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Growth performance and cost-benefit analysis of Red Sokoto goats fed diets containing varying levels of soybean milk residue as replacement for soybean meal

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ABSTRACT: To evaluate growth performance and economics of production in this study, 25 weaned Red Sokoto bucks of 8.30 to 8.50kg weight were used and fed diets containing varying levels of soybean milk residue as a replacement for soybean meal for 90 days. Fiddle leaf fig (*Ficus lyrata*) leaves were served to all the bucks as the basal diet. The bucks were managed in individual compartments with 5 bucks per treatment and each buck represented a replicate. The experimental design used in this study was the completely randomized design (CRD). Diets were coded as T1, T2, T3, T4 and T5. T1 had 0% soybean milk residue and 100% soybean meal (SBM) inclusion, T2 had 25% soybean milk residue and 75% soybean meal inclusion, T3 had 50% soybean milk residue and 50% soybean meal inclusion, T4 had 75% soybean milk residue and 25% soybean meal inclusion while T5 had 100% soybean milk residue and 0% soybean meal inclusion in the respective diets. The results show that bucks in T3 had the highest average daily feed intake 600.05 g followed by T2 (599.86 g), T5 (591.91 g) and T1 (588.61 g) while T4 (583.91 g) recorded the least average daily feed intake. The dry matter intake (DMI) of the bucks was not significantly ($p>0.05$) affected by dietary treatments. Bucks fed diets containing 0% soybean milk residue had higher total weight gain (TWG) (6.48 kg) and average daily weight gain (ADWG) (71.99 g) than the other treatment groups. The lowest values were observed in T2 (5.22 kg and 60.22 g) for TWG and ADWG, respectively. The feed conversion ratio ranged from 8.19 (T1) to 10.14 (T2). T3, T4 and T5 had a feed conversion ratio of 9.36, 9.83 and 9.19 respectively. The total cost of production ranged between ₦11,529.56 (T4) to ₦13,152.39 (T1). Revenue per goat was highest at 75% soybean meal replacement (₦38,650.00) and lowest when replacement was 50/50 (₦37,090.00). Also, profit per goat was highest at 75% soybean meal replacement (₦27,120.44) and lowest when replacement was 50/50 (₦24,606.13). The cost-benefit ratio was significantly affected ($p<0.05$) by the levels of inclusion of soybean milk residue with the highest profit generated per goat from 75% supplementation of soybean milk residue. It was concluded that the replacement of soybean meal for soybean milk residue up to 75% will ensure a better growth performance and economic benefit.

Keywords: Cost-benefit, *Ficus lyrata*, growth performance, Red Sokoto goats, soybean milk residue, soybean meal.

INTRODUCTION

The cost of production is challenging for any production enterprise. In animal production, feed cost takes 75% of the total cost of production (Agbabiaka, 2016) due to the high cost of conventional feed ingredients as a result of the increasing competition for grains between man and livestock (Akinmutimi, 2004). To curb this challenge, cheaper and alternative sources of feedstuff for livestock that will reduce production costs and boost production for utmost product supply becomes important to improve animal protein intake by an average Nigerian and sustain the livestock sector (Esonu *et al.,* 2003). Akinmutimi (2004) suggested the use of crop residues not utilized by

man. Forages not fully harnessed such as fiddle leaf fig (*Ficus lyrata*) should also be utilized. Ahamefule *et al.* (2006) reported that crop residues, by-products and sludge from processing grains, and offals from millers of grain are potential sources of feed materials for livestock feed.

Soybean milk residue is the residue (sludge) remaining after extracting juice from ground soybeans. It is rich in protein (27%) but usually dumped on refuse sites after soymilk extraction (Li *et al*., 2013). It is readily available and cheap in towns and villages where cheese is widely produced and eaten (Iyeghe-Erakpotobor, 2010). A conscious effort to properly channel this seemingly good quality feedstuff for feeding ruminants like goats will enhance additional production value. Although wet soybean milk residue cannot be stored for long, it can be sun-dried to enhance greater storability and acceptability by the animals. Soybean milk residue has been used in the diets of birds and hogs without detrimental effects (Li *et al*., 2013). Iyeghe-Erakpotobor (2010) and Emmanuel *et al*. (2021) have reported good performance in rabbits fed soybean milk residue-based diets. Rahman *et al.* (2014) reported good dry matter intake, feed conversion ratio and feed cost per kilogram of body weight for goats fed supplemental soybean milk residue. Also, Priyanto *et al.* (2017) reported good performance in terms of final body weight, average daily gain, dry matter intake, and feed efficiency when cattle were fed 70% of soybean milk residue. This study is therefore designed to evaluate the effect of soybean milk residue as a replacement for soybean meal with fiddle leaf fig (*Ficus lyrata*) leaves as basal diet on the growth performance and economics of production of Red Sokoto bucks.

MATERIALS AND METHODS

Study location

This research was carried out in the Teaching and Research farm, and Biochemistry Laboratory of Federal Polytechnic, Bali B ward, Bali Local Government Area (LGA) of Taraba State, Nigeria. Bali covers a total land area of about 5,500 km and extends between latitude 8°35' 00" North of the equator and 10°46' 00" East of the Greenwich Meridian (Taraba State Government, 2020). Bali has browse trees such as *Gmelina arborea, Daniella africana, Afzelia africana, Tamarindus indica, Parkia clappertoniana, Prosopis africana* and *Ficus spp* (Rimamchirka, 2019), and such as *Ficus lyrata, Ficus sycamorus, Ficus thoningii, Ficus regiolisa and Ficus polita* (Sylva-Nyom, 2023).

Experimental animal and diets

Twenty-five (25) Red Sokoto bucks were purchased from Gazabu general market in Bali and quarantined for 2 weeks after which they were placed in standard pens with individual compartments for each buck. Each goat represented a replicate giving a total of 5 goats per treatment; 5 treatments, and 5 replicates. Soybean milk residue was sourced from within Bali town, air-dried again, milled, and used to compound the diets. Five experimental diets designated T1, T2, T3, T4, and T5 were prepared with whole grain maize, maize offal, and sorghum chaff as the fixed ingredients for the diets while soybean milk residue was included in graded levels to replace soybean meal at 0%, 25%, 50%,75% and 100% in the designated diets respectively as seen in Table 1. *Ficus lyrata* leaves were cut from the lowland beside the river in Bali town and fed *ad libitum* to animals.

Data collection

Performance indices

Experimental animals were weighed at the commencement of the feeding trials, and thereafter, they were weighed weekly till the end of the experiment to constantly ascertain their weight changes. The initial weight was subtracted from the final weight to obtain weight changes. Total, weekly, and daily feed intakes as well as total, weekly and daily weight gain were calculated for each treatment group. Leftovers of diets offered to bucks were collected after 24 hours and weighed to determine the voluntary feed intake. The feeding trial lasted for 90 days. Feed conversion ratios were also obtained for each group by dividing the feed intake by weight gains.

$$\text{Daily Feed Intake} = \frac{Mean\ total\ feed\ intake}{Number\ of\ days}$$

$$\text{Daily Weight Gain} = \frac{\text{MFBW} - M\text{MIBW}}{Number\ of\ days}$$

$$\text{Feed: Gain Ratio} = \frac{Average\ feed\ intake}{Average\ body\ weight\ gain}$$

Where: MFBW = Mean final body weight, and MIBW = Mean initial body weight.

Cost-benefit analysis

The least market price of all live bucks and the meat cuts were summed and compared with the total cost of production to determine the profitability of the production of Red Sokoto bucks using the test feeds. Total cost of production was the sum of the total variable cost and the total fixed cost. Net farm income (NFI) analysis as described by Jabo *et al*. (2010) was used to carry out the cost-benefit analysis which is specified by Aderinola and

Table 1. Composition of experimental diet.

Ingredients	Experimental diet				
	T1	T2	T3	T4	T5
Maize	5.00	5.00	5.00	5.00	5.00
Sorghum chaff	10.00	10.00	10.00	10.00	10.00
Maize offal	57.74	57.74	57.74	57.74	57.74
SBMR	0.00	6.06	12.13	18.20	24.26
SBM	24.26	18.20	12.13	6.06	0.00
Bone ash	2.00	2.00	2.00	2.00	2.00
Common salt	1.00	1.00	1.00	1.00	1.00
Total	100	100	100	100	100
Calculated Analysis %					
Crude Protein	18.00	16.31	14.62	12.92	11.23
Crude Fibre	7.11	7.30	7.49	7.69	7.84
Ether Extract	3.26	3.39	3.53	3.66	3.79
Ash	4.63	4.46	4.29	4.12	3.95
NFE	67.00	68.60	70.07	71.67	73.19
ME (Kcal/kg)	2477.50	2401.37	2325.12	2248.84	2172.71

SBMR= soybean milk residue, SBN=soybean meal, NFE= nitrogen free extract, ME= metabolizable energy.

Akinrinola (2005) and cited by Babale *et al.* (2018) as follows:

NI=TR-(TVC+TFC)

Where: NI = Net Income (Profit of the product in Naira/kg), TR = Total Revenue of the ith product in Naira/kg, TVC = Total Variable Costs of the ith product in Naira/kg, TFC= Total Fixed Costs of the ith product in Naira/kg.

Experimental design and statistical analysis

A Completely Randomized Design was used for the experiment. The statistical model for the experiment is shown below:

$Y_i = \mu + T_i + E_{ij}$

Where: Y_{ij} = Overall observation (growth performance, cost-benefit), μ = Individual mean, T_i = Effect due to inclusion level (0%, 25%, 50%, 75% & 100%) of soybean milk residue, E_{ij} = Error

All data collected in this study were subjected to analysis of variance (ANOVA) appropriately using the Minitab16 (2004) statistical software. Significant differences between treatment means were separated by Fisher's least square difference using the same statistical package.

RESULTS AND DISCUSSION

Growth performance did not vary significantly ($p>0.05$) with varying levels of soybean milk residue inclusion as seen in Table 2. The inclusion of soybean milk residue at 50% (600.05 g) ensured the highest total feed intake followed by 25% (599.86g) but dry matter intake was highest at 25% (532.29g) inclusion of soybean milk residue followed by 50% (531.38 g). Total feed intake is similar to the 567.75 g and 628.25 g recorded by Ogunbosoye *et al*. (2022) when soybean cheese waste was supplemented up to 10%. Daily weight gain was between 60.22 to 71.99 g. This is higher than 27 g recorded by Wuanor and Ayoade (2017) for West African Dwarf goats fed white rot mushroom (*Pleurotus tuber-regium*), biodegraded rice straw and maize offal but similar to 64.29 g recorded by Ogunbosoye *et al*. (2021) for WAD goats fed Shea nut cake and 74.50g recorded by Setiawan *et al*. (2022) for Kacang goats fed fermented sago waste. This may be attributed to the consumption of both concentrated diets and forage under intensive management. Goats receiving 0% inclusion of soybean milk residue recorded the highest final weight (14.78 kg). The total dry matter intake (524.10-532.29 g) was within the required 414-597 g recommended by Carl and Kees (2004) for goats gaining 50-100 g growth per day. T4 (75% inclusion of soybean milk residue) had the least total dry matter (523.21 g) intake but recorded a good feed conversion ratio (9.83). Feed conversion was highest (10.14) at 25% inclusion of soybean milk residue and least (8.19) at 0% soybean milk residue inclusion. Rahman *et al.* (2014) reported lower dry matter intake and feed conversion ratio for goats fed supplemental soybean milk residue. Priyanto *et al.* (2017) reported good performance in terms of final body weight, average daily gain, dry matter intake, and feed efficiency when cattle were fed 70% of soybean milk residue.

Table 2. Growth performance of Red Sokoto goats fed diets containing varying levels of soybean milk residue with *Ficus lyrata* as basal diet.

Parameters	Treatments					SEM	P- value
	T1	T2	T3	T4	T5		
IBW (kg)	8.30	8.40	8.40	8.40	8.50	0.50	0.9992
ADCI (g)	229.76	233.06	243.33	232.90	239.39	5.53	0.4313
ADFI (G)	358.85	366.80	356.72	351.01	352.53	5.85	0.3697
ADFeI (g)	588.61	599.86	600.05	583.91	591.91	9.79	0.7212
TFI (kg)	52.97	54.00	54.08	52.61	53.28	0.87	0.7087
Final weight (kg)	14.78	13.82	14.18	13.86	14.42	0.56	0.7199
ADWG (g)	71.99	60.22	64.22	60.66	65.77	3.49	0.1564
TWG (kg)	6.48	5.22	5.78	5.46	5.92	0.31	0.0814
FCR	8.19	10.14	9.36	9.83	9.19	0.58	0.1979
DMIc (g)	205.70	207.21	215.27	210.31	214.41	5.15	0.6146
DMIf (g)	318.40	325.09	316.15	311.10	312.44	5.17	0.3625
TDMI (g)	524.10	532.29	531.38	523.21	526.85	8.62	0.9183

IBW= initial body weight, ADCI= average daily concentrate intake, ADFI= average daily forage intake, ADFeI= average daily feed intake, TFI= total feed intake, ADWG= average daily weight gain, TWG=total weight gain, FCR= feed conversion ratio, DMIc= dry matter intake of concentrate, DMIf= dry matter intake of forage, TDMI= total dry matter intake.

Table 3. Cost-benefit of Red Sokoto goats fed diets containing varying levels of soybean milk residue with *Ficus lyrata* as basal diet.

Parameters	Treatments					SEM	P- value
	T1	T2	T3	T4	T5		
Cost/buck	7,100.00	7,100.00	7,100.00	7,100.00	7,100.00	-	-
Feed cost/kg (₦)	139.65	119.50	99.30	70.04	59.00	-	-
TCFC (₦)	2,956.39	2,450.94	2,287.87	1,333.56	1,335.17	-	-
Cost saving/kg	0.00	20.15	40.35	69.61	80.65	-	-
OE (₦)	3,096.00	3,096.00	3,096.00	3,096.00	3,096.00	-	-
TCP (₦)	13,152.39	12,646.94	12,483.87	11,529.56	11,531.17	-	-
FCR	8.54	8.91	9.38	9.16	7.82	0.58	0.1979
Cost/kg WG	1,192.61	1,064.75	931.43	641.57	461.38	-	-
DW (kg)	11.82	11.91	11.53	12.05	11.82	-	-
Cost/kg carcass	3,000.00	3,000.00	3,000.00	3,000.00	3,000.00	-	-
Revenue/goat (₦)	37,960.00	38,230.00	37,090.00	38,650.00	37,960.00	-	-
Profit/goat (₦)	24,807.61	25,583.06	24,606.13	27,120.44	26,428.83	-	-
Cost-Benefit ratio	0.35[a]	0.33[b]	0.34[b]	0.30[c]	0.30[c]	0.00	0.0001

[abc]Means with different superscript within the same row differ significantly ($p<0.05$). TCFC= total cost of feed consumed, OE= operational expenses, TCP= total cost of production, FCR= feed conversion ratio, WG= weight gain, DW= dressed weight, C:B= cost-benefit ratio.

Results as shown in Table 3 also showed that diets containing varying levels of soybean milk residue significantly affected ($p<0.05$) the cost-benefit (0.30-0.35) of Red Sokoto goat production. Individual buck was purchased at ₦7,100.00. The cost of feeding per kilogram of feed decreased from ₦139.65 in the control to ₦59.00 at 100% supplementation as soybean milk inclusion increased just as the cost saving per kilogram increased from ₦0.00 in the control to ₦80.65 in T5. More so, the total cost of feed consumed (₦2,956.39 - ₦1,335.17) and total cost of production (₦13,152.39 - ₦11,531.17) were highest in the control and least at 100% supplementation with operational expenses fixed at ₦3,096.00. This implied that the cost of feeding goats can be greatly reduced by soybean milk supplementation and improved cost savings, in line with the report of Rahman *et al.* (2014). Ajayi *et al*. (2007) observed a reduction in feed cost when an unconventional feed ingredient was included in the diet of goats. Cost per kilogram weight gain reduced from ₦1,192.61 in the control to ₦461.38 in T5 while the cost of the carcass was fixed at ₦3,000.00 per kilogram. The highest feed conversion ratio obtained from

T3 did not translate into the highest revenue generation, rather, T4 with a feed conversion ratio of 9.16 gave the highest revenue (₦38,650.00). T3 generated the least revenue (₦37,090.00). Profit per goat was highest at 75% supplementation (₦27,120.44) and least in T3 (₦24,606.13). Unconventional feedstuff such as soybean milk residue can replace soybean meal up to 100% to achieve a good growth performance, reduce production costs and maximize profit.

Conclusion

Soybean milk residue supplementation of up to 100% in the diets of Red Sokoto goats significantly improved dry matter intake, weight gain, and feed conversion ratio. Supplementation at 75% resulted in the best growth performance and highest profit.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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