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Milk yield and Milk Composition of West Africa Dwarf Does as influenced by Body weight and Body Temperature

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Abstract
The study was conducted to determine the effect of bodyweight and body temperature on milk yield and milk composition of West Africa Dwarf (WAD) does. A total number of sixteen lactating WAD does of different body weights were selected for the experiment. The bodyweight and body temperature of the does were taken before every milking period which lasted up to 8 weeks. Milk samples from each doe were subjected to milk composition analysis using milk analyzer. The bodyweight of the does and its corresponding milk yield were grouped into four classes (12 -15 kg, 15.1 -18 kg, 18.1-21 kg, 21.1-24 kg) while the body temperature and its corresponding milk yield and properties were portioned into three ranges (low: 36.10 – 37.00 ^oC; medium: 37.10 – 38.00 ^oC; high: 38.10 – 39.00 ^oC). The data obtained were subjected to one-way analysis of variance of completely randomized design. The results revealed that bodyweight significantly ($P<0.05$) affects milk yield but not milk composition while body temperature range of 38.10-39.00 ^oC influences higher milk yield (580.60 ml). It is therefore concluded that WAD does have a relatively stable milk composition irrespective of body temperature or bodyweight while the does of higher body weight produce more milk. It is therefore recommended that body temperature and bodyweight should be among the considerable criteria when selecting WAD goats for dairy purpose.

Keywords: Lactation, Milk yield, Bodyweight, Temperature

1. Introduction

Goats generally are homoeothermic animals and are able to maintain a balance between the heat of metabolism and heat of the environment so as to avoid hyper and hypothermia [1]. Moderate energy is required to maintain constant core temperature within the thermo neutral zone while additional energy would be required to maintain homoeothermic animals when exposed to environmental temperature above the upper critical temperature or below the lower critical temperature. This additional energy is the cost for goats to make physiological and behavioral adaptations under thermal stress. Consequently, bio-energetic efficiency is decreased, and this can result in impairment of productive performance in goats. Although goats are documented to be resistant to environmental stress [2] their productivity impairment cannot be ruled out, particularly if they are not raised under a conducive environment. They are widely distributed in regions with diverse climate conditions and possess unique characteristics such as water conservation capability, higher sweating rate, lower basal heat metabolism, higher respiration rate, higher skin temperature, and constant cardiac output [3-5]. Despite these merits, some authors reported that production impairments do occur in goats under thermal stress [6, 7]. Several studies [8, 9] have confirmed that temperature is an important determinant of milk yield and composition, particularly in some exotic dairy goats, but there is limited information regarding this on West African Dwarf (WAD) goats.

The WAD goat is widely distributed across the rainforest belt of Southern Nigeria where it makes significant contributions to the livelihoods of impoverished families. A Report by Chejina and Behnke [10] indicated that Nigeria hosts the largest WAD goat population in West Africa with approximately 11million animals in the humid zone of Eastern Nigeria alone. These goats are kept mainly for meat production while their milk is rarely used for human consumption. However, harvesting this renewable product (milk) for human use would enhance the profitability of goat farming. Goat milk contains protein, vitamins, minerals, trace elements, electrolytes, enzymes and fatty acids that can be easily assimilated by the body [11, 12].

Bawala *et al.* [13] also stated that goat milk has a unique quality over other animals as it is nearest to human milk in its contents of fat and protein and also serves as a good dietary source of minerals.

Every breed of goat is known to have a non-uniform bodyweight at even a similar age. The influence of bodyweight on milk yield and milk composition of some

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exotic dairy goats and cows has been reported [14-17] while there is a paucity of information with respect to this on West African dwarf goats. Effect of live weight on milk yield and milk composition of WAD goat could assist in formulating selection criteria for the breed if they are to be used for dairy purposes.

2. Materials and Methods

2.1 Experimental Site

The experiment was carried out at the small ruminant's unit of University of Ilorin Teaching and Research Farm Ilorin, Kwara state, Nigeria. It is situated between latitudes 8° 29.7984′ N Longitude 4° 32.5284′ E of the equator, with an annual rainfall of about 900mm, and an average temperature of 33.5 ° C [18, 19].

2.2 Experimental Animals and Their Management

A total of sixteen lactating WAD does of 2 – 3 years of age and within a kidding interval of one week were used for this experiment during the dry season. All the does were subjected to similar management procedures before the commencement of the research, and were tagged for better identification. The does were managed under an intensive system. The feed (concentrate) (Table 2.1) was composed to satisfy the nutrients requirement of lactating goats [20], and was fed *ad-libitum* throughout the duration of the experiment which lasted for 8 weeks.

Table 2.1: Composition of diet fed to experimental Goats

Feed Ingredient	Percentage (%)
Wheat Bran	25.00
Palm Kernel Cake	15.00
Groundnut Cake	5.00
Rice Bran	5.00
Corn Bran	10.50
Maize	20.00
Cassava Peel	19.00
Salt	0.500
Total	**100.00**
Estimated TDN	59.09
Estimated CP	12.23

TDN-Total Digestible Nutrient; Cp- Crude Protein

2.3. Data Collection

Each doe was weighed on a daily basis in the morning using a digital platform weighing scale prior to milking. The does were restrained for milking using individual milking stands. The rectal (body) temperature of the does was also taken prior to milking using digital thermometer. All the necessary pre-milking, milking and early post milking management procedures were strictly adhered to as reported by Hurst [21]. The milking of the does was done using hand supported milking machine between the hours of 7.00hr and 9.00hr, and 16.30hr and 18.30hr for morning and evening milking respectively for 8 weeks starting from 5th day post-partum of the does. Milk yield was measured using a calibrated measuring cylinder. Milk samples collected from the does in triplicates were taken to the laboratory for milk composition analysis using a milk analyzer (Milch analyzer, Ultra scan 3100, count: 1288, SN: 28214 PC151). The milk composition analysis focused on solid non-fat, salt, fat, lactose, density, freezing point and protein content. The bodyweight of the does were classified into four ranges; 12-15 kg, 15.1-18 kg, 18.1-21 kg and 21.1-24 kg while the corresponding milk yield and compositions were appropriately fixed. Body temperature of the does were also grouped into three ranges (low: 36.10 – 37.00 ºC; medium: 37.10 – 38.00 ºC; high: 38.10 – 39.00 ºC) with its corresponding milk yield and composition appropriately fixed.

2.5 Experimental Design and Data Analysis

The experiment was laid out in a completely randomized design, and the data generated were subjected to descriptive statistics and Analysis of Variance (ANOVA). Classes of bodyweight and ranges of body temperature were considered as treatments.

3. Results and Discussion

3.1 Descriptive Statistics and Relationship between Milk Yield and Milk Composition

Descriptive statistics of the milk yield and milk composition of the experimental does were presented in Table 3.1. The milk yield observed from the does ranged from 110 – 600 ml while the fat, solid non-fat (SNF), lactose and protein ranged from 2.40 – 12.70 %, 4.8 – 5.84 %, 1.65 – 7.60 %, and 2.50 – 5.40 % respectively. The maximum density, salt and freezing point obtained from the milk of the WAD goats used for the experiment were 1047.80 kg/m^3, 1.15 % and -0.99 ºC respectively. Milk yield exhibited the highest coefficient of variation (67.79), and was followed by 30.88 % obtained for milk fat. All the milk compositions evaluated had a coefficient of variation of less than 14 % except milk fat which had 30.88 %.

3.2 Bodyweight Influence on Milk Yield and Milk Composition

The average daily milk yield (ADMY) and milk compositions of WAD goats of different body weight were presented in Table 3.2. It was observed that the body weight of the goats significantly ($P<0.05$) influenced ADMY. The ADMY of the goats with body weight ranges of 18.10 – 21.00 kg and 21.10 – 24.00 kg were not significantly different from each other but were significantly higher than the yield of goats with lower body weight. The milk compositions of WAD goats of different body sizes were not significantly different ($P>0.05$) from one another.

Table 3.1: Descriptive Statistics of Milk Yield, Milk Composition of WAD Does

Variable	Mean	SEM	CV	Minimum	Maximum
DMY (ml)	327.90	10.00	67.79	210.00	600.00
Fat (%)	7.37	0.22	30.88	2.40	12.70
SNF (%)	10.91	0.47	4.32	4.60	15.80
Density (kg/m^3)	1033.90	0.51	0.51	1014.70	1047.80
FP (℃)	0.69	0.01	10.85	0.04	0.99
Protein (%)	3.85	0.05	13.06	2.50	5.40
Lactose (%)	5.73	0.08	13.96	1.65	7.60
Salt (%)	0.85	0.01	13.39	0.40	1.15

CV: Coefficient of Variation; SEM: Standard Error of Mean; SNF: Solid non-fat; DMY: Daily Milk Yield; FP: Freezing Point

Table 3.2: Effect of Bodyweight on Milk Yield and Milk Composition of WAD Dose

Parameters	Bodyweight Classes				SEM	p-value
	1	2	3	4		
DMY (ml)	178.41^b	197.00^b	268.30^a	385.50^a	10.00	0.000
Fat (%)	10.20	10.53	12.88	10.06	0.47	0.059
SNF (%)	10.20	10.53	12.88	10.06	0.47	0.157
Protein (%)	3.76	3.84	4.06	3.68	0.05	0.094
Density (kg/m^3)	1033.27	1033.58	1036.06	1032.25	0.513	0.136
FP (° C)	-0.49	-0.57	-0.62	0.42	0.25	0.332
Lactose (%)	5.57	5.76	5.97	5.51	0.0773	0.239
Salt (%)	0.83	0.85	0.89	0.83	0.0110	0.188

DMY: Daily Milk Yield; Bodyweight Class- 1:12-15 kg, 2:15.1-18 kg, 3:18.1-21 kg, 4:21.1-24 kg; SEM: Standard Error of Mean; SNF: Solid non-fat. Values with different superscripts are significantly different (P<0.05) from each other.

3.3. Body Temperature Influence on Milk Yield and Milk Composition

The effect of body temperature on milk yield and milk composition is presented in Table 3.3. A significant effect of body temperature (P<0.5) was observed in the milk yield of the does. A comparatively higher average DMY (580.60 ml) was obtained from the goat with body temperature range of 38.10 to 39.00 ºC than other lower temperature ranges. Goat within the body temperature range of 37.10 – 38.00 also had a significantly higher (P<0.05) ADMY (329.69 ml) than the does with low body temperature. Generally, the milk compositions of the goats were not affected by body temperature of the does.

Table 3.3: Effect of Body Temperature on Milk Yield and Milk Composition on West African Dwarf Does

	Body Temperature (℃)			
Parameters	Low (36.10-37.00)	Medium (37.10-38.00)	High (38.10- 39.00)	P- value
DMY (ml)	140.50^c	326.69^b	580.60^a	0.001
Fat (%)	6.025	6.96	7.25	0.502
Density (kg/m^3)	1035.89	1034.53	1033.68	0.498
FP (° C)	-0.69	-0.69	-0.60	0.397
Protein (%)	3.90	3.88	3.78	0.391
SNF (%)	10.71	10.53	10.41	0.823
Lactose (%)	5.88	5.80	5.67	0.596
Salt (%)	0.88	0.86	0.84	0.520

DMY – Daily Milk Yield; FP – Freezing Point; SNF – Solid Non-Fat; Values with different superscripts are significantly different (P<0.05) from each other.

3.4 Discussion

The factors influencing lactation yield in goats are generally reported to be multivariate [22, 23], while a complete coverage of these factors in an experiment is practically impossible, particularly in breeds that are not recognized as dairy goats. The milk yield in the present study has a slightly wider range (210.00 – 600.00 ml) than (180 – 500 ml) reported for the WAD breed by some earlier researchers [24]. However, either of these ranges is comparatively low compared to some exotic dairy goats. The mean fat and protein content of the WAD goat used in this study are generally close to 6.9 % and 3.9 %

respectively recorded for the breed by Akinsoyinu *et al*. [25]. This protein also aligns with the value obtained by Willaims *et al*. [24] while a relatively lower range of fat (4.01 – 4.14 %) was indicated in their report compared to the present study. The Influence of dietary treatment on the goat might account for these variations [25]. Similarly, the lactose content of 4.22 – 4.41 % reported by [26] was also lower than the values obtained in the present study. The milk fat showed a considerably higher coefficient of variation (30.88 %) among the milk compositions in the present study while others generally exhibited less than 15 % coefficient of variation with milk density having the least (0.51 %) which makes it the most stable milk property in the goat. The result conforms to the study on Jamnapari goats by Verma *et al*. [28] who indicated milk fat as the composition with a higher coefficient of variation than other milk components. The mean solid non-fat reported by Ahamefule *et al*. [29] was also lower than 10.91 % obtained in the current study. Higher SNF in the current study is however in close proximity with 11.27 % reported for Kalahari red goats raised in the hot humid zone [30]. The significant effect of body weight on milk yield as observed in the current result corroborates the report of Adewumi *et al.* [31] which examined the effect of body weight on milk yield of Yankasa and WAD ewes. These authors concluded that selection for a larger body size in WAD sheep could lead to increased milk production in this breed, and which may also be applicable to WAD goats. Some other researchers [32, 33] also established that when body flesh accounts for increased body weight, higher milk yield is accruable, while increased body weight due to fat might lead to reduced milk yield. This confirms the current study which is also substantiated by Žujović *et al*. [34] who reported a significantly positive relationship between body weight and milk yield of Balkan goat breed of Serbia. Libis-Márta *et al*. [35] and Hernández *et al.* [36] also linked higher milk yield to heavier ewes in their reports. The Non-significant effect of body weight on milk composition in the current study aligns with what was reported for Zairabi and Damascus goats by Youssef *et al.* [37].

The current study also revealed a significant influence of body temperature ($P<0.05$) on milk yield with the goats having their rectal temperature within the range of 38.10 – 39.00 ºC exhibiting higher milk yield. This result corroborates the report that sensitivity of hormones responsible for lactation tends to aid increased milk yield when body temperature falls within the normal range of 38.5 – 39.7ºC and vice versa outside the range [38]. Reduction in the milk yield as rectal temperature further decreases from the medium range (37.1 – 38.0 ºC) to the low range (36.1 – 38.0 ºC) further indicates that the thermo-comfort zone of the goats was impaired [39]. Weather conditions were often reported to cause thermal stress but physiological responses such as body temperature and drop in production are used to substantiate the reason for applicable corrections in the management system [39, 40]. The non-significant effect of body temperature on the milk composition in the present study contradicts the report by [41] which indicated a depressed milk protein when goats are thermal stressed. Thus, it can be inferred that the goats used for this study were not really thermal stressed considering the non-significant effect of body temperature on the milk protein while the drop in yield could mean the goats were tending towards thermal stress. The current result also revealed that WAD goats may tend towards hypothermia when their rectal temperature is below 36.1 ºC.

4. Conclusion

It is concluded that heavier weight and body temperature of between 38.1 – 39.0 °C in WAD goat facilitates higher milk yield rather than milk composition. Body weight and rectal temperature are therefore recommended for consideration during selection of WAD goats for dairy purpose in the study area.

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