

Physico-chemical characteristics of West African dwarf goat milk as affected by *Moringa oleifera* herbage supplement

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Abstract

West African Dwarf goat milk is of good nutritive value and is gaining acceptability but faced with low yield. This study assessed the physico-chemical characteristics of WAD goat milk when offered to *Moringa oleifera* herbage as supplement to *Panicum maximum* basal diet. Forty WAD does were used for the study in a complete randomized block design with eight does in each of five treatment diets ($T_1=100\%$ *M. oleifera*; $T_2=75\%$ *M. oleifera* + 25 % *P. maximum*; $T_3=50\%$ *M. oleifera* + 50 % *P. maximum*; $T_4=25\%$ *M. oleifera* + 75 % *P. maximum* and $T_5=100\%$ *P. maximum*).

Data was collected on physical characteristics (milk temperature, pH, density), organoleptic characteristics (colour, texture taste) and proximate composition (lactose, total solids protein and ash). Treatment means were separated using Duncan multiple range test at 5 % significance level. Milk temperature ranged from 34.00 – 35.61 °C with goats offering T_5 diet having lowest temperature and goats offered T_4 diet having the highest temperature which suggests longer shelf life. The pH and density values across all the treatments ranged between 5.92 – 6.30 and 1.03 – 1.08 g/ml³ respectively. Across all the treatments, the milk samples were of yellowish white colour, creamy appearance, smooth texture and natural smell but with T_1 and T_2 having tint of *Moringa oleifera* smell. Goats offered that T_4 diet had the highest values for lactose, protein, total solids, ash, solids non-fat and fat contents. *Moringa oleifera* supplement increased the physical and organoleptic values and proximate composition of milk samples, however it is recommended not to be more than 25 % inclusion in their diet.

Keywords: Milk, physical characteristics, chemical characteristics, *Moringa oleifera* herbage supplement and West African Dwarf goats.

Introduction

Milk has been recognized as a global source of human protein intake⁹ and cow has been its major source of supply. Other animals like buffalo, camel and goat also produce milk of good nutritive value and goat milk is now of wider

acceptability. Goat milk contains high butter fat, protein digestibility and assimilation, thus has therapeutic characteristics⁷. The milk composition and characteristics of goats have been assessed although few when compared with cows¹⁴.

Findings revealed that the protein fractions (non casein nitrogen and casein nitrogen) of WAD goat milk are high⁶. It was also observed by Zahraddeen et al²¹ that WAD goat milk contained 3.27 % crude protein (CP), 0.03 % fat, 11.63 % total solid, 0.70 % ash, 4.29 % lactose and a pH of 6.21. The daily milk yield of WAD goats from literature ranged from 188 g to 300 g.^{2,3,8,13} Kumar et al¹⁰ suggested popularization of goat milk in order to enhance its production, consumption and utilization. It is of this view that the study centered on milk physical (colour, organoleptic assessment, pH, density and yield) and chemical characteristics (protein, fat, lactose, ash, solids non fat) especially when WAD goats were offered *Moringa oleifera* herbage as supplement to *Panicum maximum* basal diet.

Material and Methods

Experimental site, duration and design: At the instance of the ethics, guidelines and approval of the use of animals for research in the institution, the experiment was conducted at the Sheep and Goat unit, Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomosho. Ogbomosho (8°7' North of the equator and 4°15' East of Greenwich meridian) located in Southern Nigeria. The temperature ranges between 28°C and 34°C and humidity range is 50 to 80 %¹². The experiment lasted for ten months. In a completely randomized design, 40 West African dwarf goats were used for the experiment with eight goats randomly assigned to five treatment diets.

Experimental animals and management: 40 pregnant does of about 1-1.5yrs of age were randomly assigned to five treatment diets. The goats were fed with *Panicum maximum* leaves and *Moringa oleifera* herbage. Water and salt licks were provided *ad libitum*. The animals were managed until kidding. The experimental diets that were offered to the animals in varying proportions were:

$T_1=100\%$ *Moringa oleifera* + 0 % *Panicum maximum*

$T_2=75\%$ *Moringa oleifera* + 25 % *Panicum maximum*

$T_3=50\%$ *Moringa oleifera* + 50 % *Panicum maximum*

$T_4=25\%$ *Moringa oleifera* + 75 % *Panicum maximum*

$T_5=0\%$ *Moringa oleifera* + 100 % *Panicum maximum*

Milk collection: After parturition, milk samples were collected manually into bottles for each treatment twice in a week for a period of 8 weeks. The milk temperature was measured using a thermometer and thereafter kept in the freezer until analysis. Part of the milk samples was observed for organoleptic properties (colour, flavor, thickness and smoothness) using questionnaire which was adjudged by 50 people. Another part of the milk samples was kept in freezer until analysis.

Laboratory procedures and analysis: The collected raw goat milk samples were thawed and then analyzed in the laboratory for its physico-chemical characteristics (pH, density, total solids, lactose, solid-non-fat and ash). The pH of the milk samples was measured by an electronic digital pH meter (pH S-3C model). The milk density was evaluated using the procedures of AOAC⁵. Proximate composition of the milk samples and were determined according to AOAC⁵ procedure. The milk samples were analyzed for lactose, total solids (TS), butter fat (BF), crude protein (CP (Nx6.38), solid- non-fat (SNF) and ash. SNF was determined as the difference between TS and BF.

Statistical Analysis: Data generated were subjected to one-way analysis of variance procedure of SAS¹⁷ and treatment

means were separated using Duncan's New Multiple Range Test of the same package at 5 % significance level.

Results and Discussion

The organoleptic characteristics of the WAD goat milk: Organoleptic test which is one of the platform tests of milk is a simple and on-the-spot assessment for freshness and quality of raw milk samples prior to any detailed analysis. All the milk samples from the goats in all the treatments were tested normal with white colour, sweet taste and without sediments (Table I).

The milk samples from all the treatment diets were smooth in texture, creamy in appearance and with good natural smell except for that of T₁ and T₂ diets which had a tint of *M. oleifera* herbage odour. This could be due to the high quantities of *M. oleifera* herbage supplement being offered to the goats in these groups.

The organoleptic characteristics in terms of yellowish white colour, sweet taste, smooth texture and creamy appearance of milk from WAD goats in this study is similar to the reports of Lai et al¹¹ where Malaysian raw goat milk was used and Siriwat et al¹⁶ where goats that were native to Southern Thailand were used in the studies.

Table I
Organoleptic and Physico-chemical Characteristics of milk from WAD goats fed
***Moringa oleifera* herbage and *Panicum maximum* diet**

Parameters	T ₁	Experimental T ₂	Diets T ₃	T ₄	T ₅	SEM
Organoleptic characteristics						
Colour	Yellowish white	Yellowish white	Yellowish white	Yellowish white	Yellowish white	
Taste	Sweet	Sweet	Sweet	Sweet	Sweet	
Smell	Natural(with tint of Moringa smell)	Natural(with tint of Moringa smell)	Natural	Natural	Natural	
Sediments	None	None	None	None	None	
Texture	Smooth	Smooth	Smooth	Smooth	Smooth	
Appearance	Creamy	Creamy	Creamy	Creamy	Creamy	
Physical characteristics						
Milk temperature(° c)	34.52 ^{ab}	34.36 ^b	34.56 ^{ab}	35.61 ^a	34.00 ^b	0.19
Milk pH	6.17 ^{ab}	6.30 ^a	6.09 ^b	6.07 ^b	5.92 ^b	0.19
Milk density (g/ml ³)	1.07	1.08	1.07	1.03	1.04	0.01
Chemical Characteristics						
Lactose (%)	5.10	4.89	5.05	5.46	5.28	0.14
Protein (%)	3.20	3.10	3.40	3.41	3.00	0.13
Total solids (TS) (%)	13.23 ^{ab}	12.92 ^b	13.48 ^a	13.60 ^a	13.10 ^b	0.17
Ash (%)	0.74	0.68	0.68	0.75	0.68	0.25
Solid-non-fat (SNF) (%)	10.05	9.60	10.04	10.14	9.97	0.09
Fat (%)	3.18 ^b	3.31 ^a	3.37 ^a	3.46 ^a	3.13 ^b	0.06
Fat yield (kg) (as % of milk yield)	0.48	0.32	0.52	0.68	0.19	0.08

*T₁ = 100% *Moringa oleifera*

T₂ = 75% *Moringa oleifera*; 25% *Panicum maximum*

T₃ = 50% *Moringa oleifera*; 50% *Panicum maximum*

T₄ = 25% *Moringa oleifera*; 75% *Panicum maximum*

T₅ = 100% *Panicum maximum*

SEM- Standard error of mean a, b, c= means in the same row with the same superscripts are not significantly different (p<0.05)

This implies that milk from WAD goats compared favourably with Malaysian and Thailand goats when offered *M. oleifera* herbage. The result of the organoleptic characteristics of WAD goat from this study met the requirements of raw goat milk stated in THAI Agricultural Standard for Raw goat milk.¹⁸

Physical and Chemical Characteristics of the WAD goat milk: The milk temperature (°C) revealed that there were significant differences ($p < 0.05$) among the goats in all the treatment diets (Table I). The highest temperature value was observed in goats exposed to T₄ diet (25 % *M. oleifera* and 75% Guinea grass) followed by T₁, T₃ and T₂. The lowest temperature value was observed in T₅ diet (Guinea grass only). This revealed that the milk from goats fed *M. oleifera* herbage supplement could last longer than those not fed with *M. oleifera* herbage, in case the milk could not be refrigerated as soon as possible. This is because bacteria multiply in milk with very low temperature¹¹.

There were significant differences ($p < 0.05$) among the treatment diets in the milk pH. It varied between 5.92 and 6.30. Thus, the milk samples were slightly acidic. The milk pH values of the goats supplemented with *M. oleifera* herbage fell within the range approved by TAS¹⁸ while the milk pH of goats fed *Panicum maximum* alone (T₅) was 5.92 which was lower than the approved milk pH for raw goat milk. The finding about milk pH in this study was lower when compared with the report of Lai et al.¹¹

One of the parameters for raw milk quality control is the measurement of density⁴. The milk density of the goats supplemented with *M. oleifera* herbage supplement was higher than the goats fed *Panicum maximum* only (control), although there were no significant differences ($p > 0.05$) among the four treatment diet groups. The milk density is a function of the milk fat⁴; the higher is the milk density, the higher is the milk fat.

The result from this study corroborated this fact as the milk density and milk fat had similar trend. Also, milk fat of goats that was not supplemented with *M. oleifera* herbage had lesser milk fat and milk density. The milk fat values in this study fell within the range of 3.13 – 3.46 %.

This range is lower than the range of values 3.76 % – 4.84 % reported by Ahamefule and Ibeawuchi², Ahamefule et al¹ and Ukanwoko and Ibeawuchi²⁰ in which WAD goats were used in separate experiments. Nutritional factor and management practices could have contributed to the variation. Also the relatively low fat content in *M. oleifera* herbage could have been responsible for the lower milk fat reported in this experiment. The low fat in the milk translated into the low fat yield with the goats in the control T₅ had the least fat yield.

The solids-non-fat (SNF) portion of the milk did not vary significantly among the treatments. The goats with the

lowest portion of *M. oleifera* herbage supplement had the highest value of 10.14 % while the goats fed 75 % *M. oleifera* herbage supplement had the least value of 9.60 %. This implied an inverse relationship between *M. oleifera* herbage supplementation and the SNF value. The range of values reported in this study (9.60 – 10.14 %) for the WAD goats was higher than the range of 7.47 – 7.97 % reported by Ukanwoko and Ibeawuchi²⁰; range of 9.91 – 9.97 % of Ahamefule et al¹; 9.59 – 9.72 % of Ahamefule and Ibeawuchi² and the range of values of 8.66 – 8.94 % of Tona et al¹⁹, all of WAD goats. The SNF values from this study revealed that the milk of goats fed *M. oleifera* herbage supplement is of good quality as it is very high when compared with the 8.25 % recommended by the Thai Agricultural standard¹⁸ for raw goat milk.

The total solid (TS) values in this study ranged from 12.92 – 13.60 % with no significant ($p > 0.05$) differences among the treatment diets. However, goats fed with 75 % *M. oleifera* herbage supplement (T₂) had the least value of 12.92 % while those offered with 25 % had highest value of 13.60 %. Those fed Guinea grass only had 13.10 %. This implied that Guinea grass provided high TS value in the milk by comparing insignificantly with those fed by *M. oleifera* herbage.

The range of values reported in this study compared favourably with the range of TS values of 12.35 – 14.77 % reported by Ahamefule et al¹ and Ukanwoko and Ibeawuchi²⁰ but contrasted with the range of values of 14.72 – 15.40 % reported by Ahamefule and Ibeawuchi² which was higher. The range of values of 6.43 % - 11.63 % reported by Zahraddeen et al²¹ and Lai et al¹¹ were however lower. The variations in these values could be attributed to nutrition and location of experiment since all the studies were conducted with WAD goats.

The milk protein from this experiment ranged from 3.00 – 3.41 % among the treatment diets. However, goats fed 25 % *M. oleifera* herbage (T₄ diet) had the highest value of 3.41 % and goats in the control group (T₅ diet) had the least value of 3.00 %. Thus, feeding WAD goats with 25 % *M. oleifera* herbage supplement increased the milk protein.

These findings were similar to the reports of Ukanwoko and Ibeawuchi²⁰, Tona et al¹⁹ for WAD dose and Reyes-Sanchez et al¹⁵ for Reyna cows; but contrasted with the reports of Ahamefule and Ibeawuchi² and Ahamefule et al¹ for WAD goats 4.25 – 4.31 % which were higher. The variations buttressed further that nutrition influences milk protein. In case of lactose values, there were no significant ($p > 0.05$) differences among the treatment diets. Highest lactose value was observed in T₄ diet (25 % *M. oleifera* herbage with 5.46 % and it was followed by T₅ diet (5.28 %) while T₂ had the least value of 4.89 %.

This implied that feeding Guinea grass alone (T₅) to WAD increased lactose value of the milk. This could have

contributed immensely to the highest value recorded in milk of the goats offering 25 % *M. oleifera* and 75 % Guinea grass herbage (T₄ diet). The range of value of 4.89-5.46 % of lactose from this study is higher when compared with the range of values 4.34 – 4.57 % reported by Ukanwoko and Ibeawuchi²⁰, Tona et al.¹⁹ Ahamefule and Ibeawuchi² and Reyes-Sanchez¹⁵ but lower when compared with the report of Lai et al.¹¹ The type of feed offered, location of experiment and species of livestock could have contributed to the differences.

Conclusion

The raw goat milk samples across the diets were normal with yellowish-white colour, sweet taste, without sediments and smooth texture with good natural smell except for the milk from goats fed *M. oleifera* herbage supplement at 100 % and 75 % which had a tint smell of *M. oleifera* herbage.

The raw goat milk samples across the diets were within the range of values recommended by Thai Agricultural Standards¹⁸ for physical and chemical characteristics raw goat milk. Also, the milk yield and chemical compositions were improved by feeding *M. oleifera* herbage and Guinea grass diet to WAD goats during gestation and lactation. 25 % *M. oleifera* and 75 % Guinea grass diet resulted in highest values for milk yield, milk protein and ash, lactose, total solids (TS) and solids-non-fat (SNF). Inclusion of *M. oleifera* herbage at 25 % in WAD goat feed promoted good quality raw goat milk that meets the needs of the obese, hypertensive, aged and the diabetic while supplementing above 50% decreased the chemical composition of the milk and the milk yield. For good milk organoleptic characteristics, high milk yield, lactose, total solids and protein content, lactating goats should be fed at 25 % inclusion level of *M. oleifera* herbage with 75 % Guinea grass.

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