Changes in the performance and blood indices of Red Sokoto bucks fed diets containing soybean curd residue

*¹Millam, J. J., ¹Iliya, S., ¹Babale, D. M., ¹Abbaya, H. Y., ²John, P. A. and ³Yakubu L.R.

¹Department of Animal Production, Adamawa State University-Mubi,

²Ministry of Agriculture and Rural Development, Adamawa State.

³Department of Animal Science, Ahmadu Bello University, Zaria.

*Corresponding author: jacobjafiay@gmail.com; +234 806 150 4098

Abstract

The investigation was carried out to examine the outcome of soybean curd residue (SCR) supplementation in the diets of Red Sokoto bucks on growth performance and some blood parameters. Five (5) mixed ration was formulated to contain 14% crude protein, four (4) of which was SCR based at inclusion levels of 0% (control), 5%, 7.5%, 10% and 12.5% denoted as T_1 , T_2 , T_3 , T_4 and T_5 respectively. Twenty (20) Red Sokoto bucks were used for the experiment for a period of twelve (12) weeks. They were randomly assigned to the five dietary groups of 4 bucks each in a completely randomized design. Laboratory analyses were carried out on the SCR and the experimental diets. Parameters measured were on growth performance and some blood parameters. The results obtained showed that SCR was high in DM (93.53%), energy (3435.15 kcal/kg), protein (30.66%) and NFE (49.12%) values. The results revealed significant differences ($P < 0.05$) among all treatments. The highest values for daily weight gain was observed in T_5 (122.86 g/day); daily feed intake and feed conversion ratio was observed in T_3 (481.29 g/day and 4.66 respectively). High significant ($P < 0.05$) values for packed cell volume and haemoglobin were observed in T_5 (26% and 8.6 g/dl) compared to the control. Meanwhile, white blood cell was highest significantly ($P < 0.05$) in T_3 ($8.50 \times 10^9/L$). Most of the blood parameters observed in this study were within standard normal range for goat. This study showed that SCR did not pose any health risk to the bucks. It was concluded that supplementing soybean curd residue in the diets of goats up to 12.5% can produce a better performance.

Keywords: Total mixed ration, soybean curd residue, growth performance, haematology, serum biochemistry, goats.

Introduction

Soybean curd residue (SCR), Tofu or Okara (Japanese), is the insoluble carbohydrate residue that is left over of soymilk or tofu production. A small amount of it is eaten by humans, increasing in time of food shortages (Li *et al.*, 2013). Soybean curd residue has been widely used as a feed for livestock in some Asian countries, especially where tofu factories are located due to its high nutritional value (Kim *et al.*, 2012). Feed scarcity is one of the major constraints of livestock production in sub-Saharan Africa, especially during dry season (Millam *et al.*, 2017). Ruminants depend largely on crop residues during the long dry

periods of the year for maintenance as well as for the production of meat, milk, skin and fibre. However, animal performance with such feedstuffs can be poor due to low voluntary intake, digestibility, haematological parameters and nitrogen balance which result from low protein concentrations and high levels of indigestible or slowly degradable fibre (Abdel Hameed *et al.*, 2013). Apart from trying to solve the problem of feed scarcity during the dry season, scientific data on SCR related to the performance on livestock in Nigeria is limited (Kim *et al.*, 2012). Although, there are cases of feed shortages during the dry seasons and

domination of poor quality roughages which results in low productivity of our indigenous animals; there is need to improve the quality of these poor quality roughages available to us in abundance (Millam, 2016). Feeding value of low quality fibrous feeds can be improved through supplementation (Millam *et al.*, 2017). However, SCR alone is insufficient to support ruminants beyond the maintenance level, thus there is a need for true protein supplementation of low quality forage based diets (Orden *et al.*, 2000). Supplementation is expected to correct any imbalances in the nutrients presented for metabolism (Russell, 2002). It is well established that ruminants fed low nitrogen (N) roughages also respond well to any N sources of plant origin (such as SCR) through supplementation (Preston and Leng, 1987; Abdel Hameed *et al.*, 2013). Supplementing low quality forage-based diets with N sources (such as SCR) makes available conducive rumen conditions for the microbes to achieve maximum rates of fermentation (Abdel Hameed *et al.*, 2013). Moreover, the antinutritional factors that may be present in SCR can be handled by the activities of the microbes in the rumen (Li *et al.*, 2013).

Furthermore, SCR is a relatively inexpensive source of protein that is widely recognized for its high nutritional and excellent functional properties (Li *et al.*, 2013) and its dietary fibre plays a role in many physiological processes and in the prevention of different diseases (Li *et al.*, 2012). Despite its (SCR) nutritive value, it is hard to find scientific research data on SCR utilization and its impact on physiological characteristics of our indigenous animals such as goats. Therefore, it will be necessary to determine proper utilization method of SCR, evaluate its feeding effectiveness and some beneficial changes in growth indices and blood characteristics (Kim *et al.*, 2012). However, variation in blood profile makes it

hard to assess the health status of the various breed of goats in the tropics (Sirois, 1995). Haematological and biochemical indices have been used as diagnostic aids in the recognition of diseases especially chronic asymptomatic cases (Tietz, 1982; Jain, 1986). Besides, examination of blood and its constituents has been used to monitor and evaluate health and nutritional status of animals (Gupta *et al.*, 2007). Blood measures are frequently used in assessment because they are significantly correlated to nutritional status of some animals (Akinrinmade and Akinrinde, 2012). The results obtained from such determinations have proven to be rewarding in the formulation of appropriate therapeutic regimes and nutritional supplementation (Adeloye, 1998). Therefore, it could be useful as a functional ingredient with health-promoting attributes (Lu *et al.*, 2013). To verify this hypothesis, a mixed ration was designed to accommodate a basal feed supplemented with varying levels of SCR along with other agro-industrial by-products and fed to Red Sokoto bucks.

Materials and methods

Study location

The study was conducted at the small ruminant unit of the Department of Animal production livestock teaching and research farm, Adamawa state University (ADSU), Mubi. The area lies within the Northern-Guinea Savannah zone of Nigeria. It is located between latitude 9°30'–11' North of the equator and longitude 13°30'–14°45' East Greenwich meridian with 579 meters above sea level (ADSU Metrological Station, 2019).

Experimental diets and procedure

Five (5) total mixed rations (14% crude protein) was formulated with cowpea husk as the basal feed (Table 1). The cowpea husk and other concentrate ingredients were sourced from TIKE cattle market, Mubi South.

Table 1: Gross composition of experimental diet

Feedstuff	T ₁	T ₂	T ₃	T ₄	T ₅
Cowpea husk	60.00	60.00	60.00	60.00	60.00
Maize bran	24.50	23.30	22.70	22.00	21.30
Cottonseed meal	13.50	9.70	7.80	6.00	4.20
Soybean Curd Residue (SCR)	0.00	5.00	7.50	10.00	12.50
Bone meal	1.50	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50	0.50
Calculated analysis					
Energy	893.17	955.08	986.03	1016.57	1047.10
Protein	14.02	14.01	14.00	14.01	14.02
Crude fibre	26.39	25.64	25.26	24.90	24.54

T₁, T₂, T₃, T₄ and T₅: 0.00%, 5.00%, 7.50%, 10.00%, 12.50% levels of inclusion of soybean curd residue respectively,

The (SCR) was sourced from *Awara* (soy curd cake) producers from Mubi environs. The SCR was sun dried for 5 days to prevent mould growth and fermentation and the sun dried ingredients were compounded into a mixed rations prevent wastage and preferential selection of the feed by the experimental animals. The feed was offered to animals at 8.00h and 14.00h (5% fresh weight basis); the left overs was weighed the following morning before the subsequent feeding. Clean fresh water was provided to the animal's *ad-libitum* throughout the feeding trial. The bucks were weighed at beginning of the feeding trial; then fortnightly and the changes in weights obtained were calculated. The animals were subsequently weighed in the morning before feeding and feed offered adjusted, in line with the changes in their body weights.

Animal management and design

Twenty (20) Red Sokoto bucks with an average weight of 10 kg were used for the feeding trial. The bucks were sourced from the *TIKE* cattle market, Mubi South. The animals were weighed using hanging balance (CAMRY EMPERORS) to get their initial live weight before the commencement of the feeding trial. The bucks were randomly assigned into five (5) treatment groups of four (4) bucks each in a Completely Randomized Design (CRD). The animals were housed in individual pens

of concrete floor with full shade. The bucks were dewormed using Abendazole[®] suspension and dipped in Acaricide Amitix[®] solution one week before the commencement of the feeding trial to control endo- and ecto-parasites. The faecal remains were removed daily and environment kept clean to avoid disease outbreak. The feeding trial lasted for ninety (90) days. There was no information on acclimatization of the experimental animals before the commencement of the experiment.

Blood sampling

Approximately 5 ml of blood samples (using 10 ml syringe) was collected via Jugular Vein Puncture. Half of the blood was placed into vacutainer tubes containing Anticoagulant *ethylenediaminetetracetic acid* (EDTA) and was used to determine the haematological parameters. The other half was placed into centrifuge bottle for total protein determination. Haematological parameters were determined by acid haematin method (Benjamin, 1985) and Wintrobe's tube (Hawk, 1965), while total protein was determined using the method described by Henry and Stobel (1957).

Chemical analysis

Sub-samples of the experimental diet were collected and their chemical composition was determined using the procedures of AOAC (2005). Neutral Detergent Fibre

(NDF) and Acid Detergent Fibre (ADF) was also determined by the methods of Van Soest (1991).

Statistical analysis

The data on growth performance and haematological parameters were analysed using the Generalised Linear Models Procedure (PROC GLM) of SAS (2002) in a one-way analysis of variance. The treatment effect was tested and significant differences between treatment means were established by Dunnett Test.

Results and discussion

Proximate composition of soybean curd residue and experimental diets

The composition of soybean curd residue (SCR) varies base on country and processing. Therefore, Table 2 revealed the proximate composition of the soybean curd residue used in the study. The results showed that it had high energy, protein and NFE levels.

Table 2: Proximate composition of soybean curd residue (SCR)

Parameters	%
Dry matter	93.53
Moisture	6.47
Energy (kcal/kg)	3435.15
Crude protein	30.66
Crude fibre	8.85
Ether extract	0.52
Ash	4.38
Nitrogen free extract	49.12

SCR: soybean curd residue,

From the proximate analysis of SCR, it can be stated that it contains high energy, protein, fibre and soluble carbohydrates. The result obtained for crude protein is in consistent with the findings of Li *et al.* (2013) who obtained 27% protein levels for SCR (dry matter basis). The authors stated that the protein in SCR is of good nutritional value and has a greater protein efficiency ratio which is an indication for a prospective source of low vegetable protein for animal consumption. Similarly, Hackler *et al.* (1963) and Wang and Cavins (1989) revealed that protein of SCR was also

recognised to be of top-quality to curd protein and soymilk. The fibre in the SCR obtained in this study is believed to be digestible through fermentation in the rumen and the large intestine. It is also recognised to make available vital health gains to the body of the animals with respect to maintenance and normal bowel function (Periago *et al.*, 1997). Table 3 presents the proximate composition of the experimental diets used in this investigation. In the results, it was observed that the inclusion of SCR increased dry matter (DM), crude protein (CP) and NFE.

Table 3: Chemical composition of the SCR based diets

Parameters (%)	T ₁	T ₂	T ₃	T ₄	T ₅
Dry matter	95.5	97.0	95.0	96.0	95.0
Crude protein	14.9	13.1	15.6	17.5	18.1
Crude fibre	14.5	11.0	10.5	11.3	10.4
Ether extract	1.7	1.6	1.8	1.9	1.8
Ash	4.5	4.6	5.8	5.9	4.8
Nitrogen free extract	59.9	66.7	61.3	60.3	60.0

SCR: soybean curd residue, T₁, T₂, T₃, T₄ and T₅: 0.00%, 5.00%, 7.50%, 10.00%, 12.50% levels of inclusion of soybean curd residue respectively,

DM and NFE increased in T₂ (97% and 66.7% respectively) compared to the T₁ (95.5% and 59.9% respectively). CP increased in T₅ (18.1%) compared to T₁ (14.9%). The increase in dry matter, crude protein and nitrogen free extract might have been due to the inclusion of SCR in the diet. Investigations have revealed that mixing SCR with other feed ingredients in animal diets led to increased protein, dietary fibre and soluble carbohydrates compared with those without SCR (Rinaldi *et al.*, 2000; Alu *et al.*, 2013; Babale *et al.*, 2018).

Growth performance in Red Sokoto bucks

Table 4 shows the productive performance of Red Sokoto bucks fed soybean curd residue in total mixed ration. The overall results revealed that there are significant

($P < 0.05$) difference among treatments for all parameters measured. Higher weight gain was observed in T₅ (total; 10.32 kg and daily; 122.86 g) compared to the control (total; 5.71 kg and daily; 68.00 g). The increase in the daily weight gain observed in this study is consistent with the reports of Kim *et al.* (2012) and Mohammed *et al.* (2014) who stated that greater body weight change and gain-to-feed ratio was obtained in ruminants on soybean curd waste meal diet than those without soybean waste. This may be attributed to high nutritional characteristics of soybean waste, which is rich in energy and protein (Knaus *et al.*, 2012). It may also be due to the nutritive value and its excellent property (Harjanti *et al.*, 2012; Rahman *et al.*, 2013).

Table 4: Productive performance of RSB fed SCR based diets

Parameters	T ₁	T ₂	T ₃	T ₄	T ₅	SEM
Initial weight(kg)	12.40 ^a	10.84 ^c	12.24 ^{ab}	10.60 ^d	11.20 ^b	0.10
Final weight (kg)	18.11 ^b	17.80 ^b	21.36 ^{ab}	18.24 ^b	21.52 ^a	0.86
Weight gain (kg)	5.71 ^c	6.96 ^b	9.12 ^{ab}	7.68 ^b	10.32 ^a	0.92
Daily weight gain (g)	68.00 ^c	82.86 ^b	108.57 ^{ab}	91.43 ^b	122.86 ^a	10.90
Daily feed intake (g)	458.31 ^{ab}	417.43 ^b	481.29 ^a	341.14 ^b	452.72 ^{ab}	16.39
Water intake (ml)	654.80 ^{ab}	578.10 ^b	691.10 ^a	674.70 ^{ab}	675.70 ^{ab}	37.78
FCR	8.87 ^c	7.00 ^b	4.66 ^a	5.58 ^{ab}	5.72 ^{ab}	0.89

abc: Means with different superscripts within a row are significantly different ($P < 0.05$). RSB: Red Sokoto bucks, SCR: soybean curd residue, T₁, T₂, T₃, T₄ and T₅: 0.00%, 5.00%, 7.50%, 10.00%, 12.50% levels of inclusion of soybean curd residue respectively, FCR: feed conversion ratio, SEM: standard error of means

It was also observed that feed intake was higher significantly ($P < 0.05$) in T₃ (total; 3369.00 g and daily; 481.29 g) compared to the control (total; 3208.20 g and 458.31 g). The high feed intake recorded in this study was similar with work of Rahman *et al.* (2015), who reported that feeding soybean curd residue to goats increased daily weight gain due to high increased feed intake. The high increase in daily feed intake observed in the present study indicates that the animal readily eats the feed which may be associated with absence of toxins and the taste or smell (palatability) of diet (Abdulquadri, 2016; TheCattleSite, 2019). This influence the prehension and intake

level of bucks (Decruyenaere *et al.*, 2009). For the daily water intake, it was also higher significantly ($P < 0.05$) in T₃ (691.10 ml/day) compared to the control (654.80 ml/day). High water intake observed in this study may be due to available protein in SCR which increase water intake because of fibre digestion (Vee and Schaefer, 1950). Values for feed conversion ratio (FCR) for T₃ (4.66) was significantly ($P < 0.05$) better compared to the control (8.89). The better FCR observed in this study revealed that incorporating 7.5% SCR in the diets of goats gives a remarkable feed conversion to weight. This is in consistent with the work of Mohammed *et al.* (2014) who reported

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that, increased FCR was observed in their diet supplemented with soybean curd residue. It is also consistent with the findings of Kim *et al.* (2012) that the inclusion of soybean curd residue in the diets of goats improves the digestibility of nutrients. This indication shows that including SCR in diets of bucks could improve FCR.

Effects of SCR on some blood parameters

The effects of feeding soybean curd residue in the diets of Red Sokoto bucks on some blood parameters are presented in Table 5. The results indicate that there were significant ($P<0.05$) differences among all parameters measured. It was observed that packed cell volume (PCV) and haemoglobin count (Hb) were higher significantly ($P<0.05$) in T_5 (26.00% and 8.60 g/dl respectively) compared to the

control (24.00% and 8.00 g/dl respectively). The Hb for T_2 (7.10 g/dl) and T_3 (6.70 g/dl) were below normal range values of haemoglobin count for goats. The high PCV and Hb values obtained in this study were within normal standard range values (22-38% and 8-12 g/dl respectively) for goat's haematology parameters. This implies that, the value obtained did not pose any danger to the health of the animal (Etim *et al.*, 2013a). The improvement observed in the results from the present study may be due to the addition of SCR up to 12.5% level of inclusion. This is an indication that SCR increased the production of haemoglobin and haematocrit in the system of the bucks. This is similar to the findings of Etim *et al.* (2013a) that, the increase in the percentage of PCV and Hb after feeding trial may be due to improved nutrition.

Table 5: Effect of feeding SCR based diets to RSB on some haematological components

Parameters	T ₁	T ₂	T ₃	T ₄	T ₅	SEM	Normal range
PCV (%)	24.0 ^c	23.0 ^d	18.0 ^c	25.0 ^b	26.0 ^a	0.20	22.0-38.0
Hb (g/dl)	8.0 ^c	7.1 ^d	6.7 ^c	8.3 ^b	8.6 ^a	0.05	8.0-12.0
RBC ($\times 10^{12}/L$)	5.6 ^a	4.9 ^d	5.2 ^b	5.1 ^c	4.7 ^c	0.04	5.0-8.0
WBC ($\times 10^9/L$)	7.8 ^b	6.5 ^c	8.5 ^a	6.5 ^c	5.2 ^d	0.02	4.0-13.0
TP (g/dl)	7.8 ^a	7.4 ^c	7.5 ^b	7.5 ^b	7.2 ^d	0.05	6.4-7.9

^{a-c} means with different superscripts are significantly different ($p<0.05$) RSB: Red Sokoto bucks, SCR: soybean curd residue, T₁, T₂, T₃, T₄ and T₅: 0.00%, 5.00%, 7.50%, 10.00%, 12.50% levels of inclusion of soybean curd residue respectively, Hb: haemoglobin count, PCV: packed cell volume, RBC: red blood cell count, WBC: white blood cell count, TP: total protein, SEM: standard error of mean

Red blood cell count (RBC) was higher significantly ($P<0.05$) in the control ($5.60 \times 10^{12}/L$) compared to other dietary treatment; RBC values were below the normal range values ($5-8 \times 10^{12}/L$) for goats in T_2 (4.90 g/dl) and T_5 (4.7 g/dl). The low values of RBC count observed from the present study may be associated with anaemia or deficiency due to diarrhoea (as observed during the trial) which depressed performance. This has been documented by some authors (Schalm *et al.*, 1975; Addas *et al.*, 2010; Bunn, 2011; Etim *et al.*, 2013b) that low RBC count may be associated with

iron deficiency, internal bleeding, some type of anaemia or some vitamin deficiency. The RBC count for other treatments falls within the normal range ($5-8 \times 10^{12}/L$), this implies that the SCR inclusion was able to maintain their normal range of RBC and did not affect the production of RBC (Campbell *et al.*, 2003). White blood cell count (WBC) was higher significantly ($P<0.05$) in T_3 ($8.50 \times 10^9/L$) compared to the control. The WBC count recorded in this study was within the normal range of haematology parameter for goats, $4-13 \times 10^9/L$ (Radostits *et al.*, 2000;

Etim *et al.*, 2013b). The high value observed for WBC may be due to addition of SCR in the diet which contributes to the nutritional status of the diet (Mohammed *et al.*, 2014). Total protein (TP) was higher significantly ($P < 0.05$) in the control (7.80 g/dl) compared to other dietary treatments. The TP observed from this study was similar to that obtained by some authors (Oduye and Adadevoh, 1976; Daramola *et al.*, 2005) but in conflict with that reported by some authors (Ajala *et al.*, 2000, Waziri *et al.*, 2010; Akinrinmade and Akinrinde, 2012). Dietary protein has influence on the serum protein which in turn manifest on the total protein value. The high value obtained in this study may be attributed to vitamin A deficiency; the deficiency increased blood albumin levels which in turn increased serum protein (Pradhan, 2016).

Conclusion

From the study, it was observed that SCR has high levels of dry matter, energy, protein and crude fibre. The inclusion of SCR increased DM by 1.5%, CP by 3.19% and NFE by 6.73%. This indicates that SCR inclusion improved the Red Sokoto bucks (RSB) diets. SCR inclusion increased daily weight gain by 54.86 g, feed intake by 22.98 g and feed conversion ratio by 4.21. This revealed that SRC inclusion in diets of RSB improves performance. SCR increased PCV by 2%, Hb by 0.6 g/dl and WBC by $0.7 \times 10^9/L$. this means that SCR inclusion in diets does not affect the health status of RSB. Therefore, it can be concluded that inclusion of SCR in goat's diets put on a better performance, which is an indication that SCR can be a very good feed resource for feeding ruminants.

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