EVALUATION OF GINGER (*ZINGIBER OFFICINALE*) AS FEED ADDITIVE ON THE PERFORMANCE AND COST BENEFIT OF RED SOKOTO BUCKS FED *DIGITARIA SMUTSII* BASAL DIET

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ABSTRACT

A study was conducted to evaluate the effect of inclusion levels of ginger on performance of Red Sokoto bucks (RSB). A total of twenty-four (24) bucks weighing on the average 17.86 kg were used for the experiment. The animals were randomly assigned to four diets, containing 0, 250, 500 and 750 g/100kg diet levels of ginger respectively, with six animals per treatment diets, in a completely randomized design. The animals were fed concentrate at 1.5 % of body weight. Feed intake, weight gain and nutrient digestibility were recorded. The data obtained were subjected to analysis of variance using the Statistical Analysis Software (SAS) and significant treatment means were separated using Duncan Multiple Range Test (DMRT). Results obtained showed that bucks fed diet containing 250 and 750 g ginger consumed more feed even though with no significant difference (p>0.05) across the treatment. Animals fed diet containing 750 g ginger had significantly higher (p<0.05) weight gain (2.50 kg) and significantly best (p<0.05) feed conversion ratio (28.08) while significantly least (p<0.05) weight gain (1.17 kg) was recorded in the group fed diet containing 500 g ginger. Including ginger at 750 g saved cost of feeding/kg weight gain by 17 % compared to the control. The study showed that ginger inclusion in the diet of RSB improved weight gain, feed conversion ratio, digestibility and reduced cost of feed per kg weight gain. The study showed that ginger can be included up to 750g/100 kg diet of RSB for better performance.

Keywords: Red Sokoto bucks, *Digitaria smutsii* basal diet, Ginger, Performance, Digestibility

INTRODUCTION

The high cost of cattle production has encouraged the production of small ruminants (sheep and goats) which cost less in terms of feeding and other management practices (Ikyume *et al.,* 2017). Goats are prolific animals with unique ability to kid twice in every 14 months with high tendency of multiple kids per litter which cannot be achieved by cow (Haldar *et al.*, 2014). There is much attention on small ruminants in developing countries like Nigeria because of their ability to produce meat, milk, skin and wool even in harsh environment (Konlan *et al.,* 2012). Hence, the need for increased efficiency in ruminant production given its importance to the society.

Feeding ruminants with low quality feed contribute to global warming by releasing greenhouse gas emissions through normal rumen fermentation (Iqbal and Hashim, 2014). Herbs such as ginger (*Zingiber officinale* Roscoe, Zingiberales: Zingiberaceae) enhances the activities of digestive enzymes and nutrient absorption by reducing bacterial colony counts and fermentation products which improves

nutrient digestion and probably reflecting an overall improved gut equilibrium (Odoemelam *et al.*, 2013)**.** In addition, some of the herbs and spices or their derivatives have been reported to promote intestinal mucus production. This effect may explain improved production performance after including these phytogenic feed additives (Odoemelam *et al.*, 2013). Ginger is used throughout the world as an important cooking spice. It possesses some antinutritional factors such as alkaloids, saponin, tannins and glycosides (Osabor *et al.*, 2015). They are known to stimulate digestive system as well as helps in reducing fever (Bode and Dong, 2011). Saponins are mainly produced by plants, some lower marine animals and some rhizobacteria (Faizal and Geelen, 2013). They are known to affect gas and microbial production to different extents in *in-vitro* gas systems containing buffered rumen microbes and feed. For example, ginger saponins decreased gas production, but increased microbial protein without affecting true digestibility (Srinivasan *et al.,* 2003). This research seeks to explore the efficacy of feeding ginger powder on performance of RSB.

MATERIALS AND METHODS

Experimental Location: The experiment was conducted at the National Animal Production Research Institute (NAPRI), Ahmadu Bello University (ABU), Shika, Zaria, Nigeria. Shika is located at latitude 11º 12'N and longitude 7º 33'E at an altitude of 640 meters above sea level (Akpa *et al.*, 2002). The climate is relatively dry with annual rainfall range of 700 – 1400 mm. The rain starts between late April and early May to September. The dry season begins in October with cold weather that ends in January. This is followed by relatively hot-dry weather between February and April just before the rain begins. The daily temperature ranges from 14^0C – 24^0C during the cold season, and from 19^0C – 36^0C during the hot season. The relative humidity during dry and wet seasons are 21 and 72 % respectively (IAR, 2018).

Experimental Feed Preparation: Feed was compounded (Table 1) with inclusion levels of ginger at 0, 250, 500, and 750 g/100kg. The formulation was done at the Feeds and Feeding Unit of NAPRI It was compounded to contain 12 % crude protein. Dry ginger was sourced from Samaru local market in Zaria and ground into find powder.

Table 1: Gross composition of the experimental concentrate diets fed to Red Sokoto bucks

Ingredients (%)	Inclusion levels of ginger (g/100kg diet)			
	0	250	500	750
Maize grain	15.00	15.00	15.00	15.00
Maize offal	20.00	20.00	20.00	20.00
Wheat offal	10.00	10.00	10.00	10.00
Cotton seed cake	5.00	5.00	5.00	5.00
Cowpea husk	46.50	46.50	46.50	46.50
Bone meal	2.50	2.50	2.50	2.50
Salt	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00
Calculated Chemical Composition				
ME (Kcal/kg)	2488.00	2490.00	2493.00	2496.00
Crude protein (%)	12.00	12.00	12.00	12.00
Crude fibre (%)	18.00	18.00	18.00	18.00

ME=metabolizable energy

Experimental Animals Feeding: Body weight of each buck was taken at the beginning of the experiment (day 0). Subsequently, the bucks were weighed fortnightly for body weight changes. The animals were individually fed according to their body weights (1.5 % for the concentrate as supplement diet and 2.5 % *D. smutsii* hay as basal diet). The concentrate was given to them at 8:00 am followed by the hay 3 hours later. Clean drinking water was offered *ad libitum*. Feed intake was measured and recorded daily by subtracting the left over from the quantity of feed offered to the animals the previous day. Feed conversion ratio was determined using feed intake over body weight gain.

Metabolism Trial of Red Sokoto Bucks: Twenty (20) RSB from the feeding trial (5 bucks per treatment) were used for metabolism trial. They were housed in individual metabolism cage

with facilities for separate collection of feces and urine as described by Osuji *et al.* (1993). Each buck was individually fed the same experimental diet used in the feeding trial to evaluate the digestibility of the diet. The study comprised seven days preliminary period of adaptation to the metabolic cages and seven days of samples collection. Daily total fecal samples were collected from each buck, weighed and 50 g was collected for dry matter determination and was bulked and stored in polythene bags until required for laboratory analysis.

Cost Benefit Analysis of Feeding Red Sokoto Bucks: Cost-benefit analysis was carried out to determine the profitability of including ginger in the diets of RSB. The cost of ginger and the other feed ingredients were estimated based on feed cost per kilogram weight using the prevailing market prices at the time of the study.

Chemical Analysis: The feeds and fecal samples were analyzed for dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), and ash using the procedures outlined by the Association of Official Analytical Chemists (AOAC, 2007). Acid detergent fibre (ADF) and neutral detergent fibre (NDF) were determined according to Van Soest *et al.* (1991) procedures.

Statistical Analysis: Data generated on daily feed intake, live weight changes and nutrient digestibility coefficients were analyzed statistically using the General Linear Model (GLM) procedure (SAS, 2004). Significant differences between treatment means were determined at $p<0.05$ using Duncan's Multiple Range Test of the same software. Data on fortnightly weight changes of bucks were subjected to analysis of variance for repeated measure analysis using Proc Mixed Procedure (SAS, 2004).

RESULTS

Chemical Composition of the Concentrate Diets, *Digitaria smutsii* and Ginger Fed to Red Sokoto Buck: Results of chemical composition of the concentrate diets, *D. smutsii* hay and ginger fed to RSB is presented in Table 2.

Growth Performance of Red Sokoto Buck Fed Varying Inclusion Levels of Ginger: Results of growth performance of RSB fed varying inclusion levels of ginger are presented in Table 3. The result of the study indicated no significant differences ($p>0.05$) in concentrate intake (kg), hay intake (kg) and feed intake (kg) (overall and daily). No significant difference ($p>0.05$) was recorded for final body weight across the treatments. Total weight gain and daily weight gain were significantly higher ($p<0.05$) in the treatment fed diet containing 750 g/100kg ginger inclusion. Inclusion of 750 g/100kg ginger had the lowest (best) feed conversion ratio (28.08).

Nutrient Digestibility of Red Sokoto Buck Fed Varying Inclusion Levels of Ginger: Results of nutrient digestibility of RSB fed varying inclusion levels of ginger is presented in Table 4. It showed no significant difference ($p>0.05$) in crude fibre and organic matter digestibility. But all other parameters (DM, Ash, EE, CP, EE, NDF and ADF) respectively were significantly affected ($p<0.05$) by ginger inclusion. They recorded higher values in animals fed diet containing 750 g ginger.

Economic Benefit Analysis of Feeding Ginger to Red Sokoto Bucks: The results of economic benefit analysis of feeding ginger to Red Sokoto bucks are presented in Table 5. Cost of feed per kg weight gain was affected by ginger inclusion levels. Bucks fed diet containing 750 g/100 kg ginger inclusion had the lowest cost of feed/kg weight gain (₦2,860.23). The total feed consumed was higher (70.64 kg) in the group fed diet containing 250 g/100 kg ginger inclusion.

DISCUSSION

Chemical Composition of the Concentrate Diets Fed to Red Sokoto Bucks: The high DM content of the formulated diet may be as a result of high dry matter content of the ingredients used in the diet formulation which is the

Table 2: Chemical composition of concentrate diets, *Digitaria smutsii* hay and ginger fed to Red Sokoto Buck

Parameters (%)	Inclusion levels of ginger (g/100 kg diet)				*D. smutsii*	Ginger
	0	250	500	750		
Dry Matter	91.60	91.90	92.10	92.40	90.04	96.09
Organic Matter	81.39	81.67	81.85	82.13	87.39	88.72
Ash	10.21	10.23	10.25	10.27	2.65	7.37
Ether Extract	4.08	4.10	4.11	4.13	0.54	5.90
Crude Fibre	18.47	18.50	18.53	18.56	30.05	12.28
Crude Protein	12.10	12.10	12.10	12.20	5.36	11.36
Nitrogen Free Extract	55.14	55.07	55.01	54.84	61.40	63.09
Neutral Detergent Fibre	36.99	37.03	37.70	37.11	63.81	16.99
Acid Detergent Fibre	18.44	18.46	18.48	18.50	33.94	8.83

Table 3: Growth performance of Red Sokoto Buck fed diets containing varying inclusion levels of ginger

Parameters	Inclusion levels of ginger (g/100 kg diet)			
	0	250	500	750
Total concentrate intake (kg)	38.90 ± 1.21	39.73 ± 1.21	37.53 ± 1.21	39.17 ± 1.21
Daily concentrate intake (g/day)	432.22 ± 12.50	441.44 ± 12.50	417.00 ± 12.50	435.22 ± 12.50
Total hay intake (kg)	30.02 ± 1.06	30.91 ± 1.06	30.06 ± 1.06	31.03 ± 1.06
Daily hay intake (g/day)	333.56 ± 8.20	343.44 ± 8.20	334.00 ± 8.20	344.76 ± 8.20
Total feed intake (kg)	68.92 ± 2.26	70.64 ± 2.26	67.59 ± 2.26	70.20 ± 2.26
Daily feed intake (g/day)	765.78 ± 25.15	784.89 ± 25.15	751.00 ± 25.15	780.00 ± 25.15
Initial body weight (kg)	17.92 ± 0.62	17.92 ± 0.62	17.83 ± 0.62	17.75 ± 0.62
Final body weight (kg)	19.92 ± 0.73	20.25 ± 0.73	19.00 ± 0.73	20.25 ± 0.73
Total weight gain (kg)	2.00 ± 0.48^{ab}	2.33 ± 0.48^{b}	1.17 ± 0.48^{a}	2.50 ± 0.48^{b}
Daily weight gain (g/day)	22.22 ± 5.37^{ab}	25.89 ± 5.37^{b}	13.00 ± 5.37^{a}	27.78 ± 5.37^{b}
Feed conversion ratio (Feed/gain)	34.46 ± 8.95^{a}	30.32 ± 8.95^{a}	57.77 ± 8.95^{b}	28.08 ± 8.95^{a}

^{ab} Means within the same row with different superscripts are significantly different ($p<0.05$)

Table 4: Nutrient digestibility of diets containing varying levels of ginger fed to Red Sokoto Buck

Parameter (%)	Inclusion levels of ginger (g/100 kg diet)			
	0	250	500	750
Dry Matter	80.14 ± 0.56^{a}	81.94 ± 0.56^{bc}	81.27 ± 0.56^{b}	82.71 ± 0.56^{c}
Ash	74.14 ± 0.86^{a}	77.10 ± 0.86^{bc}	75.88 ± 0.86^{b}	78.43 ± 0.86^{c}
Organic matter	78.35 ± 0.23	78.60 ± 0.23	78.15 ± 0.23	78.57 ± 0.23
Ether extract	61.71 ± 2.37^{a}	67.00 ± 2.37^{b}	60.15 ± 2.37^{a}	67.53 ± 2.37^{b}
Crude fibre	80.71 ± 0.73	80.63 ± 0.73	80.85 ± 0.73	81.90 ± 0.73
Crude Protein	77.02 ± 0.77^{a}	78.32 ± 0.77^{ab}	77.27 ± 0.77^{a}	79.57 ± 0.77^{b}
NDF	83.42 ± 0.09^{a}	83.63 ± 0.09^{b}	83.80 ± 0.09^{bc}	83.82 ± 0.09^{c}
ADF	82.82 ± 0.14^{a}	83.13 ± 0.14^{b}	83.23 ± 0.14^{b}	83.39 ± 0.14^{b}

^{abc} Mean within the same column with different superscripts are significantly different ($p<0.05$), NDF=neutral detergent fibre and ADF=acid detergent fibre

characteristics of most tropical crops (Millam *et al.*, 2018). The crude protein content of the diet was adequate to meet the optimum microbial need in the rumen as it was above 7 % protein required for minimal microbial growth (Gatemby, 2002). The similarities in some nutrients composition of the feeds might be attributed partly to closeness of the ingredients in their chemical composition and partly due to fact that the ingredients might have originated from the same sources (possibly from similar climatic and soil conditions).

Growth Performance of Red Sokoto Bucks Fed Diets Containing Varying Inclusion Levels of Ginger: Ginger has the ability of improving feed intake. Al-dain and Jarjeis (2015) reported a significant increase in the daily intake of

Table 5: Economic benefit analysis of feeding ginger containing diets to Red Sokoto Buck

Parameters	Inclusion levels of ginger (g/100 kg diet)			
	0	250	500	750
Cost of concentrate/kg (₦) (a)	51.13	52.73	54.34	55.95
Cost of *D. smutsii*/kg (₦) (b)	45.80	45.91	45.92	45.91
Total cost of feed/kg (₦) (c)	96.93	98.64	100.26	101.86
Total feed consumed (kg) (d)	68.93	70.64	67.59	70.20
Cost of feeding (₦/buck) (e)	6,681.38	6,967.93	6,776.57	7,150.57
Weight gain (kg) (f)	2.00	2.33	1.17	2.50
Cost of feed/kg gain(₦/kg) (g)	3,340.69	2,990.53	5,791.94	2,860.23
Value of gain (₦) (h)	1,000.00	1,165.00	585.00	1,250.00
Cost over gain (₦) (i)	3.34	2.57	9.90	2.29

₦ = Naira, Cost of concentrate = a; Cost of hay = b; Total cost of feed/kg = c; Total feed consumed=d; Cost of feeding = e = c x d; Weight gain = f; Cost of feed/kg gain = g = e/f; value of gain = h = wt gain x ₦ 500 per kg live wt. (NAPRI price) cost over gain = I = g/h

concentrate ration, straw and total feed respectively in animals supplemented with ginger compared to the control (with zero ginger inclusion). This might be because ginger roots contain ingredients like Aryl alkanes that gives pungent taste which enhances the appetite of animals and improve the nutrients palatability causing increase in feed intake (Al-dain and Jarjeis, 2015; Ismail *et al.*, 2021). In the present study, there was an increase in total feed intake and daily feed intake in bucks fed diet containing 0 g ginger inclusion level compared to those fed diet containing 250 g/100kg ginger inclusion even though there was no significant difference ($p>0.05$). Total weight gain and daily weight gain followed the same pattern with the feed intake as it increased from control (0 g ginger inclusion) to 250 g ginger inclusion levels. The decrease in daily weight gain in bucks fed diet containing 500 g ginger inclusion may be as a result of the decreased in total and daily feed intake by the bucks in this group. But there was an increase in daily and total weight gain of bucks fed diet containing 750 g ginger inclusion. The increase may be as a result of the increase in hay intake by the bucks fed diet containing 750 g ginger. A phenomenon of dietary compensation was observed by Muhammad *et al.* (2016) where Yankasa rams were fed with varying inclusion levels of ginger. Bucks in the treatment with the highest ginger inclusion level ate more of the hay in an attempt to compensate for lower concentrate intake. The decrease in concentrate intake might be attributed to high inclusion of ginger which is known to have pungent smell and hot nature induced by the nature of its phytochemicals which could affect microbial activities (Greathead, 2003). The non-significant difference ($p>0.05$) in concentrate intake, hay intake and total feed intake showed that the feed was palatable to the animals. Bucks fed diet containing 750 g ginger inclusion had the significantly ($p<0.05$) higher weight gain. The best (lowest) feed conversation ratio was recorded in bucks fed diet containing 750 g ginger inclusion.

Nutrient Digestibility of Diets Containing Varying Levels of Ginger Fed to Red Sokoto Bucks: Digestibility of all the nutrients were high (>60) as observed in the present study. All the nutrients with the exception of organic matter recorded higher in the group fed diet containing 750 g ginger inclusion. It was reported that maximum dietary CF digestion in the rumen occurs when dietary CP was between 12 and 16 % (Ashiru *et al.,* 2018). The CP digestibility showed that dietary protein was properly utilized by the animals. This may be because some phytochemicals like tannins and saponins found in ginger prevent protein degradation in the rumen so that it can be effectively digested in the abomasum and the small intestine. The same reason may be attributed to higher DM, OM, CF, CP, EE, Ash, NDF and ADF digestibility. This is because CP intake and digestibility can affect digestibility of other nutrients (Muhammad *et al.*, 2011). Consequently, the digestibility values obtained in the present study were higher than the

findings of Ikyume *et al.* (2017) when WAD goats were fed varying levels of garlic powder.

Economic Benefit Analyses of RSB Fed Varying Inclusion Levels of Ginger: Feed, either purchased or produced in the farm, accounts for a large part of the expenses (60 % or more) incurred in sheep and goat production (Schoenian, 2015). The result of cost analysis showed a decline in cost of feed per kg weight gain from bucks fed diet containing 0 g ginger to those fed diet containing 750 g ginger. This result was in agreement with Adegun and Aye (2013) who reported a reduction in cost of feed/kg gain in West African Dwarf rams fed varying inclusion levels of *Moringa oleifera* and cotton seed cake as protein supplements to *Panicum maximum.* All the treatment groups fed *M. oleifera* had lower cost of feeding compared to the control. Availability of feedstuff is important when considering its use in farm enterprises. Ginger is readily available in the market.

Conclusion: It was concluded that ginger inclusion levels in the diets of RSB improved weight gain, feed conversion ratio and nutrient digestibility with no effect on feed intake. It also helped to reduce cost of feeding/kg weight gain. Ginger can therefore, be included in the diets of RSB up to 750g/100kg diets without detrimental effect on performance.

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