International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 5 Issue 5, July-August 2021 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Quantitative and Qualitative Attributes of Milk Produced by Lactating Bunaji Cows Fed Shea Cake (*Vitellaria Paradoxa*) Supplement

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ABSTRACT

Quantitative and qualitative attributes of lactating Bunaji cows fed shea cake meal supplement was investigated. Sixteen (16) lactating Bunaji cows were allotted to four (4) dietary treatments comprising of Four (4) animals per treatment in a completely randomized experimental completely design. Milk collection began from 7th day of calving for each animal. The result were significantly (P<0.05) different across the treatments. First seven (7) weeks of milk collection recorded increasing yield for all treatments. Total yield for T1, T2, T3, and T4 at twelfth were 185.64kg, 240.52kg, 301.70kg, 250.95kg respectively. There was no significant (P>0.05) difference among the treatments for Total solids (TS) at T2, T3, and T4. Protein recorded a values range of 3.25% (T1) to 3.85% (T3). Fat content had 3.25%, 3.53%, 3.85% and 3.66% for T1, T2, T4 and T4, respectively. Ash content differed significantly (P<0.05) at TI (1.26%) and 1.06% (T2). Lactose was not significant different (P>0.05) at T2 and T3. T2(10kg supplement) recorded highest value of 6.50% above T3(5.30%) and T4(4.86%). Minerals (Calcium - Ca, Magnesiun - Mg, Sodium – Na, Phosphorus – P and Potassium- K) were significantly (P<0.05) different. Ca value ranged from 228.00 mg/100g (T1) to 245.00mg/100g (T3), Mg ranged from 72.00mg/g(TI) to 90.35 (T3). Na recorded 82.00mg/100g (T1) and 95.75mg/100g (T3), while P had a ranged values of 90.00mg/g (T1) to 98.90mg/g. K recorded the highest record value of 345.00mg/g; with no significant difference (P>0.05) at T2 and T3. The experiment showed shea cake as good supplement for lactating Bunaji cows.

KEYWORDS: *Lactating Bunaji cows, Shea cake, supplement, milk yield, milk composition*

How to cite this paper: Okunlola D. O | Amuda A. J | Olatunji O. O | Shittu M. D | Ojoawo O. T | Olaniyan O. S | Olateju B. O | Fasola A. A | Alao A. J "Quantitative and Qualitative Attributes of Milk Produced by Lactating Bunaji Cows Fed Shea Cake (Vitellaria Paradoxa) Supplement" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-5, August 2021, pp.2431-2438, URL: www.ijtsrd.com/papers/ijtsrd47750.pdf

IJTSRD47750

INTRODUCTION

The dairy industry of any nation is a major contributing factor to its economy. The import bill on milk and dairy products till date in Nigeria is high as nation still imports about 700 metric tonnes of milk to meet the requirement of ever increasing human population. Solving this problem requires improving the local breeds of cattle in Nigeria. Cattle provides more than 90% of the total annual domestic milk output in Nigeria (Walshe *et al.,* 1991) with the White Fulani breed recognized as the principal producer (Adeneye, 1989). Unfortunately, the domestic output of about 407,000 metric tonnes of milk (Olaloku, 1999) from an estimated 14 million cattle can hardly satisfy the dairy demands of an ever increasing population of Nigerians. Aside using imported semen to inseminate the local breeds, feeding of nutrient rich feed to improve their performance and milk yield and quality is a step in the right direction. Globally, cattle

rearing are predominantly aimed at milk and meat production. However, meat is the major product in many countries (Croston and Pollot, 1994). The main objective of any livestock enterprise is to convert feedstuffs into animal products at a faster and cheaper rate (Payne, 1990). Most small scale cattle farmers in Nigeria face a lot of challenges in generating income from the stock due to the slow growth rate, unstable weight gains related to seasonal imbalances of feed and reproductive problems (Annor *et al,* 2007). Hence, the need for improvement. Of the local breeds of indigenous cattle in Nigeria, White Fulani breed serves the dual purpose of meat and milk production. The breed represents 37% of the national herd (Alphonsos and Essien 2012). It is generally known that raising young animals on high concentrate diets results in higher daily gains, dressing percentage and carcass quality than on a forage system (Ahaotu *et al.,* 2017). The productivity of Cattle can be improved by improving the nutrition either by concentrate feeding or provision of additional forage. Feeding and management systems affect the productivity of animals. These animals display a unique ability to adapt and survive in areas where they are found and consequently their wide geographical distribution in Nigeria.

Poor nutrition and low reproductive performance have been highlighted as some of the major factors affecting milk production from our indigenous cattle breeds (Olaloku, 1999). The agro-pastoral system of cattle production in Nigeria provides nourishment for stock only on range and this present with difficulties especially in the dry season. Crop residues remains important sources of feed for livestock Production in most developing countries especially Nigeria. Apart from crop residues, agro-by- products are useful sources of nutrition for ruminants owing to the development of small scale industries. One agro-by-product which needs to be examined for its role in ruminant nutrition is Shea cake (SC). Shea cake is gotten from solidified effluent from the production of shea butter, an extraction from shea nuts produced by shea tree (*Vitellaria paradoxa)*, a multi- purpose plant highly valued for the fat obtained from its seeds. The plant grows wild in the savannah zone of Africa. In Nigeria, Shea trees are widely produce about 135,000 tonnes of nuts per annum (Adomako, 1985). There are two main methods of shea butter extraction which are traditional method and mechanical methods. Extraction procedures in the two methods follows similar processes which are cold press method and hexane/chemical method respectively (Agyente and Kwame. 2010). Following extraction of butter from the nuts, the discharged effluent (Waste) solidifies in earthen or concrete tank. This effluent is nutrient rich with potentials to meet the nutritional requirement of ruminant animals, hence, the reason for feeding this nutritious but underutilized feed resource to lactating White Fulani cows with the purpose of improving the qualitative and quantitative attributes of the milk produced.

MATERIALS AND METHODS

Location of the study

The study was conducted at Ruminant Unit of the Teaching and Research Farm and Animal Nutrition and Biotechnology laboratory of Ladoke Akintola University of Technology, and Gaa Amodu Fulani settlement in Ogbomoso, Oyo State, in South West Nigeria. Ogbomoso is in the derived savanna zone, and at about 600 m about sea level and located on latitudes 8^{o} 07' and 8^{o} 12' N and longitudes 4^{o} 04' and 4^{o} 15' E (Oguntoyinbo, 1978). The town has a maximum temperature of 33^{o}C and a minimum temperature of 28^{o}C. The humidity of the area is high (74 %) with annual rainfall of over 100 mm (Olaniyi, 2006). The location has good population of browse plants and grasses, especially *Pennisetum purpureum* and *Panicum maximum.*

Preparation of Experimental Diets - Solidified effluent (Shea cake) was collected from four (4) different shea butter production factories located in the derived savannah area of Oyo State namely, Ofiki, Ipapo, Saki and Tede. Samples of the experimental diets were taken and stored in a covered plastic container for laboratory analysis; following the procedures of (AOAC, 2003). Of the samples from various locations, shea cake sample from Saki had best composition compared to others; following laboratory examinations, and was adopted as experimental diet for this research alongside ruminant premix which was made available to all experimental animals.

Experimental Animals

Sixteen (16) lactating Bunaji cows were used for the study. The animals were fed 0kg, 5kg, 10kg, and 15kg shea cake processed from solidified effluent from shea butter production. The animals were allotted to four treatments comprising of Four (4) animals per treatment in a completely randomized experimental design. The experimental animals were tethered while feeding the supplement; to prevent crossing to each other's allotted feed after finishing the quantity available to them. The animals were tagged for identification purpose and were released for grazing on daily basis throughout the period of the experiment.

Duration of experiment

The experiment lasted for seven (7) months with milk collection of 84 days for each of the animals. Since

the experimental animals were not synchronized to facilitate group calving. Adequate gestation record was ensured for each experimental animal. Feeding of experimental diets for each animal commenced at the last phase of gestation, prior to calving.

Evaluation of experimental diets

Proximate composition of shea cake was carried out according to the procedure of AOAC (2003). The crude protein was determined by the Kjeldahl method as described by AOAC (2003). Crude fiber determination was carried out using trichloroacetic acid (TCA) method. The ash and crude fat content were obtained by charring in furnace and extraction with ether. Analysis of selected minerals of interest (Ca, K, Mg, Na and P) was determined by wet digestion of samples; using Atomic Absorption Spectro-photometer (AAS).

Milk collection

Milking commenced seven (7) days post-partum to give calves access to sufficient colostrum. Thereafter, calves were allowed to suckle for 20 minutes at 9.00, 12.00 and 15.00 h daily. Milk intake by calves was estimated using the weigh-suckle-weigh method (Williams *et al.,* 1979). Animals were hand milked once daily between 7.00 and 9.00 h. Milk off-take was measured daily using a measuring cylinder and, daily milk yield was estimated as a summation of milk off-take and intake by the calves over a 12-week period (84 days).

Milk sampling

Milk sampling was initiated a week after parturition and terminated on the 84th day (12 weeks) post partum for each lactating cow. Sample from daily milk yield for each doe was recorded and stored in a refrigerator (-5^{o}C). At the end of 12th week of samples collection; Total solids, crude protein, fat and ash content in each treatment were analyzed for as described by AOAC (2003). Mineral Analysis was carried out by wet digestion of samples using Atomic Absorption Spectro-photometer (AAS).

Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) using the procedure of SAS (2003) package to determine the effect of dietary treatments on the various parameters studied. Significant means were separated using Duncan multiple range test of the same software.

Result and Discussion

Table 1 presents the proximate composition of shea cake in the Derived Savannah Area of Nigeria. Samples were taken from four locations to ensure evenness. Each location represents the treatments (T1 – T4). The dry matter value ranges from 87.02 – 89.65%; with the sample on T3 (Sample from Saki) recording the highest value (89.65%). T2 (Ipapo) recorded the least dry matter of 87.02 %. The least value recorded by T4 was just in comparison among samples from other location as its value (87.02%) and not of less quality for use in ruminant feed composition or formulation. The dry matter values across the treatment is an indication of good shelf life and storage value of shea cake. Crude protein (CP) values on the other hand recorded a value range of 7.00 (T2) - 8.75 (T3). This agreed with the findings of (Enaberue *et. al*., 2014) in a research on shea fruit pulp. The CP values recorded justified shea cake as a good feed resource in ruminant nutrition. The ether extract (EE) recorded was high across treatments. The values ranged from 19.20% (T4) – 22.00% (T2). This could be linked to the nature of shea tree (*Vitellaria paradoxa*); being an oil rich tree. Comparatively, Shea cake from T3 had best results among other treatments, and was considered for use in this study at various inclusion level.

A number of factors may have contributed to the moisture content of the shea cake which may include timing and method of harvest of the shea nuts and environmental conditions, such as humidity and rain. Generally, mould susceptible feed ingredients are prone to spoilage at lower dry matter. This implies that, the dry matter content recorded of shea cake confers a good shelf-life on it. This result agreed with the findings of Mutayoba *et.al.,* (2011) where high dry matter content was adjudged beneficial for livestock farmers because it increase the unit value of the feed components.

The Crude Protein (CP) of Shea cake in this study ranged between 8.60 - 9.75%, which is nutritionally adequate for ruminant animals. However, T3 was used in the experiment; considering its advantage over others. Variation in protein content of the sampled Shea cake could be linked to a number of factors, prominent of which was leaching of nutrients in processing method which involves soaking and boiling in the process of lipid extraction. The CP values in this study agreed with values reported by Ugese *et.al* 2010 (9.20%) in a study on shea butter cake meal. However, Dei *et. al.,* 2008 and Rami-Reddy *et. al.,* 2008 recorded a higher values of 14.46% and 14.12%, respectively, in separate study on shea butter cake. The disparity in values; compared to the finding from this study could be linked directly to composition of shea butter cake and the effluent from the processed shea nuts, which solidifies in the earthen or concrete tank after extraction. Generally, the shea cake fed to lactating

cows in this study shows adequacy in nutritional composition of feed resource to ruminants.

Table 2 Present the weekly milk yield (kg) over 84 days of lactating Bunaji cows fed Shea Cake meal *(Vitilleria paradoxa)* supplement. The result is significantly (P<0.05) different among the treatments for the seventh weeks of collection. Milk yield progressively increased for all treatments from week one to week seven where the peak was recorded at various values of 15.75 kg (T1), 25.62kg (T2), 29.40kg (T3) and 26.60kg (T4). The differences in milk yield may be attributed to utilization of the nutrients in the experimental diets by individual animals and the quantity of supplement offered. Bunaji cow among other cattle breeds is known to be a good milker. This could be responsible for animals on control diet which recorded steady increase in yield till ninth week of milk collection. Animals on T3 experimental diet (15kg SC supplement) however, recorded highest overall value of 31.50kg at week eight of milk collection. Though, a decrease in yield was recorded at all levels, from week nine, animals on T3 diet had highest total yield of 301.70kg at the twelfth week of collection ahead of T4 (250.95kg), T2 (240kg) and T1 (control); 185kg. The milk yield of animals on various level of inclusion was a testimony that shea cake supplement enhanced milk production in the experimental animals. Research reports (Ahamefule *et. al*., 2012 and Akpa *et al*. 2003) showed peak in milk yield at the 4th week of lactation for West African Dwarf and Red Sokoto goats. This variation could be linked to breed, feed offered and philological response of experimental animals to the diets offered, as well as season of the experiments. Tona *et al*., (2017) reported decline in milk yield in an experiment on white Fulani cows under free range grazing with and without concentrate supplementation where milk yield declined towards late lactation period. Generally, animals have access to more grasses and water during wet season to compliment concentrates and or supplements offered and this encourage high milk synthesis and letdown by ruminant animals. Findings from this study agreed with reports of (Akpa *et al*., 2001), and (Okunlola 2016) where milk yield increase progressively for the first eight week of collection in Red Sokoto goats fed graded levels of baobab *(Adansonia digitata* L.*)* fruit meal supplement.

The composition of milk in lactating Bunaji cows fed shea cake (*Vitalleria paradoxa*) supplement is presented in Table 3. In all parameters investigated, T3 (10 supplement) recorded highest values. Total Solid value of the milk varied from 13.10% (T1) to 16.75% (T3), while Protein content varied from 3.25% (T1) to 3.85% (T3), Fat value varied from 4.10% (T1) to 6.62% (T4), Ash value varied from 1.26% (T1) to 1.60% (T3), and Lactose value varied from 4.49% (T1) to 6.50% (T2). The nutritional role of milk and milk products in human diet especially in developed countries has been reported (Ibeawuchi *et al*. 2000). Milk from ruminants is a good alternative to augment animal protein intake. Lactose in milk cannot be easily altered by nutrition. Ahamefule *et al.,* 2012, Okunlola *et. al*., 2015. Being a disaccharide synthesized in the udder. It is composed of a molecule of galactose joined to a molecule of glucose. (Okunlola *et.al*., 2015). Lactose is responsible for brain development. Hence its nutritional importance cannot be overemphasized. Lactose values range recorded in this research work 4.49% (T1) to 6.50% (T2) confirms the suitability of the milk produced by lactating Bunaji cows as good raw milk required in manufacturing of infant foods for humans. Lactose in milk is consistent in nature. Attestation of this was ascertained by Ahamefule *et al.* (2003) where lactose concentrations of 4.46%, 4.62% and 4.60% were recorded in early, mid and late lactation stages in West African Dwarf goat which affirm the relative consistency of lactose in milk. High content of Lactose in this research could be linked to nutritional composition of shea cake which encouraged good yield and composition of Bunaji cows' milk.

Lactose content of a milk sample is determined by the composition of Total solids (TS) therein, being the summation of protein, fat and Ash contents less the total solid value. The Total solids content of a milk produced by experimental animals in this study ranged from 13.10% (T1) to 16.75% (T3). There was no significant difference (P>0.05) in the values of TS. The experimental animals relishingly consumed various quantity of shea cake offered them and this manifests in quality of milk produced. The total solids recorded in this experiment was at pal with values obtained by Tona *et. al.*, 2017 (16.44%) on a supplementary feeding experiment on White Fulani cattle. Total solids composition of milk is well documented. These includes Bille *et al*., 2009 (12.33%), Mirzadeh *et al*., 2010 (12.57%) and Teklemichael 2012 (12.80%). These values are lower than 16.50% (T2), 16.75% (T3) and 16.69% (T4) in this research work. The variation could be traced to experimental fed to the animals, breed and age of the experimental animals. The acceptability of shea cake by lactating Bunaji cows could be the reason for infinitesimal range amongst the TS values recorded in this study.

The fat content of milk in this study ranged from 4.10% (T1 - 0kg supplement) to 6.62% (T4-15kg

supplement). Values of fat in this experiment increase with quantity of shea cake supplement. This was due to the nature of shea tree (*Vitellaria paradoxa*); an oil rich tree; which produces shea nuts from which shea cake is obtained after the extraction of shea butter. The fat content range (4.10% - 6.62%) of the milk produced by experimental animals in this study slightly higher than 4.70% recorded by Tona *et al.,* 2017 in an experiment on supplementary feeding of White Fulani cows. The high fat composition could be linked to considerable variation in residual fat content of shea nut cake associated with variable efficiencies of fat extraction methods (Hall *et al*., 1996). Especially, traditional method of fat extraction is considered to be inefficient, leading to higher fat in the by-product as well as variation in fat content of shea cake may also be due to geographical location of the shea butter trees.

Mineral composition (Ca, Mg, Na, P and K) of milk produced by lactating Bunaji cow fed shea cake supplement was significantly different ($P<0.05$) across the treatments (Table 4). Calcium values ranged from 228.00 mg/100g (T1) to 245.00 mg/100g (T3). Mg, Na and P followed same trend. Mg had record value range of 72.00mg/100g (TI) to 90.35(T3), Na recorded 82.00mg/g (T1) to 95.75mg/g (T3), while P values was 90.00mg/100g (T1) to 98.90mg/100g (T3). K recorded the highest values ahead of other minerals investigated, with record value of 325mg/g (T1) and 345.00mg/g for T2 and T3**,** respectively. Results obtained from this study showed that shea cake meal best influenced experimental animals milk mineral composition This could be traced to the nutritional potentials of shea cake, as well as the breed of experimental animals. Zamberlin *et al.* (2012) linked milk mineral composition to animal breed and feed quality; among others.

Several reports have been made of K and Ca as leasing minerals in milk (Ahamefule, 2012 and Yoo *et al.* 2013). Hence, adequate potassium to calcium ratios are important for nutrition and development, ditto to phosphorus, sodium and magnesium due to their roles in various body activities. Magnesium plays an important role in many physiological processes, such as metabolism of proteins and nucleic acids, neuromuscular transmission and muscle contraction, bone growth and blood pressure regulation, Cacium is crucial for bone and teeth formation and functions (Zamberlin et al., 2012). Na functions in the osmo-regulatory status of animals. Qin, *et al.* (2009). Following the yield, composition and mineral values recorded in this study, shea cake is justified as productive feed resource and recommended as supplement to enhance quantity and quality of milk of Bunaji cows, and by extension; other ruminants.

Conclusion

Finding from the study shows Shea cake as a good feed supplement in diet of lactating Bunaji cows as it enhanced quantity and quality of the milk produced. The fat content of milk produced by the experimental animals makes it suitable for manufacturing dairy products like butter, yoghurt and ice cream. Availability of shea cake with little or no cost will increase livestock farmers income. Its use as supplementary feed will compliment dry season scarcity of fresh and nutritious forages which usually orchestrates cattle herders-farmers clash.

Worthy of mention was the faeces of the experimental animals that was firm with low moisture, thereby making the ranch dried with reduced population of flies and other cattle ranch associated pest and odor. Storage facilities is encouraged to store shea cake for use all year round, since it has good shelf life quality. Further research should be embarked upon to determine the limit of its inclusion for better performance. Also fat is a precursor of semen synthesis and production, shea cake is recommended to be fed to as supplement could improve semen production and quality.

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Table 1: Proximate composition of Shea Cake (SK) in the Derived Savannah Area of Nigeria

Parameters (%)	Ofiki (T1)	Ipapo (T2)	Saki (T3)	Tede (T4)
Dry matter	89. 15^{b}	88. 50^{d}	89. 65^{a}	87. 02^{c}
Crude protein	8. 60^{b}	8. 00^{c}	9. 75^{a}	8. 26^{ab}
Crude fibre	4. 00^{b}	4. 00^{b}	4. 50^{a}	4. 22^{ab}
Ether extract	20. 00^{b}	22. 00^{a}	21. 50^{a}	19. 20^{c}
Ash	4. 55^{b}	4. 60^{b}	5. 05^{a}	4. 30^{c}
Moisture	10. 85^{b}	11. 50^{b}	10. 35^{c}	12. 98^{a}
Nitrogen free extract	52. 00^{a}	49. 90^{b}	48. 85^{c}	51. 04^{a}

^{abcd} *Means within each row with different superscripts are significantly different (p<0. 05*

Table 2: Milk yield (kg) of lactating White Fulani cow fed Shea cake (SC) supplement

Week	T_1 (SC-0 kg)	T_2 (SC-5kg)	T_3 (SC-10kg)	T_4 (SC-15kg)
1	10. 29^{c}	14. 00^{b}	17. 50^{a}	17. 50^{a}
2	13. 65^{d}	16. 45^{c}	18. 20^{a}	17. 85^{b}
3	15. 75^{d}	18. 20^{c}	22. 75^{a}	21. 00^{b}
4	14. 00^{c}	21. 00^{b}	28. 00^{a}	21. 00^{b}
5	12. 25^{d}	21. 00^{c}	26. 60^{a}	22. 75^{b}
6	14. 00^{c}	22. 75^{b}	26. 60^{a}	22. 75^{b}
7	15. 75^{c}	25. 62^{c}	29. 40^{a}	26. 60^{b}
8	19. 95^{d}	23. 80^{c}	31. 50^{a}	24. 50^{b}
9	21. 00^{b}	21. 00^{b}	29. 75^{a}	21. 00^{b}
10	18. 55^{d}	19. 60^{c}	27. 65^{a}	21. 00^{b}
11	16. 45^{d}	19. 60^{b}	24. 50^{a}	17. 50^{c}
12	14. 00^{c}	17. 50^{b}	19. 25^{a}	17. 50^{b}
TOTAL	**185. 64^{d}**	**240. 52^{c}**	**301. 70^{a}**	**250. 95^{b}**

^{abcd} *Means within each row without superscript in common are different at P<0. 05*

SC-0 - No supplement, SC-5 - Shea cake (5kg supplement), SC-10 - (10kg supplement), SC-15 - (15kg supplement)

Table 3: Milk composition of lactating White Fulani cow fed Shea cake (SC) supplement

Components (%)	T_1 (SC-0kg)	T_2 (SC-5kg)	T_3 (SC-10kg)	T_4 (SC-15kg)
Total solids	13. 10^{b}	16. 50^{a}	16. 75^{a}	16. 69^{a}
Protein	3. 25^{c}	3. 53^{ab}	3. 85^{a}	3. 66^{b}
Fat	4. 10^{c}	5. 41^{b}	6. 00^{a}	6. 62^{a}
Ash	1. 26^{b}	1. 06^{c}	1. 60^{a}	1. 55^{a}
Lactose	4. 49^{c}	6. 50^{a}	5. 30^{b}	4. 86^{b}

^{abc}*means within the same row with different superscripts are significantly different (P<0. 05).*

**Lactose was calculated as total solids – (protein + fat + ash)*

SC-0: No supplemet, SC-5: Shea cake (5kg supplement), SC-10: (10kg supplement), SC-15: (15kg supplement)

Table 4: Mineral composition of Milk produced by lactating White Fulani cow fed Shea cake (SC) supplement

Minerals (mg/100g)	T_1 (SC-0kg)	T_2 (SC-5kg)	T_3 (SC-10kg)	T_4 (SC-15kg)
Calcium (Ca)	228. 00^{c}	235. 00^{b}	245. 00^{a}	245. 00^{a}
Magnesium(Mg)	72. 00^{d}	83. 05^{c}	90. 35^{a}	86. 55^{b}
Sodium (Na)	82. 00^{c}	90. 25^{b}	95. 75^{a}	90. 00^{b}
Phosphorus (P)	90. 00^{d}	92. 20^{c}	98. 90^{a}	95. 00^{b}
Potasium (K)	325. 00^{c}	345. 00^{a}	345. 00^{a}	340. 00^{b}

^{abcd}*means within the same row with different superscripts are significantly different (P<0. 05).*

SC-0: No supplement, SC-5: Shea cake (10kg supplement), SC-10: (10kg supplement), SC-15: (15kg supplement)