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# A COMPARATIVE STUDY ON THE NUTRITIONAL AND MICROBIAL SAFETY OF FRESH 'WARA' HAWKED IN ILORIN AND OGBOMOSO TOWNS

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**Abstract:** Malnutrition resulting from low protein intake is one of the nutritional problems facing most developing countries including Nigeria. Most proteinaceous food sources are costly and in short supply. 'Wara' is a proteinaceous ready to eat food product made by curdling milk. It does not normally undergo any further safety treatments before consumption. Frequent hawking on our major streets and roads calls for determination of the safety of these products. 'Wara' samples sourced from four different locations each at Ilorin, Kwara State and at Ogbomoso, Oyo State respectively, were analysed for nutritional and microbial safety. Proximate composition of the samples over the period of storage showed that moisture content and carbohydrates increased from 59.69% to 72.00% and from 2.39% to 11.39% respectively, while protein, fat and ash contents reduced from 22.20% to 10.80%, 15.80% to 3.62% and from 2.99% to 0.25%, respectively. Microbial and fungal counts ranged from 2.0 X $10^2$cfu to 6.3 X $10^5$cfu and from 2.0 X $10^2$cfu to 7.1 X $10^5$ cfu, respectively. *Klebsiella*and *Salmonella species*, *Escherichia coli* and some fungiwere isolated. The study revealed that some of the hawked cheeses were not safe for consumption. Attributable reasons were unhygienic practices of the hawkers or producers and/or lack of requisite preservatives.

**Key words:** 'wara', quality, safety, hawking, preservation, pathogens.

## 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 etc. In modern times, ready to eat food is usually supplied by food industries (Jango-cohen, 2005).

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Animals are used as food either directly or indirectly, mostly after processing. Animal foods include milk, which is obtained from the mammary glands of mammals, e.g. cow milk, which in many cultures is drunk or processed into various other dairy products (Curry, 2013). Livestock farming in general and milk production in particular still play an important socio-economic role in many developing countries, Nigeria inclusive. In Nigeria, the Fulani pastoralists process their surplus fresh milk into various products like 'warankasi', 'nono' (fermented skimmed milk) and 'mai-shani' (meaning milk fat in the Hausa language) (Belewu et al., 2005; Ashaye et al., 2006). Milk, an extremely nutritious food, is a good source of rich nutrients and an excellent medium for microbial growth (Akinyele et al., 1999; Adesokan et al., 2009; Sangoyomi et al., 2010), hence a highly perishable commodity.

Cheese, on its own, is a concentrated dairy commodity produced by acid or rennet coagulation or curdling of milk, stirring and heating of 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 cheese called 'wogachi' is made in Northern provinces of Benin Republic, a French speaking country, to the western part of Nigeria. The Fulanis of northern Nigeria are traditionally cattle rearers and have access to fresh milk. 'Wara' cheese making is thought to have started in the Northern region and as a result of their nomadic lifestyle, and this lifestyle has spread to other parts of Nigeria, such as Kwara, Oyo, and Ondo States (Bamidele, 2006), and according to FDA (2003), two criteria, moisture and the milk fat contents, were used to define cheeses.

Cheese can be classified into two groups depending on raw material, texture, type, interior or exterior characteristics, and composition. Cheese flavour and texture are overwhelmed by fatty acid composition of milk 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 cheese found in Nigeria is believed to normally have a shelf life of around 2 days when immersed in its whey, because of its fresh nature and how it has been handled. 'Wara' has a relatively short shelf life due to the presence of some food borne microbial flora comprising bacteria and fungi (Belewuet al., 2005).

Various preservation methods used for the preservation of cheese have been well documented (Aworh and Egounlety, 1985). Joseph and Akinyosoye (1997), in their report, used 0.8% propionic acid and 0.8% sodium benzoate to preserve cheese for 8 days. Cheese is equally an excellent source of protein, fat and minerals such as calcium, iron and phosphorus, vitamins and essential amino acids, and, therefore, is an important food in the diet of both young and old people (Tona et al., 2013).

Local cheeses are hawked in almost all the major streets of the states in Nigeria, mainly by the Fulani tribes. Previous research reported that hygienic standards in the preparation of locally fermented cereal and dairy foods are very poor (Omemu and Aderoju, 2008; Olasupo et al., 2002). For example, Olasupo et al. (2002) isolated *Staphylococcus aureus* and *Klebsiella species* from 'wara',while *Escherichia coli, Salmonella* and *Klebsiella species* were isolated from 'nono', a fermented milk product. Cheese is highly perishable and must be handled properly for extended shelf life. Hence, in this study, the safety of the cheeses hawked in Ilorin town, Kwara State and Ogbomoso town, Oyo State was determined.

## Materials and Methods

Cheese samples were obtained from the northern, southern, western and eastern parts of both Ilorin and Ogbomoso towns directly from the local producers. The samples were collected aseptically immediately after production into a clean white covered container and conveyed to the laboratory for immediate analyses.

The 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 established methods of Fawole and Oso (2007).

## Results and Discussion

Physical properties of stored cheese samples

The collected cheese samples were analysed over a 7-day storage period. During this period, it was observed that the cheese samples developed a bad odour, loss of curd by the fresh samples, i.e. the fresh cheeses were no longer firm, they were out of shape and became slippery. These observations suggest degradation in some quality parameters, as a result of microorganisms and/or enzymes naturally present in the cheese samples. The changes noticed started manifesting prominently from the third day of storage.

Proximate composition of stored cheese samples

There was a significant difference ($p<0.05$) in the proximate composition of the cheese measured over five days (Tables 1, 2 and 3). Moisture and carbohydrate contents of the cheese were increasing during storage. But the protein, fat and ash contents were decreasing accordingly. This scenario signifies a reduction in the nutrients as the storage period progresses. According to FAO (2003), the moisture and milk fat play an active role in the quality of cheeses. The loss of fat, protein and ash contents during storage could have made the cheese lose its firmness,

flavour and texture. The increase in the moisture content could have supported the fact stated earlier, that is, an increase in the microbial activities eventually leads to nutrient loss and reduction in consumer acceptance. High moisture content creates a favourable environment for the growth of microorganisms (Belewu et al., 2005).

Table 1. Proximate composition of fresh cheese samples in (%) on day one.

| Sample | Moisture | Fat | Protein | Ash | Carbohydrate |
|---|---|---|---|---|---|
| A | 64.00±0.00$^{b}$ | 9.26±0.01$^{g}$ | 21.80±0.00$^{b}$ | 1. 89±0.00$^{c}$ | 3.05±0.05 |
| B | 67.01±0.01$^{a}$ | 9.20 ±0.00$^{g}$ | 19.80± 0.00$^{d}$ | 1.59 ±0.00$^{c}$ | 2.40±0.00$^{d}$ |
| C | 59.99±0.00$^{f}$ | 9.90±0.01$^{f}$ | 22.00±0.00$^{a}$ | 2.00 ±0.00$^{b}$ | 6.11±0.00$^{a}$ |
| D | 60.01±0.01$^{e}$ | 15.80±0.00$^{a}$ | 20.20±0.01$^{c}$ | 1.60±0.00$^{e}$ | 2.39±0.01$^{d}$ |
| E | 62.00±0.00$^{c}$ | 10.62±0.00$^{e}$ | 21.60± 0.00$^{b}$ | 1.78±0.00$^{d}$ | 4.00±0.00$^{c}$ |
| F | 60.01 ±0.01$^{e}$ | 11.10±0.00$^{d}$ | 22.20±0.00$^{a}$ | 1.74±0.00$^{d}$ | 4.95±0.05$^{b}$ |
| G | 61.79 ±0.00$^{d}$ | 11.67 ±0.00$^{b}$ | 19.90±0.00$^{d}$ | 1.69±0.00$^{e}$ | 4.95±0.05$^{b}$ |
| H | 59.69±0.01$^{f}$ | 11.63±0.00$^{c}$ | 20.70±0.00$^{c}$ | 2.99±0.00$^{a}$ | 4.99±0.00$^{b}$ |

Mean ± SD. Means with different superscripts along the column are significantly different ($p$<0.05).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 samples in (%) on day three.

| Sample | Moisture | Fat | Protein | Ash | Carbohydrate |
|---|---|---|---|---|---|
| A | 67.15±0.02$^{b}$ | 9.00±0.05$^{c}$ | 19.00±0.00$^{b}$ | 1.65±0.00$^{b}$ | 3.20±0.00$^{f}$ |
| B | 70.88±0.01$^{a}$ | 5.51±0.00$^{f}$ | 16.00±0.00$^{d}$ | 0.88±0.00$^{g}$ | 6.73±0.00$^{d}$ |
| C | 62.29±0.01$^{c}$ | 9.32±0.00$^{ab}$ | 19.70±0.00$^{a}$ | 1.45±0.00$^{d}$ | 7.24±0.00$^{b}$ |
| D | 64.79±0.00$^{e}$ | 9.30±0.00$^{ab}$ | 18.80±0.00$^{c}$ | 1.11±0.00$^{f}$ | 6.00±0.00$^{de}$ |
| E | 67.69±0.00$^{b}$ | 7.37±0.00$^{e}$ | 16.40±0.00$^{e}$ | 1.50±0.00$^{c}$ | 7.04±0.00$^{bc}$ |
| F | 64.00±0.00$^{d}$ | 8.70±0.00$^{d}$ | 18.60±0.00$^{c}$ | 1.29±0.00$^{e}$ | 7.41±0.00$^{b}$ |
| G | 66.89±0.00$^{c}$ | 9.99±0.00$^{a}$ | 15.70±0.00$^{e}$ | 1.42±0.00$^{d}$ | 6.00±0.00$^{de}$ |
| H | 63.27±0.00$^{f}$ | 9.96±0.00$^{a}$ | 16.60±0.00$^{d}$ | 2.02±0.00$^{a}$ | 8.15±0.05$^{a}$ |

Mean ± SD. Means with different superscripts along the column are significantly different ($p$<0.05).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).

The proximate composition of the cheese samples was similar to that reported by Alalade and Adeneye (2006) and Ojedapo et al. (2014). The rapid rate of deterioration observed in the samples could be attributed to lack of standardisation in the production methods being used by the local producers, environmental influence and lack of good hygienic practices (Adetunji, 2011; Adetunji et al., 2008). The sample sourced from Aroje area of Ogbomoso had the highest protein content of 22.20% of all the samples, while the sample sourced from Asa dam area of Ilorin had the least protein (19.80%). Regarding fat, the sample sourced from Kulende area of Ilorin had the highest content (15.80%), and the sample from Asa

dam, the least (9.20%). It was noticed that none of the sample sourced from a particular area had the best quality overall. This could be attributed to many factors ranging from cow's variety, feeding habits, age of the animal, condition of the animal during milking, time of milking, weather conditions, health status of the animals etc. that influence quality. The high moisture content noticed in all the samples could have been responsible for the less firmness of the cheese samples as compared to that of cheddar cheese, which normally ranges from between 33% and 36% (Smith, 1995; David, 2007).

Table 3. Proximate composition of fresh cheese samples in (%) on day five.

| Sample | Moisture | Fat | Protein | Ash | Carbohydrate |
|---|---|---|---|---|---|
| A | $71.09\pm0.01^{b}$ | $3.62\pm0.00^{f}$ | $14.00\pm0.00^{c}$ | $1.39\pm0.00^{a}$ | $9.90\pm0.00^{d}$ |
| B | $72.00\pm0.00^{a}$ | $3.85\pm0.00^{d}$ | $16.70\pm0.00^{b}$ | $0.31\pm0.00^{e}$ | $10.14\pm0.00^{f}$ |
| C | $68.48\pm0.00^{c}$ | $5.09\pm0.00^{c}$ | $16.90\pm0.00^{a}$ | $1.09\pm0.00^{c}$ | $8.44\pm0.00^{e}$ |
| D | $70.80\pm0.00^{c}$ | $5.75\pm0.00^{b}$ | $12.70\pm0.00^{d}$ | $0.25\pm0.00^{f}$ | $10.50\pm0.00^{c}$ |
| E | $71.00\pm0.00^{b}$ | $5.50\pm0.00^{b}$ | $11.30\pm0.00^{f}$ | $1.21\pm0.00^{b}$ | $10.99\pm0.01^{b}$ |
| F | $70.01\pm0.01^{c}$ | $3.77\pm0.00^{e}$ | $16.40\pm0.00^{b}$ | $0.75\pm0.00^{d}$ | $9.07\pm0.00^{d}$ |
| G | $71.00\pm0.00^{b}$ | $6.52\pm0.00^{a}$ | $10.80\pm0.00^{e}$ | $0.89\pm0.00^{d}$ | $10.79\pm0.00^{b}$ |
| H | $69.88\pm0.01^{f}$ | $5.88\pm0.00^{b}$ | $12.30\pm0.00^{d}$ | $0.55\pm0.00^{e}$ | $11.39\pm0.00^{a}$ |

Mean ± SD. Means with different superscripts along the column are significantly different ($p<0.05$).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).

Microbial population of stored cheese samples

There are significant differences among the samples for the bacterial and fungal counts (Tables 4 and 5), with high microbial loads noticed in the stored samples. All the samples showed a progressive increase in their microbial load over the period of storage. This could be attributed to the high moisture content of the samples, which invariably may have been favourable for the growth of microorganisms, the reduction rates and shorter shelf life noticed in the nutritional content of the cheese samples respectively. On day one, the microbial load of sample F was the highest, while that of sample A was the highest on day seven of storage (Table 4). For the fungal counts, samples A, B, D and E were significantly different from each other, and were with higher fungal loads, while sample A had the highest fungal load on day seven of storage (Table 5). The unhygienic nature or practices of the local producers and/or hawkers coupled with the high ambient temperature of the environment could have equally contributed to the high microbial load recorded. Lack or absence of a known preservative could have also contributed to the reduced shelf life. The reduction in the protein, fat and ash contents of the cheese samples (Tables 2 and 3) may be explained by the proliferation of the microorganisms (Tables 4 and 5), which may have fed on the

nutritional components. The increase in microbial population may have possibly contributed to the reduction in the shelf life of the samples, and the corresponding loss of flavour, texture and firmness. Previous studies similarly found significant reductions in the fatty acid composition of the milk, protein and ash contents of Africa soft cheese during storage (Belewu et al., 2005).

Table 4. Total bacteria counts of the cheese samples (in cfu/g).

| Sample | Day 1 | Day 3 | Day 5 | Day 7 |
|---|---|---|---|---|
| A | $2.2\pm2.0^{b}x10^{2}$ | $2.0\pm2.2^{a}x10^{4}$ | $5.1\pm3.1^{b}x10^{4}$ | $6.1\pm3.2^{a}x10^{5}$ |
| B | $2.0\pm1.3^{c}x10^{2}$ | $1.7\pm1.8^{b}x10^{4}$ | $4.4\pm2.4^{c}x10^{4}$ | $5.6\pm2.6^{c}x10^{5}$ |
| C | $2.1\pm1.7^{b}x10^{2}$ | $1.7\pm1.8^{b}x10^{4}$ | $4.2\pm2.3^{c}x10^{4}$ | $5.8\pm2.3^{c}x10^{5}$ |
| D | $2.1\pm1.7^{b}x10^{2}$ | $1.8\pm2.1^{b}x10^{4}$ | $4.9\pm2.2^{b}x10^{4}$ | $6.0\pm2.0^{b}x10^{5}$ |
| E | $2.2\pm2.0^{b}x10^{2}$ | $1.9\pm2.5^{b}x10^{4}$ | $5.0\pm2.9^{b}x10^{4}$ | $6.0\pm2.0^{b}x10^{5}$ |
| F | $2.4\pm2.1^{a}x10^{2}$ | $2.1\pm2.3^{a}x10^{4}$ | $5.3\pm2.8^{a}x10^{4}$ | $6.3\pm2.5^{a}x10^{5}$ |
| G | $2.0\pm1.3^{c}x10^{2}$ | $1.6\pm1.4^{c}x10^{4}$ | $5.1\pm3.1^{b}x10^{4}$ | $5.4\pm2.9^{c}x10^{5}$ |
| H | $1.8\pm2.1^{d}x10^{2}$ | $1.3\pm2.0^{d}x10^{4}$ | $5.4\pm3.0^{a}x10^{4}$ | $5.0\pm3.1^{d}x10^{5}$ |

Mean ± SD. Means with different superscripts along the column are significantly different ($p$<0.05). 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 5. Total fungal counts of the cheese samples (in cfu/g).

| Sample | Day 1 | Day 3 | Day 5 | Day 7 |
|---|---|---|---|---|
| A | $3.0\pm2.8^{a}x10^{2}$ | $2.6\pm1.4^{a}x10^{4}$ | $3.1\pm1.5^{b}x10^{4}$ | $7.1\pm2.4^{a}x10^{5}$ |
| B | $2.8\pm2.0^{a}x10^{2}$ | $1.7\pm1.1^{c}x10^{4}$ | $2.8\pm2.1^{c}x10^{4}$ | $6.2\pm2.5^{c}x10^{5}$ |
| C | $2.7\pm2.3^{b}x10^{2}$ | $1.7\pm1.1^{c}x10^{4}$ | $2.1\pm2.2^{e}x10^{4}$ | $6.0\pm2.3^{c}x10^{5}$ |
| D | $2.9\pm1.6^{a}x10^{2}$ | $1.8\pm1.7^{c}x10^{4}$ | $3.3\pm1.8^{b}x10^{4}$ | $6.1\pm1.6^{c}x10^{5}$ |
| E | $2.9\pm1.6^{a}x10^{2}$ | $1.9\pm2.1^{c}x10^{4}$ | $3.1\pm1.5^{b}x10^{4}$ | $6.3\pm1.2^{c}x10^{5}$ |
| F | $2.4\pm2.1^{c}x10^{2}$ | $2.2\pm2.0^{b}x10^{4}$ | $2.4\pm2.0^{d}x10^{4}$ | $6.7\pm1.8^{b}x10^{5}$ |
| G | $2.6\pm1.2^{b}x10^{2}$ | $1.6\pm1.2^{d}x10^{4}$ | $3.8\pm1.4^{a}x10^{4}$ | $5.9\pm2.0^{d}x10^{5}$ |
| H | $2.0\pm1.4^{d}x10^{2}$ | $1.1\pm1.3^{e}x10^{4}$ | $3.6\pm1.7^{a}x10^{4}$ | $5.2\pm2.1^{e}x10^{5}$ |

Mean ± SD. Means with different superscripts along the column are significantly different ($p$<0.05).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).

Microbial isolates from stored cheese samples

Having considered the shortcomings, the presence of pathogenic organisms in the hawked samples was investigated. Different types of organisms were isolated from the cheese samples (Table 6). Organisms such as *Escherichia coli* were noticed in three of the eight samples. Other organisms isolated from the samples include *Aspergillusniger*, *Aspergillusflavus*, *Rhizopus species*, *Salmonella species*, *Lactobacillus acidophilus*, and *Klebsiellaspecies*. The presence of these organisms

suggests that some of the 'wara' samples hawked on major streets in Ogbomoso and Ilorin towns may have been contaminated. The contamination noticed could be due to unhygienic conditions under which the cheeses were produced, or probably, the unsterilised nature of the equipment and materials (Adetunji et al., 2007). The contamination could have equally emanated from the raw milk or its sources, which may have been contaminated (Ibrahim and Falegan, 2013).

Table 6. Isolated and identified organisms from the cheese samples.

| Organism isolated\samples | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| *Klebsiella species* | - | + | + | + | + | - | + | + |
| *Salmonella species* | - | + | + | + | - | + | + | + |
| *Lactobacillus acidophilus* | + | + | + | + | + | - | - | + |
| *Escherichia coli* | + | - | - | - | - | - | + | + |
| *Aspergillusniger* | + | + | + | + | + | + | + | + |
| *Aspergillusflavus* | + | - | - | + | + | + | + | + |
| *Rhizopus species* | + | - | + | - | + | + | + | + |

Fungal species; + (present); - (absent). 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).

## Conclusion

Stored cheese samples showed a progressive reduction noticed in its nutritional value, which could be due to the progressive increase in the microbial load. The high microbial load could have been caused by the high moisture content and the action of the identified pathogenic organisms. All the shortcomings noticed could be traced to the behavioural lifestyle of the processors, hawkers and/or other handlers who may have handled the productor its raw materials in an unhygienic way. The health of consumers of the hawked cheeses is at risk, as a result of the unsafe nature of the hawked cheeses. The regulatory body saddled with the responsibility of overseeing the quality of food in the country should seriously look into the quality of local cheeses being hawked around.

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# KOMPARATIVNO ISTRAŽIVANJE HRANLJIVE VREDNOSTI I MIKROBIOLOŠKE BEZBEDNOSTI SVEŽEG SIRA "WARA" KORIŠĆENOG U GRADOVIMA ILORIN I OGBOMOSO

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R e z i m e

Neuhranjenost koja je rezultat niskog unosa proteina, jedan je od problema ishrane sa kojim se suočava većina zemalja u razvoju uključujući Nigeriju. Većina proteinskih izvora hrane je skupa i deficitarna. 'Wara' je proteinski prehrambeni proizvod gotov za upotrebu, koji se pravi podsirivanjem mleka. Pre upotrebe uglavnom ne podleže nikakvim daljim bezbednosnim tretmanima. Česta prodaja na našim glavnim ulicama i putevima zahteva određivanje bezbednosti ovih proizvoda. Uzorci sira 'wara' sa četiri različite lokacije u Ilorinu, državi Kvara odnosno u Ogbomosu, državi Ojo analizirani su radi provere hranljive vrednosti i mikrobiološke bezbednosti. Neposredni sastav uzoraka tokom perioda skladištenja pokazao je da su se sadržaj vlage i ugljeni hidrati povećali sa 59,69% na 72,00% odnosno sa 2,39% na 11,39%, dok su se sadržaji proteina, masti i pepela smanjili sa 22,20% na 10,80%, 15,80% na 3,62% odnosno sa 2,99% na 0,25%. Broj bakterija i gljiva kretao se od 2,0 X $10^2$cfu do 6,3 X $10^5$cfu odnosno od 2,0 X $10^2$cfu do 7,1 X $10^5$ cfu. Izolovane su vrste *Klebsiella* i *Salmonella*, *Escherichia coli* i neke gljive. Istraživanje je pokazalo da neki od korišćenih sireva nisu bezbedni za upotrebu. Navedeni razlozi su bili nehigijenska praksa trgovaca ili proizvodjača i/ili nedostatak potrebnih sredstava za zaštitu.

**Ključne reči:** 'wara', kvalitet, bezbednost, prodaja (na ulici), čuvanje, patogeni.

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