

Bacteriological Quality of Commercially Prepared Fermented Ogi (Akamu) Sold in Some Parts of South Eastern Nigeria

Alloysius C. Ogodo, Ositadinma C. Ugbogu, Uzochukwu G. Ekeleme

Abstract—Food poisoning and infection by bacteria are of public health significance to both developing and developed countries. Samples of ogi (akamu) prepared from white and yellow variety of maize sold in Uturu and Okigwe were analyzed together with the laboratory prepared ogi for bacterial quality using the standard microbiological methods. The analyses showed that both white and yellow variety had total bacterial counts (cfu/g) of 4.0×10^7 and 3.9×10^7 for the laboratory prepared ogi while the commercial ogi had 5.2×10^7 and 4.9×10^7 , 4.9×10^7 and 4.5×10^7 , 5.4×10^7 and 5.0×10^7 for Eke-Okigwe, Up-gate and Nkwo-Achara market respectively. The Staphylococcal counts ranged from 2.0×10^2 to 5.0×10^2 and 1.0×10^2 to 4.0×10^2 for the white and yellow variety from the different markets while Staphylococcal growth was not recorded on the laboratory prepared ogi. The laboratory prepared ogi had no Coliform growth while the commercially prepared ogi had counts of 0.5×10^3 to 1.6×10^3 for white variety and 0.3×10^3 to 1.1×10^3 for yellow variety respectively. The Lactic acid bacterial count of 3.5×10^6 and 3.0×10^6 was recorded for the laboratory ogi while the commercially prepared ogi ranged from 3.2×10^6 to 4.2×10^6 (white variety) and 3.0×10^6 to 3.9×10^6 (yellow). The presence of bacteria isolates from the commercial and laboratory fermented ogi showed that *Lactobacillus* sp, *Leuconostoc* sp and *Citrobacter* sp were present in all the samples, *Micrococcus* sp and *Klebsiella* sp were isolated from Eke-Okigwe and ABSU-up-gate markets varieties respectively, *E. coli* and *Staphylococcus* sp were present in Eke-Okigwe and Nkwo-Achara markets while *Salmonella* sp were isolated from the three markets. Hence, there are chances of contracting food borne diseases from commercially prepared ogi. Therefore, there is the need for sanitary measures in the production of fermented cereals so as to minimize the rate of food borne pathogens during processing and storage.

Keywords—Bacterial quality, fermentation, maize, Ogi.

I. INTRODUCTION

Ogi (akamu) is a product of fermented maize (*Zea mays*) widely eaten in Africa [1], [2]. Similar maize preparations in Ghana are referred to as “Akana” or “Kenkey”. Ogi is often marketed as a wet cake formerly wrapped in leaves but presently in transparent polythene bags. Gelatinized Ogi (a porridge) called “pap” is mainly used as a breakfast

meal for adults and weaning food for infants especially by low income earners who cannot afford the more expensive imported weaning foods [2], [3].

Pap meal is served in Nigeria as a weaning food for infants (1-3 year old) and a morning breakfast food for children and adults. Most preparation of pap meal is from cereals, namely, maize, guinea corn or millet readily available in all parts of the country. These cereals have similar chemical compositions of carbohydrates (68-88%), protein (9-15%), fat (3-5%) and vitamin B, range 0.45-0.6mg/100g [3]. In the tropics, food poisoning is common and is among the major causes of death among children. In Nigeria alone, from 1971-76, there were 2.5 million reported cases of food-borne infection and in Lagos alone, from 1971-75 there were 53260 reported deaths of which 6900 originated from food-borne diseases and 66.6% of which were children under 5 years [3].

In most parts of Africa especially in Nigeria, children are fed with mashed adult foods. These foods are bulky and this therefore reduces food intake by a child, often resulting in malnutrition. The development of nutritionally balanced calorie dense, low bulk and easily digestible weaning food becomes mandatory. This involves the use of simple but time consuming traditional fermentation technology [4]. The traditional fermentation method employed in Ogi production is a wild process and microorganisms are not controlled. Microbiological analyses have shown the presence of several genera of bacteria, moulds and yeasts in the fermented maize product- Ogi [5], [6].

The traditional production of wet flour paste (pap) used for the preparation of different cereal dishes (from diverse cereal grains) variously called ogi or eko or akamu, in local parlance, dates back to the medieval times. In Nigeria, the production process of the wet flour paste, a staple food mostly consumed by children in rural communities and also by adults even in the metropolis, requires the use of water which is often not pure because of the high risk of environmental pollution. An estimated 4 billion cases of diarrhoeal disease associated with dirty water usage occur every year worldwide, causing 3 million to 4 million deaths, mostly among children [7]. Although the traditional method of producing wet paste gives that unique fermented taste for which the product is known and loved, preliminary studies have shown that the processing and wet storage methods of this prepared paste permit microbial growth including pathogens. Furthermore, not only is the storage cumbersome, which involves daily changing of the water used for storing the wet flour paste, but also very

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unreliable because of the prevalent electric power failures in Nigeria [7].

Fermentation process serves as a mean of providing a source of nourishment for large rural populations. Fermentation enhances the nutrient content of foods through the synthesis of proteins, vitamin, and essential amino acids [8]. Pap (akamu) is a porridge prepared from fermented maize. It is a popular breakfast cereal and infant weaning food among the Igbo – speaking people of Nigeria. Akamu is similar to ogi, a lactic acid fermented food made from maize, sorghum or millet which may be fortified with legumes [9]-[11].

Akamu is prepared by soaking clean maize grains in water for 2-3 days. The grains are washed and ground to a paste. The paste is sieved to smooth slurry which is allowed to settle and the supernatant decanted. The slurry is mixed with hot water with stirring until it forms a gel which serves as food. Fermented foods have become a major source of diarrhoeal diseases [12], [13] reported that maize porridge samples prepared for infants in Ghana were contaminated with pathogenic bacteria including *Aeromonas*, *Bacillus cereus*, *Salmonella*, *Staphylococcus aureus* and *Vibrio cholerae*.

Ogi is fairly acidic (pH 4.8), which tends to inhibit the growth of some bacteria. Its spoilage however, is enhanced by some extrinsic factors amongst which are storage temperature. Extension of the shelf life of Ogi is carried out using various techniques, which include refrigeration, freezing and drying (dehydration) to reduce the microbial load and consequently spoilage [2].

The microbiology of many of these products is quite complex and unexploited. In most of these products the fermentation is natural and involves mixed cultures of yeasts, bacteria and fungi. Some microorganisms may participate in parallel, while others act in a sequential manner with a changing dominant biota during the course of fermentation. The common fermenting bacteria are species of *Leuconostoc*, *Lactobacillus*, *Streptococcus*, *Pediococcus*, *Micrococcus* and *Bacillus*. The fungal genera are mainly representatives of *Aspergillus*, *Paecilomyces*, *Cladosporium*, *Fusarium*, *Penicillium* and *Trichothecium* whereas the most common fermenting yeast species is *Saccharomyces*, which contributes to alcoholic fermentation [14]. Yeasts have been reported to be involved in several different types of indigenous fermented foods and beverages [15]-[20]. The most dominant yeast species associated with African indigenous fermented foods and beverages is *Saccharomyces cerevisiae* [21]. Therefore, the aim of this study is to compare the bacteriological qualities of commercially and laboratory based fermented ogi (akamu) prepared from maize.

II. MATERIALS AND METHODS

A. Source of Materials

Grains of white and yellow varieties of maize (*Zea mays* Linn.) was procured in appropriate quantities from Eke-Okigwe market, Imo State, Nigeria and used for the study. Pap (Akamu) was purchased from Eke-Okigwe market, ABSU-Upgate market and nkwo-Achara market. The Ogi (Akamu)

was wrapped in a clean polyethene bag to avoid further contamination and was taken to the Microbiology Laboratory of Abia State University, Uturu within two hours of collection for bacteriological analysis.

B. Processing of Ogi (Akamu)

The method described by [22] was used for the processing of Ogi. The maize was sorted, cleaned and steeped in water for 72 hours. The softened corn was washed and ground in a mechanized mill. The ground materials was rinsed with water and passed through a sieve (muslin cloth) to remove parts of the hull. The filtrate almost pure starch was placed in pots of water to settle and was covered up completely for laboratory analysis.

C. Bacterial Analysis

The samples (purchased ogi) were subjected to bacteriological analysis to determine their sanitary state. The laboratory prepared wet pastes ogi that served as control was also analyzed bacteriologically for comparison. Exactly 1g of each ogi (Akamu) sample was added to 9.0 mls of sterile physiological saline in a test tube and ten-fold serial dilutions were made. Then 0.2 ml was aseptically transferred to plates of Nutrient Agar, Mannitol Salt Agar, MacConkey Agar and MRS Agar and was spread using a sterile bent glass rod. The culture plates were incubated at 37°C for 24hrs with the exception of MRS which was incubated for 24-72 hrs. At the end of the incubation, the plates were examined for bacterial growth and counted.

On establishment of growth, each cultured plate was examined closely for the presence of distinct colonies from which inocula were taken and sub-cultured in fresh sterile medium. The subcultures were incubated at 37°C for 24-48h and observed for pure cultures. The pure cultures obtained above were identified using a four step characterization process reported by [23], [24].

III. RESULT

The present study was carried out to evaluate the bacteria quality of ogi (akamu) prepared from maize. This was achieved by comparing the laboratory prepared ogi with the commercial purchased ones. The bacterial loads of the laboratory prepared white and yellow variety of pap showed total bacterial growth (CFU/g) of 4.0×10^7 and 3.9×10^7 respectively. No Staphylococci and Coliform growth, while Lactic acid bacterial load of 3.5×10^6 and 3.0×10^6 was recorded respectively (Table I).

The commercial purchased white variety of ogi from the markets (Eke-Okigwe, ABSU Up-gate and Nkwo-Achara) showed total bacterial growth of 5.2×10^7 , 4.9×10^7 and 5.4×10^7 respectively. The Staphylococci growth count of 3.0×10^2 , 2.0×10^2 and 5.0×10^2 respectively, while the Coliform count of 1.0×10^3 , 0.5×10^3 and 1.6×10^3 and the Lactic acid bacterial loads of 4.0×10^6 , 3.2×10^6 and 4.2×10^6 respectively (Table II).

The commercial yellow variety of ogi from the markets (Eke-Okigwe, ABSU Up-gate and Nkwo-Achara) showed

total bacterial growth of 4.9×10^7 , 4.5×10^7 and 5.0×10^7 respectively. The Staphylococci growth count of 2.0×10^2 , 1.0×10^2 and 4.0×10^2 respectively, while the Coliform count of 0.8×10^3 , 0.3×10^3 and 1.1×10^3 and the Lactic acid bacterial loads of 3.5×10^6 , 3.0×10^6 and 3.9×10^6 respectively (Table III).

TABLE I

BACTERIAL LOADS OF LABORATORY PREPARED WHITE AND YELLOW VARIETY OF OGI (AKAMU)

| Growth medium | White variety (cfu/g) | Yellow variety (cfu/g) |
|--------------------|-----------------------|------------------------|
| Nutrient agar | 4.0×10^7 | 3.9×10^7 |
| Mannitol salt agar | NBG | NBG |
| MacConkey agar | NBG | NBG |
| M. R. S | 3.5×10^6 | 3.0×10^6 |

MRS= De Man, Rogosa and Sharpe Agar, NBG = No bacterial growth; CFU/g= Colony forming unit per gram.

TABLE II

BACTERIAL LOADS OF COMMERCIAL PREPARED WHITE VARIETY OF OGI (AKAMU) PURCHASED FROM DIFFERENT MARKETS

| Growth medium | Eke-Okigwe (cfu/g) | ABSU up-gate (cfu/g) | Nkwo-Achara (cfu/g) |
|--------------------|--------------------|----------------------|---------------------|
| Nutrient agar | 5.2×10^7 | 4.9×10^7 | 5.4×10^7 |
| Mannitol salt agar | 3.0×10^2 | 2.0×10^2 | 5.0×10^2 |
| MacConkey agar | 1.0×10^3 | 0.5×10^3 | 1.6×10^3 |
| M. R. S | 4.0×10^6 | 3.2×10^6 | 4.2×10^6 |

MRS= De Man, Rogosa and Sharpe Agar; CFU/g= Colony forming unit per gram.

TABLE III

BACTERIAL LOADS OF COMMERCIAL PREPARED YELLOW VARIETY OF OGI (AKAMU) PURCHASED FROM DIFFERENT MARKETS

| Growth medium | Eke-Okigwe (cfu/g) | ABSU up-gate (cfu/g) | Nkwo-Achara (cfu/g) |
|--------------------|--------------------|----------------------|---------------------|
| Nutrient agar | 4.9×10^7 | 4.5×10^7 | 5.0×10^7 |
| Mannitol salt agar | 2.0×10^2 | 1.0×10^2 | 4.0×10^2 |
| MacConkey agar | 0.8×10^3 | 0.3×10^3 | 1.1×10^3 |
| M. R. S | 3.5×10^6 | 3.0×10^6 | 3.9×10^6 |

MRS= De Man, Rogosa and Sharpe Agar; CFU/g= Colony forming unit per gram.

TABLE IV

OCCURRENCE OF THE BACTERIAL ISOLATES ON COMMERCIAL AND LABORATORY FERMENTED OGI (AKAMU)

| Organism | Eke-Okigwe | ABSU up-gate | Nkwo-Achara | Lab. |
|-------------------------------|------------|--------------|-------------|------|
| <i>Lactobacillus</i> species | + | + | + | + |
| <i>Leuconostoc</i> species | + | + | + | + |
| <i>Micrococcus</i> species | + | - | - | - |
| <i>Salmonella</i> species | + | + | + | - |
| <i>E. coli</i> | + | - | + | - |
| <i>Citrobacter</i> species | + | + | + | + |
| <i>Klebsiella</i> species | - | + | - | - |
| <i>Staphylococcus</i> species | + | - | + | - |

+ = Positive, - = Negative

The bacteria isolated from the commercial and laboratory fermented ogi were *Lactobacillus* species, *Staphylococcus* species, *Leuconostoc* species, *Micrococcus* species, *Salmonella* species, *E. coli*, *Citrobacter* species and *Klebsiella* species. *Lactobacillus* species, *Leuconostoc* species and *Citrobacter* species were present in all the samples,

Micrococcus species and *Klebsiella* species were isolated from Eke-Okigwe and ABSU-up-gate markets varieties respectively, *E. coli* and *Staphylococcus* species were present in Eke-Okigwe and Nkwo-Achara markets while *Salmonella* species were isolated from the three markets (Table IV).

IV. DISCUSSION

The total bacterial counts taken for both samples of the laboratory prepared ogi (akamu) were found to be higher in the white variety of pap than that of the yellow variety. Hence, the lactic acid bacteria counts were also higher in white variety (3.5×10^6 cfu/g) than the yellow variety of ogi (3.0×10^6 cfu/g). However, no Staphylococci growth and Coliform growth was recorded. This shows that the ogi were aseptically prepared starting from the raw materials to the finished product. This is in accordance with [25] who assayed for the microbial quality of ogi prepared in the laboratory and isolated mostly Lactic acid bacteria and some non-pathogenic microorganisms. The higher counts of the white variety of the ogi in-respect to the yellow variety could be as a result of differences in their inherent properties as stated by [25].

The microbial counts of the commercially purchased ogi from the markets (Eke-Okigwe, ABSU Up-gate and Nkwo-Achara) were significantly high. The white and yellow variety of the ogi purchased from ABSU up-gate market had lesser bacterial count when compared with the other markets (Eke-Okigwe and Nkwo-Achara). The high bacterial counts found in this study might be due to microorganisms already present on the cereal grains from which the ogi was obtained, the milling method and machine. These organisms now continue to multiply in the product. The presence of the high bacterial counts generally shows food processor information regarding raw materials, processing conditions, storage conditions and handling products [26].

The bacteria isolated from the commercial and laboratory fermented pap were *Lactobacillus* species, *Staphylococcus* species, *Leuconostoc* species, *Micrococcus* species, *Salmonella* species, *E. coli*, *Citrobacter* species and *Klebsiella* species. *Lactobacillus* species, *Leuconostoc* species and *Citrobacter* species were present in all the samples, *Micrococcus* species and *Klebsiella* species were isolated from Eke-Okigwe and ABSU-up-gate markets varieties respectively, *E. coli* and *Staphylococcus* species were present in Eke-Okigwe and Nkwo-Achara markets while *Salmonella* species were isolated from the three markets. No pathogenic bacteria was isolated from the laboratory Prepared ogi (Akamu). However, the presence of pathogenic organisms (*Escherichia coli*, *Salmonella* species, *Klebsiella* species, *Micrococcus* species) observed in the commercial ogi could be attributed directly to the unhygienic state of the environment, preparation, storage, contamination of water samples used to prepare the ogi (akamu) or as a result of the exposure during sales of the ogi in the various markets which may not be unconnected with the high human activities. This study is in line with [3] who studied the microbial quality of ogi prepared from cereals, maize sold in Bauchi markets, Nigeria and isolated *Klebsiella*, *Staphylococci*, *Lactobacillus* and *E. coli*

bacteria. The contamination of the commercially available ogi could be from poor water quality and poor handling.

V. CONCLUSION

This study has shown that the chances of contracting food borne diseases from commercially prepared ogi (akamu) are very high. Therefore, there is need for sanitary measures to be taken in the production of fermented cereals so as to minimize the rate of contamination during processing and storage.

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