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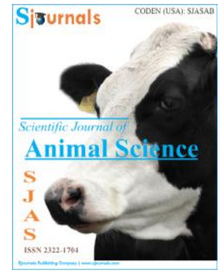

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Original article

Evaluation of high energy diets and fattening regimes on performance, carcass characteristics and fat production of Yankasa rams for use as alternative thermal storage medium

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ABSTRACT

An experiment was conducted to evaluate high energy diets and fattening regimes on performance, fat production and carcass characteristics of Yankasa rams. Fifteen intact Yankasa rams with an average live weight of 42Kg and condition score three (3) were randomly allocated into three treatments in a completely randomized experimental design (CRD) replicated five times. The animals were divided into three treatment groups according to the length of the fattening period. The treatments were designated as teatments 1, 2 and 3 respectively for three, two and one month fattening period. Results indicated significant diffrence (P<0.05) in the final live weight (kg), weight gain (kg), slaughter and carcass weight. There was no significant difference (P>0.05) in feed intake, water intake, average daly gain (ADG), feed conversion ratio (FCR), dressing weight, dressing %, subcutaneous, abdominal and total fat production. It was concluded that fattening regime has no significant effect on the performance of Yankasa rams fed high energy diets.

1. Introduction

In animal production, nutrition is one of the most important determinants to productive performance (Devendra, 1988). Consequently, the underlying principle for feed utilization efficiency in ruminants is minimizing energy losses through improving diet digestibility and manipulation of rumen fermentation toward propionate production (McDonald et al., 2002). These enhances protein metabolism, decrease methane production and reduce nutritional stress, such as bloat thus improving animal health and profit maximization. The body composition of animals, including lean meat, body fats and bones are affected by nutritional status of animals, management system and practices.

Adequacy and supply of feeds (quality and quantity) and the management techniques adopted by farmers are important in detecting overall performance of animals in terms of output of livestock products (Adebowale and Taiwo, 1996). Extensive management of animals accounted for over 80% of livestock produced in Nigeria (FDLPCS, 1992). The low input low output characterized by the system is the main factor responsible for low turn out of livestock products including meat, milk, fats, hides and skin. Thus management practices adopted by farmers affect overall body condition and general well being of animals. Different methods could be employed to determine the well being of an animal and its potentials in providing useful livestock products including animal fats. These include assessment of live performance, body condition (assessment of relative body fatness), determination of the carcass characteristics and its fat composition.

Although animal fats has its potential use for other economic activities such as its use as bio-fuel, as thermal storage material in solar water heating system, as a component of livestock feeds etc, its utilization as feed for man has been restricted due partly to its high composition of cholesterol. It is noteworthy that the word "cholesterol" has great influence on the population, probably because it is associated with health problems, as increase in blood cholesterol is considered one of the main factors causing cardiovascular diseases (Careri et al., 1998). In addition, strokes are the principal cause of death, followed by acute myocardial infarction. Because of this, importance has been placed on raising awareness among the population about foods that contain cholesterol and the determination of the quantities of cholesterol in mg per 100 g of food (Dinh et al., 2008).

Due to the effect of cholesterol on human health and considering the large amount of fats obtained from animals at slaughterhouses and during festivities in Nigeria, its utilization for other economic activities could be one way of reducing the risk behind its consumption. It is well known that the use of fats for other purposes (whether on small or on large scale) has not received maximum attention. High energy diets are known to hasten animal growth, reduce finishing time and enhances fat production (Muhammad, 2011).

The increasing cost and shortage of conventional energy sources, in addition to the concerns over sustainability, necessitates exploration of other renewable alternative energy sources that do not pollute the environment (Garba, 2009). Solar energy is only available in the daytime; therefore, to improve the reliability of these renewable energy systems, especially for solar water heating, solar drying and solar cooking applications, energy storage is deemed necessary for possible integration into the proposed drying and cooking systems. Solar energy has enormous potentials that could be harnessed for lighting, heating, cooling and ventilation of buildings, solar cooking, crop drying, and supply of hot water for various applications. The main problem while utilizing solar energy is that it is often intermittent, variable, and unpredictable. These aforementioned problems associated with solar energy could be addressed by employing thermal storage as backup to the systems (Garba, 2009). This study was designed to evaluate high energy diets and fattening regimes on performance, carcass characteristics and fat production of Yankasa rams and investigates its potential use as an alternative thermal storage medium.

2. Materials and methods

2.1. Location of the study

The experiment was conducted at Sokoto Energy Research Centre (SERC), Usmanu Danfodiyo University, Sokoto. The centre is located at the main campus of the Usmanu Danfodiyo University Sokoto. Sokoto state is located in the northwestern part of Nigeria between longitude $4^{o}8'$ and $6^{o}54'$E and latitudes $12^{o}0'$N and $13^{o}58'$N and at altitude of 350m above sea level (Mamman et al., 2000). Sokoto state has a semi-arid climate, which is characterized by low rainfall varying widely in amount from year to year (500-1300mm) and long dry season. Diurnal and seasonal fluctuations are very wide. Maximum temperature of $41^{o}C$ is attained in April while minimum temperature of 13.2 ^{o}C occurs in January (Mamman et al., 2000). Humidity is very low during most part of the year and the solar radiation is relatively high due to dry atmosphere and clear skies (Mamman et al., 2000). Sokoto state has abundant livestock resources, because the climate is more suitable for livestock production than for any other Agricultural activity due to the absence of tsetse fly on an open grassland. Sokoto ranks second in livestock production in the country with livestock population of over 8 million (SSDG, 2002).

2.2. Phase I: Feeding trial

2.2.1. Experimental animals and their management

Fifteen (15) Yankasa rams (intact) with an average live weight of 42kg was purchased from Achida market and used in the experiment. The animals were quarantined at the Energy Research Centre, Usmanu Danfodiyo University, Sokoto, treated against ecto and endo parasites with ivemectin (1ml per 10kg live body weight) and Oxytetracycline Hcl (a broad spectrum antibiotic) at a rate of 2ml per 10kg live weight, against possible bacterial infection. Faeces and urine of the animals were removed everyday from the feeding pens to ensure adequate hygiene and minimal ammonia accumulation. Feed and water troughs were cleaned every morning before feeding.

2.2.2. Experimental diet formulation

One experimental diet was formulated and used at different feeding regimes. Composition of the experimental diet is shown in Table 1.

Table 1
Composition of the experimental diet.

	Treatments [Fattening regime (days)]		
Ingredients (%)	**1 (30)**	**2 (60)**	**3 (90)**
Maize	20.46	20.46	20.46
Cowpea husk	12.55	12.55	12.55
Cotton seed cake	10.98	10.98	10.98
Rice offal	12.65	12.65	12.65
Cowpea hay	39.86	39.86	39.86
Salt	0.50	0.50	0.50
Bone meal	2.50	2.50	2.50
Premix	0.50	0.50	0.50
Total	100	100	100
Calculated chemical composition			
Energy (Kcal ME/kg)	2800	2800	2800
CP (%)	12.00	12.00	12.00
CF (%)	23.82	23.82	23.82

2.2.3. Experimental design and feeding procedure

Five animals were allocated to each treatment in a completely randomized experimental design (CRD). Each animal was housed in a pen measuring 2m x 1m; each group was assigned to the experimental diet and fed *ad libitum* in the morning and evening for 90, 60 and 30 days respectively. Water and salt lick were offered *ad libitum*.

2.2.4. Feed intake and live weight changes

The animal’s weight was taken prior to the commencement of the experiment and subsequently on the same day of every week between 8:00-9:00am after withdrawing feed for 14-16 hours to avoid error due to gut fill (McDonald et al., 2002). Daily records of feed intake, water intake and body weight was taken throughout the feeding trials.

2.3. Phase II: Carcass and fat characterization

At the end of the feeding trial for each regime, all the animals were slaughtered for carcass and fat characterization. Slaughter weights, dress weight, dressing %, gut, offal characteristics and fat production were determined.

2.4. Statistical analysis

The data generated from the experiment was subjected to analysis of variance (ANOVA) using Statview statistical package (SAS, 2002). Where significance difference exist Least Significant Difference (LSD) will be used to separate the means.

3. Results and discussion

Results (Table 2) showed no significant difference in dry matter intake across the treatments (P>0.05). The same observation was also made for other nutrients (P>0.05). There was a slight decrease in intake of all nutrients including energy from 90 days to 30 days feeding regime (P>0.05) (Table 2).

Table 2
Nutrient intake of Yankasa sheep fed high energy diets at different feeding regimes.

	Treatments [Fattening regime (days)]			
Parameter	**1 (90)**	**2 (60)**	**3 (90)**	**SEM**
Dry matter intake (g/day)	1144.81	1166.14	1306.25	99.85
Energy intake (ME Kcal/day)	3005.68	3337.77	3809.89	322.80
Crude protein intake (g/day)	143.10	147.81	163.28	10.93
Crude fibre intake (g/day)	284.06	287.23	324.11	19.20
Ether extract intake (g/day)	70.84	73.33	80.82	4.95
Nitrogen free extract (g/day)	619.39	628.82	673.40	43.37

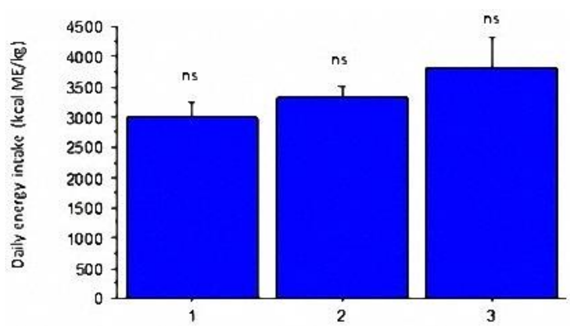

Fig. 1. Metabolizable energy intake (Kcals) of Yankasa sheep fed high energy diets at different fattening regimes (ns= no significant difference).

3.1. Performance of Yankasa sheep fed high energy diets at different fattening regimes

Results indicated no significant difference in feed intake, water intake, initial weight, average daily gain and feed conversion ratio (P>0.05). There was significant difference in final live weight, weight gain and feed intake as % body weight (P<0.05) (Table 3).

Table 3
Feed intake, water intake and growth performance of Yankasa sheep fed high energy diets at different fattening regimes.

	Treatments [Fattening regime (days)]			
Parameter	**1 (90)**	**2 (60)**	**3 (90)**	**SEM**
Feed intake (Kg/day)	1.19	1.29	1.36	0.19
Water intake (Liters/day)	5.88	5.60	5.54	0.51
Initial weight (Kg)	41.7	43.0	42.0	1.46
Final weight (Kg)	54.33^{a}	50.33^{ab}	46.07^{b}	1.37
Weight gain (Kg)	12.67	7.33	4.08	1.10
Average daily gain (Kg)	140.74	122.22	136.0	7.98
Feed conversion ratio	8.53	8.20	8.16	0.96
Feed intake as % body weight	1.85^{b}	1.89^{b}	2.78^{a}	0.163

Means in the same row with different superscripts are significantly different (P<0.05).

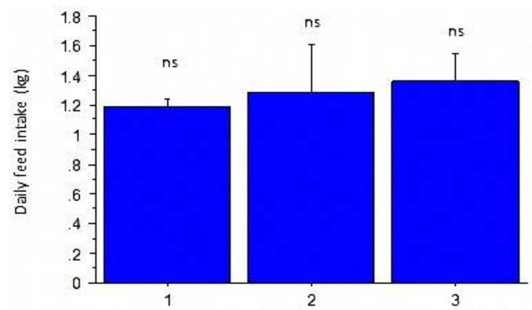

Fig. 2. Feed intake (Kg) of Yankasa sheep fed high energy diets at different fattening regimes.

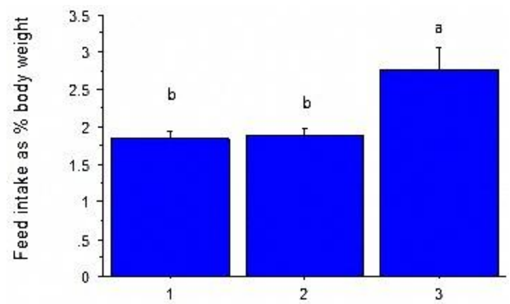

Fig. 3. Feed intake as % body weight of Yankasa sheep fed high energy diets at different fattening regimes.

3.2. Carcass characterization and fat production of Yankasa sheep fed high energy diets at different fattening regimes

There was no significant difference in dressed weight, dressing %, Kidneys, liver, lung, spleen, small and large intestine and the spleen (P>0.05). Live weight, slaughter weight, carcass weight, heart and stomach weight are significant across the treatments (P<0.05) (Table 4). Abdominal and subcutaneous fat were not significant (P>0.05) (Table 5). Total fat production (kg/animal) and fat production as % body weight was the same across the treatments (P>0.05) (Table 5).

Table 4

Carcass characterization of Yankasa sheep fed high energy diets at different feeding regimes.

	Treatments [Fattening regime (days)]			
Parameter	**1 (90)**	**2 (60)**	**3 (90)**	**SEM**
Live weight (kg)	54.33^{a}	50.33^{ab}	48.67^{b}	1.37
Slaughter weight (kg)	52.67^{a}	47.67^{b}	44.33^{b}	1.18
Dressed weight (kg)	42.33	39.48	38.33	1.19
Carcass weight (kg)	26.00^{a}	23.33^{b}	23.17^{b}	0.47
Dressing %	47.86	46.35	50.29	5.84
Head (kg)	4.23^{a}	3.75^{b}	3.95^{b}	0.097
Legs (kg)	1.42^{a}	1.08^{b}	1.32^{ab}	0.057
Offals (kg)	9.75^{a}	8.18^{b}	8.85^{ab}	0.28
Kidneys (kg)	0.17	0.14	0.15	0.17
Liver (kg)	0.90	0.76	0.78	0.069
Lungs (kg)	0.62	0.72	0.70	0.051
Heart (kg)	0.42^{a}	0.28^{b}	0.27^{b}	0.026
Spleen (kg)	0.22	0.34	0.15	0.079
Small intestine (kg)	1.23	1.04	1.23	0.16
Large intestine (kg)	0.23	0.30	0.22	0.026
Stomach (kg)	2.20^{a}	1.94^{ab}	1.43^{b}	0.156
Testis weight (kg)	0.77^{a}	0.55^{b}	0.53^{b}	0.075

Means in the same row with different superscripts are significantly different (P<0.05).

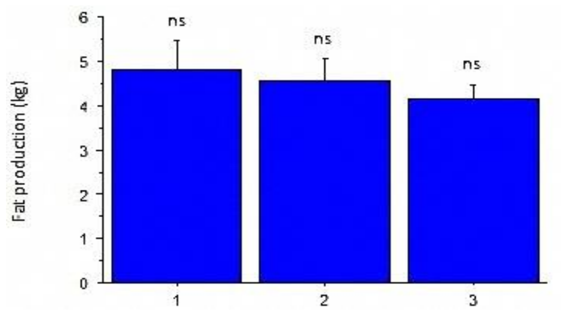

Fig. 4. Fat production (kg) of Yankasa sheep fed high energy diets at different fattening regimes.

Table 5
Fat production of Yankasa sheep fed high energy diets at different fattening regime.

	Treatments [Fattening regime (days)]			
Parameter (kg/animal)	**1 (90)**	**2 (60)**	**3 (90)**	**SEM**
Abdominal fat	3.43	2.93	2.92	0.41
Subcutaneous fat	1.38	1.62	1.12	0.15
Total fat	4.82	4.55	4.17	0.48
Fat production as % body weight	8.87	9.04	8.57	0.27

3.3. Nutrients intake

The non significant difference in nutrients intake between the treatments could be explained partly by the non significant difference in feed intake and partly due to non significant difference in energy intake. The non significant difference in feed and energy intakes was due to the fact that the animals were fed diets having same composition. This could be responsible for similar nutrients intake even though there is variation in the length of the fattening period. This observation is supported by the animal's non significant difference in daily gain. ARC (1990), Muhammad (2011), Muhammad et al. (2016a) observed no significant difference in feed and nutrients intake in animals placed on diets with similar chemical composition.

3.4. Feed intake, water intake and growth performance

Absence of significant difference in water intake could be due to non significant difference in feed and energy intakes. The values observed for water intake in the present study was higher than those reported by Muhammad et al. (2012). This variation might be as a result of the difference in energy density and dry matter composition of the diet offered to the animals; the animals being offered diets lower in energy in the latter compared to the diet offered to the animals in the present study. Dry matter and energy composition of diets have been observed to influence feed and water intake of small ruminants (McDonald et al., 2002).

The significant difference observed in the final live weight was due to variation in length of the fattening. Animals in treatment 1 (90 days fattening) had a significantly higher weight gain due to the fact the animals were offered the diet for longer period compared to those in treatments 2 and 3. The ADG values obtained in the present study is higher than those obtained by Abil et al. (1992) and Semenye et al. (2001). The non significant difference in ADG between all the animals irrespective of the treatment is an indication that animals can be fattened in a short period of time. This might be as a result of high energy content of the diet offered to the animals. The non significant difference in FCR could explain further non significant difference in ADG. The energy density of the diet (2800 Kcal ME/Kg) is higher than 2600 Kcals ME/Kg recommended by Muhammad (2011) for Uda Sheep even though the two experiments were conducted under similar environmental condition. This shows that Yankasa sheep could tolerate even higher energy diet. This could explain why animals in the present study had a higher ADG compared to those obtained by Muhammad (2011), Muhammad et al. (2016a) and Muhammad et al. (2016b). However, the energy density of the diet used in the present study is lower than the recommended value of 4400 Kcal ME/kg by Tailor and Field (2004). This is because animals in the temperate regions require higher energy due to difference in temperature.

The significant decrease in feed intake as % body weight with increase in the length of the fattening indicated that intake requirements of animals decrease with energy intake over time. This might be because, the closer the animal become in meeting its energy requirement, the lesser the amount of feed required. Animals generally eat to satisfy their energy requirements (NRC, 1985; ARC, 1990; McDonald et al., 2002; Chesworth, 2006). The resultant decrease in feed intake as % body weight and the non significant difference in ADG between all the animals indicate that a farmer may need to spend less on feeding when using high energy diets.

3.5. Carcass characterization and fat production

The significant difference in live and slaughter weight was due to variation in the length of the fattening period. Animals on three months fattening (Treatment 1) had a significantly higher slaughter weight because slaughter weight is directly proportional to live weight as shown by Eniolorunda et al. (2011). Similar explanation could be made for carcass weight. Accumulation and deposition of fats over time could be responsible for significantly greater heart weight for animals on treatment 1 compared to other treatments. The same observation could be attributed to the weight of the testis. Fat synthesis promoted by feeding high energy diets over time might have caused significant difference in the weight of the testis. Muhammad et al. (2016c) observed that high energy diets increased testicular traits in sheep. Similar findings were also reported by Fourie et al. (2004). Fernandez et al. (2004) while comparing diets with different protein concentrations also reported a significant increase in the weight of the testis.

Adjustment to the feeding regimes by the experimental animals might be responsible for the significant difference in the weight of the stomach. Animals fattened for a longer period (Treatment 1) had a significantly higher stomach weight. Increase in abdominal fat from treatment 1 to treatment 3 may also cause difference in the stomach weight. Even though there is significant increase in the weight of the carcass with length of fattening, the dressing % was insignificant due to non significant difference in the dressed weight. This indicates that the weight of the visceral might have contributed to the dressed weight.

Although the final and slaughter weight are significant between the treatments, the non significant difference in abdominal, subcutaneous and total fat production were not significant. This proves the animal's efficiency of feed utilization even with variation in length of the fattening. The non significant difference in FCR could be responsible for lack of significant difference in dressed weight, dressing % and fat production.

4. Conclusion

It was concluded that fattening regime has no significant effect on fat production of Yankasa rams. Feeding high energy diet improve animal's potentials to producing the required amount of fat for use as thermal exchange material. For fast and efficient fat production, the energy density of fattening diet should be raised to 2800 Kcals ME/kg.

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