de qualité alimentaire; Traitement III, avec 20 mg de vitamine E de qualité alimentaire; Et le traitement IV a été administré une

combinaison de 3 mg de sélénium de qualité d'alimentation et de 20 mg de vitamine E. Les traitements ont été administrés une fois par semaine, tandis que les animaux ont reçu un accès gratuit à l'alimentation et à l'eau fournis à la publicité. Les vaches ont été nourries les régimes de traitement une fois par semaine jusqu'à ce que le vêlage et la traite pendant 90 jours. Le rendement au lait et la teneur en cendres étaient plus élevés ( $p < 0,05$ ) pour allaitant les vaches de la Bunaji X BunajiFeed SE + Vitamine E des régimes complémentaires que dans d'autres groupes, tandis que les propriétés de la composition du lait étaient toutes similaires ( $p > 0,05$ ). Magnésium (14,73 - 81,27 mg / L), potassium (1700,30 - 2449.80 mg / L) et phosphore (1362,90 - 2151.50 mg / L) avaient plus élevé ( $p < 0,05$ ) Valeurs Composition minérale en lait de SE, Vitamine E et SE + Vitamine E Supplément pour les vaches de la BunajiFriesian X Bunaji. On peut conclure que la supplémentation de vitamines et de sélénium améliore le rendement et la composition du lait.

**Mots-clés:** Friesian X Bunaji, sélénium, vitamine E, composition de lait

## Introduction

Vitamins and minerals play an important role in the growth of animals and their reproductive performance. Antioxidants have been defined as substances that delay or inhibit oxidative damage to cellular molecule (Gutteridge *et al.*, 1994). Vitamin E and selenium are essential nutrients that have complementary biological functions as antioxidants to minimize cellular damage caused by endogenous peroxides (Kolb *et al.*, 1997). Selenium has a biological function related to vitamin E in that selenium is an essential component of GPx, an enzyme involved in detoxification of hydrogen peroxide and lipid hydroperoxides. According to Muñiz-Naveiro *et al.* (2005), the highest selenium levels were found in milk whey (56.6%) while the lowest level was found in the fat phase (10.1%). A fraction of 55%–75% of selenium found in milk is incorporated in casein, while of 17%–38% is contained in the whey and 7% are localized in fat (Van Dael, 1991). These findings do not vary with the type of ingested selenium (Muñiz-Naveiro *et al.*, 2005). The selenium content in milk varies mainly with the amount of selenium in the diet of cows. Ivancic and Weiss (2001) derived the equation highlighting a positive correlation existing between plasma and milk selenium content:  $y = 0.37x - 4.2$ , with  $x = [\text{Se}]$  in the plasma

(g/L) and  $y = [\text{Se}]$  in the milk (g/L). The amount of selenium in the milk is directly proportional to the organic selenium content in the feedstuffs of cows (Ceballos *et al.*, 2009; Meyer *et al.*, 2014). Ceballos *et al.* (2009) reported that on the average, cows fed organic selenium have 0.37 mol/L more milk selenium than cows supplemented with inorganic forms. The addition of selenium yeast or sodium selenite in the cow feeds increases significantly selenium content (Hork' y, 2015), the percentage of the polyunsaturated fatty acids (PUFA) and linoleic acid content in milk compared to the control (Ran *et al.*, 2010). The increase of parameters is more pronounced in case of selenized yeast as compared to sodium selenite supplementation. In addition, organic selenium supplementation in the rations of dairy cows in form of selenised yeasts was shown to increase selenium concentration in milk, reaching levels up to 190% higher as compared to milk from cows supplemented with inorganic selenium (Ortman and Pehrson, 1999). The same difference was observed by Salman *et al.* (2013) in milk and colostrum. Conversely, selenium supplementation of feedstuffs appears to have no significant effect on milk production in cows and its chemical composition (in terms of fat, protein, lactose) (Ran *et al.*, 2010; Salman

*et al.*, 2013; Horky, 2015). Supplementation of selenium combined with iodine and cobalt in the form of a ruminal bolus has been reported to have positive effect on milk production (Cook and Green, 2010), or when selenium is combined with vitamin E (Eulogio *et al.*, 2012). Eulogio *et al.* (2012) reported also an increase in percentage of crude protein, solids non-fat and lactose, when selenium supplementation is combined with vitamin E. This increase in milk production of the cows is not observed when the trace element association is made as an injection. It has been established that Vitamin E supplementation has an encouraging consequence not only on animal health, but also on milk quality. Results from most studies (Baldi *et al.*, 2000, Politis *et al.*, 1995, Politis *et al.*, 2004) sturdily suggest that high levels of Vitamin E supplementation (2000-3000 UI/cow per day) during the periparturient period are effective in reducing milk Somatic Cells Count by about 29% in treated cows. Furthermore, as an antioxidant Vitamin E helps to retard lipid peroxidation and to maintain oxidative stability and flavour of milk (Vagni *et al.*, 2011). Bovine milk is susceptible to auto-oxidation when the level of vitamin E falls below 20 µg/g of fat and this leads to the development of an “oxidized flavour” (OF), described as cardboard-like, metallic or tallow-like (Atwal *et al.*, 1990). The fatty acid profile of milk fat is a major factor in the development of oxidized flavour, and milk with a high concentration of polyunsaturated fatty acids, as linoleic or linolenic acid, is more likely to develop oxidized flavour (Weiss, 2005). There has been a considerable interest in developing specific animal feeding regimes in order to increase the polyunsaturated lipid content of milk, and in particular the content of fatty acids thought to benefit human health, such as conjugated linoleic acids (Vagni *et al.*, 2011). Therefore, the objective of the study

was to evaluate the effect of selenium and vitamin E supplementation on milk yield and composition of lactating Friesian x Bunaji cows.

## **Materials and methods**

### ***Study location***

The study was conducted at the Dairy Research Programme farm of the National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika-Zaria, Nigeria. Shika is located in the Northern Guinea Savannah zone and lies on latitudes 11° 06' 40" N and longitudes 7° 43' 21" E at an elevation of 644 m above sea level, with an annual maximum and minimum temperature of 31.0 ± 3.2°C and 18.0 ± 3.7°C, respectively. Shika-Zaria has an average annual rainfall of 1100 mm, usually lasting from May to October, 2017 with a mean relative humidity of 72 %. The dry season lasts from November to April, 2017 with the mean daily temperature, ranging from 15 – 36°C, and mean relative humidity ranging from 20 – 37 % (IAR, 2017).

### ***Experimental design and management of animals***

A total of 20 lactating Friesian x Bunaji cows with an average weight between 300 and 350 kg were used for this study. There were four treatments in each experiment. The animals were divided into four groups of five animals, and the animals were randomly assigned the treatments in a completely randomized design (CRD).

Treatment I served as the control with no administration of either selenium or vitamin E. Treatment II was administered with 3 mg of feed grade selenium. Treatment III was administered 20 mg of feed grade vitamin E. Treatment IV received a combination of 3 mg feed grade selenium + 20 mg of vitamin E. They were supplemented at weekly interval for the period of 90 days between April and June, 2017

The animals were allowed to graze on

pastures (*Digitariasmutsi*), crop residues and supplemented with a concentrate diet, consisting of 48 % cotton seed cake, 13.7% wheat bran, 35.3% maize, 2% bone meal, 1% common salt; the diet comprised about 88% dry matter, 15% crude protein and 55% total digestible nutrients. Water was provided *ad libitum*. All the experimental animals were ear-tagged for ease of identification. The animals were dipped once a week during the dry season and twice a week during the wet season for effective control of ectoparasites.

#### **Source of mineral and vitamin**

Selenium and vitamin E were purchased from Hi-nutrients International, Lagos, Nigeria.

Permission was obtained from the Committee on Animal Use and Care, Ahmadu Bello University, Zaria with the Approval No: **ABUCAUC/2017/004**

#### **Data collection**

They were hand milked twice daily; in the morning (07:00 hours) and in the evening (17:30 hours) for a period of 90 days. Daily milk yield was recorded in litres for the period of 90 days. Milk samples were collected at the end of the experiment into sample bottles and stored at 4°C until analyzed at the Central Laboratory of National Animal Production Research Institute (NAPRI) for fat, crude protein, pH, titratable acidity, milk gravity, solid not fat (SNF), total solid (TS), ash, calcium, sodium, potassium, phosphorus and magnesium were analyzed using the method of AOAC (2001).

#### **Statistical analysis**

Data generated were analysed using the General Linear Model of SAS (2002). Significant means were compared using Dunnett (1964).

Model:  $Y_{ij} = \mu + T_i + e_{ij}$

Where:

$Y_{ij}$  = observation

$\mu$  = overall mean

$T_i$  = fixed effect of the  $i^{\text{th}}$  treatment

$e_{ij}$  = random error

#### **Results and discussion**

The milk yield and ash content were higher ( $P < 0.05$ ) for Friesian x Bunaji cows with Se + vitamin E supplementation compared to the other treatments as represented in Table 1. There were no signs of both sub or clinical signs of mastitis in all the experimental treatments. Milk fat, crude protein, solid-not-fat, total solids, dry matter, pH, titratable acidity and gravity were all similar ( $P < 0.05$ ). Milk yield and DM increased between the control and Se treatments, declined with vitamin E treatment, and then increased again with Se + vitamin E treatment. The ash content decreased between the control and Se treatment, and then increased with Vitamin E and Se + Vitamin E treatments. Other parameters did not follow a particular fashion. Milk gravity was constant (1.03) across the treatments. The milk yield and ash content were higher ( $P < 0.05$ ) for Friesian x Bunaji cows with Se, vitamin E and Se + vitamin E supplementation. Milk fat, crude protein, solid-not-fat, total solids, dry matter, pH, titratable acidity and gravity were all similar ( $P < 0.05$ ) in the supplemented and control cows. There were no signs of both sub or clinical signs of mastitis in all the treatments even though selenium deficiency has economically significant implications on incidence of mastitis (Eulogio *et al.*, 2012; Sordillo, 2013). Milk production in Friesian x Bunaji cows for the control treatment was 443.00 litres, while treatments supplemented with Se, vitamin E, and Se + vitamin E recorded the values of 820.20 litres, 751.20 litres and 835.89 litres, respectively. This result is an indication that Se and vitamin E improved milk production (Cook and Green 2010; Eulogio *et al.*, 2012). The result obtained in this study is in contrast to that of other

**Table 1: Effect of Selenium, Vitamin E and Selenium + Vitamin E supplementation on milk yield and composition of Friesian x Bunaji cows**

Parameters	Control	Se	Vit-E	Se+ Vit-E	SEM	P-value
Milk yield (litres) 90 days	443.00 <sup>b</sup>	820.20 <sup>a</sup>	751.20 <sup>a</sup>	835.80 <sup>a</sup>	79.555	0.0098
Fat (%)	3.67	3.55	3.60	3.59	0.08	0.7456
Crude protein (%)	4.34	4.24	4.75	4.37	0.15	0.1314
Solid not fat (SNF) (%)	8.93	8.85	8.96	8.98	0.06	0.4532
Total solids (%)	12.60	12.40	12.55	12.48	0.009	0.4778
Ash	0.62 <sup>b</sup>	0.54 <sup>b</sup>	0.56 <sup>b</sup>	0.77 <sup>a</sup>	0.03	0.0003
Dry matter	11.81	13.86	13.58	15.18	1.12	0.2460
pH	6.54	6.52	6.62	6.52	0.41	0.2985
Titrateable acidity	0.11	0.32	0.12	0.12	0.10	0.4217
Milk Gravity	1.03	1.03	1.03	1.03	0.00	0.814

<sup>ab</sup>Means within the same row having different superscript letters are significantly (P<0.05) different. Se - Selenium, Vit-E - Vitamin E, SEM - Standard Error of Mean.

**Table 2: Effect of Selenium, Vitamin E and Selenium + Vitamin E supplementation on milk mineral composition of Friesian x Bunaji cows**

Parameters (Mg/L)	Control	Se	Vit-E	Se + Vit-E	SEM	P-value
Calcium	672.50	839.61	746.81	841.29	55.97	0.1385
Magnesium	14.73 <sup>b</sup>	39.26 <sup>ab</sup>	55.81 <sup>ab</sup>	81.27 <sup>a</sup>	13.83	0.0246
Potassium	1700.30 <sup>b</sup>	2147.30 <sup>ab</sup>	1786.10 <sup>ab</sup>	2449.80 <sup>a</sup>	184.58	0.0400
Sodium	679.00 <sup>ab</sup>	878.10 <sup>ab</sup>	1076.60 <sup>a</sup>	541.40 <sup>b</sup>	120.45	0.0321
Phosphorus	1362.90 <sup>b</sup>	1735.80 <sup>ab</sup>	1617.50 <sup>b</sup>	2151.50 <sup>a</sup>	126.97	0.0038

<sup>abc</sup>Means within the same row having different superscript letters are significantly (P < 0.05) different. Se - Selenium, Vit-E - Vitamin E, SEM - Standard Error of the Mean.



authors (Ran *et al.*, 2010; Salman *et al.*, 2013; Horky, 2015), who reported no significant difference in milk production in cows, whose diet were supplemented with Se. The increase in milk production could be attributed to the antioxidative activities of Se and vitamin E scavenged for ROS, thereby reducing oxidative cell damage and channeling all energy to milk production. The ash (0.54 – 0.77) content of milk were similar in all the treatment groups. This finding was lower than the value reported by Cayot (1998). The result of the present study could be due to the synergistic role of Se and vitamin E as antioxidants, thereby reflecting in the milk mineral composition as the ash content is always a reflection of the mineral content.

The calcium values were similar ( $P>0.05$ ) in all the treatment groups. Magnesium, potassium, sodium and phosphorus values were similar ( $P<0.05$ ) in all the treatment groups. Magnesium, potassium and phosphorus had higher ( $P<0.05$ ) values with Se + vitamin E supplementation on milk mineral composition of Friesian x Bunaji cows than in other treatments. Sodium was higher ( $P<0.05$ ) in milk of Friesian x Bunaji cows with vitamin E supplementation. The mineral concentrations did not follow a particular pattern, but fluctuated with the treatments. Besides, sodium recorded the highest value with vitamin E treatment, while all other parameters measured were highest with the Se + vitamin E treatment.

The calcium values were similar ( $P>0.05$ ) across the treatment groups. There were significant ( $P<0.05$ ) differences in magnesium, potassium, sodium and phosphorus values. Magnesium had higher ( $P<0.05$ ) values with Se, vitamin E, and Se + vitamin E supplementation. Potassium had higher values in all the treatments, except the control while phosphorus was higher in Se, and Se + vitamin E supplementation on milk mineral

composition of Friesian x Bunaji cows. Sodium was higher ( $P<0.05$ ) in milk of Friesian x Bunaji cows in the control, vitamin E and Se treatments. The milk magnesium (14.73 – 81.27 mg/l), potassium (1700.30 – 2449.80 mg/l), sodium (541.40 – 1076.60 mg/l) and phosphorus (1362.90 – 2151.50 mg/l) values were similar, but disagree with the findings of other others (Ran *et al.*, 2010; Salman *et al.*, 2013; Horky, 2015), who reported that supplementation had no effect milk mineral composition. This could be a reflection of the effect of supplementation on the ash content of the milk, which has a direct relationship to the mineral content of a material. The combination of Se and vitamin E treatment recorded the highest values except for the mineral sodium. This result could be attributed to the finding that sodium does not complement either selenium or vitamin E. The high values recorded could be attributed to the synergistic role of Se and vitamin E (Eulogio *et al.*, 2012).

## **Conclusion**

The study showed that vitamin E and selenium supplementation were effective in improving milk yield, ash, magnesium, potassium, sodium, phosphorus of lactating Friesian x Bunaji cows due to antioxidative efficacy that delayed or inhibited oxidative damage to cellular molecule. Vitamin E and selenium are essential nutrients that have complementary biological functions as antioxidants to minimize cellular damage caused by endogenous peroxides.

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