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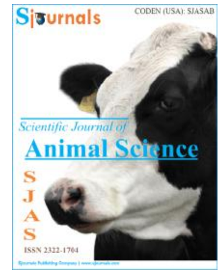

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Original article

Nutrients intake and digestibility of growing and fattening Uda sheep fed graded levels of ginger in semi-arid Nigeria

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A B S T R A C T

Two separate experiments were conducted at Usmanu Danfodiyo University Livestock Teaching and Research Farm to assess intake and digestibility of nutrients for growing and fattening Uda sheep fed graded level of ginger (*Zingiber officinale*) in semi-arid region of Nigeria. In each experiment, fifteen intact male animals with an average weight of 17 and 21.4 kg respectively, were allocated to three treatment diets in a completely randomized Experimental Design (CRD) replicated five times. Experimental diets containing 0 (control), 2.5 g/kg (treatment 2) and 5.0 g/kg (treatment 3) were formulated separately for each experiment. Each experiment lasted for 90 days feeding trial and three weeks digestibility trial. Results indicated that, for growing animals (experiment 1), ginger inclusion has an overall negative effect on nutrients intake and digestibility (P<0.05). However, for fattening animals (experiment 2), intake and digestibility were affected (P<0.05) when ginger inclusion exceeds 2.5%. It was concluded that ginger inclusion had a negative effect on intake and digestibility of growing animals and on fattening animals above 2.5%.

1. Introduction

It was reported that voluntary intake and digestibility of feed by ruminants is affected by environmental condition, feeding management, physiological condition, physical and chemical composition of feed and various sensory inputs (Balch and Campling, 1992; Conrad, 1996; Baile and Forbes, 1974). It was further indicated that proportion of forages in feeds and distention of digestive tract are the major determinant of intake and digestibility in ruminants (Balch and Campling, 1992). Van Soest (1982), cited forage composition and digestibility as important factors influencing voluntary intake of herbage by ruminants. McDonald et al. (2002) reported that the rate of passage of ingesta is one of the important factors affecting efficiency of feed utilization. They further observed that digestibility of a food is closely related to its chemical composition. Feed that are fairly constant in their composition from one species to another will show little variation in digestibility. Other foods, partly fresh or conserved herbages are much less constant in composition and therefore vary more in digestibility and both the amount and chemical composition of the fibre are important (McDonald et al., 1995). Ginger (*Zingiber officinale* Rosc.) (Family: *Zingiberaceae*) is a herbaceous perennial, the rhizomes of which are used as spice. It stimulates the secretion of saliva and enhances the synthesis of bile acids in the liver and their excretion in bile which beneficially effects the digestion and absorption of lipids. Most spices stimulate the function of pancreatic enzymes (lipases, amylases and n mucosa and thus enhances digestibility (Kraszewski et al., 2002; Greathead, 2003). There are numerous studies showing beneficial effects of herbs and spices on feed intake, immune functions and health, rumen fermentation and productivity of young and adult ruminants (Kraszewski et al., 2002; Greathead, 2003; Wawrzynczak et al., 2000; Cardozo et al., 2006). The positive effect of plant supplements in nutrition of sheep and goats were also reported (Butter et al., 1999). Some of the useful herbs and spices are indigenous to Africa and include ginger (*Zingiber officinale*), garlic (*Allium sativium*), scent leaf (*Ocimumgratissimum*), bitter leaf (*Vernomniaamygdalia*); they have been reported to enhance the performance of livestock animals (Muhammad et al., 2009). Therefore, this study was carried out to evaluate graded ginger levels on intake and digestibility of nutrients for Uda sheep fed graded levels of ginger.

2. Materials and methods

2.1. Experimental location

The study was conducted at the Usmanu Danfodiyo University Sokoto, Livestock Teaching and Research Farm. The farm is located within the permanent site of the university at about 10km North of Sokoto metropolis in Wamakko Local Government area of Sokoto State. Sokoto is located between latitudes 12^0N and 13^0N and Longitude 4^0 and 6^0E within the Sudan Savannah Semi-arid Zone in the Extreme North Western part of Nigeria (Mamman et al., 2000). Sokoto state share border with Niger republic to the north, Kebbi state to the south west, Zamfara state to the south.

2.2. Climatic condition

Sokoto state has a semi-arid climate which is characterized by low rainfall, varying widely in amount from year to year and strongly erratic in incident. The mean annual temperature is 34.9^0c with the highest temperature recorded in April (41.0^0c) and the minimum temperature occurring in January (13.2^0) (SEPP, 1996). Diurnal and seasonal temperature fluctuations are very wide, humidity is low during most part of the year with relatively high solar radiation due to dry atmosphere and clear skies. Sokoto has two (2) main seasons, the dry season, which lasts from October to May or June and raining season which lasts from June/July to September.

In extreme Northern part of the state, the humidity in January is less than 20%. In the Southern areas, it varies between 20 – 40%. The mean annual rainfall is about 700mm. Maximum temperature of 41^0c has been reported in January (SEPP, 1996).

2.3. Experimental feed preparation

Feed ingredients used in diet formulation were maize, cowpea husk, cotton seed cake (CSC), salt, rice offal, bone meal and salt. Rice offal was purchased from rice processing area at Kalambaina area of Sokoto metropolis. The dried ginger rhizome was purchased from the Sokoto central market. The bone meal was purchased from the Sokoto abattoir. The remaining variable ingredients were purchased from the Kara market in Sokoto metropolis.

Cowpea hay was obtained from Kwakwalawain Wammako local government, Sokoto state. Maize grains as well as the cotton seed cake were crushed to reduce the particle size, so as to enhance diet formation. The test material (ginger) was properly dried and grinded.

2.4. Experimental diets formulation

For each experiment, three experimental diets were formulated to contain 0, 2.5, and 5g ginger/kg of diet (i.e. 0, 2.5, and 5%). The gross compositions of the experimental diets are shown in the Tables 1 and 2.

Table 1
Gross composition of diets for experiment 1.

Ingredients	Treatments (% Ginger level inclusion)		
	1 (0)	**2(2.5)**	**3(5.0)**
Maize	20.46	20.46	20.46
Cowpea husk	12.25	12.25	12.25
Cotton seed cake (CSC)	15.98	15.98	15.98
Rice offal	12.64	12.64	12.64
Cowpea hay	35.85	35.85	35.85
Salt	0.50	0.50	0.50
Bone meal	2.50	2.50	2.50
Premix	0.50	0.50	0.50
Total	100.00	100.00	100.00
Calculated nutrient contents			
Crude Protein (%)	16.00	16.00	16.00
Energy (kcal/kg)	2200.25	2200.25	2200.25
Crude Fibre (%)	21.59	21.59	21.59

Table 2
Gross composition of diets for experiment 2.

Ingredients	Treatments (% Ginger level inclusion)		
	1 (0)	**2 (2.5)**	**3(5.0)**
Maize	38.65	38.65	38.65
Cowpea husk	15.70	15.70	15.70
Cotton seed cake (CSC)	14.70	14.70	14.70
Rice offal	0.95	0.95	0.95
Cowpea hay	26.50	26.50	26.50
Salt	0.50	0.50	0.50
Bone meal	2.50	2.50	2.50
Premix	0.50	0.50	0.50
Total	100.00	100.00	100.00
Calculated nutrient contents			
Crude Protein (%)	12.30	12.30	12.30
Energy (kcal/kg)	2635.07	2635.07	2635.07
Crude Fibre (%)	20.11	20.11	20.11

2.5. Experimental animals and their management

In each experiment, fifteen entire male rams of Uda sheep breed were purchased from Achida market in Wurno Local Government area of Sokoto State and used for the experiment. The animals were dewormed with Albendazole(R) by oral administration at 10ml/10kg body weight. The animals were also treated with Oxytetracycline Hydrochloride (a broad spectrum antibiotic) to prevent possible bacterial infection. The animals were quarantined for 7 days at the small ruminant unit of livestock teaching and research farm of the University.

Before the commencement of the experiment, the animals were balanced for weight and were housed each in a pen measuring 1m x 2m.

2.6. Data collection

Feed and water were given *ad libitum* in the morning. The experimental animals were weighed on weekly basis early in the morning after overnight fasting to avoid error due to gut-fill. Feed intake was calculated on a daily basis by subtracting the left over from the feed offered the previous day. The data collection lasted for 90 days for feeding trial. Feacal samples were collected using a harness bag at the last 7 days of the digestibility trial.

2.7. Experimental design

The animals were allocated randomly into their completely randomized design (CRD) (Steel and Torrie, 1980). This design contained 3 treatments and 5 replications. Each animal served as a replicate (experimental unit).

2.8. Chemical analysis and statistical analysis

Chemical analysis of the feed and feacal samples were carried out according to AOAC (1990) procedure. The data generated from the two experiments was subjected to analysis of variance (ANOVA) using Statview statistical package (SAS, 2002).

3. Results and discussion

3.1. Proximate composition of the experimental diets for experiment 1 (%)

The dry matter content of the experimental diets ranges from 94.6 to 95.7 (table 3). The crude fibre and ash contents increase with increased ginger inclusion, but ether extract and NFE contents decreased (Table 3).

Table 3
Proximate composition of the experimental diets (%) for experiment 1.

Parameter (%)	Treatments (% Ginger level inclusion)		
	1 (0)	2 (2.5)	3 (5.0)
Dry matter	94.50	94.91	95.72
Crude protein	15.71	16.13	16.10
Crude fiber	23.65	27.60	29.34
Ether extracts	6.15	5.62	4.98
Ash	17.18	18.32	19.22
NFE	47.57	44.25	41.83

3.2. Proximate composition of the experimental diets for experiment 2

The Dry Matter (DM) content of the experimental diets varied between 94.67 and 95.87. The highest was recorded for treatment 3 and the lowest for treatment 1. Ether Extracts (EE) and Nitrogen free extract (NFE) contents decreased slightly from treatment 1 to treatment 3 while Crude Fibre (CF) and Ash contents increased (Table 4).

Table 4
Proximate composition of the experimental diets (%) for experiment 2.

Parameter (%)	Treatments (% Ginger level inclusion)		
	1 (0)	2 (2.5)	3 (5.0)
Dry matter	94.67	95.58	95.87
Crude protein	12.01	12.31	12.42
Crude fiber	22.01	25.67	30.33
Ether extracts	6.10	5.32	4.76
Ash	16.01	18.62	19.18
NFE	50.55	46.02	41.60

3.3. Feed and nutrient intake (g/day) of growing Uda lambs fed varying levels of ginger (*Zingiber officinale*)

Feed and nutrients intake (g/day), ash intake as % body weight, ether extract intake as % body weight and NFE intake as % body weight were higher (P<0.05) for treatment 1 compared to treatments 2 and 3. Dry matter intake as % body weight was higher (P<0.05) for treatments 1 and 2 compared to treatment 3. No difference (P>0.05) in crude protein intake as % body weight and fibre intake as % body weight for all the treatments (Table 5).

Table 5
Feed and nutrient intake (g/day) of Uda rams fed graded levels of ginger (*Zingiber officinale*).

Parameter	Treatments (% Ginger level inclusion)			SEM
	1 (0)	2 (2.5)	3 (5.0)	
Feed intake (g/day)	1126.157[a]	732.443[ab]	570.286[b]	122.01
Dry Matter intake (g/day)	1064.782[a]	701.607[ab]	545.877[b]	116.09
Crude Protein intake (g/day)	131.873[a]	88.845[ab]	66.552[b]	14.44
Ether Extract intake (g/day)	69.259[a]	41.163[b]	29.142[c]	7.08
Crude Fibre intake (g/day)	295.443[a]	214.939[ab]	168.525[b]	33.97
Ash intake (g/day)	484.036[a]	315.247[ab]	238.122[b]	53.11
NFE intake (g/day)	610.470[a]	374.271[b]	297.784[c]	36.56
Dry Matter intake as % body weight	4.159[a]	3.501[ab]	3.138[b]	0.22
Crude Protein intake as % body weight	0.515	0.443	0.383	0.03
Ether Extract intake as % body weight	0.270[a]	0.205[b]	0.168[c]	0.01
Fibre intake as % body weight	1.154	1.072	0.969	0.07
Ash intake as % body weight	1.895[a]	1.569[bc]	1.369[c]	0.10
NFE intake as % body weight	2.387[a]	1.870[bc]	1.711[c]	1.99

abc, means in the same row with different superscript are significantly different (P<0.05).

3.4. Feed and nutrient intake (g/day) of fattening Uda rams fed graded levels of ginger (*Zingiber officinale*)

Table 6 indicated no difference (P>0.05) between the treatments in dry matter intake (g/day), ash intake (g/day), dry matter intake as % body weight, crude protein intake as % body weight, ash intake as % bodyweight and NFE intake as % body weight. Feed intake (g/day), crude protein intake (g/day), NFE intake (g/day) and ether extract intake as % bodyweight were higher (P<0.05) for treatments 1 and 2 compared treatment 3. Ether extracts intake (g/day) was higher (P<0.05) for the control diet (treatment 1) compared to treatments 2 and 3. However, fibre intake as % body weight was higher for animals fed treatment 3 compared to the control diet (treatment 1) and 2.5% supplemented ginger level (treatment 2).

3.5. Nutrients digestibility (%) of growing Uda lambs fed varying levels of ginger (*Zingiber officinale*)

DM, CP, EE and NFE digestibility were higher (P<0.05) for treatments 1 and 2 compared to treatment 3 (Table 7). There were no difference (P>0.05) between treatments 1 and 2 in terms of DM, CP, EE and NFE digestibility. Treatment 3 (5% ginger) had lower digestibility for all the nutrients (P<0.05).

3.6. Nutrients digestibility (%) of fattening Uda rams fed graded levels of ginger (*Zingiber officinale*)

Table 8 indicated that digestibility of all the nutrients with the exception of crude fibre were higher (P<0.05) for the control treatment and treatment 2 compared to treatment 3. The crude fibre digestibility was higher (P<0.05) for animals in treatments 2and 3 compared to treatment1.

Table 6
Feed and nutrient intake (g/day) of fattening Uda rams fed graded levels of ginger (*Zingiberofficinale*).

Parameter	Treatment (%Ginger level inclusion)			
	1(0)	2(2.5)	3(5)	SEM
Feed intake (g/day)	2076.643[a]	1953.400[ab]	1745.757[b]	95.11
Dry Matter intake(g/day)	1741.015	1673.428	1493.340	88.00
Crude Protein Intake (g/day)	351.368[a]	318.600[ab]	282.987[b]	15.73
Ether Extract intake (g/day)	126.675[a]	103.921[b]	83.098[c]	5.21
Crude Fibre intake (g/day)	457.069	500.461	494.533	23.71
Ash intake(g/day)	728.006	728.198	662.721	32.93
NFE intake (g/day)	1159.909[a]	1018.421[a]	852.483[b]	47.46
Dry Matter intake as % body weight	5.284	5.515	5.078	0.25
Crude Protein intake as % body weight	1.070	1.051	0.961	0.05
Ether Extract intake as % body weight	0.386[a]	0.343[a]	0.282[b]	0.02
Fibre intake as % body weight	1.393b[b]	1.651[ab]	1.681[a]	0.09
Ash intake as % body weight	2.216	2.405	2.256	0.12
NFE intake as % body weight	3.534	3.364	2.899	0.17

abc, means in the same row with different superscript are significantly different (P<0.05).

Table 7
Nutrients digestibility (%) of growing Uda lambs fed varying levels of ginger (*Zingiber officinale*).

Parameter (%)	Treatment (% Ginger level inclusion)			
	1 (0)	2 (2.5)	3 (5.0)	SEM
Dry matter (DM) digestibility	58.812[a]	55.834[a]	40.824[b]	1.52
Crude protein (CP) digestibility	60.150[a]	63.964[a]	48.064[b]	2.52
Crude fibre (CF) digestibility	62.126[a]	55.960[a]	48.764[b]	2.15
Ether extract (EE) digestibility	54.136[a]	51.44	41.928[b]	2.18
NFE digestibility	55.762[a]	53.606[a]	39.650[b]	1.57

abc, means in the same row with different superscript are significantly different (P<0.05).

Table 8
Nutrients digestibility (%) of fattening Uda rams fed graded levels of ginger (*Zingiberofficinale*).

Parameter (%)	Treatment (% Ginger level inclusion)			
	1 (0)	2 (2.5)	3 (5.0)	SEM
Dry matter digestibility	65.834[a]	68.812[a]	50.824[b]	1.55
Crude protein digestibility	73.594[a]	70.150[a]	58.064[b]	2.49
Crude fibre digestibility	58.764[b]	72.126[a]	65.960[a]	2.16
Ether extract digestibility	65.762[a]	63.606[a]	49.650[b]	1.59
NFE digestibility	64.136[a]	61.442[a]	51.928[b]	2.14

abc, means in the same row with different superscript are significantly different (P<0.05).

4. Discussion

Crude protein content of the experimental diets for the growing and fattening animals were within the values reported respectively by ARC (1994) and Muhammad et al. (2011) for growing and fattening sheep. Increased crude protein, fibre and ash contents from diet 1 to diet 3 could due to increased ginger inclusion. The same reason could be attributed to decreased ether extract and NFE contents.

The lower feed intake observed for the growing animals feed diets containing supplemented ginger levels and the fattening animals receiving higher ginger levels could be due to the suppressive effect of the test material on the overall digestibility of nutrients as observed in tables 7 and 8. Lower nutrient intake could generally be attributed to lower feed intake and dry matter intake. Feed intake and NFE intake as % body weight observed for the control diets could be due to their higher feed intake. The difference ($P<0.05$) in dry matter digestibility, crude protein digestibility, crude fibre digestibility, ether extract digestibility and NFE digestibility could be attributed to the increased ginger inclusion in the diets. Nutrient digestibility in sheep is dependent on the rumen microbial fermentation, which is upon dependent on microbial specie composition. Ginger possesses antimicrobial effect and has the tendency to stabilize or affect rumen microbial population and specie composition. On the other hand, the age of the animals could be attributing factor; being that at that age, rumen micro-organisms are not fully stabilized in terms of specie and composition. Higher ginger levels might have induced decreased rumen microbial population and specie compositionaffecting the fermentation process with subsequent suppressive effect on intake and digestibility of nutrients for the growing animals receiving the supplemented ginger levels and the fattening animals receiving higher ginger levels. Huston and Pinchak (1995) and McDonald et al. (2002) observed that the rate at which digestibility occurs is dependent upon the overall rumen fermentation and the speed at which particles pass through the gut which determines the subsequent amount of feed to be consumed. Adanlawo et al. (2007) observed that Ginger is known to contain some phyto-chemicals which at higher levels could hinder digestibility and nutrient utilization. In addition, Lamborne et al. (1986) and Mcdonald et al. (2002) reported that the reduction in size and efficiency of microbial population, which decrease the fermentation process could reduce the rate of passage of food out of the rumen and hence reduce intake and digestibility. This could add to the reason why the growing animals and the fattening animals fed diets containing higher ginger levels (above 2.5%) had a significantly lower performance.

5. Conclusion

It was concluded that ginger inclusion had a negative effect on intake and digestibility of nutrients in growing Uda sheep and fattening Uda above 2.5%.

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