2018 Journal of Agricultural Production and Technology ISSN: 2360-9364

QUALITY EVALUATION OF MILK AND CHEESE FROM WHITE FULANI CATTLE

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ABSTRACT

Milk and milk products are important component of food for all age groups. The quality evaluation of milk and cheese from White Fulani cattle managed on the Teaching and Research Farm of Osun State University was the focus of this study. About 21.4 liters of milk was collected from 5 cows of 2 years of age, at mid-lactation, using hand milking, very early in the morning and divided into two samples of 10.7 liters each. One was pasteurized at 89 ^{0}C for a second while the other, was processed into fresh and fried cheeses (about 500g average weight of fresh cheese was also fried using 500ml of vegetable oil and salted at 5% of sample}, both samples were compared with their commercial equivalent for microbial load, proximate and mineral compositions, TBARS and palatability status, in a completely randomized design. Samples were named as Pasteurized Commercial Milk (PCM), Pasteurized Laboratory Milk (PLM), Fresh Commercial Milk (FCM), Fresh Laboratory Milk (FLM), Fresh Commercial Cheese (FCC), Fresh Laboratory Cheese (FLC), Laboratory Fried Cheese (LFC), Fried Commercial Cheese (FRCC). Results showed that, FLM had the significantly highest mineral content than PCM, PLM and FCM but PLM had the least microbial load. FCC and FLC had the highest ($P<0.05$) ether extract, ash, protein, with least moisture content than PLM, FLM, PCM and FCM. The CFC had the highest ($P<0.05$) TBARS (Thiobarbituric Acid Reactive Substance) status and microbial load (0.29 -0.52 µM/g), (3400 – 6270 x 10^4 cfu/g) than LFC (0.21 -0.32 µM/g), (2550 – 4920 x 10^4 cfu/g) within 5 days of storage. The FLC and LFC were rated significantly higher in overall acceptability than FCC, FRCC, PLM and PCM. Milk and cheese prepared in the laboratory had best nutrients (in terms of minerals and proximate) composition compared to other samples evaluated and producing milk into cheese products help to preserved the nutrient in fresh milk, thereby increasing its shelf life.

Keywords: Milk, Cheese, Pasteurized milk, Fresh cheese, Fried cheese and White Fulani cattle
J. Agric. Prod. & Tech.2018; 7:1-8

INTRODUCTION

Milk protein is one of the most important sources of amino acid for humans and can be remedial for protein shortage in Nigeria. Milk from dairy cows has been regarded as nature's perfect food, providing an important source of nutrients including

high quality proteins, carbohydrates and selected micronutrients. More than 95% of the cow milk proteins are constituted by caseins and whey proteins. Among the caseins, beta casein is the second most abundant protein and has excellent nutritional balance of amino acids (Monika *et al*., 2012). Milk has higher protein which is a good food for human consumption having more advantages to human health. Like higher protein diets may be effective for weight loss because of changes in energy metabolism and appetite signaling that promote decreased energy intake (Leidy *et al*., 2015). Furthermore, during weight loss, high-protein diets can help maintain resting energy expenditure (Leidy *et al*., 2015; Halton and Hu, 2004; Eisenstein *et al*., 2002). Protein or milk protein also has a greater effect on satiety than carbohydrate or fat, which may lead to reduced energy intake (Leidy *et al*., 2015; Bosse and Dixon, 2012).

Cow milk contains about 87% water, 3.7% fat, 4.9% lactose and 3.5% protein (Aduku and Olukosi, 2000). Milk component differs between breeds and within breeds of animals (FAO, 2018) Also, other factors like plane of nutrition, a variability of adequate water, environmental temperature, length of lactation, herd management practices, health and age of animals may influence the composition of the milk.

Milk produces essential nutrients and is an important source of dietary energy, high quality protein and fat and milk can make a significant contribution to the required nutrient intakes for calcium, magnesium, selenium, riboflavin, vitamin B_{12} and pantothenic acid. Milk and milk products are nutrient dense foods and their consumption can add diversity to plant–based diets. Animal's milk plays an important role in the diets of calcium in populations with very low fat intakes and limited access to other animal food sources (FAO, 2018). Fresh milk is very scarce in Nigeria and where they are available; its preservation is a huge problem to the producers which are often the low income level local milk producers in the rural areas of Nigeria. Most producers are the Fulani cattle rearers that major in cattle rearing, while their women focus on the production and selling of fresh cow milk and other products. Aduku and Olukosi (2000), observed in Nigeria that consumers are more ready to accept locally produced milk and milk products.

Parihar and Parihar (2008) also reported that there is need to extend the shelf life of milk for human consumption by preventing the transmission of diseases via milk, and that this versatile food could then be preserved using fermentation, heating, cooling, removal of water, and by concentration or separation of components to produce food products from it, such as butter, yoghurt, cheese, etc.

Cheese is an important milk product with milk nutrients having good storage properties with increased shelf life. It is traditionally produce to preserve the nutrients of milk. It is said to be the product of selective concentration of milk (Parihar and Parihar, 2008). A variety of cheese is produced from different types of animal milk and it may be fresh, soft or hard. It is usually prepared within 24 hours of milking with lactic acid and rennet and is consumed immediately. Cheese is less perishable, less bulky and concentrated milk product than fresh milk. It consists mainly of fat, casein and insoluble salts together with water in which small amounts of soluble salts, lactose and albumin are found.

Many cheese varieties are manufactured around the world but they are all broadly classified by the degree of hardness or moisture content, hence we have very hard (30 -35% moisture content), hard (35 - 40%), semi – soft (40 -45%), and soft

cheese (45 – 50%). Several types of cheese are produced in Africa. *Wara* is a fresh white cheese commonly produced and consumed in Nigeria and it is similar a type produced in Benin Republic called *Waoagachi. Wara* is usually sold all day and is brought to the market in a container with cool water. The moisture content of *wara* is about 65%. It is usually unsalted and uncoloured and 1 kg of cheese can be obtained from about five liters of milk. *Wara* could be sold fresh or fried, fried cheese has better shelf life than fresh cheese and milk. This study therefore evaluated the qualities of milk and cheese products from White Fulani cattle.

MATERIALS AND METHODS

Sample Collection: Ten White Fulani cows at early stage of lactation at the University Teaching and Research Farm, Osun State University, Ejigbo Campus in Nigeria were hand milked. Early in the morning the nursing White Fulani cows were restrained from free-range, clean bowl was placed under the udder of each cow and their teats were massaged to let out milk. Ten cows were milked, given a yield of about 21.4 liters of milk. The commercial milk sample and cheese (fresh and fried) from White Fulani cattle were purchase from Gaa Fulani, Isundunrin, Ejigbo in Osun State of Nigeria, which is a reliable and reputable source, where Fulani cattle were being raised and cheese were produced on a daily basis. The samples were named as follows; Fresh Commercial Milk- FCM, Fresh Commercial Cheese- FCC and Fried Commercial Cheese- FRCC.

Processing

Pasteurization: About 10.4 liters of the fresh milk collected from the farm, and the commercially purchased milk were pasteurized in the laboratory at 89^0C for one second. The samples were named as PLM- Pasteurized Laboratory Milk after pasteurization and PCM- Pasteurized Commercial Milk after pasteurization.

Cheese Making: About 10.4 liters of fresh milk samples were processed into cheese in the laboratory (FLC – Fresh Laboratory Cheese) and compared with it commercial equivalent (FCC – Fresh Commercial Cheese). The local method was employed in order to obtain similar results. Sodom apple (*Calotropis procera*) leaf extract (ratio 5:1 v/v in water) was used as coagulant. Coagulation commenced after ten minutes and stopped after another twenty minutes. The curd was separated from whey by pouring the mixture into a sieve and left to cool in which the final product (cheese) was formed. About 500g average weight of fresh cheese was also fried using 500 ml of vegetable oil and salted at 5% of sample. Thus, at the end of the experiment, eight samples were produced with three replicate per treatment. These are Pasteurized Commercial Milk (PCM), Pasteurized Laboratory Milk (PLM), Fresh Commercial Milk (FCM), Fresh Laboratory Milk (FLM), Fresh Commercial Cheese (FCC), Fresh Laboratory Cheese (FLC), Laboratory Fried Cheese (LFC) and Fried Commercial Cheese (FRCC).

Palatability Status: Twenty trained panelists were randomly selected and allocated to all the samples. The rating test was coded on a five-point hedonic scale for colour, texture/viscosity, taste, aroma, and overall acceptability according to Fakolade (2016).

Microbiological Analysis: The microbial count was carried out on all the samples using the methods of American Public Health Association (APHA, 2016).

Determination of Oxidative Rancidity: The oxidative rancidity was determined by the Thiobarbituric Acid Rreactive Ssubstance (TBARS). It was carried out on

the fried cheese samples (LFC and CFC) by the modified methods of (Witte *et al.,* 1970).

Proximate and Mineral Composition: The protein, crude fiber, ether extract, ash and moisture content, as well as the calcium, phosphorus and Magnesium composition were evaluated using the method of AOAC (2005).

Experimental Design: The experimental design used for this study was the complete randomized design (CRD). The treatments were replicated three times.

Statistical Analysis: All data was subjected to ANOVA. Means were compared using Tukey HSD test. The SPSS (2008) computer software was used for all statistical analysis.

RESULTS AND DISCUSSION

Cheese is a food made from the pressed curds of milk, firm and elastic or soft and semi-liquid in texture. It was made as a way of preserving the nutrients in fresh milk and 4.5 liters of fresh milk will produce 1kg of cheese Parihar and Parihar (2008).

The mineral and microbial count of fresh milk, pasteurized milk, and cheese is as shown in Table 1 below. It showed the reduction in the minerals and microbial loads of samples after pasteurization. The fresh laboratory cheeses had significantly ($p < 0.05$) higher mineral and microbial content. The milk obtained from the Teaching and Research Farm, and cheese prepared from it had higher ($p < 0.05$) mineral content and least microbial load than commercial samples. Values observed in table 1 showed that fresh milk has a lot of nutrient benefits but with lot of microorganisms. Gillespie *et al*. (2003) observed that raw milk had been a known vehicle of pathogens for more than 100 years. Pasteurization of milk helps to reduce the microorganisms present in the milk. More of these microorganisms could be from the body of the animal, from the utensils used, from handling process and the cloth of the Fulani's milk producers. It was observed that the commercial product had more microbes and fewer nutrients than those products that are pasteurized. In the state laws of the United States of 1993 – 2006, it was reported that, healthy animals at times may carry germs that can contaminate milk, and that there is no substitute for pasteurization in assuring milk is safe to drink. Though pasteurization reduces microbial load, it could also destroy enzymes, diminishes vitamins and minerals, denatures fragile milk proteins, kills beneficial bacteria and promotes pathogens instead (Mercola, 2014). Sierra (2016) also observed that pasteurized milk of nowadays is a far cry from the real stuff, since milk undergoes harsh processing before getting to consumers.

The high values obtained for mineral and microbial content of all the cheese samples could be as a result of accumulation of nutrient as moisture context in the milk has been extracted to a reasonable extent.

The mineral content values of milk samples ranges from 28.61 – 103.82 mg/100g which were lower than values of 94 – 1135 mg/kg reported by Sanz Ceballoz *et al*., (2009) for milk from Holstein Friesian cows of South Eastern Spain. The microbial loads from the laboratory and commercially produced samples could possibly be attributed to the type of management, handling and processing the products undergo, since the commercial samples were processed by the Fulani women. Coorevits *et al*. (2008) reported that differences in feeding and housing strategies of cows may influence the microbiological quality of milk. Karmen and Slavia (2008) also observed that the number of microorganisms in milk immediately after milking is affected by factors such as animal and equipment cleanliness, season, feed and animal health in a research conducted on milk's microbiological quality. .

Table 1: Mineral and microbial count of fresh milk, pasteurized milk, and cheese

Parameters	FCM	PCM	FLM	PLM	FCC	FLC	SEM
Calcium (mg/100g)	99.04^{e}	97.93^{f}	103.82^{c}	102.02^{d}	188.00^{b}	197.00^{a}	0.66
Phosphorus (mg/100g)	71.29^{e}	68.98^{f}	74.30^{c}	72.66^{d}	118.00^{b}	128.00^{a}	1.09
Magnesium (mg/100g)	29.91^{e}	28.61^{f}	34.39^{c}	31.25^{d}	57.85^{b}	62.34^{a}	0.70
Microbial load (cfu/g)	380000^{c}	335000^{d}	270000^{e}	235000^{f}	450000^{a}	385000^{b}	0.46

[a-f] Means on the same row with different superscript are significantly different ($p < 0.05$)
FCM = Fresh Commercial Milk; PCM = Pasteurized Commercial Milk; FLM = Fresh Laboratory Milk; PLM = Pasteurized Laboratory Milk; FCC = Fresh Commercial Cheese; FLC = Fresh Laboratory Cheese; SEM = Standard error of mean.

The TBARS Status and microbial count of fried cheese is as shown in Table 2 below. There was an increase in the oxidative rancidity and microbial count as storage days increased and laboratory fried cheese had significantly ($p < 0.05$) lesser values than commercially purchased ones. Frying is a good means of preserving cheese as it prolonged the shelf life and lowered the microbial load. It was observed that there were very drastically significant lower mark values of microbial loads in the fried cheese on the first day of storage or production. However, storing for more than three days may not guarantee safety in consumption as a vast increase in microbial accumulation was observed as the days increased. This could be due to the absorption of moisture from the environment which in turn increased the water holding capacity and the water activity of the products thereby increasing the microbial loads. The value gotten on the 5th day was higher than the standard limit for microorganism in milk which is 750,000 cfu/g; for all somatic cell count. (NYSDAM, 2006). The oxidative rancidity can also be said to increase as the microbial accumulation increased, since the action of microorganisms on the samples would result in the breakdown and a resultant spoilage of the samples.

Table 2: TBARS Status and microbial count of fried cheese

Parameters	Period	LFC	FRCC	SEM
TBARS Status	DAY 1	0.21^{a}	0.29^{a}	0.01
	DAY 3	0.26^{b}	0.39^{a}	0.01
	DAY 5	0.32^{b}	0.52^{a}	0.01
Microbial load (cfu/g)	DAY 1	2550^{b}	3400^{a}	0.09
	DAY 3	329000^{b}	490000^{a}	0.10
	DAY 5	49200000^{b}	62700000^{a}	0.16

[ab] Means on the same row with different superscript are significantly different (P<0.05)
LFC = Laboratory Fried Cheese; FRCC = Fried commercial cheese; SEM = Standard error of mean.

The Proximate composition of pasteurized milk, Fresh milk and cheese is as shown in Table 3 below. Fresh Commercial Cheese and Fresh Laboratory Cheese (FCC and FLC) had highest protein content (12.40 and 12.27% respectively) but lower moisture content of (61.62 and 62.95%), than other samples. The ash and crude fiber components were similar ($p > 0.05$) for all the samples. This might be due

to the fact that the animals used were of the same breeds and milk was collected and processed on the same day, using the same method. It could also be due to the fact that pasteurization had little or no significant effect on the minerals and fiber content of milk samples. This agrees with the report of USFDA (2012) which stated that pasteurization does not significantly change or reduce the nutritional value of milk. However, ether extract had some slight significant reduction when the products were pasteurized. The different is the case with cheese that was produced as there was accumulation of nutrients for both the fresh commercial and the fresh laboratory cheese in protein content, dry matter and ether extract content. These could be as a result of reduction in the moisture content during the process of production. The values however for ash, ether extract, and crude protein ranged from 1.25 – 12.40 % and did not agree with the report of Augustine *et al*. (2014) which ranged from 2.03 – 18.40 % (respectively) using similar method in cheese production. The results of ash, ether extract, and crude protein of milk samples (0.98 – 1.13, 5.15 – 5.95, and 3.34 – 3.62 % respectively) were in line with the findings of Ndubueze *et al*. (2006) who reported 0.82 – 0.99% ash, 3.78 – 5.07 crude fat, and 3.46 – 3.58 % crude protein for cheese. A report by the USFDA (2012) also affirmed that the crude protein in cow's milk is about 3.5 % and the fat content of *Bos indicus* can be as much as 5.5%.

Table 3: Proximate composition of pasteurized milk, Fresh milk and cheese

Parameters (%)	FCM	PCM	FLM	PLM	FCC	FLC	SEM
Crude protein	3.45^{b}	3.34^{b}	3.62^{b}	3.55^{b}	12.40^{a}	12.27^{a}	0.20
Ash	0.98	1.06	1.13	1.00	1.35	1.25	0.03
Moisture content	79.48^{a}	80.45^{a}	79.50^{a}	80.23^{a}	61.62^{c}	62.95^{b}	0.29
Dry matter	20.52^{c}	19.55^{d}	20.50^{c}	19.77^{d}	38.38^{a}	37.05^{b}	0.29
Ether extract	5.50^{c}	5.15^{d}	5.95^{c}	5.45^{d}	9.95^{b}	10.30^{a}	0.12
Crude fiber	0.01	0.01	0.01	0.01	0.01	0.01	0.00

$^{a-d}$Means on the same row with different superscript are significantly different ($P<0.05$)
FCM = Fresh Commercial Milk; PCM = Pasteurized Commercial Milk; FLM = Fresh Laboratory Milk; PLM = Pasteurized Laboratory Milk; FCC = Fresh Commercial Cheese; FLC = Fresh Laboratory Cheese; SEM = Standard error of mean..

The palatability status of pasteurized milk, fresh and fried cheese is as shown in Table 4. The panelists rated the laboratory fried cheese and fresh laboratory cheese higher than other products evaluated as they gave the highest value to aroma (4.33 and 3.50 respectively), and the taste (4.17 and 3.67) which later influenced their acceptability. It was observed that products from milk are readily preferred by the panelists to milk in its ordinary state and so people should be encouraged to consume fresh milk. Products from milk (in form of yoghurt, cheese etc.) should be worked on to get more of it in the market to meet the demand for its consumption as it had the highest overall acceptability of the panelist.

Table 4: Palatability status of pasteurized milk, fresh and fried cheese

Parameters	PCM	PLM	FCC	FLC	FRCC	LFC	SEM
Colour	2.43^{c}	2.50^{c}	3.83^{a}	3.00^{b}	3.00^{b}	2.67^{c}	0.45
Texture/Viscosity	3.93^{b}	3.83^{b}	4.33^{a}	2.50^{c}	2.33^{d}	2.83^{c}	0.35
Taste	3.40^{b}	2.83^{c}	2.67^{d}	3.67^{b}	3.10^{c}	4.17^{a}	0.39
Aroma	3.07^{c}	2.67^{d}	3.33^{c}	3.50^{b}	3.50^{b}	4.33^{a}	0.25
Overall acceptability	3.67^{b}	3.33^{c}	3.17^{c}	4.50^{a}	3.67^{b}	4.50^{a}	0.43

$^{a-e}$ Means on the same row with different superscript are significantly different ($p < 0.05$)

CONCLUSIONS AND RECOMMENDATIONS

- Milk and cheese prepared in the laboratory had best nutrients in terms of minerals and proximate composition compared to other samples evaluated.
- Producing milk into cheese products helped to preserve the nutrient in fresh milk, thereby increasing its shelf life.
- Fresh milk is rich in nutrients and nourishing; therefore, people should be encouraged to consume more fresh milk.
- Cheese a preserved product from milk equally has same nutrients quality as fresh milk, therefore its production and consumption should be encouraged to increase the protein consumption of the populace.

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