PHYSICAL AND CHEMICAL PROPERTIES OF WEST AFRICAN DWARF GOAT MILK ON VARYING PASTEURIZATION TEMPERATURES

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ABSTRACT
Raw West African Dwarf goat milk (800 ml) was purchased to determine its physical and chemical properties after undergoing varying pasteurization temperatures. The milk sample was divided on the basis of pasteurization temperatures into four treatments (0, 65, 75 and 85 °C) containing 200 ml of milk each. Each treatment was further sub-divided into four replicates containing 50 ml each. After heating, milk samples from each replicates were cooled and physical and chemical analyses were determined. The data obtained were subjected to analysis of variance in a completely randomized design. The results revealed a pH range of 6.21 to 6.33; viscosity and total solids were significantly ($p<0.05$) highest in milk samples heated at 85 °C (270.00 (m^2/s) and 30.38%, respectively) than 107.67 (m^2/s) and 15.64%, respectively recorded at 0 °C. Also, the value of titratble acidity of milk samples was highest at 65°C (0.59). In addition, moisture, crude protein and ash contents were significantly ($p<0.05$) highest (84.36, 0.47 and 2.26%, respectively) at 0 °C and lowest (69.62, 0.27 and 0.66%, respectively) at 85 °C. However, Ether Extract and calcium contents of heated milk were significantly ($p<0.05$) highest (16.32% and 552.53 mg/L, respectively) at 85 °C and lowest (8.90% and 310.43 mg/L) at 0 °C. It was concluded that West African Dwarf goat milk pasteurized at 65 °C had better milk pH and acidity.

Keywords: West African Dwarf goat, milk quality, pasteurization temperatures.

INTRODUCTION
Although, the West African Dwarf goats are managed extensively in Nigeria by subsistence and rural farmers, the evidence of low milk production of this breed is well documented; however the composition, quality and safety of its milk are the major areas of concern for producers and consumers (Ahamefule and Ibeawuchi, 2005). Heat treatment of raw milk prior to further processing is of great importance attributable to the high microbial load present in raw milk. Thus, pasteurization is commonly used to eliminate all pathogenic and most of non-pathogenic organisms in raw milk before its further processing (Aly and Galal, 2002).

Hence, this study aimed to investigate the effect of varying pasteurization temperatures on the physical and chemical properties of West African Dwarf goat milk.

MATERIALS AND METHODS
Experimental Site
The experiment was carried out at the Food Chemistry Laboratory, Department of Food Science and Technology, Federal University of Agriculture, Abeokuta.

Experimental Procedure
A total of 800 ml of raw West African Dwarf goats' milk sample was purchased from the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta. After collection, the milk sample was cooled in ice packs at 15 °C to retard the growth of spoilage organisms and maintain the original quality of the milk before being transferred into a vat pasteurizer for heat treatment. The milk sample was divided into four treatments (0, 65, 75 and 85 °C) containing 200 ml of milk each. In other words, milk samples were heated in a vat pasteurizer for 30 minutes at temperatures; 0, 65, 75 and 85 °C. Each treatment was further sub-divided into four replicates containing 50 ml each. Subsequently, milk samples from each replicates were cooled and physical and chemical analyses were determined.

Data collection
Physical properties of milk
Determination of milk pH and viscosity

10 g of pasteurized milk samples were diluted with 70 ml distilled water and mixed thoroughly for pH determination. A Digital pH meter was calibrated with standard buffers 4 and 7 before measuring the pH of the mixture. Also, viscosity of milk samples was measured in a glass capillary viscometer.

Determination of Milk Specific Gravity

After pasteurization, milk samples from each replicate were cooled for at least 1 - 2 hour(s) before being tested with a lactometer. Milk samples were thoroughly mixed until homogeneous mixtures were obtained and were poured into measuring cylinders at similar temperatures.

Determination of Titratable Acidity

The acidity of pasteurized goat milk samples were determined by titration following the methods described by AOAC (2012) using phenolphthalein as an indicator. The titratable acidity of the samples was calculated by using the following equation:

$$\text{TTA (\%)} = \frac{0.009 \times \text{volume of NaOH used}}{\text{weight of the sample}} \times 100$$

Where, TTA = Titratable Acidity (AOAC, 2000)

Determination of Total solid

20 ml each of milk samples per replicate were weighed and dried in a boiling water bath. Subsequently, samples were dried in hot air oven at 102 ± 2 °C and from the weight of the residues, the total solids contents were determined. Total solid of samples will be determined as follows;

$$\text{\% Total Solid Content} = \frac{\text{M (initial)} - \text{M (dried)}}{\text{M (initial)}} \times 100$$

Where, M (initial) and M (dried) are the mass of milk samples before and after drying

Chemical properties of milk

Proximate Analysis

20 ml of milk samples per replicate were collected for proximate composition analysis. The milk samples were analysed according to the official methods of analysis as described by AOAC (2000) to determine the Dry matter (DM), Ash, Crude protein (CP) and Ether Extract (EE) contents.

Mineral Composition

Approximately, 0.50 g of WAD goat milk samples per replicate were weighed into a PTFE vessel and 2 ml of concentrated HNO_3, 0.5 ml of concentrated HCl, 2 ml of 30% H_2O_2 and 5.5 ml of H_2O were added. Samples were digested simultaneously with the optimized microwave digestion system. After digestion, the solutions were transferred into a volumetric flask and made up to 25 ml with ultra-pure water. Concentrations of mineral elements (Ca and Fe) in treated milk samples were determined with an Inductive Coupled Plasma with optical emission spectroscopy (ICP–OES).

Statistical Analysis

Data generated were subjected to Analysis of Variance (ANOVA) in a Completely Randomized Design. Significantly ($P<0.05$) different means were separated using Duncan's Multiple Range Test as contained in SAS (2010) package.

RESULTS AND DISCUSSION

The results of the physical properties of WAD Goat Milk performed on pasteurized milk samples are depicted in Table 1. All parameters measured were significantly ($p<0.05$) influenced except for specific gravity. Comparable means (6.28 and 6.21) for milk pH were recorded at 0 and 85 °C, respectively which are significantly ($P<0.05$) lower than 6.33 recorded at 65 °C. The pH range found in this study is slightly lower than the findings of Rehman and Salaria (2005) who reported milk pH range of 6.38 to 6.77. Similarly, Titratable acidity was significantly ($P<0.05$) highest (0.59 g/L) at 65 °C and lowest (0.37 g/L) at 0 °C. This supports the findings of Erdam and Yuksel (2005) reported that heat treatment resulted in increased milk acidity as a result of increase in concentration of lactic acid produced from degradation of lactose content in milk. Also, viscosity and total solids were significantly highest at 85 °C (270.00 (m^2/s) and 30.38%, respectively) than 107.67 (m^2/s) and 15.64%, respectively recorded at 0 °C. This is in agreement with the findings of Jeurnink and de Kruif (1993) who reported that heat treatment of milk resulted in increase in milk viscosity.

In Table 2, the effect of pasteurization temperatures on the chemical properties of WAD goat milk is presented. Moisture, crude protein and ash contents were significantly ($P<0.05$) highest (84.36, 0.47 and 2.26%, respectively) at 0 °C and lowest (69.62, 0.27

and 0.66%, respectively) at 85 °C. The present results are in line with reports of Sharma (2006) who concluded that increase in temperature causes evaporation of moisture during heat treatment which eventually resulted in increased total solid contents in treated samples. Also, Miyamoto *et al.* (2009) stated that temperature above the level of 60 °C results in denaturation of protein content thus decreases the level of protein in treated samples. However, Ether Extract and calcium contents of WAD goat milk were significantly ($P<0.05$) highest (16.32% and 552.53 mg/L, respectively) at 85 °C and lowest (8.90% and 310.43 mg/L) at 0 °C. This supports the findings of Winarso and Foekh (2011) who observed reduction in fat content of milk samples heated at higher temperatures due to evaporation of some components of milk during the heating process. In addition, statistically similar means for iron content were observed at 75 and 85 °C (3.73 and 3.79, respectively) which are significantly higher than 2.71 observed at 65 °C

CONCLUSION

From this study, it was concluded that WAD goat milk pasteurized at 65 °C had better milk pH and acidity.

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Table 1: Effect of Pasteurization Temperatures on the Physical Properties of WAD Goat Milk

Parameters	Temperatures				SEM
	0°C	65°C	75°C	85°C	
pH	6.28^{b}	6.33^{a}	6.30^{ab}	6.21^{b}	1.70
Specific gravity	0.99	0.98	0.98	0.97	0.02
Viscosity (m^2/s)	107.67^{c}	155.67^{b}	237.67^{ab}	270.00^{a}	25.30
Titratable Acidity (g/L)	0.37^{d}	0.59^{a}	0.48^{b}	0.43^{c}	0.02
Total solids (%)	15.64^{c}	17.79^{b}	20.62^{ab}	30.38^{a}	1.70

^{a,b,c,d}: Means with different superscript within the same row are significantly different at 5% significant level.

Table 2: Effect of Pasteurization Temperatures on the Chemical Properties of WAD Goat Milk

Parameters	Temperatures				SEM
	0 °C	65 °C	75 °C	85 °C	
Proximate Analysis (%)					
Moisture	84.36^{a}	82.21^{b}	79.38^{c}	69.62^{d}	1.70
Crude protein	0.47^{a}	0.41^{b}	0.31^{c}	0.27^{d}	0.04
Ether extract	8.90^{b}	12.66^{ab}	11.67^{ab}	16.32^{a}	0.80
Ash	2.26^{a}	1.59^{ab}	1.34^{ab}	0.66^{b}	0.18
Minerals (mg/L)					
Calcium	310.43^{d}	318.07^{c}	426.03^{b}	552.53^{a}	29.75
Iron	3.22^{b}	2.71^{c}	3.73^{a}	3.79^{a}	0.14

^{a,b,c,d}: Means with different superscript within the same row are significantly different at 5% significant level