



Effects of feeding soybean curd residue at varying levels in diets of Red Sokoto bucks on nutrient intake and digestibility

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Abstract

The experiment was conducted to evaluate the effect feeding soybean curd residue at varying levels in diets of Red Sokoto bucks on nutrient intake and digestibility. It was carried out at Adamawa State University Teaching and Research farm, Mubi from 25th July–15th August, 2018. The experimental diets (5 diets) comprised of a control which excludes the test material (soybean curd residue) denoted as T₁ (0.00%) while the other 4 treatments are soybean curd residue based; the soybean curd residue were included at varying levels, 5.00% (T₂), 7.50% (T₃), 10.00% (T₄) and 12.50% (T₅) of the whole diet. The soybean curd residue was dried, milled and thoroughly mixed with other ingredients to make up the total mixed ration. The diets were formulated to contain 14% crude protein and fed to the Red Sokoto bucks in a completely randomised design with 3 bucks per dietary treatment. The bucks were kept in individual metabolism cages. The experimental diets and water were supplied to the animals *ad libitum*. The experiment lasted for 21 days. The parameters measured were nutrient intake and nutrient digestibility. The results revealed significant improvements in all the parameters measured. Nutrient intake and nutrient digestibility was observed to increase significantly ($P < 0.05$) with T₃ and T₁ compared to other dietary treatment. It is concluded that 7.5% level of inclusion of SCR increased daily feed intake, water intake and dry matter intake by 22.98%, 36.30% and 19.53% respectively, while 5% SCR inclusion level increased dry matter digestibility, ash retention and nitrogen free extract by 2.26%, 3.55% and 4.19% respectively. Therefore, inclusion level involving SCR at 7.5% in Red Sokoto bucks diet tend to increased nutrient intake but had a relatively reduced nutrient digestibility.

Key words: Soybean curd residue, Dry matter intake, Nutrient digestibility, Red Sokoto bucks.

Introduction

Shortage of feed resources often imposes major constraints on the development of animal production in the tropics and sub-tropics (Aregheore, 2000). Considerable quantities of crop residues are generated every year in most developing countries and their use in animal feeding is not a common practice in tropical countries, especially Nigeria (Akinfemi *et al.*, 2012). These feed resources are usually poor in quality and they comprise a huge part of ruminant feeds in Nigeria (Millam *et al.*, 2017). This amounts to low plane of nutrition with attendant low

productivity of our indigenous animals (Otaru *et al.*, 2011). In line with solving the problem of feed scarcity during the dry season, scientific data on soybean curd residue related to the performance on livestock in Nigeria is scarce (Kim *et al.*, 2012). And again, large quantities of soybean curd residue produced annually especially in regions where it is produced in large quantities, pose a significant disposal problem (O'Toole, 1999).

Consequently, the problem of dry season feeding of livestock in particular, has

directed research efforts towards harnessing and enhancing the utilization of abundant arable by-products (Malau-Aduli *et al.*, 2003). Besides, soybean curd residue contains mostly crude fibre composed of cellulose, hemicellulose, and lignin; about 25% protein; 10–15% oil; with little starch or simple carbohydrates (O'Toole, 1999). Therefore, the concept of matching ruminant livestock production with available feed resources (Preston and Leng, 1987) has consequently intensified research into evaluation of more crop residues (such as soybean curd residue) for use as livestock feeds in Nigeria rather than discarding it. Hence, using soybean curd residue for feeding livestock may provide low-cost and readily available feed resource among rural communities where soybean production is predominant, while making it better by removing the “waste”. For this reason, this study is geared towards a comprehensive development and utilization of soybean curd residue, with the hope to obtain prospective economic benefits.

Though feeding goats with crop residues on its own is not enough to support ruminants beyond maintenance level (Orden *et al.*, 2000), thus the need for supplementation. It is established that ruminants fed low crude protein roughages also respond well to nitrogen sources of plant origin through supplementation (Preston and Leng, 1987). Since animal performance with feedstuffs such as crop residues can be poor due to low voluntary intake and digestibility, which result from non-bioavailable protein concentrations and high levels of indigestible or slowly degradable fibre (Abdel Hammeed *et al.*, 2013), supplementation is paramount. Therefore, this study is aimed at evaluating the effects of feeding soybean

curd residue in diets of Red Sokoto bucks on nutrient intake and digestibility.

Materials and Method

Location of the study

The study was conducted at the Small Ruminant unit of Adamawa State University Teaching and Research farm, 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°30'45" East Greenwich meridian with 579 meters above sea level (Geodatos, 2019). The experiment began from 25th July–15th August, 2018.

Experimental diets and procedure

Five (5) total mixed rations (14% crude protein) was formulated (4 of which will be soybean curd residue based) with cowpea husk as the basal diet (Table 1). The cowpea husk and other concentrate ingredients (maize offal, cotton seed meal, bone meal and salt) used to compound the experimental diets were sourced from *TIKE* cattle market, Mubi South. The soybean curd residue was sourced from Awara (soybean curd cake) producers within Mubi environs. The soybean curd residue was sun dried for 5 days, to prevent mould growth and fermentation. The feed ingredients were mixed thoroughly into a total mixed ration. This is to prevent wastage and preferential selection by the experimental animals. The feed was offered to the bucks (5% body weight, fresh weight basis) at 8.00h and 14.00h; the left over was weighed the following morning before the subsequent feeding. Portable water was available to the animal's *ad-libitum*, so also the experimental diets.

Animal management

Fifteen (15) Red Sokoto bucks with an average weight of 10 kg were used for the trial. The bucks were sourced from the *TIKE* cattle market, Mubi South. The animals were weighed using hanging balance (CAMRY EMPERORS, FA00336) to get their live weight before the commencement of the trial. The animals were housed in individual pens of concrete floor with full shade during the acclimatization period (2 weeks). The bucks were dewormed using Abendazole[®] suspension and dipped in Acaricide Amitix[®] solution during the acclimatization period to control endo- and ecto-parasites. The faecal remains were removed daily and environment kept clean.

Experimental design and digestibility trial

The bucks were randomly assigned into five (5) treatment groups of four (3)

DM feed intake = DM feed offered daily – DM feed refused daily

$$\% \text{ DM Digestibility} = \frac{\text{nutreint consumed} - \text{nutrient in faeces}}{\text{nutrient consumed}} \times 100$$

Chemical analysis

Proximate analysis of the sub-samples from the feed and that of the faeces was determined using the procedures of AOAC (2005). Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) was determined by the methods of Van Soest (1991).

Statistical analysis

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

Results

bucks each in a Completely Randomized Design (CRD). The bucks were housed individually in metabolism cages (1.0×0.8m), elevated 0.8m above ground, with provision for separate collection of faeces and urine as described by Osuji *et al.*, (1993). The metabolism cages were kept in a well-ventilated room. The bucks were allowed 14 days' adjustment period on the crate, followed by 7 days of collection of faeces and urine. Daily collection of faeces and urine were weighed. At the end of collection period, the faecal samples were bulked and dried. From the dried sample, 50 g faeces were sampled, placed in a paper bag and saved pending proximate analysis. Dry-matter (DM) feed intake and digestibility coefficient (McDonald *et al.*, 2010) of the feed was calculated as follows;

Compositions of the experimental diets

The chemical composition of soybean curd residue is presented in Table 2. The results showed that it had high levels of energy, protein and soluble carbohydrates. The proximate composition of the experimental diets is shown in Table 3. The results revealed that the inclusion of soybean curd residue increased dry matter, crude protein, oil, ash and nitrogen free extracts. But low crude fibre was recorded.

Nutrient intake in Red Sokoto bucks fed experimental diets

Table 4 shows the nutrient intake of the experimental diets as consumed by the Red Sokoto bucks. There were significant ($P < 0.05$) difference observed

in all parameters measured, with a higher daily feed intake obtained in T₃ (481.29%) compared to all other treatments. Similarly, water intake and dry matter intake was highest ($P<0.05$) in T₃ (691.10 ml/day, 457.22% respectively) compared to other treatments. Observing crude protein intake, treatments T₅ (81.72%) increased significantly ($P<0.05$) compared to T₁ (68.11%). For the crude fibre intake, T₁ was the highest (66.46%) significantly ($P<0.05$) than the test groups, the lowest was observed in T₂ (45.92%).

Nutrient digestibility in Red Sokoto bucks fed experimental diets

Table 5 presents the nutrient digestibility of the experimental diets. The overall results showed that there was significant ($P<0.05$) differences among the treatments for all the parameters measured. Apparent digestibility of dry matter (DM) decreases as the levels of SCR increases. Dry matter digestibility in T₂ (60.69%) was the highest ($P<0.05$) compared to other treatments. Crude protein, crude fibre and ether extract digestibility decreases as the levels of SCR increases. The crude protein, crude fibre, and ether extract digestibility was highest ($P<0.05$) in T₁ (59.20%, 64.01% and 60.20% respectively) compared to the other treatments. For Ash retention and nitrogen free extract digestibility, it was highest ($P<0.05$) in T₂ (62.95% and 60.96% respectively) compared to other treatments.

Discussion

Composition of the experimental diets

From the proximate composition of the soybean curd residue, it can be stated that it contains relatively high energy, protein, and fibre. The protein value observed for soybean curd residue in this study is in consistence with the findings of Li *et al.* (2013) who reported protein

of soybean curd residue to be 27% (dry basis). The authors further stated that the protein in soybean curd residue is of good nutritional value and has a greater protein efficiency ratio which is an indication for a prospective source of vegetable protein for animal consumption. Hackler *et al.* (1963) also stated that protein in soybean curd residue was top-class to curd protein and soymilk. On a similar note, the fibre in the soybean curd residue is digestible through fermentation in the rumen and large intestine. It is recognised to make available vital health gains to the body of animals with respect to maintenance and normal bowel functions (Periago *et al.*, 1997). According to PennState Extension (2013), neutral detergent fibre (NDF) is a good measure of feed quality. Thus, below 40% contents of NDF would be considered good quality while 50% and above, poor, for leguminous feedstuffs. In this study, the NDF value indicates a rather in-between status (neither good nor poor). According to Van Soest (1994), from which up till now our analysis of fibre fraction in developing countries is based, NDF below 60% is considered a good quality.

For the experimental diets, the increase observed in dry matter, protein and nitrogen free extract in the treatments might have been as a result of the soybean curd residue inclusion. Investigations have revealed that mixing soybean curd residue with other feed ingredients in animal rations have led to the increase in protein, dietary fibre and soluble carbohydrates compared with those without it (Rinaldi *et al.*, 2000).

Nutrient intake of soybean curd residue in Red Sokoto buck's diets

The quality of a diet can influence the feed intake of ruminants through its effect on digestion in the gastrointestinal tract (Zimmermann, 1980). 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; The Cattle Site, 2019). This influences the prehension and intake level of bucks (Decruyenaere *et al.*, 2009). It is also expressed that increased intake might be as a result of low fibre concentration in the diet in which the feed is not chewed for a longer time and thus, rate of passage (Decruyenaere *et al.*, 2009; Abdulquadri, 2019). In a similar study, Arthington and Brown (2005) stated that increased intake may be due to the diet having less cell wall and lignified tissues which decrease diet retention time in the rumen. Increase in water intake observed in the present study may have resulted due to the level of dryness of the feed; the drier the feed the greater the amount of water required by the animal to maintain water content in its body and lubrication of the oesophagus (Abdulquadri, 2019). Hayirli *et al.* (2002) expressed that increased dietary fat increase dry matter intake when diets contained above average rumen undegradable protein or below average crude fibre content. Also, Vasquez and Smith (2000) expressed that low crude fibre content increase dry matter intake of ruminant diets. The increase in dry matter intake might also be as a result of the nutritional requirement of the bucks. The bucks are growing animals and thus required about 14-15% protein in the diet to meet its physiological state; growth needs (Hristov *et al.*, 2005; Farruggia *et al.*, 2006). If a judicious supplementation of forage is achieved, the diets nutritional balance is improved and so, increased the voluntary intake (Vasquez and Smith 2000). Furthermore, nutrient concentrations of diets increase dry matter intake such that the animal

eats to maximize its production potential under some constraints such as gut volume and diets quality (Yearsley *et al.*, 2001). The increased crude protein intake might have been as a result of its increase in the respective dietary groups. This seems that a unit of dry matter intake with high crude protein content will be converted more efficiently for animal tissue than intake with a lower crude protein content (Zimmermann, 1980).

Nutrient digestibility of soybean curd residue in Red Sokoto buck's diets

Digestibility of a feed is the ability of the animal to breakdown or utilizes the feed such that it provides the necessary nutrients required for the animal's growth (Abdulquadri, 2016). Despite the reduced daily feed intake observed in treatment involving 5% SCR level of inclusion, the dry matter (DM) digestibility increased but decreased as SCR level increases. The increase in DM digestibility may be attributed to the nutrient quality present in the treatment (slightly lower CF; increased soluble carbohydrates, nitrogen free extracts; high DM with probably high degradable protein). This is consistent with the study of Edonard *et al.* (2008) that informed the digestibility of diets to proliferate as fibre levels decreased. Some authors also reported increased apparent digestibility with increased dry matter intake which is in conflict with the present study (Grant *et al.*, 1974; Saastamoinen and Hellamaki, 2012; Merritt and Julliand, 2013). Some authors have concluded that fore and hind gut fermenters respond well to a reduction in fibre component of diets by increasing DM (Sufyan, 2018; Veterian key, 2016; Esmail, 2019). According to Naseri (2000), the DM digestibility recorded in this study indicates that the treatment

can be classified as moderately digestible (60-70%).

The increase crude protein digestibility in the present study, might be as a result of an efficient microbial activity which indicates that the diet supplied the necessary condition for microbes to work efficiently without any inhibitory constraints (McNab, 1975; Naseri, 2000). It may also be that the protein in the dietary group is highly soluble (Sufyan, 2018). Lower digestibility values for crude protein observed in the treatments involving 10.5% SCR level of inclusion might be attributed to antinutritional factors associated probably with the protein of the SCR related to the ones occurring naturally, in soybeans (Gilani and Sepehr, 2002).

Higher crude fibre digestibility in the present study is in conflict with the reports of some authors stating that nutrient digestibility is reduced with increased fibre levels in the diets (Edonard *et al.* 2008; Millam, 2016; Sufyan, 2018; Esmail, 2019). Even though there was high crude fibre content as reflected in the treatment (that without SCR), nutrient digestibility was not reduced. This may be attributed to either higher fibre intake which was necessary for microbial activities (Naseri, 2000); the diet has protein of high degradable fraction which is required for efficient digestion of high fibre in ruminants, or the dietary fat was considerably less to favour the fibre digestion as high fat (greater than 8% in diets) reduces fibre digestion (Sufyan, 2018). Increased levels of fat digestibility in the present study might have resulted from the type of degradable triglycerides in the dietary fat, composition of the diet and intestinal microflora (McNab, 1975).

Increased NFE observed from the present study may have been influenced by some dietary factors such as high dry matter, less crude fibre, and high nitrogen free extract levels of the dietary group (McNab, 1975; Esmail, 2019).

The decrease nutrient digestibility observed in this study might be attributed to digestion obstructions (diarrhoea and constipation) observed by animals on treatment involving 10% and 12.5% SCR level if inclusion during the experiment. Hinks and Hupka (1995) reported that livestock served with high levels soybean curd residue will have digestion problems which will probably interfere with the rapid growth of animals. Abdulquadri (2019) also reported that sick (physically degraded) animals digest feed poorly. The results of present study conflicts with the reports of some authors that stated, the fibre in soybean curd residue has been reported to reduce the occurrence of constipation, maintains normal bowel functions, have a positive effect in diarrhoea management and can be used as a treatment for irritable bowel (Bosaeus, 2004; Barrett *et al.*, 2012).

Conclusion

It was observed that 7.5% SCR inclusion in diets of Red Sokoto bucks increased daily feed intake, water intake and dry matter intake by 22.98%, 36.30% and 19.53% respectively. Crude protein intake was increased by 13.61% in 12.5% SCR inclusion while crude fibre intake decreased by 20.54%. Dry matter digestibility, ash retention and nitrogen free extract was observed to increase by 2.26%, 3.55% and 4.19% respectively in 5% SCR inclusion, while crude protein, crude fibre and oil digestibility was decreased by 19.21%, 37.82% and 29.90% respectively. This is an indication that 7.5% level of inclusion of

SCR in Red Sokoto bucks diet increased nutrient intake but had a relatively reduced nutrient digestibility. Thus, enzyme supplementation can be used to increase soybean curd digestibility.

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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	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

Table 2: Chemical composition of the soybean curd residue

Parameters	%
Dry matter	93.53
Moisture	6.47
Energy	3435.15
Protein	30.66
Ether extract	0.52
Ash	4.38
Nitrogen free extract	49.12
Acid detergent fibre	53.45
Neutral detergent fibre	46.48

DM: dry matter, CP: crude protein, EE: ether extract, NDF: neutral detergent fibre, ADF: acid detergent fibre, NFE: nitrogen free extract

Table 3: Proximate composition of the soybean curd residue based diets

Parameters (%)	T ₁	T ₂	T ₃	T ₄	T ₅
Dry matter	95.50	97.00	95.00	96.00	95.00
Protein	14.86	13.13	15.63	17.54	18.05
Crude fibre	14.50	11.00	10.45	11.30	10.40
Oil	1.70	1.60	1.80	1.85	1.75
Ash	4.50	4.60	5.80	5.85	4.80
Nitrogen free extract	59.94	66.67	61.32	60.26	60.00

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

Table 4: Productive performance of RSB fed soybean curd residue based diets

Parameters (%)	T ₁	T ₂	T ₃	T ₄	T ₅	SEM
Daily feed intake	458.31 ^{ab}	417.43 ^b	481.29 ^a	431.14 ^b	452.72 ^{ab}	16.40
Water intake ^{ml}	654.80 ^{ab}	572.10 ^b	691.10 ^a	654.70 ^{ab}	675.70 ^{ab}	37.78
Dry matter intake	437.69 ^{ab}	404.90 ^b	457.22 ^a	413.90 ^b	430.08 ^{ab}	15.69
Crude protein intake	68.11 ^c	54.81 ^d	75.62 ^{bc}	75.62 ^b	81.72 ^a	2.65
Crude fibre intake	66.46 ^a	45.92 ^c	50.29 ^b	48.72 ^{bc}	47.08 ^{bc}	1.91

^{abc}: Means with different superscripts within a row are significantly different (P<0.05), RSB: Red Sokoto bucks, ^{ml}: millilitres per day, T₁, T₂, T₃, T₄ and T₅: 0.00%, 5.00%, 7.50%, 10.00%, 12.50% levels of inclusion of soybean curd residue respectively, SEM: standard error of means

Table 5: Nutrient digestibility in RSB fed soybean curd residue based diets

Parameters (%)	T ₁	T ₂	T ₃	T ₄	T ₅	SEM
Dry matter	58.43 ^{ab}	60.69 ^a	54.55 ^{ab}	27.10 ^b	33.50 ^b	3.66
Crude protein	59.20 ^a	58.34 ^{ab}	58.53 ^{ab}	39.99 ^c	47.57 ^b	3.08
Crude fibre	64.01 ^a	61.27 ^{ab}	54.19 ^b	26.19 ^c	28.60 ^c	3.79
Oil	60.20 ^a	58.20 ^{ab}	55.68 ^{ab}	32.16 ^b	30.30 ^b	3.73
Ash	59.40 ^{ab}	62.95 ^a	55.09 ^{ab}	22.60 ^c	32.74 ^b	3.71
Nitrogen free extract	56.77 ^{ab}	60.96 ^a	53.51 ^{ab}	24.51 ^b	30.27 ^b	3.82

^{abc}: Means with different superscripts within a row are significantly different (P<0.05), RSB: Red Sokoto bucks, T₁, T₂, T₃, T₄ and T₅: 0.00%, 5.00%, 7.50%, 10.00%, 12.50% levels of inclusion of soybean curd residue respectively, SEM: Standard error of means