COMPARATIVE STUDY OF THE NUTRITIONAL AND MICROBIAL SAFETY OF FRIED "WARA"(LOCAL CHEESE) WIDELY HAWKED IN ILORIN AND OGBOMOSO TOWNS IN NIGERIA

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Abstract
Malnutrition resulting from low protein intake is one of the nutritional problems facing developing countries including Nigeria. Proteinaceous foods are costly and in short supply mostly in developing countries. Local cheese (called locally wara in Nigeria) is a product that does not undergo any further treatment to ensure their safety before consumption. Due to recent hawking of these local cheeses on our major streets and roads, there was the need to determine the nutritional safety of the hawked products. Wara samples sourced from four different locations each at Ilorin, Kwara State and Ogbomoso, Oyo State respectively, were analysed for nutritional and microbial safety.
The proximate composition of the samples shows moisture content and carbohydrate increased from 59.69-72.00% and 2.39-11.39% respectively over the period of storage, while protein, fat and ash contents reduced from 22.20-10.80%, 15.80-3.62% and 2.99-0.25% respectively over same period. Microbial and fungal counts showed that the samples had microbial loads of 2.0 X 10^2 to 6.3 X 10^5 CFU/g and 2.0 X 10^2 to 7.1 X 10^5CFU/g respectively during storage. Klebsiella and salmonella species, Escherichia coli and some fungi organisms were isolated from some of the samples.
The study revealed that some of the local cheeses (wara) being hawked on our major streets and roads are not really safe for consumption after about three days of production, even after being fried. The short comings could be attributed to unhygienic practices of the hawkers/producers and/or lack of requisite preservation or standardised production conditions.

Keywords*:* Wara (local cheese), quality safety, hawking, nutrition, pathogens.

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1. INTRODUCTION

Food is a biological material consumed to provide nutritional support for the body (provide energy, maintain life and stimulate growth). It is usually of plant and animal origin and contains essential nutrients such as fat, protein, vitamins and minerals. In modern times, food is usually supplied by food industry (Jango-cohen, 2005).
Animals are used as food either directly or indirectly by the product they produce. Animal foods include milk, which is gotten from the mammary gland of mammals e.g cow milk, which in many culture is been drunk or processed into various dairy products (Curry, 2013).
Livestock farming in general and milk production still play an important socio-economic role in many developing countries. In our nation Nigeria, the Fulani pastoralist process surplus fresh milk from their cows into various stable products like "warankasi" (coagulated milk product), "nono" (fermented skimmed milk) and "mai-shani" (milk fat) (Belewu *et al.*, 2005 and Ashaye *et al.*, 2006). Milk, an extremely nutritious food, is a source of rich nutrient and an excellent medium for microbial growth (Akinyele *et al.*, 1999; Adesokan *et al.*, 2009; Sangoyomi *et al.*, 2010) hence, a perishable commodity.
Cheese is a concentrated dairy commodity produced by acid or rennet coagulation or curdling of milk, stirring and heating the curd, draining off the whey, collecting and pressing the curd. The cheese is ripened, cured, or aged to develop the flavour and texture (Raheem *et al.*, 2009; Beresford *et al.*, 2001). The manufacture of "wara" cheese is widespread in Nigeria and a similar local cheese called "wogachi" is made in Northern provinces of Benin Republic, a French speaking country, to western part of Nigeria. The Fulanis of northern Nigeria are traditionally cattle rearers,

and have access to fresh milk. "Wara" cheese (or local cheese as it may be called) making is thought to have started in the region and as a result of the nomadic lifestyle of the fulani's, it spreads to other parts of Nigeria, such as Kwara, Oyo, Ondo States (Bamidele, 2006), and according to FDA, 2003, two criteria; moisture content and the milk fat content were used to define cheeses.

Cheese can be classified into two groups varying from raw material, texture, type, interior or exterior characteristic, and composition. Cheese flavour and texture are overwhelmed by fatty acid composition of milk fat and the firmness up to 24 hours. Cheese, however, has a shelf life from 4-5 days up to 5 years depending on the variety. The West African soft cheese which is a special type of local cheese found in Nigeria has a shelf life of about 2days when immersed in its whey by the local producers. "Wara" or local cheese has a relatively short shelf life due to the presence of some food borne microbial flora comprising of bacteria and fungi (Belewu *et al*., 2005).

Various preservation methods for cheese were documented by Aworh and Egounlety, 1985, while Joseph and Akinyosoye, 1997 used 0.8% propionic acid and 0.8% sodium benzoate to preserve cheese for 8days and of recent, hawking of fried cheeses on the major roads of our nation, Nigeria surfaced and have been on the increase, probably hoping to extend its shelf life. Cheese, an excellent source of protein, fat and minerals such as calcium, iron and phosphorus, vitamins and essential amino acid, is an important food in the diet of both young and old people (Tona *et al*., 2013).

Cheeses are hawked in almost all the major streets of the states in our country by many fulanis, and as a result of the high nutritive and perishable nature of these local cheeses, the need to ascertain the safety of these cheeses being hawked all around our major streets is very important. A case study of Ilorin and Ogbomoso towns in Kwara and Oyo States respectively were looked at in this research work, as hawking of these cheeses is prominent there.

2. MATERIALS AND METHODS

Fried local cheese (known as *Wara* in this part of the world) samples were sourced from the North, South, West and Eastern parts of both Ilorin and Ogbomoso towns of Kwara and Oyo States respectively directly from the producers. The samples were collected aseptically immediately after production into a clean covered container and conveyed to the laboratory for immediate analyses.

Proximate analysis of the samples was determined in triplicate in accordance with the procedure described by AOAC, 2005.

Total bacterial and fungal counts, as well as isolation of pathogenic organisms were determined by the method of Fawole and Oso, 2007.

3. RESULTS AND DISCUSSIONS

The local cheese (*wara*) samples were analysed over a 22-day storage period. During this period, the cheeses samples were observed to gradually develop bad odour, loss of curd after some days, that is, lost their soft and firmer texture and turn to hard and tough cheese. The colour change started from the eighth day, with the colour surface changing from bright brown to dark brown and then to slightly black colour, but the inner part remained white. The shape becomes slippery, which indicate degradation in some quality parameters, as a result of the possible presence of microorganism and/or enzymes (naturally) in the cheese samples.

The proximate composition of the local cheeses (*Wara*) was similar to that reported by Alalade and Adeneye, 2006 and Ojedapo *et al*., 2014. There were significant difference ($p<0.05$) in the proximate composition measured over fifteen days (Tables 1, 2 and 3). It was observed that the moisture contents of the samples ranged from (39.96% to 54.55%), protein contents (16.80% to 28.90%), fat (11.08% to 21.90%), ash contents (0.56% to 5.04%), and carbohydrates (3.98% to 13.96%). The results obtained were similar to that reported by Omotosho *et al.*, (2011). It was equally observed that the ash contents of the

samples were similar to that reported by Augustine *et al*., (2014), where ash content of the cheese was said to be around 2.0%. The low ash content may be due to loss of mineral during the storage period; similar to the report of Ashaye *et al*., 2006.

The rate of deterioration observed in the samples could be attributed to lack of standard method of production being used by the local producers, environmental influence and lack of good hygienic practices (Adetunji, 2011; Adetunji *et al*., 2008). Sample sourced from Tanke area of Ilorin had the highest protein content of 28.90%, while sample sourced from Aroje area of Ogbomoso had the least protein (24.60%) on day one of the analysis. However, samples sourced from Asa dam area of Ilorin and Taki area of ogbomoso had the least protein content after the fifteen day of storage.

It was noticed that no single sample sourced from an area had the best quality overall, which could be attributed to many factors ranging from cow's variety, feeding habit, age of the animal, condition during milking, time of milking and many more.

According to FAO, 2003, the moisture and milk fat play active role in the quality of cheeses. Loss of fat, protein and ash contents during storage could make the cheese lose its firmness, flavour and texture, and in this case, a gradual loss was experienced when compared to fresh wara (local cheese) samples. Compared to fresh wara (local cheese) samples, fried samples had less moisture content, which was not favourable for the growth of microorganism, as reported by Belewu *et al*., 2005 for fresh cheeses.

Also, the high fat content of the fried *wara* (local cheese) was as a result of the vegetable oil used in frying the cheeses.

Table 1: Proximate Composition of Fresh Cheese Sample in (%) on Day One

Sample	Moisture	Fat	Protein	Ash	Carbohydrate	Fibre
A	42.73 ± 0.01^{d}	21.90 ± 0.11^{a}	27.90 ± 0.20^{b}	3.49 ± 0.30^{c}	3.98 ± 0.35^{d}	___
B	44.25 ± 0.11^{c}	19.80 ± 0.01^{c}	25.90 ± 0.01^{d}	5.04 ± 0.01^{a}	5.01 ± 0.02^{d}	___
C	39.96 ± 0.00^{f}	21.50 ± 0.11^{a}	28.90 ± 0.02^{a}	3.65 ± 0.02^{c}	5.99 ± 0.02^{b}	___
D	40.43 ± 0.01^{e}	21.78 ± 0.40^{a}	26.90 ± 0.11^{c}	3.89 ± 0.01^{c}	7.00 ± 0.22^{a}	___
E	45.30 ± 0.10^{b}	19.90 ± 0.20^{c}	24.60 ± 0.02^{e}	4.15 ± 0.20^{b}	6.05 ± 0.23^{b}	___
F	45.01 ± 0.11^{b}	19.90 ± 0.20^{c}	24.90 ± 0.20^{e}	4.02 ± 0.11^{bc}	5.99 ± 0.05^{b}	___
G	44.91 ± 0.10^{bc}	20.11 ± 0.00^{b}	25.80 ± 0.02^{d}	4.21 ± 0.03^{b}	5.17 ± 0.05^{c}	___
H	46.00 ± 0.01^{a}	19.51 ±0.01^{c}	24.80 ± 0.10^{e}	3.69 ± 0.00^{c}	6.00 ± 0.00^{b}	___

Result in the same column with same alphabet were not significantly different ($p<0.05$).
Legend:**A**: Fresh Oja-Oba Sample (Ilorin); **B**: Fresh Asa dam sample (Ilorin); **C**: Fresh Tanke Sample (Ilorin); **D**: Fresh Kulende Sample (Ilorin); **E**: Fresh Ogbomoso Sample (Aroje); **F**: Fresh Ogbomoso Sample (Taki); **G**: Fresh Ogbomoso Sample (Owode) and; **H**: Fresh Ogbomoso Sample (Gambari).

Table 2: **Proximate Composition of Fresh Cheese Sample in (%) on Day Eight**

Sample	Moisture	Fat	Protein	Ash	Carbohydrate	Fibre
A	48.39 ± 0.00^{c}	18.57 ± 0.05^{a}	22.20 ± 0.12^{b}	1.94 ± 0.03^{e}	7.90 ± 0.11^{c}	___
B	50.76 ± 0.02^{a}	14.89 ± 0.03^{e}	20.60 ± 0.10^{d}	4.14 ± 0.01^{a}	9.71 ± 0.10^{a}	___
C	45.55 ± 0.01^{d}	16.04 ± 0.02^{d}	25.90 ± 0.03^{a}	2.55 ± 0.00^{d}	9.96 ± 0.02^{a}	___
D	44.00 ± 0.01^{e}	17.44 ± 0.02^{b}	25.80 ± 0.02^{a}	3.19 ± 0.04^{c}	9.57 ± 0.20^{a}	___
E	50.00 ± 0.01^{a}	16.13 ± 0.04^{cd}	20.70 ± 0.01^{d}	3.29 ± 0.01^{b}	9.88 ± 0.20^{a}	___
F	49.01 ± 0.02^{bc}	16.63 ± 0.22^{c}	21.10 ± 0.00^{c}	3.79 ± 0.02^{b}	9.47 ± 0.03^{b}	___
G	49.69 ± 0.02^{b}	15.98 ± 0.12^{d}	21.80 ± 0.03^{c}	3.14 ± 0.02^{c}	9.39 ± 0.10^{b}	___
H	50.00 ± 0.01^{a}	16.52 ±0.01^{c}	20.40 ± 0.03^{d}	3.29 ± 0.01^{b}	9.79 ± 0.15^{a}	___

Result in the same column with same alphabet were not significantly different ($p<0.05$).
Legend as in Table 1

Table 3: Proximate Composition of Fresh Cheese Sample in (%) on Day Fifteen

Sample	Moisture	Fat	Protein	Ash	Carbohydrate	Fibre
A	52.95 ± 1.01^{bc}	15.41 ± 0.11^{a}	18.20 ± 0.01^{c}	0.56± 0.00^{d}	12.88 ± 0.02^{b}	___
B	54.53 ± 0.200^{a}	13.15 ± 0.22^{c}	16.80 ± 0.00^{e}	3.64 ± 0.00^{a}	11.88 ± 0.03^{c}	___
C	51.00 ± 0.30^{c}	14.93 ± 0.20^{b}	20.70 ± 0.02^{a}	1.29 ± 0.00^{c}	12.08 ± 0.20^{c}	___
D	50.00 ± 0.30^{d}	15.56 ± 0.01^{a}	19.90 ± 0.01^{b}	1.75 ± 0.00^{c}	12.79 ± 0.10^{b}	___
E	53.00 ± 0.10^{b}	12.91 ± 0.20^{d}	17.90 ± 0.20^{d}	2.15 ± 0.00^{b}	13.96 ± 0.01^{a}	___
F	54.55 ± 0.21^{a}	13.12 ± 0.03^{c}	16.80 ± 0.00^{e}	2.19 ± 0.00^{b}	13.43 ± 0.10^{a}	___
G	53.39 ± 0.10^{b}	13.19 ± 0.02^{c}	18.50 ± 0.02^{c}	2.95 ± 0.00^{a}	11.97 ± 0.20^{c}	___
H	54.04 ± 0.11^{a}	11.08 ± 0.02^{e}	19.30 ± 0.22^{b}	1.79 ± 0.00^{c}	13.79 ± 0.22^{a}	___

Result in the same column with same alphabet were not significantly different ($p<0.05$).
Legend as in Table 1

Table 4: Total Bacteria Counts of the Cheese Samples (in Cfu/g)

Sample	Day 1	Day 8	Day 15	Day 22
A	NG	$1.0x10^{2}$	$2.1x10^{3}$	$4.1x10^{5}$
B	NG	NG	$1.4x10^{1}$	$3.6x10^{5}$
C	NG	$1.7x10^{1}$	$2.2x10^{3}$	$3.2x10^{4}$
D	NG	NG	$1.1x10^{2}$	$2.6x10^{4}$
E	NG	$1.9x10^{1}$	$3.0x10^{2}$	$4.0x10^{4}$
F	NG	$0.5x10^{2}$	$2.3x10^{2}$	$3.3x10^{5}$
G	NG	$1.1x10^{3}$	$2.1x10^{3}$	$3.4x10^{4}$
H	NG	NG	$5.4x10^{3}$	$4.4x10^{5}$

Legend as in Table 1; NG- No growth

Table 5: Total Fungal Counts of the Cheese Sample (in Cfu/g)

Sample	Day 1	Day 8	Day 15	Day 22
A	NG	$2.1x10^{1}$	$2.1x10^{2}$	$4.1x10^{4}$
B	NG	$0.2x10^{1}$	$2.2x10^{1}$	$3.6x10^{4}$
C	NG	$1.1x10^{1}$	$2.1x10^{2}$	$3.1x10^{4}$
D	NG	$1.3x10^{2}$	$3.3x10^{2}$	$4.4x10^{5}$
E	NG	$1.9x10^{1}$	$3.1x10^{2}$	$3.3x10^{3}$
F	NG	$0.2x10^{2}$	$2.4x10^{2}$	$4.2x10^{4}$
G	NG	$1.1x10^{2}$	$3.8x10^{2}$	$3.2x10^{4}$
H	NG	$0.1x10^{2}$	$3.6x10^{2}$	$6.1x10^{5}$

Legend as in Table 1; NG- No Growths

Microbial and fungal loads were noticed in the stored samples (Tables 4 and 5) from around the eighth day. There was no growth in all the samples until around the eighth day, where progressively increase in the microbial load were experienced, which could be due to favourable environmental conditions for their growth, as well as the reduction noticed in the nutritional content of the cheese samples over the period of storage. Also, the unhygienic nature or practices of the local producers and/or hawkers could have equally contributed to the high microbial load recorded over the period, as well as lack or absence of a known preservative.

As the storage period progresses, environmental and other conditions began to be favourable for the growth of microorganism (comprising bacteria and fungi), which led to the reduction in the shelf life of the samples, and equally causes the loss of flavour, texture and firmness of the local cheese.

Sample from Gambari area of Ogbomoso had the highest microbial load after 22 days with 4.4 X 10^{5}CFU/g, while sample from Kulende area of Ilorin had the lowest (2.6 X 10^{4}). For the fungal growth, sample from Gambari area of Ogbomoso equally had the highest fungal growth of 6.1 X 10^{5}CFU/g, while sample sourced from Aroje area of Ogbomoso (3.3 X 10^{3}) had the lowest. These recorded values were similar to that reported by Oladipo and Jadesimi, 2013 though for fresh cheese samples. The high fungal growth could be due to favourable environmental condition (pH) (Ledenbach and Marshall, 2009).

Table 6: Isolated and identified Organisms from the Cheese Samples

Organism Isolated/Samples	A	B	C	D	E	F	G	H
Klebsiella specie	-	+	+	+	+	-	+	+
Salmonella specie	+	-	+	+	-	+	+	+
Lactobacillus acidophilus	+	+	+	+	+	-	-	+
Escherichia coli	-	-	-	-	-	-	-	-
**Aspergillus niger*	+	+	+	+	+	+	+	+
**Aspergillus flavus*	+	+	+	+	+	+	+	+
**Rhizopus species*	+	-	+	-	+	+	+	-

Legend as in table 1; *****Fungi species; + (present); - (absent)

Having considered the shortcomings, the presence of pathogenic organisms in the hawked samples was then investigated. Table 6 gave the organisms that were isolated from the samples. Organisms isolated from the samples include *Aspergillus niger, Aspergillus flavus, Rhizopus species, Salmonella species, Lactobacillus acidophilus*, and *Klebsiella species*.

As a result of the organisms isolated, it could be deduced that some of the local cheese (*wara*) samples could have been contaminated. The contamination could be due to unhygienic condition under which the local cheeses were produced or unsterilized nature of the equipment and materials (Adetunji *et al*., 2007), as well as favourable environmental conditions during the period of storage (Adetunji *et al*., 2003). The contamination could have equally come from the sourcing of the raw milk or its sources, which may have been contaminated (Ibrahim and Falegan, 2013), though this may be less likely, as the cheeses passed through oil at over 100^{o}C.

4. CONCLUSION

It could be concluded that the reduction in the nutritional value of the samples could be due to the progressive increase noticed in the microbial load, most especially, after about eight days. The high microbial load could have been caused by the favourable condition under which the samples were stored. All the shortcomings noticed could be traced to the behavioural lifestyle of the processors, hawkers and/or other handlers who may have handled the product un-hygienically. The health of consumers of hawked cheeses is at risk, as a result of the unsafe nature of the hawked cheeses, most especially, if the cheese was not purchased and consumed on the day of production. I will propose proper awareness and training for the producers of the local cheeses in the various developing nations (Nigeria inclusive) so that the health of the various consumers can be protected.

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