



Effect of Energy Level on Milk Yield and Composition of Red Sokoto Goats

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Abstract

This study was carried out to investigate the effect of energy levels on Red Sokoto Goat milk yield and composition. A total of twenty (20) yearling Red Sokoto Does (RSD) which were estrus synchronized and impregnated using a buck, kindled at approximately the same time with ± 2 days differences between and within treatment groups. The animals were divided into four dietary energy treatment groups of five (5) animals each with four graded energy levels of 2,400, 2,200, 2,000 and 1,800 kcal/kg M.E in a completely randomized design (CRD). Duncan's Multiple Range Tests (DMRT) was used to separate means among the treatments. Results obtained revealed that the proximate composition of the experimental diets were within the dietary recommendation for lactating goats. The result of milk yield was not statistically ($P>0.05$) different with decrease in energy levels. The chemical compositions of lactating RSD were greatly influenced ($P<0.05$) by energy levels. Milk fat, protein, acidity and titerable acidity percentages and milk specific gravity (g) were all significantly ($P<0.05$) higher with higher energy levels. However, the result of mineral profile of milk from RSD did not follow a regular pattern in relation to the energy changes, although, significant ($P<0.05$) differences in sodium, calcium, zinc, iron, copper and phosphorus (mg/kg) were recorded. It can be concluded therefore, that increased energy levels in the diets of lactating RSD to 2,200kcal/kg ME will increase milk yield up to 438 ml/day and considerable changes in both their physico-chemical and mineral profile. It is however recommended that 2,200 Kcal/kg ME energy be fed to the lactating RSD under the same condition.

Key words: Lactating, Energy, RSD, and Milk

Introduction

Food Agricultural Organization in 2019 reported that Nigeria has a population of 81.8 million goats in which larger proportion of the above goat population are highly concentrated in the northern region of the country (FAO, 2019). These concentrations are most likely influenced by the ecological condition of the region which is characterized by low rainfall, lighter sandy soils and longer dry season as well as being a tsetse fly infestation free zone (FAO, 2019). Goats provide over 1.9 million tonnes of meat annually representing 3.5% of the total world meat production and 8.5% of the total estimated meat production in developing countries (Ozung *et al.*, 2011).

There are a number of critical management concerns with the pregnant doe that need to be addressed in an effort to minimize potential health problems and ensure high milk production. Like the dairy cow, the dairy goat udder requires a minimum period of "time-off", usually 4 to 6 weeks, to allow the mammary gland to undergo a process of involution. During this period, milk secreting cells degenerate and are absorbed. With the subsequent commencement of lactation, remaining milk secretory cells proliferate to initiate milk production where cell number is directly proportional to milk yield. Inadequate nutrients during the dry periods result in reduced cell number and milk yield. Short dry periods as well as inadequate late gestation nutrition, may also have a negative impact on quantity and

quality of colostrum produced (Sahlu and Goetsch, 1998).

Energy is the major dietary element responsible for nutrient utilization, productivity, and gain (Hosseini *et al.*, 2008). Productivity of goats is fostered by the efficient utilization of nutrients possibly with an adequate supply of energy. Energy requirements are affected by age, body size, physiological state, environmental factors, hair growth, muscular activity, and relationships with other nutrients (Acero-Camelo *et al.*, 2008). Weather conditions such as temperature, humidity, sunshine, and wind velocity may increase or decrease energy needs depending on the region. Stress of any kind may increase energy requirement (NRC, 1981; Garba *et al.*, 2021). Energy limitations may result from inadequate feed intake, low quality feed and improper roughage to concentrate ratios. Insufficient energy can lead to weight loss, infertility and reduced production. Energy demands as the doe reaches peak lactation follow a similar course. Depending on the age of doe, peak lactation generally occurs between weeks 6 and 9 after kidding. Feed intake does not peak until weeks 12 to 16, postpartum. Therefore, body reserves are used to meet the energy and protein demands for milk production in early lactation. The doe's nutrient intake will not meet her demands until milk has decreased to 60 to 80% of peak (Sahlu and Goetsch, 1998).

Material and Methods

Experimental Location

The experiment was conducted at the Teaching and Research Farm, Federal University, Dutsin-Ma, Katsina State. The farm is situated within the latitude 12°27'18" North and 7°29'29" East and 605 meters above the sea level in the Sudan savannah ecological zone (Gaddafi, *et al.*, 2019). Katsina State is bordered by Kaduna State to the South, Niger Republic to the North, Zamfara State to the West and Kano

and Jigawa States to the East. It covers an area of about 23,983 sq kilometers. The weather varies according to the season of the year. Maximum temperature ranges from 29° to 38°C in the hot and dry period (March-May). The Harmattan season is November- February with lower temperatures, which range from 18° to 27°C. The wind is dry from January to April, signaling the arrival of the rainy season, which lasts from May to September. The mean annual rainfall ranges from 400 to 1300 mm (KTARDA, 2001).

Experimental Feed Preparation

All the feed materials used in the experimental diet's preparation were purchased from selling and processing centres in Dutsin-Ma and Funtua. Soyabean straw and groundnut hay were chopped and packed in sacks for experimental diets compounding. Whereas cotton seed cake was ground before mixing, other feed ingredients such as wheat offal, cowpea husk, bone meal, rice milling waste and table salt were purchased from the different centres in Dutsin-Ma town.

Experimental Diet Formulation

Four complete experimental diets containing graded energy levels of 2,400, 2,200, 2,000 and 1,800 kcal/Kg ME were formulated and designated as treatments 1, 2, 3, and 4, respectively. The formulation was done using Microsoft excel (2007).

Milk Yield Measurement and Kid Performance

Milk yield monitoring commenced five days after kidding, kids live weight changes were used to determine the milk yield. The kids were fasted overnight (6pm to 8am) and their live weight were taken and recorded early morning before they were allowed to suckle (Akpa *et al.*, 2002). The kids were weighed again after they suckled the milk for 2 hours. Milk yield was then determined thus: Weight of kid after

suckling – Weight of kid before suckling. The milk yield obtained was then expressed in ml/day. Samples of milk were collected when the kids were suckling at 6th week of lactation. The sampling was done at the beginning

and after about 30 minutes of suckling, then pooled to have one representative sample. The samples collected were preserved in flasks containing ice packs and transported to the Department of Biochemistry, Bayero University, Kano.

Table1: Gross Composition of the Experimental Diets

Ingredient (%)	1(2, 400)	2(2,200)	3(2,000)	4 (1,800)
Maize	16.50	5.50	0.00	0.00
W/offal	11.70	17.00	40.00	36.70
RMW	9.00	17.00	3.00	26.10
Cowpea husk	6.80	6.80	15.00	16.50
CSC	28.00	26.70	15.00	0.00
Soya bean straw	25.00	25.00	25.00	6.00
Soya bean meal	0.00	0.00	0.00	9.70
Bone meal	1.00	1.00	1.00	4.00
Salt	1.00	1.00	1.00	1.00
Total	100	100	100	100

W/offal=wheat offal, RMW=rice milling waste, CSC=cotton seed cake, CP=Crude Protein, CF=Crude Fibre

Laboratory Analysis

Temperature of the milk was taken at the point of sampling. Milk pH and density as well as specific gravity were measured prior to chemical analysis. Milk samples from each goat were analyzed for milk fat, protein, lactose, and solid non-fat (SNF) using the speedy lab milk analyzer (ASTORT TECHNITIA, di Fagothi Giovanni and C. SAC Viastalle II, 250 20 poncerale (BS), Italy). Before analysis, milk samples were pre-heated in warm water and thoroughly mixed to evenly distribute fat globules and dissolve any milk residue for proper reading following the manufacturer’s instruction. Physico-chemical characteristics of goat milk was evaluated. Mineral profile of the milk was analyzed using the procedures described by AOAC (2000) at the Department of Biochemistry, Bayero University Kano.

Results

Chemical Composition of Experimental Diets

Results of the proximate composition of the experimental diets are shown in Table 2. From the table, it could be deduced that diet

2 had the highest dry matter (94.08%) with diet 3 having the lowest (93.11%) value. Crude Protein (CP) content was higher in diet 4 (15.88%) and lower in diets 1 and 3 (15.01%). The highest value of Ether Extract (EE) was obtained in diet 3 (5.03%) and the lowest was recorded in diet 1 (4.02). The Crude Fibre (CF) content was highest in diet 3 (28.68%), followed by 28.48% and 28.37% in treatments 1 and 2 respectively, while the lowest (28.08%) value was in treatment 4. The highest value of Ash content was in treatment 2 (10.17%) and the lowest value was obtained in treatment 1 (8.41%). Nitrogen free-Extract (NFE) was lower in diet 4 (25.55%) and higher in diet 1 (44.07%).

Fibre fractions of the experimental diets were also indicated in table 2. Treatment 1 had the highest value of Acid Detergent Fibre (ADF) (29.17%) whereas Treatment 2 recorded the lowest value (18.66). The Neutral Detergent Fibre (NDF) recorded the highest value in diet 1(42.87%) followed by 41.94% and 29.77% for treatments 3 and 2 respectively, the lowest value was however recorded in treatment 4 (36.78%).

Similarly, diet 1 had the highest lignin value (12.35%) followed by diet 2 (11.67%), the lowest value was recorded in diet 4 (8.59).

Physico-Chemical Milk Properties of Lactating Red Sokoto Doe Fed Graded Energy Levels

Table 3 presents the results on milk chemical composition of lactating sokoto red does as influenced by different energy levels. The mean milk intake (MI) did not differ significantly between all the treatments but decreased from 438ml/day in

treatment 2 containing 2200Kcal/Kg to 246ml/day in treatment 3 containing 2000Kcal/Kg. Highest value (17.97%) of Total solid was obtained in treatment 1 fed 2, 000Kcal/Kg ME compared to the groups of lactating does fed 2,400, 2,200 and 1,800 Kcal/Kg ME. Milk of lactating does fed 1,800Kcal/Kg ME had significantly (P<0.05) higher fat content (5.26%) compared to those fed with 2,400 (4.67), 2200 (4.78) and 2000 (4.64) Kcal/Kg ME. Treatments 1(2400) and 3(2000) were statistically similar (P>0.05).

Table 2: Proximate Composition of the Experimental Diets Containing Graded Energy Levels Fed to Red Sokoto Goat

Nutrients (%)	Treatments (Energy levels, kcal ME/ Kg)			
	1 (2,400)	2 (2,200)	3 (2,000)	4 (1,800)
DM	94.04	94.08	93.11	93.67
CP	15.01	15.46	15.01	15.88
CF	28.48	28.37	28.67	28.08
EE	4.02	4.15	5.03	4.28
NFE	44.07	37.90	30.82	25.55
Ash	8.41	10.17	8.57	9.21
ADF	29.17	18.66	22.10	20.03
(NDF	42.87	39.77	41.94	36.78
Lignin	12.35	11.67	9.87	8.59
Energy (ME Kcal/Kg)	2434	2241	2042	1828

DM=Dry matter, CP=Crude Protein, CF=Crude Fibre, EE=Ether Extract, NFE=Nitrogen Free Extract, ADF=Acid Detergent Fibre, NDF=Nitrogen Detergent Fibre

Protein values (9.00 and 8.53%) were significantly (P<0.05) higher in the milk of lactating does fed 2,400Kcal and 1,800Kcal/Kg ME compared to those fed 2200 and 2000 Kcal/Kg ME which are statistically similar (P<0.05). Density and Specific gravity for milk of lactating Red Sokoto Goats fed 2200Kcal/Kg ME were Significantly (P<0.05) higher than those fed with 2400, 2000 and 1800 Kcal/Kg ME. No significant (P>0.05) differences were recorded for the pH values between all the treatments though treatment 1 recorded the highest value (7.00%) followed by treatments 3 and 4. Treatment 2 (2200) recorded the lowest value (6.84).

Physico-chemical characterization of Red Sokoto Goat milk as influenced by graded energy levels revealed significant (P<0.05) differences between values in terms of acidity (0.22%) for treatment 4 containing 1,800Kcal/Kg and treatment 2 (2200 Kcal/Kg ME). Treatments 1 (2400) and 3 (2000) Kcal/Kg were statistically similar (P>0.05) though differ significantly with treatments 2 and 4 containing energy levels of 1,800 and 2200 Kcal/Kg respectively. Similarly, Titerable acidity were significantly (P<0.05) higher in the milk of lactating does fed 2400, 2200 and 2000 Kcal/Kg ME compared to the value (0.15) in treatment 4 (1800kcal/Kg ME).

Mineral Compositions of Milk from Red Sokoto does Milk as Influenced by Diets Containing Graded Energy Levels

Results from Table 4 indicated that significant (P<0.05) differences were recorded between all the groups for Sodium, calcium, zinc, Iron, copper and phosphorous. However no Significant (P>0.05) differences were recorded amongst the treatment groups for Potassium, Magnesium and Manganese.

Higher statistical (P<0.05) value of 130.18 (µg/100g) was obtained for Zinc in treatment 1 followed by treatments 2 (107.99) 3(44.77) and 1(26.95) whose values showed significant (P<0.05) differences among each other. There were significant (P<0.05) differences for the values obtained for copper presented in with treatment 3 ((4.46 µg/100g) having the highest while treatment 2 recorded the lowest value (1.65 µg/100g).

Table 3: Milk yield and Chemical Composition of Lactating Red Sokoto Goat Milk Fed Diets Containing Different Energy Levels

PARAMETER	Treatments (Energy levels, kcal ME/ Kg)				
	1 (2,400)	2 (2,200)	3 (2,000)	4 (1,800)	SEM
Milk yield (ml/d)	366	438	246	302	48.48
Fat (%)	4.67 ^b	4.78 ^a	4.64 ^b	5.26 ^a	0.11
Protein (%)	9.00 ^a	8.40 ^{ab}	6.43 ^b	8.53 ^{ab}	0.73
Ash (%)	0.94	0.77	0.98	1.06	0.09
Specific gravity (g)	1.02 ^a	1.04 ^a	1.02 ^b	1.03 ^{ab}	0.01
pH	6.98	6.84	6.94	6.86	0.06
Total solid (%)	15.81	13.53	17.97	14.42	1.81
Acidity (%)	0.17 ^b	0.13 ^c	0.17 ^b	0.22 ^a	0.00
Titerable acidity (%)	0.21 ^a	0.18 ^a	0.19 ^a	0.15 ^b	0.01

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

Table 4: Mineral Profile of Milk from Red Sokoto does Milk Fed Diets Containing Different Energy Levels

PARAMETER	TREATMENTS				
	1 (2,400)	2 (2,200)	3 (2,000)	4 (1,800)	SEM
K (mg/Kg)	0.15	0.28	0.25	0.33	0.06
Na (mg/Kg)	0.25 ^a	0.17 ^{ab}	0.15 ^{ab}	0.19 ^b	0.03
Mg (mg/Kg)	0.02	0.02	0.03	0.02	0.01
Ca (mg/Kg)	0.19 ^b	0.36 ^a	0.59 ^a	0.45 ^a	0.08
Zn (µg/ Kg)	26.95 ^d	107.09 ^b	44.77 ^c	130.18 ^a	5.26
Fe (µg/ Kg)	40.36 ^a	36.95 ^a	23.40 ^b	23.12 ^b	3.09
Mn (µg/ Kg)	13.74	15.60	11.99	11.36	7.19
Cu (mg/Kg)	2.35 ^{ab}	2.65 ^b	4.46 ^a	2.84 ^b	0.79
P (mg/Kg)	0.03 ^b	0.06 ^b	0.07 ^b	0.09 ^a	0.02

Means with different letters in the same row are significantly different (P<0.05), Zn=Zinc, Cu=Copper, Fe=Iron, Na=Sodium, K=Potassium, Ca=Calcium, P=Phosphorous

Milk Yield, Chemical Compositions, Physico-Chemical Characterization and Mineral Profile of Goat Milk Fed Diet Containing Varying Energy Levels

Result of the daily milk yield indicated no significant differences among all the treatments. However, treatment 2 had the highest yield (438ml/d). This might be

partly associated to the relatively high energy content of the diet (2,200Kcal/Kg ME) though it is not the highest energy level in the study and partly to the feed intake of does which was numerically higher in the same treatment group. This high milk yield recorded could be associated to the type of birth. It is also observed that energy level had a positive association with milk yield. The low milk yield value (246ml/d) recorded in treatment 3 could be associated to the energy level (2,000Kcal/Kg ME) of the diet. This is because adequate amount of energy is required to produce a particular quantity of milk. The maximum and minimum milk yield values recorded in the present study were higher than the values reported by several authors (Akpa *et al.*, 2002; Makun *et al.*, 2008; Ahamefule *et al.*, 2012; Luka and Kibon, 2014; Okunola *et al.*, 2015 and Ahmad (2017). These could be associated to the adequate energy intake by the does breed of the animal used, milking frequency, location and environmental temperature.

Total solid Values were higher in treatment three containing 2000 Kcal/Kg. This might be attributed to the reasons that the diets formulated were iso-nitrogenous. Therefore, the influence of crude protein has been masked, but the influence of the source of protein might be there. Goat provides milk with higher total solids compared to cow and also depends on feeding system and stage of lactation. Milk solids are the non-water components of milk – protein, lactose, and minerals. Sometimes the combination of protein, lactose and minerals is called the solids non-fat content, and when the fat is included it is called total solids content. The total solid of milk may change due to differences in relative rates of synthesis and secretion of milk components by the mammary gland. Variations are due to differences among species, between individuals within a breed, and between conditions affecting an individual.

Conditions affecting the doe may include the weather or seasons, the stage of lactation and water consumption. This is in harmony with the reports of Mehaia and Al-Kahnal (1989) Bayoumi (1990) and El-Agamy, (2007).

Higher values of Fat content were obtained in treatment four (1800 kcals ME/Kg) and the trend goes on in reversed trend with the lowest value in treatment one (2400kcal/Kg ME). This is in agreement with the reports of Ahmad (2017) when the author fed combination of cereals and legumes to lactating Red Sokoto Goats. A positive correlation was reported between milk fat content and energy level of the diet in the Semi-Arid zone (Hassan, 2000).

Protein content values obtained in this study showed a uniform increase which followed similar trend with fat content in a reverse way in which fat and protein are inversely related which is the normal trend. Abu-Lehia (1989), FAO (2006) and Khan *et al.* (2011) reported similar values on Protein content of goat milk, but Dell'Orto *et al.* (2001) and Nabag *et al.* (2006) reported lower values in goat milk.

The Density of the lactating Red Sokoto Milk did not follow any particular trend based on energy levels. However, the highest value was in treatment two followed by treatment four, treatments one and three were similar. Variations observed in the density of lactating Red Sokoto Goats milk were attributed to several factors, such as energy level of the diet, number kids, and breed of goats. This agreed with the reports of Al-Attas (2008). Values of pH were similar across the treatments. However, the values reported from this experiment are within the normal range (6-7) reported by several authors (Abu-Taraboush *et al.* 1998, El-Agamy 2007 and Khan *et al.* 2011).

Physico-chemical characterization of Red Sokoto Goat milk as influenced by energy

levels across the treatments revealed the highest values of Acidity in treatment four while treatments one and three followed with similar values. The present report agreed with the reports of Brazel *et al.* (2013) who reported similar values. The Specific Gravity of Red Sokoto Goat milk obtained was higher in treatment two followed by treatment four while treatments one and three had similar values. The results obtained were in agreement with studies of Hassan *et al.* (2011) who reported similar values. Higher values of Titrable Acidity were observed in treatment one with lowest value recorded in treatment four. These results were in accordance with other investigators (Abu-Lehia, 1989a and Abu-Lehia *et al.*, 1989) who observed similar percentage of Titrable Acidity in goat milk irrespective of energy level of the diets. Taha and El-Leboudy (1991) reported that environmental and physiological factors such as stage of lactation and genetic difference influenced Titrable Acidity.

Values of Ash were higher in treatment four. The result revealed lower ash content in the diet containing 2200 kcal/Kg ME. This is in agreement with the report of Yagil (1982) who reported that higher energy levels are usually related to low ash content. However, breed and seasonal variations were found to be the most effective factors in goat milk composition (Konuspayeva *et al.*, 2009 and Al-Attas 2008).

Mineral content of Red Sokoto Goats milk did not follow any pattern in relation to energy levels. Milk is an excellent source of most essential minerals (Cu, Zn, Fe, Na and K) required for kid performance. The composition of goat milk from nutritional point of view, sodium and potassium are considered together because they are electrolytes that play an important role in maintaining osmotic pressure in the extra and intra cellular fluids, and in maintaining acid-base balance in milk. Therefore, the

result presented indicated that goat tries to prevent the loss of these elements especially in the drier tropics. This result is in agreement with reports of Yagil (1982); Zia Ur Rahman *et al.* (1994); Al-Awadi and Srikumar (2001); Dell'Orto, *et al.* (2001); Khan and Al-Bukhari (2004); Al-Attas (2008); Hassan, *et al.* (2011); Konuspayeva *et al.* (2009); Al Haj and Al Kanhal (2010) and Riyadh, *et al.* (2012) who reported higher mineral concentrations in goat milk.

Conclusion

It can be concluded that, increasing the energy levels in the diets of lactating Red Sokoto does to 2,200kcal/kg ME will increase milk yield to 438 mls/day with considerable changes in both their physico-chemical and mineral profile.

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