International Journal of Innovation Scientific Research and Review
Vol. 04, Issue, 07, pp.3027-3030, July 2022
Available online at http://www.journalijisr.com
SJIF Impact Factor 4.95

ISSN: 2582-6131

Research Article

EFFECTS OF PASTEURIZATION AND BOILING ON SOME COMPONENTS OF COW'S MILK

[1]Idris Adam Idris Abdalla, [2]Ghada Mohamed Ahmed Ibrahim, [1]Sallam Abulfadiel Bakheit Sabeil, [3]Salah Abdul Gabar Salah Bukhari, [1,] *Jumaa Barram Jadalla

[1]Department of Animal Production, Faculty of Natural resources and Environmental Studies, University of Kordofan, Sudan.
[2]Ministry of Production and Economic Resources North Kordofan state, Sudan.
[3]Department of Animal Production, Faculty of Natural resources and Environmental Studies, University of Alsallam, El Fula, Sudan.

Received 09th May 2022; Accepted 10th June 2022; Published online 20th July 2022

ABSTRACT

This study was conducted with the objective of investigating the effects of pasteurization and boiling on cow's milk fat, protein and lactose. Forty (40) milk samples were collected from cows at different parity, number of parity and at the beginning of the lactation season from the morning milking and preserved in a vaccine carrier (cooler). At the laboratory, each milk sample was divided into three equal parts after using the homogenizer to distribute the fat granules in the milk. The first, control sample was left fresh without being subjected to heat treatment. The second sample was pasteurized at temperature of 650 C for a quarter of an hour with a basin pasteurizer and abruptly cooled down. The third sample was boiled using water bath without being exposed to direct flame. Boiling was done at temperature of 102° C. After cooling, the samples were analyzed to estimate the % fat, protein and lactose (N = 120). The data was analyzed using analysis of variance. Differences among means were detected by LSD test. The results showed that pasteurized and fresh milk fat was insignificant, while it was highly significant among boiled, pasteurized and fresh. The mean % fat in fresh milk was 4.68± 0.48, while the fat % in pasteurized milk was 4.24 ± 0.56. As for boiled milk, the average fat % was 2.68 ± 0.25. Using the LSD test, the results of the study confirmed that boiling the milk led to a large loss of fat due to heat and it was found that the pasteurization process did not significantly affect the % of fat in cows' milk confirming that boiling decreased nutritive value of milk, while pasteurization did not significantly affect the milk protein. The % of lactose was not significantly affected. The % lactose in fresh, pasteurized and boiled milk was 4.8 ± 0.62, 4.2 ± 0.59 and 2.5 ± 0.48%, respectively. There were very significant differences between % fat of boiled and untreated and pasteurized milk. The study concluded that pasteurization do not change the natural properties of milk and did not negatively affect its nutritional value. Boiling cow's milk affected the % of lactose, protein and fat in the milk leading to reduction of the nutritional value and changes its properties. The study concluded that pasteurization of milk for the duration of its preservation period and disposal of pathogenic microorganisms to humans and boiling decreased nutritive value. The study recommended that milk be pasteurized to retain nutritive value and increase shelf life as well as avoiding infection.

Keywords: cow's milk, heat treatment, Boiling, pasteurization, milk constituents.

INTRODUCTION

Livestock occupies an important aspect in the national economy, especially the Sudanese agricultural economy, whether in terms of its contribution to the gross domestic product or the size of the workforce or the capital invested in livestock sector (Behnke, 2012). Animals are kept for meat milk, hide and skins as well as source of work. It is known that milk is the natural secretion of the mammary glands for the young animal before being able to consume feed. It is also an important mammalian product that is used by humans. Cattle goats, sheep and camels are among the most important species that are kept for milk production. The cow's milk is widely accepted and used by many communities. The dairy industry in the world depends primarily on cow and sheep's milk then comes the milk produced by goats in the second degree (El Hag *et al.,*2001 and Darag *et al.,* 1993). The most important constituents of cows are protein, fat and lactose. Of course water is of the highest percentage. Milk is considered sensitive medium for microorganisms and subject to spoilage, decomposition and contamination by enzymes and environmental microbes, because it is biodegradable components such as lactose, proteins and lipids. Therefore, the activity of contaminated microorganisms must be put to an end, even if it is for a few hours. Milk is preserved in several ways, the most important of which are thermal treatments, the most important of which are pasteurization, boiling, and sterilization. This is done by traditional and modern methods in order to kill pathogenic microbes and most non-pathogenic microbes and in order to stop the activity of enzymes in milk that help to spoil it. These treatments help to provide healthy milk to the consumers. In addition it helps to extending the shelf life (Šestan and Bratovčić, 2016). Since the introduction of pasteurization, heat treatment of milk has attracted a huge amount of research attention. Consequently, there is large body of literature on many aspects of the technology (Deeth and Lewis (2017). The pasteurization process is one of the most important operations in the world of food industries, due to its importance in preserving milk and dairy products in general, and increasing their shelf life, and thus enabling traders and dairy traders to keep products for a longer period without fear of expiration of their validity and losing their nutritional value. Thermal treatments also contribute to protecting the consumers from the dangers of food poisoning that may result from the presence of harmful bacteria in milk. It is known that the life of unpasteurized milk products, especially milk and yoghurt, does not last more than a day or two at the latest, even if they are kept in a cool place (Kelly *et al.,*2012).

The Objective of the Study

This study aimed, in general, to find out the effect of pasteurization and boiling on the nutritional value of cow's milk through its effect on protein, fat and lactose,

***Corresponding Author: Jumaa Barram Jadalla,**
1Department of Animal Production, Faculty of Natural resources and Environmental Studies, University of Kordofan, Sudan.

MATERIALS AND METHODS

Study area

North Kordofan State is located in central Sudan, with an area of 19,480 square kilometers. It is located between longitudes 32^0 and 56^0 east and latitudes 12^0 and 16^0 north and shares borders with five states: South Kordofan, West Kordofan, Northern State, Khartoum and White Nile (Ministry of Agriculture, Livestock and Irrigation, North Kordofan, 2011). The northern part of the state is characterized by a semi-desert climate, while the southern part of the state is located in the dry savannah region. The population of the state is estimated at about 1578000, where the rural population represents 68.1% of the total population. About 79% of the state's residents are engaged in agriculture and herding activities. The population is concentrated in the urban areas, while low population density in the northern localities. The state is characterized by the presence of different types of soils, sandy, clay and sandy loams or alluvial soil. The state is interspersed with many valleys and seasonal streams. The average annual rainfall ranges from 250 to 400 mm. As for the most important land use in the state, it is represented in the production of field crops (16%), natural pastures (50%) and forests (9%), while the reserved areas represent 24%, and residential areas occupy 2% of the total area in the state. The state was subjected to a series of drought cycles (particularly the 1984-1985 drought cycle) which led to the deterioration and loss of many natural resources. The phenomenon of the overall deterioration of the ecosystem is one of the main problems that North Kordofan State suffers from. This phenomenon is represented in the deterioration of soil and vegetation cover, desertification and water imbalance. There are natural factors and others resulting from human intervention behind this phenomenon and its negative effects. The main causes of environmental degradation include excessive logging, overgrazing, erosion of the surface layers of the earth and unplanned agricultural expansion. All these factor affected type of animals kept by rural inhabitants and decreased cattle population. Vegetation cover shows that the upper vegetation cover consists of trees and shrubs such as *Acacia senegal*, *Acacia tortilis, Ziziphus spineehisti,* Baobab *Adansonia digitata, Leptodania pyrotechnica, and Maeura crassifolia.* Herbs and grasses are *Cassia tora, Aristida mutabilis, Aristida ssp, Echinocloa colonum, Dactyloctenium aegyptium*

Data collection method

This study was conducted in North Kordofan State, and milk samples were brought from the Kholouj dairy farm, and they were sent to the Joud Dairy Factory, one of the branches of the Kholouj Company for Investment in Animal Production. Forty (40) milk samples were collected from closely related cows in the parturition period at the beginning of the lactation season, taking into account the gradation of age groups. All samples were from morning milking and the proportion of the distance between the place of sample collection and the laboratory, a cooler serum holder was used to save the samples. Two hours later, the samples were entered into the laboratory, the sample receiving unit in the factory, where each milk sample was divided into three equal sections after using a homogenizer for the purpose of distributing the fatty granules in the milk medium. The first sample was left fresh (F) without being subjected to heat treatment, which is the control sample. The second sample was pasteurized at a temperature of 65 degrees Celsius for a quarter of an hour with a tub pasteurizer and promptly cooled down and this sample was called pasteurized (P), while the third sample was boiled using a bath. The sample was boiled at a temperature of 102 ° C without exposure to direct flame, and the sample was called boiling (B). After cooling, the laboratory analysis was carried out to estimate the percentage of protein, fat and lactose sugar in all samples (N=120). The milk pasteurization sample was placed in the numbered flasks in a pasteurization basin, a double vessel fitted with a thermometer, where the milk temperature was raised to 65°C for 15 minutes, and then the milk was gradually cooled to 4°C. Pasteurizers are made of stainless material, and are equipped with a stirrer to stir the milk continuously during heating to prevent any undesirable changes in the milk such as the straw or cooked taste. The process of cooling the milk in the same container was carried out by passing cold water through the space between the walls of the container. The boiling milk samples were placed in the numbered flasks in a large pot and inserted into a large pot filled with water, and then the temperature of the stove was raised so that the water in the pot represented a water bath. Method used for estimating the percentage of fat in milk was as follows: the prevailing method, where the test is carried out in Babcock devices using Babcock tubes, which is a 23 ml tube consisting of a bulge topped by a leg graded from zero to 7 (or from zero to 10). Ten (10) ml of concentrated sulfuric acid with a concentration of 91% or a density of 1.820-1.825 was taken and 11 ml of the milk sample to be tested was added. After that 1 ml of alcohol was added in dry a tube, then closed with stopper. With great care and for personal safety, the contents were shaken taking the sample or tube with a forward movement several times until an internal clot forms and then dissolves by continuous shaking. After shaking and melting the clot, the sample or tube was stirred several times, paying attention to the heat conditions resulting from the reaction in the different parts of the tube. One was placed in another tube of plain water. After that, the centrifuge was rotated at 1200 revolutions per minute for a period of 3-5 minutes, after which the tubes are taken out of the machine and placed in a water bath at a temperature of 150 F for 2 minutes, taking care not to mix the contents of the tube. The percentage of fat in the sample was read from the grading leg, so it was the percentage of fat (Robert *et al.,* 2018). Method used for estimating the percentage of protein in milk according to Didier *et al.,(*2018), was done as follows; the sample was put as 10 ml of the milk sample in a 500-800 ml Kieldahl flask. Digestion flask with the adjuvant (add 0.7 gm of nitrogen-free mercury oxide) and add 15 g of anhydrous potassium sulfate powder. After that 25 ml of concentrated sulfuric acid 93-98% was added and the beaker was placed on the digestive system and continued to boil for 30 minutes until the solution becomes clear. After that, the beaker was raised to cool to less than 25 degrees Celsius. This is called the stage of digestion. Then comes the stage of distillation by adding 200 ml of water, then a few zinc granules are added. Then the beaker is fixed in the distillation apparatus. With the addition of 80 ml of sodium hydroxide solution) and the end of the condenser should be immersed in the standard acid solution, to which 5-7 drops of evidence (methyl red and bromocresol green are added by dissolving 0.16 g of methyl red -0.83 g of bromocresol green guide in a liter of ethanol) shake a flask. The distillation is well heated until all the ammoniacal compounds are volatilized and condensed and the equilibration or titration stage begins so that at least 150 ml of the standard guide is received, then the receiving flask is lifted and the end of the condenser is washed, then the nitrogen is equalized in the receiving flask with a solution of hydrochloric acid 1 caliber The calculations are carried out according to the equation N x T x 0.014 x 20 x 6.38 x 100 W.S. Where: N = Normality of H_2SO_4 T = Titrate Volume W.S. = Weight of Sample Method for estimating the percentage of lactose (milk sugar) in milk followed the procedure described by Hana and Martina (2016). The estimation of the sugar content in milk was done by Bertrand method. The basis of the method depends on the fact that lactose is a disaccharide of galactose and glucose, and this sugar has a reducing property as a result of it containing the aldehyde group present in glucose sugar. Bertrand's method for measuring the proportion of lactose depends mainly on finding the amount of copper reduced by lactose during the boiling process of protein-free whey with the basic solution of copper salts of the first and second, during which the lactose will undergo an oxidation process and many other changes. However, it reduces in an acidic environment an amount equal to HLA from the iron (III) to the(II). Thus, the iron(II), which is formed, will reduce the same amount of hepta-magnesium to the(II), and on the basis of the amount of potassium permanganate used to oxidize the iron(II), the same amount of reduced copper is calculated, and then the amount of lactose in the milk.

Statistical analysis

The complete randomized design (CRD) was used in the design of the experiments, and the data were statistically analyzed by ANOVA using the M-Stat-C program on the computer, and then the least significant difference test (LSD) was used to differentiate between the means and the significance test for the trials.

RESULTS AND DISCUSSION

Effect of heat treatments on milk fat is presented in table (1). The results showed significant differences (P<0.001) in fat % of the milk upon boiling as compared with untreated samples where the average percentage of fat in cow's milk was 3.65, 3.59 and 2.76% for untreated, pasteurized and boiled milk, respectively. The difference among the averages of the treatments indicated that boiling milk led to loss of a large proportion of the fat due to the heat. It was found that the pasteurization process does not have a significant effect on the percentage of fat, as the results showed that the noticeable difference in the percentage of fat between fresh and boiled, with a standard deviation of 0.59. Decreased fat percentage was due to volatile nature of milk fat that was evaporated at high degree of heat that pasteurization. The results reported here are similar to those reported by Šestan *et al.,* (2016) who showed that heating above 80 ^{0} C could change milk composition.

Table 1. cow's milk fat as affected by heat treatment

TREATMENTS

	untreated	boiled	pasteurized	Standard Deviation
samples	15	15	15	-
fat %	3.6527	2.7620	3.5920	0.59

Table 2. Effect of heat treatment on cow's milk protein, fat and lactose

TREATMENTS

	untreated	boiled	pasteurized	Standard deviation
Samples	40	40	40	NS
Fat	4,2717	2,6119	3,9517	0.55525***
protein	4,0583	2,6780	3,7400	0.52953***
lactose	4,7050	2,6305	4,1633	0.4677***

The results indicated that boiling unlike pasteurization affected milk constituents and especially the percentage of fat in cow's milk significantly. Significant differences (P<0.01) were recorded in fat % when untreated, pasteurized and boiled milk, respectively. This study concluded that heat treatments affected significantly the percentage of fat between fresh and boiled milk samples. This study also found that heat treatments greatly affected the protein and fat content, and thus affect the nutritional value of milk. In general heat treatments had changed % milk components where values recorded between treatments, showed that average protein content in fresh milk was 0.59 + 4.27, while it was found to be 0.56 + 3.95 in pasteurized milk, while in boiled milk it was average protein % was only 0.900 + 2.61 %. Heating is also responsible for denaturation of protein and losing some part of it. These results are in line with finding reported by Didier *et al.,* (2018) in effects of heat on milk protein. The observed difference in protein percentage between fresh and boiled was not significant (P>0.5). This study recommended the pasteurization of milk instead of boiling is the appropriate heat treatment that preserve milk nutritional value and fresh is in need of heat treatment order to eliminate the microorganisms and to preserve it for a longer period.

Table 3. comparison of milk constituents as affected by heat treatments

constituents	treatment		average	SE
protein	untreated	pasteurization	0.31833	0.9490
		boiling	1.38037	0.9530
	pasteurization	untreated	31833	0.9490
		boiled	1.6203	0.9530
	boiling	untreated	1.38027	0.9530 **
		pasteurization	1.6203	0.9530 ***
	untreated	pasteurization	32000	0.96520 **
Fat		boiling	1.65980	0.96930 ***
	pasteurization	untreated	32000	0.96520 ***
		boiled	1.33980	0.96930 **
	boiling	untreated	1.65980	0.96930 ***
		pasteurization	1.33980	0.96930 ***

Table 4. Correlation coefficients between treatment effects of cow's milk

	heat treatments	% fat in milk	% protein in milk	% lactose in milk
heat treatments	1	**760	***718	**6040
% fat in milk		1	**602	**0.4770
% protein in milk			1	**0.539
% lactose in milk				1

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