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FEED INTAKE, GROWTH PERFORMANCE AND NUTRIENT UTILIZATION IN FRIESIAN X BUNAJI CALVES FED SOYMILK BASED MILK REPLACER

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ABSTRACT

The study was carried out to evaluate the growth performance and nutrient utilization of Friesian x Bunaji calves fed different ratios of soy:cow milk. Soybean was sourced, cleaned and soaked in clean water for 72 hours. The water was changed twice after every 24 hours of soaking. Thereafter, the soybean was rinsed, sun-dried for 8 days, milled, sieved and then taken to the laboratory for chemical analyses. Results showed that soymilk produced from the 72 hours soaked soybean contained 87.11% moisture, 12.89% total solid (TS), 3.30% fat, 9.59% solid-non-fat (SNF), 5.55% protein and 0.82% ash. While the milk obtained from Friesian x Bunaji cows had moisture, TS, fat, SNF, protein and ash content of 88.30%, 11.70%, 2.69%, 9.01%, 3.29% and 0.67%, respectively. The protein content of the different ratios of soy:cow milk diets increased with increase levels of soymilk and varies from 3.29% in 0:100 to 5.23% in 75:25 ratio of soy:cow milk. The TS, fat, SNF and ash contents also followed similar pattern. Sixteen Friesian x Bunaji dairy calves with body weight of 34.8±0.7kg were randomly assigned to four dietary treatments (which consisted of 0:100, 25:75, 50:50 and 75:25 ratios of soy:cow milk) with four calves per treatment in a Completely Randomized Design (CRD). Each calf received two litres of the mixture of soy:cow milk daily. Results from the growth trial showed significant ($P>0.05$) difference in total feed intake among calves fed the different ratios of soy:cow milk. Calves fed diet containing 25:75 ratio of soy:cow milk had the lowest total feed intake (409.64 kg), average daily feed intake (4.18 kg/day) and better ($P<0.05$) total weight gain (74.25 kg), average daily weight gain (0.76 kg/day) and feed conversion ratio (5.52) as against (416.29 kg), (4.25 kg/day), (66.00 kg), (0.67 kg/day) and (6.31), respectively in calves fed cow milk alone (control). Digestibility of dry matter, organic matter, crude protein, neutral detergent fibre and acid detergent fibre were significantly ($P<0.05$) influenced by the inclusion of soymilk at different ratios. Nitrogen retained were similar ($P>0.05$) in calves fed 75:25, 50:50 and 25:75 ratios of soy:cow milk. However, calves fed 25:75 and 75:25 ratios of soy:cow milk had better nutrient digestibility and nitrogen balance, respectively. It was concluded that feeding 25:75 soy:cow milk gave higher live weight gain of 0.76 kg/day as against 0.67kg/day in calves fed cow milk alone. Therefore, feeding calves with 25:75 ratio of soy:cow milk is recommended for better growth performance and feed conversion than feeding cow milk alone.

Key Words: Intake, Soymilk Replacer, Performance, Nutrient Utilization, Calves

INTRODUCTION

Calves are the future producers of milk for human consumption, but depend solely on milk for their nutritional needs at the early stage of life. Milk is a unique food for calves and supplies a lot of nutrients essential for growth and organ development (Ghorbani *et al*., 2007). Post-natal feeding of dairy calves is very important for better health and growth especially in commercial as well as smallholder dairy

farms (Khan *et al*., 2012). But the indigenous breeds of cattle in Nigeria are naturally poor milk producers. They do not produce enough milk for optimum sustainability of their calves talk less of having surplus milk for human consumption. This results in underfeeding or starvation of calves with a consequence of stunted growth and mortality of calves. Shortage of nutrients especially during the early stages of life in calves reflects later in their whole life in terms of productive and reproductive performances (Roy *et al*., 2016). If suitable substitutes for milk are made available, the nutrition of infant pre-ruminants can be improved and survivability can be increased (Khan *et al*., 2012). The benefits of improved nutritional status of calves in the first 2 – 3 months of life may include reaching maturity age sooner, improved ability to withstand infectious challenges and increased subsequent milk production (Drackley, 1999).

Milk replacers (MR) are very good sources of liquid feed for calves (Roy *et al*., 2016). Khan *et al*. (2012) defined milk replacers as those feed ingredients or a mixture of such ingredients that can be used as substitute for whole milk in the diets of calves. They are made from by-products of milk with the addition of some other ingredients in such a way that the final product is comparable to whole milk. A typical MR comprises of skim milk powder, whey powder and vegetable oils. Crude protein content is usually 20%, and the fat content typically ranges from 15 to 22% (DM basis) (Mete *et al*., 2000). In developed countries, alternatives to whole milk feeding to pre-ruminants are formulated using by-products of milk processing industry (Oliveira *et al*., 2015). Such practice is not feasible in a developing country like Nigeria where the demand for milk and milk products in human nutrition is constantly increasing as a result of the rapid increase in human population (ATA, 2013). The aim of using milk replacer is to cut down the cost of whole milk in calf rearing programme and to improve their performance (Mete *et al*., 2000). There are many types of low cost, high quality plant protein viz, soyflour, soymilk, soy protein concentrate and wheat protein which could be used in the formulation of milk replacers (Ghorbani *et al*., 2007). However, Roy *et al*. (2016) showed that soy protein is widely used in milk replacer formulations because of its high-quality protein content. Soybean contains up to 40% protein compared with 1.0 to 5.6% protein content of most animal milk (Ghorbani *et al*., 2007) and has an acceptable amino acid profile (Gernah *et al*., 2013). Soymilk not only provides protein but is also a good source of carbohydrate, fat, vitamins and minerals (Nitsan *et al*., 2005).

Soymilk, a novel milk replacer has been used for artificial rearing of young animals (Ghorbani *et al*., 2007). Few studies indicated that feeding soymilk as milk replacer to calves resulted to increased growth performance when compared to whole milk feeding (Bartlett *et al*., 2006; Ghorbani *et al*., 2007; Masum *et al*., 2009; Roy *et al*., 2016). Despite soybean's pivotal role in animal nutrition, it cannot be fed unprocessed because there are some anti-nutritional factors (ANFs) which limits its utilization. These ANFs include: protease inhibitors, tannins, phytates, oxalates, saponins, etc. Fortunately, the levels of these ANFs can be eliminated or reduced through soaking, cooking, sprouting, fermentation, toasting, etc (Soetan and Oyewole, 2009). In additon, soaking could reduce ANFs such as protease enzyme inhibitor, phytates, etc due to their partial or total solubilization and removal with the discarded solution (Prodanov *et al*., 2004). However, in calves with completely functioning rumens, ANFs and complex proteins are not as detrimental, and thus processing is not as crucial (Liener, 1994).

MATERIALS AND METHODS

Location of the Study

The study was conducted at the National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika-Zaria, Nigeria. Shika is located within the Northern Guinea Savanna ecological zone of Nigeria between

latitude 10°11'N and longitude 7°8'E, at an altitude of 650m above sea level (Ovimaps, 2016). The area receives a mean annual rainfall of 1150mm which commences from May and last till October. Following the wet season is a period of dry cool weather known as 'harmattan' which marks the onset of the dry season. This extends from mid-October to March when the hot weather sets in. At this period, the mean minimum and maximum temperatures range from 12 – 28°C during the cold 'harmattan' season and 20 – 36°C in the hot season. The mean relative humidity is 21% and 72% during the 'harmattan' and the rainy seasons respectively (IAR, 2016).

Source of Feed Materials

The soybean variety used for this study was Samsoy II and was purchased from an open market in Giwa Local Government Area of Kaduna State. While the other feed materials (*Digitaria smutsii* hay, concentrate diets and Friesian x Bunaji milk) were obtained from Dairy Research Programme of NAPRI, Shika-Zaria, Nigeria.

Preparation of Soyflour

The collected soybean was cleaned by winnowing and hand picking of stones and debris. The cleaned soybean was soaked in excess water in plastic containers for 72 hours. The water was changed twice after every 24 hours during the soaking period. After which the soybean was rinsed with clean tap water and sun-dried for 8 days. The dried soybean was milled into flour and sieved with the aid of 0.04mm sieve. The resultant soyflour was stored in polythene bags and samples were taken to the laboratory for chemical analyses. The flowchart of the processing method is shown in figure 1.

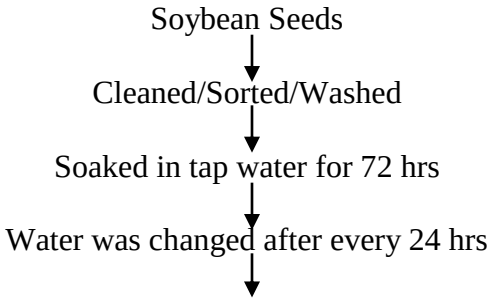


Figure 3.1: Flowchart for Soybeans Processing into Soyflour.
Source: Revised from Pele *et al*. (2016).

Experimental Diets

Ten (10) litres of Friesian x Bunaji milk from the Dairy Research programme of NAPRI was collected at 08:00am and used for the morning feeding, while another 10 litres was collected at 04:00pm and used for the evening feeding, respectively. The experimental diets were prepared immediately after fresh milk collection. Soymilk was prepared in batches according to standard procedure. To formulate one litre of soymilk, 125g of the 72 hrs soaked soyflour was dissolved in 1000ml of clean tap water according to methods described by Sarker *et al*. (2015). Thereafter, 6 litres of soymilk was prepared by dissolving 750g of the 72 hrs soaked soyflour in 6000 ml of clean tap water. The mixture was homogenized by constant stirring to prevent coagulation.

The soymilk was added to fresh cow milk in a stainless container at the ratio of 0:1000mls (which served as the control); 250:750mls; 500:500mls and 750:250mls soymilk:cowmilk respectively before feeding to the calves. The different ratios of the soy:cow milk used are as follows:

- **Experimental Diet 1 =** 0% soymilk + 100% cow milk (control)
- **Experimental Diet 2 =** 25% soymilk + 75% cow milk
- **Experimental Diet 3 =** 50% soymilk + 50% cow milk

- **Experimental Diet 4 =** 75% soymilk + 25% cow milk

Experimental Animals, Design and Management

Sixteen (16) Friesian x Bunaji dairy calves of mixed sexes (8 males and 8 females) aged between 2 – 3 weeks, with live weight of 34.8±0.7kg from the Dairy Research Programme of the National Animal Production Research Institute (NAPRI), Ahmadu Bello University (ABU), Shika-Zaria were used for the growth trial. The calves were identified with ear tags, weighed and randomly distributed into four (4) dietary treatments consisting of 4 calves per treatment in a Completely Randomized Design (CRD). The calves were housed in an open-sided, well-ventilated building (calf-pen) with a concrete floor and equipped with both feeding and watering troughs. Each animal received two (2) litres of whole milk and mixture of soymilk and cow milk daily (one litre of the liquid feed was provided between 08:00 – 09:00am, and another 1 litre was provided in the evening between 04:00 – 05:00pm. In addition, the experimental animals were given weighed quantities of concentrate diet and *Digitaria smutsii* hay to stimulate rumen development. The concentrate diet was made up of maize, maize offal, cotton seed cake (CSC), bone meal, common salt (NaCl) and vitamin-mineral premix (Table 1). Fresh and clean drinking water was also provided daily *ad libitum.* Proper sanitary measures were obeserved to protect the calves against parasitic infestations and other contagious diseases. The growth trial was carried out for a period of 98 days (between October, 2016 to February, 2017).

Feed Intake and Live Weight Changes

Feed offered and leftovers (orts) were recorded daily. Concentrate diet and hay were offered in the morning in separate feeding troughs; remnants were weighed the following morning and total feed intake was determined by difference. Body weight changes of calves were recorded fortnightly before the morning feeding. Total weight gain was calculated from the difference between initial body weight and final body weight. Average daily weight gain (ADWG) was determined by dividing the total weight gain by the number of days of the feeding trial (i.e. 98 days). Feed conversion ratio (FCR) was calculated from the ratio of average daily feed intake to average daily weight gain.

Metabolism Trial

The aim of this study was to determine the nutrient digestibility and nitrogen balance of the experimental diets. At the end of the growth study, all the experimental animals were carefully transferred to metabolism crates fitted with facilities for separate collection of faeces from urine according to methods of Osuji *et al*. (1993). During the trial however, the animals were maintained on the same treatment diets as indicated in the growth trial. Clean drinking water was provided *ad libitum*. An adjustment period of 10 days was observed before a 7 day collection period, during which feed offered, left over (orts), urine and faeces collected were weighed and recorded at 08.00hours every day. Nitrogen loss from urine was prevented by collecting urine for each animal into a plastic container acidified with 100mls of 0.1N tetraoxosulphate (VI) acid (H_2SO_4) placed under the metabolism crate. Ten percent of the daily urine output was taken from each animal and bulked in well-labelled plastic bottles stored in a refrigerator. At the end of the 7 day's collection period, 10% of the total urine bulked from each of the experimental animal was sub-sampled and kept in the refrigerator pending analysis (Osuji *et al*., 1993). Daily total faecal output were also collected, weighed and sample was taken for dry matter determination. The representative samples were bulked and sub-sampled, milled and stored in polyethene bags pending analyses (Osuji *et al*., 1993).

Laboratory Analyses

Milk sample was collected from Friesian x Bunaji dairy cows that were kept on the Dairy Research Programme farm of NAPRI, Shika, Zaria. To avoid contaminations, the plastic containers used for milk sample collection were

cleaned by soaking them for 24 hours in 10% HNO_3, then in distilled water for another 24 hours after which the containers were rinsed with more distilled water, and then dried before used for collecting milk samples. The milk samples in the cleaned plastics containers were stored in ice packed cooler at 0 ± 6^0C and quickly transported to the laboratory and stored in a deep freezer at -4^oC pending analysis.

The chemical composition of feed samples (milk from Friesain x Bunaji dairy cows, soymilk, soy:cow milk mixtures, *Digitaria smutsii* hay and concentrate diets) were determined. Dry matter content of *Digitaria smutsii* hay, concentrate diet and faecal samples were determined by oven drying at 60^oC for 48 hours. Crude protein content (Nitrogen x 6.25) of the feed samples and urine were determined using the Micro Kjeldahl procedure of the Association of Official Analytical Chemists (AOAC, 2005). Total ash was determined by charring the samples in a muffle furnace at 500^oC for about 3 hours. Ether extract (EE) and crude fibre (CF) were determined according to standard procedures (AOAC, 2005). While nitrogen free extract (NFE) was determined by subtraction (on DM basis): NFE = DM – % CP + % CF + % EE + % Ash. Neutral detergent fibre (NDF), acid detergent fibre (ADF) and hemicelluloses were determined by the method of Van Soest *et al*. (1991). Cow milk and soymilk samples were analyzed for gross composition (moisture, total solids, solid-non-fat, fat, protein and ash). The total solid (TS) was determined according to the method described by Bradley Jnr (2003) by drying 5g of milk samples to a constant weight at 105^oC for 3 hours. Fat content was estimated by the Gerber method (AOAC, 2005). Solid-non-fat (SNF) was calculated as the difference between TS and fat content (SNF = TS – fat). While milk protein (Nitrogen x 6.38) was determined by semi-micro distillation method using Kjeldahl and Makhamps apparatus. All chemical analyses were carried out according to standard procedures at the Central Laboratory of the National Animal Production Research Institute, Ahmadu Bello University, Zaria, Nigeria.

Statistical Analyses

Data generated from this study were analyzed using the General Linear Model (GLM) procedure of Statistical Analysis System (SAS, 2002) to see the response of the experimental animals to measured parameters. Significant differences among treatment means were compared using Dunnette's Test in the SAS package. The model used for the feeding trial was:

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

Where:

Y_{ij} = j^{th} observation of the i^{th} ratios of soy:cow milk;

μ = Overall mean;

T_i = effect of the i^{th} ratio of soy: cow milk on performance (i = 0:100, 25:75, 50:50 and 75:25%);

e_{ij} = random error.

RESULTS

Table 1: Ingredient Composition of Concentrate Diet fed to Friesian x Bunaji Calves.

Ingredients	Percentage (%)
Maize	24.20
Maize Offal	8.10
Cotton Seed Cake	64.45
Bone Meal	2.00
Common Salt (NaCl)	1.00
Vitamin-Mineral Premix	0.25
Total	**100.00**
Calculated Analysis	
% CP = 18.00	
ME:kcal/kg =2592	

Chemical Composition of Friesian x Bunaji Milk and SoyMilk (on wet basis)

The result of the chemical composition of milk from Friesian x Bunaji cows and soymilk is presented in Table 2. The cow milk had a total solid, fat, solid-non fat, protein and ash content of 12.44, 2.90, 9.54, 3.29 and 0.75%, respectively. While soymilk had a total solid, fat, solid-non fat, protein and ash content of 87.11, 12.89, 3.30, 9.59, 5.55 and 0.82%, respectively.

Table 2: Chemical Composition of Friesian x Bunaji Milk and Soymilk (on wet basis).

Parameters (%)	Friesian x Bunaji Milk	Soymilk (soaked for 72 hrs)
Moisture	88.30	87.11
Total Solid	11.70	12.89
Fat	2.69	3.30
Solid-Non-Fat	9.01	9.59
Protein	3.29	5.55
Ash	0.67	0.82

Chemical Composition of Different Ratios of Soy:Cow Milk fed to Dairy Calves (on wet basis).

Table 3 shows the results of the chemical composition of the different ratios of soy:cow milk fed to Friesian x Bunaji calves. The moisture content differed significantly ($P<0.05$) and ranged from 81.98 in the diet containing 75:25 ratio to 88.30% in 0:100 ratio (the control diet). There was a significant ($P<0.05$) increase in total solids as the level of soymilk inceased in the diet. The fat, solid-non fat, protein and ash content also follow similar trend. Total solids, fat and solid-non-fat were higher in diet

containing 75:25 ratio (18.02, 4.75 and 13.27%) but not significantly (P>0.05) different from 50:50 ratio (16.52, 3.75 and 12.77%), respectively. However, protein and ash contents in the diet containing 75:25 ratio of soy:cow milk were higher (5.23 and 1.45%) compared with (3.29 and 0.67%) of protein and ash in the control diet.

Table 3: Chemical Composition of Different Ratios of Soy:Cow Milk fed to Calves (on wet basis).

	Ratios of Soy:Cow Milk (%)				
Parameters (%)	**0:100**	**25:75**	**50:50**	**75:25**	**SEM**
Moisture	88.30[a]	84.80[b]	83.48[c]	81.98[d]	0.21
Total Solids	11.70[b]	15.20[ab]	16.52[a]	18.02[a]	0.83
Fat	2.69[b]	3.02[ab]	3.75[a]	4.75[a]	0.53
Solid-Non-Fat	9.01[b]	12.18[ab]	12.77[a]	13.27[a]	0.39
Protein	3.29[b]	4.35[ab]	4.40[ab]	5.23[a]	0.67
Ash	0.67[c]	0.99[b]	1.08[b]	1.45[a]	0.09

[abcd] means with different superscripts within the same row differed significantly (P <0.05).
SEM = Standard Error of Mean.

Chemical Composition of Concentrate Diet and *Digitaria smutsii* Hay

The results of the chemical composition of concentrate diet and *Digitaria smutsii* hay used for the growth trial are presented in Table 4. The dry matter and crude protein contents of the concentrate diet and *Digitaria smutsii* hay were 91.65 and 13.85%, 95.54 and 7.76%, respectively. While the crude fibre, ether extract, ash, NFE, NDF, ADF and hemicellulose contents of the concentrate diet were 14.70, 18.88, 11.94, 32.28, 23.43, 68.50 and 42.80%, respectively. However, *Digitaria smutsii* hay had 10.50% CF, 13.65% EE, 8.53% ash, 55.10%, NFE, 49.29% NDF, 63.73% ADF and 9.88% hemicellulose as shown in Table 4.

Table 4: Chemical Composition of Concentrate Diet and *Digitaria smutsii* Hay.

	Parameters (%)								
Feed Materials	**DM**	**CP**	**CF**	**EE**	**Ash**	**NFE**	**NDF**	**ADF**	**Hemi**
Concentrate Diet	91.65	13.85	14.70	18.88	11.94	32.28	23.43	68.50	42.80
Digitaria smutsii Hay	95.54	7.76	10.50	13.65	8.53	55.10	49.29	63.73	9.88

DM = Dry Matter; CP = Crude Protein; CF = Crude Fibre; EE = Ether Extract; NFE = Nitrogen Free Extract; NDF = Neutral Detergent Fibre; ADF = Acid Detergent Fibre; Hemi = Hemicellulose.

Effect of Feeding Different Ratios of Soy:Cow Milk on Intake and Live Weight Changes of Friesian x Bunaji Calves

The results of feed intake (dry and liquid feeds) and weight changes of calves fed different ratios of soy:cow milk are presented in Table 5. The average total dry matter intake of calves on 0:100 ratio of soy:cow milk (i.e. the control) was significantly (P<0.05) higher (2.25kg/day) compared to 2.18kg/day in calves fed 25:75 ratio of soy:cow milk and 2.22 kg/day in 50:50 ratio of soy:cow milk. Average total DM intake of calves on 50:50 SCM diet (2.22kg/day) was not different from calves on 75:25 ratio of soy:cow milk. Total feed intake (kg) and average daily feed intake (kg/day) also followed similar pattern.

The results of the weight changes of the experimental animals in Table 5, showed that there were significant differences (P<0.05) in the final body weight (kg) of calves across the treatments. Calves fed 25:75 ratio of soy:cow milk had higher final weight gain (109.75kg) though not significantly (P>0.05) different from calves fed 50:50 ratio of soy:cow milk (106.6kg). similar pattern was also observed in total weight gain (kg), average daily weight gain (kg/day) and feed conversition ratio (FCR). The results of this study revealed that calves fed 25:75 ratio of soy:cow milk had significantly (P<0.05) better live weight gain (0.76 kg/day) and feed conversion ratio of (5.52) indicating better convertion of feed to body tissues compared with 0.67kg/day with FCR of 6.31 in calves fed the control diet and 0.59kg/day with FCR of 7.11 in calves fed 75:25 ratios of soy:cow milk, respectively.

Table 5: Feed Intake and Growth Performance of Friesian x Bunaji Calves fed Different Ratios of Soy:Cow Milk

	Ratios of Soy to Cow Milk (%)				
Parameters	**0:100**	**25:75**	**50:50**	**75:25**	**SEM**
Dry Matter Intake (Kg/day)					
Average Concentrate Intake	1.96^{a}	1.92^{b}	1.95^{a}	1.96^{a}	0.01
Average Hay Intake	0.28	0.26	0.27	0.27	0.01
Average Total DMI	2.25^{a}	2.18^{c}	2.22^{b}	2.22^{b}	0.01
Liquid Feed Intake					
ALFI (L/h/day)	2.00	2.00	2.00	2.00	0.00
Total Feed Intake (Kg)	416.29^{a}	409.64^{c}	413.14^{b}	413.91^{b}	0.93
ADFI (Kg/day)	4.25^{a}	4.18^{c}	4.22^{b}	4.22^{b}	0.01
Live Weight Changes					
Initial Weight (Kg)	34.50	35.50	34.00	35.25	2.43
Final Weight (Kg)	100.50^{ab}	109.75^{a}	106.00^{a}	93.50^{b}	3.83
Total Weight Gain (Kg)	66.00^{b}	74.25^{a}	72.00^{a}	58.25^{c}	2.64
ADWG (Kg/day)	0.67^{b}	0.76^{a}	0.73^{ab}	0.59^{c}	0.03
Feed Conversion Ratio	6.31^{b}	5.52^{a}	5.74^{ab}	7.11^{c}	0.29

^{abcd} means with different superscripts within the same row differed significantly (P <0.05).
DMI = Dry matter intake; ALFI = Average Liquid Feed Intake; ADFI = Average Daily Feed Intake;
L/h/day = Litre Per Head Per Day; ADWG = Average Daily Weight Gain;
SEM = Standard Error of Mean.

Nutrient Digestibility and Nitrogen Balance in Friesian x Bunaji Calves fed Different Ratios of Soy:Cow Milk

The result of the nutrient digestibility and nitrogen balance in Friesian x Bunaji calves fed different ratios of soy:cow milk is presented in Table 6. Dry matter (DM) digestibility was higher in calves fed soy:cow milk at 25:75 (49.74%) and 50:50 (48.07%). The lowest DM digestibility was observed in calves fed 75:25 (45.34%) ratio of soy:cow milk. Organic matter (OM) digestibility were significantly (P<0.05) higher in calves fed 75:25, 50:50 and 25:75 ratios of soy:cow milk, while calves on 0:100 ratio of soy:cow milk had significantly (P<0.05) lowest OM digestibility (58.13%) compared to calves on the other dietary treatments. Crude protein (CP) digestibility was significantly (P<0.05) higher (69.70%) in calves fed 25:75 ratio of soy:cow milk. Calves on the control diet had the lowest CP digestibility (62.94%).

The digestibility of neutral detergent fibre (NDF) and acid detergent fibre (ADF) followed similar trend. The results of nitrogen intake showed significant (P<0.05) difference across treatments. Calves fed 25:75 and 50:50 ratios of soy:cow milk had significantly (P<0.05) higher and similar nitrogen intake. While those fed 75:25 and 0:100 (control) were similar and lower. Urinary nitrogen output did not show any significant (P>0.05) difference across treatments. Faecal nitrogen and total nitrogen output decreased significantly (P<0.05) with increased levels of soymilk in the diets. Calves fed 50:50 and 25:75 ratios of soy:cow milk had similar nitrogen retention with those fed 75:25 ratio of soy:cow milk which was higher (P<0.05) than those fed 0:100 ratio of soy:cow milk (control).

Table 6: Nutrient Digestibility and Nitrogen Balance in Friesian x Bunaji Calves Fed Different Ratios of Soy:Cow Milk.

	Ratios of Soy to Cow Milk (%)				
Digestibility Coefficient (%)	**0:100**	**25:75**	**50:50**	**75:25**	**SEM**
Dry Matter	46.35^{ab}	49.74^{a}	48.07^{a}	45.34^{b}	1.82
Organic Matter	58.13^{b}	64.27^{a}	66.93^{a}	68.01^{a}	1.90
Crude Protein	62.94^{c}	69.70^{a}	65.65^{b}	67.05^{b}	1.22
NDF	57.81^{b}	59.61^{a}	54.43^{c}	55.78^{c}	0.74
ADF	60.62^{c}	63.15^{a}	61.55^{b}	59.27^{d}	0.42
Nitrogen Balance (g/day)					
Nitrogen Intake	74.36^{b}	78.90^{a}	76.32^{ab}	75.89^{b}	1.35
Urinary Nitrogen	5.49	5.24	4.86	3.42	1.98
Faecal Nitrogen	35.20^{a}	32.82^{b}	28.93^{c}	24.68^{d}	0.59
Total Nitrogen Output	40.69^{a}	38.06^{b}	33.79^{c}	28.10^{d}	1.29
Nitrogen Retained	33.67^{b}	40.84^{a}	42.53^{a}	47.79^{a}	3.49
Nitrogen Retained (% N-Intake)	45.28^{b}	51.76^{b}	55.73^{ab}	62.97^{a}	4.44

^{abcd} means with different superscripts within the same row differed significantly (P <0.05).
NDF = Neutral Detergent Fibre; ADF = Acid Detergent Fibre; g =gram; N = Nitrogen;
SEM = Standard Error of Mean.

DISCUSSION

Chemical Composition of Friesian x Bunaji Milk and SoyMilk (on wet basis)

Milk is a complex mixture of fat, proteins, carbohydrate, minerals, vitamins and other miscellaneous constituents dispersed in water (Harding, 1999). Milk composition including moisture, protein, fat, total solid and solid-non fat are an important indicators of milk quality (Alabi, 2005). The percentage of total solid obtained for Friesian x Bunaji milk was lower than the value reported in Holstein Friesian cow milk (Ahmed *et al*., 2002). A similar result to this study was obtained in White Fulani cow milk (Ibeawuchi and Dalyop, 1995). The low value recorded for total solid content in this study when compared with other researchers may be due to low nutrition and other management practices adopted. The milk protein content of Friesian x Bunaji milk obtained in this study was comparable with values reported by (Ndubueze *et al*., 2006) for grazing White Fulani cows, and Friesian x Bunaji cattle in Nigeria (Ibeawuchi and Umoh, 1990).

The total solids of cow milk obtained in this study was slightly below the value reported by (Sarker *et al*., 2015) which might be due to the difference in breed and feed. The milk fat content obtained in this study was slighlty lower than the value reported by Roy *et al.* (2016). Higher milk fat was also reported by Sarker *et al*. (2015). The low milk fat content observed in this study might be attributed to age of cows from which the milk was collected, breed of the cows, stage of lactation and nutrition. The breed of cow whose milk were used were a crosses between Bunaji and Holstein Friesian, so the milk fat will not be as high as those from pure breeds of Friesian or other dairy cattle like Jersey. Fayeye *et al*. (2013) reported that Jersey breed of dairy cattle had higher milk fat than Holstein Friesian breed. Egbowon (2004) reported that milk fat content decreases at mid-lactation and continue to decrease until the end of lactation.

Also, underfeeding can cause lower proportion of milk components. Similarly, Nickerson (1999) reported that genetic factor, nutrition, environment and milking management practices have important effect on milk composition and quality. The protein content of the 72 hours soaked soymilk observed in this study on wet basis (5.55%) was slightly above the value (4.0%) reported by Sarker *et al*. (2015) for soymilk obtained by boiling soybeans at 100 ^{o}C for 15 minutes, but similar to the values of (4.5%) reported by Odumodu (2010) for soybeans soaked for 18 hours. The total solids (12.89%), fat (3.30%) and ash (0.82%) obtained in this study for soymilk were slightly higher than (10.70%), (2.70%) and (0.60%) reported by Sarker *et al*. (2015). This study found that soaking increased the protein content of the soybeans. This is consistent with the report of Pele *et al*. (2016) who found that soaking increased the CP content of soybeans soaked for 12 and 24 hours.

Chemical Composition of Different Ratios of Soy:Cow Milk fed to Dairy Calves

The mixture of soy:cow at different ratios showed significant ($P<0.05$) increase in nutritional content as compared with cow milk or soymilk alone. The similar fat content in the diets containing different ratios of soymilk might be attributed to the low fat content in cow milk which had little effect on the total fat content in the mixture. However, the protein content of the mixture of soymilk and cow milk were higher than those of cow milk alone. The non-significant ($P>0.05$) difference observed in the protein contents of the diet containing soymilk in addition to cow milk might be due to the low protein content of cow milk used. Other authors (Sarker *et al*., 2015; Roy *et al.*, 2016) reported higher fat and protein contents in cow milk but the low levels obtained in this study may be attributed to breed of cow, feeding and stage of lactation.

Chemical Composition of Concentrate Diet and *Digitaria smutsii* Hay

The dry matter (95.54%) content of *Digitaria smutsii* hay observed in this study was higher than (90.40%) reported by Yashim (2014) but slightly higher than (94.29%) reported by Yusuf (2016). The high DM content observed in this study could be attributed to the season of harvest and the curing process and storage. The crude protein content (7.76%) observed in this study for *Digitaria smutsii* hay was higher than (5.36%) reported by Yashim (2014) but slightly lower than (9.63%) reported by Yusuf (2016). Crude protein content of hay is dependent on the stage at which the hay was harvested, duration of curing and also the leaf to stem ratio (Yashim, 2014). The neutral detergent fibre (49.29%) was lower than (69.23%) reported by Yashim (2014). However, the acid detergent fibre (63.73%) observed for *Digitaria smutsii* hay in this study was higher than the (33.88%) reported by Yashim (2014). The differences in the chemical composition of the *Digitaria smutsii* hay could be attributed to variation in the nutrient content of the soil, weather, stage of maturity, method of harvest, curing and also storage. The crude protein content (13.85%) of the concentrate diet in this study was similar to 13.88% reported by Iriso *et al*. (2016) for Friesian x Bunaji crossbred heifers. While the NDF (23.43%) was lower than (35.13%) reported by Iriso *et al*. (2016) but ADF (68.50%) reported in this study was higher than 23.68% reported by Iriso *et al*. (2016). The differences in NDF and ADF observed could be attributed to differences in the ingredients used in the ration formulation. And could also be as a result of human error during the laboratory analyses.

Effect of Feeding Different Ratios of Soymilk and Cow milk on Intake and Live Weight Changes of Friesian x Bunaji Calves.

The total dry matter intake observed in this study was higher than those reported by Roy *et al*. (2016) for calves fed soybeans based milk replacer. The higher DMI observed in this study could be attributed to the inclusion levels of soymilk in the diets of the calves which might have stimulated intake. Reducing milk feeding had been reported to hasten intake of starter feeds and promotes rumen development in calves (Hussain *et al*., 2009). The similarities observed in the total dry matter intake in this study could be attributed to group housing of the calves. Group housing was shown to influence calf feed intake in comparison with individual housing (Montoro *et al*., 2013).

The total weight gain of 66.00kg and 58.25kg obtained in this study for calves fed cow milk alone and 75:25 ratio of soy:cow milk were comparable with 69.50kg and 59.00kg reported by Jasper and Weary (2002) for Holstein calves fed cow milk *ad libitum* and conventional milk replacer, respectively. The higher total weight gain of 74.25kg and 72.00kg obtained in this study for calves fed 25:75 and 50:50 ratios of soymilk and cow milk could be attributed to better feed utilization. The average daily weight gain obtained in this study was higher than the those reported by Roy *et al*. (2016). However, the ADWG (0.76 kg/day and 0.59 kg/day) obtained in this study for calves fed 25:75 and 75:25 ratios of soymilk and cow milk, respectively were similar to 0.78 kg/day and 0.48 kg/day reported by Jasper and Weary (2002) for Holstein calves fed cow milk *ad libitum* and conventional milk replacer respectively. This study showed that calves fed 25 and 50% soymilk gained weight much more rapidly as compared with calves on cow milk alone.

The significant drop in total weight gain (58.25 kg) and ADWG (0.59 kg/day) observed in calves fed 75:25 soy:cow milk might be attributed to the presence of some anti-nutritional factors which must have inhibit nutrient utilization when high levels of soymilk was fed to the animals. Khorasani *et al*. (1989) also observed similar pattern with the use of high levels of soyflour in milk replacer which decreased growth rates in calves. In addition, Nitsan *et al*. (2005) reported that inclusion of soybean meal up to 73% of the total protein in milk replacer

resulted in poor calf performance due to low protein digestibility and decreased fat and ash absorption. However, it was earlier shown that the two main factors that influence calf performance on soybean based milk replacers are the proportion of the total protein replaced with the soybeans and the age of the calf (Roy *et al*. (2016).

Feed conversion (FCR), which explains the transformation capacity of dietary nutrients in body tissue, was lower for calves fed 25:75 ratio of soymilk and cow milk though not statistically different from calves on 50:50 soy:cow milk. The FCR observed in this study was relatively better in calves fed 25:75 ratio of soymilk and cow milk than those fed cow milk alone. This implies that calves fed 25:75 ratio of soymilk and cow milk had better feed utilization compared to calves on the other treatments.

Nutrient Digestibility and Nitrogen Balance in Friesian x Bunaji Calves fed Different Ratios of Soy:Cow Milk

Nutrient digestibility in animals is the classical and direct method for estimating feed digestion by ruminants; hence studies on digestibility of ruminant feeds are very important as they allow for the estimation of nutrients actually available for ruminant nutrition (Yashim *et al*., 2016). The results obtained in this study on dry matter, organic matter and crude protein digestibility were lower than the values reported by Azevedo *et al*. (2016) for Holstein x Gyr crossbred calves fed increasing amounts of milk replacer powder in whole milk. Also, the dry matter and crude protein digestibility obtained in this study for calves fed 25:75 ratio of soymilk and cow milk was lower than those reported by (Rahman *et al*., 2016) in calves fed soybeans, shotti and skim milk based milk replacers. This might be due to the differences in the type, quantity and chemical composition of the liquid feeds used.

Davis and Drackley (1998) reported that digestibility varies depending on the overall composition of the milk replacer, origin of the ingredients and the animal's age. Improvement in the digestibility of dry matter and crude protein by the calves fed 25:75 ratio of soymilk and cow milk could be attributed to the additive effects of soymilk and cow milk feeding as compared to calves fed only cow milk. It could also be as a result of soaking which reduced the levels of ANFs in the soybean diets thereby improving protein degradation in the rumen. This agrees with earlier report of Njoku and Evbuomwan (2014) that the presence of ANFs lowers the solubility of proteins entering the abomasum and small intestine for digestion. However, decreased crude protein digestibility was reported with increased soybean protein in milk replacers for young calves (Erickson *et al*., 1989). The significant difference in organic matter digestibility observed in this study is similar with the report of Rotger *et al.* (2006) who stated that a change in feed ingredients alters the amount of OM and its fermentation rate in the rumen. The digestibility of feed was reported to be influenced by the composition, available energy and retention time in the gastrointestinal tract (Abdu *et al*., 2012).

The digestibility of NDF and ADF were better in calves fed soymilk and cow milk in the ratio of 25:75 compared with calves fed 100% cow milk. The difference observed in NDF and ADF digestibility could be due to microbial activity in the rumen and the composition of the diets. The improvement in calves performance and overall increase in digestibility could be due to nutritional additive effect. Although nitrogen intake was significantly different across treatments, positive nitrogen balance was recorded in calves fed soymilk. Calves receiving soymilk milk had highest nitrogen retention as compared with calves fed only cow milk. This finding differs from the report of Shakya *et al*. (2016) who found that retention of digested nitrogen is often lower for calves receiving non-milk proteins not properly processed when compared with calves fed milk protein which suggests poor availability of essential amino acids in the non-milk proteins.

This indicates that the nitrogen obtained from soymilk contributed to the total nitrogen balance in the calves. Nitrogen retention obtained in this study were lower than the values reported by (Rahman *et al*., 2016) in calves fed soybeans, shotti and skim milk based milk replacers. Nitrogen retention is the major indicator used to assess the protein nutrition status of ruminant livestock (Abdu *et al*., 2012). The low nitrogen retention observed in this study could be attributed to the method of soybean processing used and the CP content of the soymilk and cow milk diets supplied to the calves. This supports the findings of Sarwar *et al*. (2003) who observed that nitrogen retention depends on good digestibility and utilization of nutrients. However, the values fall within the normal range of (52.80 – 64.6%) reported by Azevedo *et al*. (2016).

The positive nitrogen balance obtained in this study signified that anti-nutrient contents of soybeans did not depress their utilization by the calves. This shows the significance of soaking as a processing method. Conversely, relatively poor growth, digestibility and nitrogen retention resulted when cooked soybeans, soybean meal or lightly cooked soybean flour were used in feeding calves (Gorrill and Thomas, 1967).

CONCLUSION

From the results of this study, it was concluded that feeding 25:75 ratio of soy:cow milk reduced feed intake but had a positive influence on feed utilization and growth performance of 0.76 kg/day against 0.67kg/day for 0% replacement. Therefore, farmers could include soymilk upto 25% in the diets of calves for better performance and feed conversion.

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