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Microbiological and Physiochemical Assessment of Corn Meal (Agidi)

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ABSTRACT

Corn meal (Agidi) is a gel-like traditional fermented starchy food item produced from maize, although millet and sorghum can also serve as raw materials. It is known by different names in different localities. A total of 30 corn meal (Agidi) from different sellers from various communities and comprising of 15 white and 15 jollof agidi samples from Choba market in Port Harcourt Rivers State were examined and analyzed using standard microbial techniques. The Total Bacteria count for white (plain) Agidi ranged of 6.30 - 8.06 logcfu/g. The Staphylococci count for White Agidi samples ranged of 6.0 – 8.2 logcfu/g. The Coliform count ranged of 6.00- 7.96 logcfu/g. The results generated from this study exceeded the permissible limit for bacteria in food. Bacteria isolated from White agidi include Staphylococcus spp (31.58%) and Enterococcus sp (21.05%). Bacillus sp, (18.42%), Escherichia coli (15.75%) and Klebsiella sp (10.53%). Pseudomonas sp (2.63%). For jollof agidi, the bacterial isolated Staphylococcus spp (30.8%) Bacillus spp (24.6%). Enterococcus sp (20.0%), Escherichia coli (12.3%), Klebsiella sp 7(10.8%) and Pseudomonas sp (1.5%). pH of corn meal ranged from 4 – 6, the moisture content ranged from 80% – 90%, while the titratable acidity ranged of 0.20 – 0.40. Proper handling of agidi during production must be taken.

1. INTRODUCTION

Fermentation is one of the oldest, most typical, and most economical methods of processing and preserving foods [1]–[4]. This can also help to maintain against the surge of aflatoxin [5]. Aflatoxins are toxic compounds produced by molds, particularly from species such as Aspergillus flavus, which can contaminate a wide range of food products [6]–[8]. Fermented cereal-based food products produced in African countries can be classified based on either the raw cereal ingredient used in their preparation or the texture of the fermented product [9][10]. Classification based on raw cereals ingredients includes Wheat-based foods, e.g., Bouza, kishk; Rice-based food, e.g., Buza; Maize-based foods, e.g., ogi (agidi), kenkey; Millet-based food, e.g., kunuzaki; Sorghum-based foods, e.g., pito, bogobe, kisra, burukutu, injera. Classification based on food texture includes Liquid (gruel), e.g., ogi, mahewu, burukutu, pito, and Uji, Solid (dough) and dumplings, e.g., kenkey, agidi, and Dry (bread), e.g., kisra, injera. Maize is one of the principal food sources in Africa and South America, more than in the developed world. Cereal consumption was estimated to be more than 100kg per year inhabitant. Recently, an increase in the consumption of maize has been noticed due to an increased population. The introduction of foreign `high- tech' processing concepts and food products like wheat bread, wheat-based, milk-based weaning foods, yogurt, and larger beer to tropical countries was followed by a rapidly increasing demand during the early post-independence period, these expensive products provided status [11]–[15].

Corn meal (Agidi) is a gel-like traditional fermented starchy food item produced from maize (Zea mays), although millet and sorghum can also serve as raw materials [16][17]. Its colour depends on the cereal used. It is cream to glassy white from maize, light brown from sorghum, and grey to greenish colour from millet [18][19]. It is known by different names in different localities, such as eko (Yoruba), akasan (Benin), komu (Hausa), and agidi (Ibo)[20].

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It is becoming very popular with acceptability cutting across the various multi-ethnic groups and socioeconomic classes. The ease of consumption, alone or with soup, stew, bean cake (akara), or moi-moi, as a light meal, especially amongst post-operative patients and other hospital patients, makes it very popular. Corn meal (Agidi) has economic potential, especially now that the emphasis is on developing local foods [21][22]. Production of Corn meal (Agidi) is laborious, cumbersome, and time consuming. Currently, it varies from one locality to another, resulting in a non-uniform product, non-specified quality indices, unknown shelf life, and lack of safety indices (thus limiting product acceptability to immediate locality [23][24].

Corn meal (Agidi) is typical to the western people of Nigeria. It can be eaten by dissolving it in cold water containing milk on a hot afternoon or eating it with stew or vegetables. Agidi has economic potential, especially now that the emphasis is on developing local foods [25]. Traditionally, agidi can be produced first by washing and steeping the maize grains in clean water for 2 or 3 days [10][26]. The softened grains are then wet-milled into a fine slurry, which is subsequently sieved using a muslin cloth. The resulting pomace is discarded while the sieve is allowed to settle in a plastic bucket and ferment for 2 to 3 days. The starch paste is called ogi. In addition to water, the boiled and cooked ogi, with continuous stirring, gives a stiff gel known as agidi. The resulting agidi is wrapped and cooled before serving (Figure 1). Despite the advancement of science and technology in Africa, fermented foods, including agidi ones, are still primarily produced using traditional techniques [27]-[30]. These crude forms of processing encourage high microbial contamination, which at times could lead to contamination by spoilage and pathogenic microorganisms [31]-[33].

Most students, especially University of Pot Harcourt Campus students, do not prepare corn meal (Agidi) food themselves. This demand for food allows the hawkers and vendors to serve as major vending sites where students can purchase food daily. Therefore, this work was designed to examine the microbiological quality of cornmeal (Agidi) at the University of Port Harcourt to determine whether this food meets permissible microbiological standards and specifications. This study aims to determine the microbial and physiochemical quality of white and Jollof corn meal (Agidi) in Port Harcourt.

2. MATERIALS AND METHOD

2.1. Description of Study Area

The study was conducted within and around Choba and Rivers State University campus in Port Harcourt, Rivers State. The choice of both locations is associated with the population, including students and staff of host tertiary institutions around these study areas.

2.2. Sample Collection

A total of 30 samples from different vendors of Corn meal (Agidi) were purchased randomly. Comprising of 15 white corn meal and 15 jollof corn meal. The samples were transported to the Food Microbiology Laboratory.

Figure 1. Plate (a) White (plain) agidi, (b) Jollof agidi

2.3. Preparation of Culture Media

Commercially available nutrient media were used to isolate, identify, and characterize microorganisms. The media used include Plate count agar, nutrient agar, peptone water, MacConkey agar, Mannitol salt agar, Potato dextrose agar.

2.4. Enumeration of Bacteria

A homogenate was prepared by measuring 10g of each corn meal sample, transferred into 90 ml of normal saline, and homogenized for 30 seconds aseptically. A 5 10-fold dilution tube containing 9ml of sterile saline was used, and 1ml was transferred from the residue homogenate, aseptically using a sterile syringe, to the first dilution tube; the same procedure was used. 1 ml was aseptically withdrawn from the first to the second dilution

bottle. This was repeated until the dilution was completed. Using a new 1 ml pipette, 0.1 ml was aseptically transferred from the dilution tubes labeled 10-4, 10-5, and 10-6, aseptically to freshly prepared and dried Plate count agar plates (for Total Heterotrophic Count), Mac Conkey agar plates (for Total Fecal Coliform Count) and Mannitol salt agar (total staphylococcus count) followed by spread with a sterile bent rod aseptically. The plates were then incubated at 37oC for 24 hours for bacteria and were done in duplicate. The number of colonies was counted, and the average was taken; the colony forming unit of each average was calculated using the average divided by the dilution factor, multiplied by the volume plated. The total population was expressed as Colony Forming Units per gram (Cfu/gm). The enumeration process was conducted by [34]-[37].

2.5. Enumeration of Fungi

A homogenate was prepared by measuring 10 gr of each food sample purchased from the Corn meal (Agidi), which was transferred into 90 ml of normal saline and homogenized for 30 seconds aseptically. A 5 – 10-fold dilution tube containing 9 ml of sterile saline was used, and 1 ml was transferred from the residue homogenate, aseptically using a sterile syringe, to the first dilution tube; the same procedure was used. 1 ml was aseptically withdrawn from the first to the second dilution bottle. This was repeated until the dilution was completed. Using a new 1 ml pipette, 0.1 ml was aseptically transferred from the dilution tubes labeled 10-4, 10-5, and 10-6 aseptically to a freshly prepared and dried Potato Dextrose agar (for Total Heterotrophic Fungi) and spread with a sterile bent rod aseptically. The plates shall then be incubated at an ambient temperature of 250C. This was done in duplicate. The number of colonies was counted, and the average was taken; the colony forming unit of each average was calculated using the average divided by the dilution factor, multiplied by the volume plated. The total population shall be expressed as Colony Forming Units per gram (Cfu/gm).

2.6. Isolation and Characterization of Bacteria

The isolates were further stored on slants at 4°C refrigeration temperature for identification. Characteristic bacteria isolates were identified was based on colonial morphology, microscopy and biochemical tests as described.

2.7. Characterization and Identification of Isolates

Colonies of different bacteria species were then picked out using a sterile inoculating loop and sub-cultured for purification by streaking on nutrient agar and incubated at 30^{O}C for 24h. Individual colonies were characterized based on their colony morphology, microscopic examination, and biochemical characteristics.

2.8. Isolation and characterization of Fungi

Pure culture of fungi isolates obtained from the corn meal samples was repeated subculture on freshly prepared Potato Dextrose agar and incubated at room temperature for 3-7 days. Wet preparations were made by placing the swabs in 10% potassium hydroxide (KOH) mounted on a glass slide with a cover slip. This was then examined microscopically with an x40 objective for the presence of hyphae and arthrosporous. Identification of isolates was based on gross morphology and microscopy. For fungal identification, a mash of hypha of the test organism was made on slides containing Lacto phenol cotton blue, covered with a cover slip and observed in a x40 microscope.

2.9. Physicochemical Tests

Determination of pH and Total Titratable Acidity (TTA) The pH and TTA were determined using the AOAC method. pH was determined by homogenizing 10 g of the various samples in 20 ml of distilled water and using a referenced glass electrode pH meter. Titratable acidity was carried out by titrating 0.1 N sodium hydroxide against 10 ml of a sample using a phenolphthalein indicator, as previously reported by AOAC. The sample's moisture content was done as described by AOAC.

2.10. Statistical Analyses

Analysis of variance (ANOVA) was used to compare means at $p < 0.05$. This analysis was performed to visualize the association between the microbial loads of the different Corn meal samples using SPSS (Statistical Package for the Social Sciences), also known as IBM SPSS Statistics, a software package used for statistical data analysis [38]-[42]. Mean total show in Figures 2-6. Microbial counts shown in Figures 7 and 8.

3. RESULTS AND DISCUSSION

3.1. Organism Isolated

In this study, Organism isolated from Corn meal (Agidi) includes bacteria Staphylococcus sp, Bacillus sp, Escherichia coli, Enterococcus sp, Pseudomonas sp, and Klebsiella sp, while fungi isolated include Aspergillus sp, Yeast, Fusarium sp and Penicillium sp. It can be seen in Figure 9 and Figure 10. The details of

the Organism isolated from the white and Jollof Corn meal can be seen in Table 1. Percentage frequency shown in Tables 2-5.

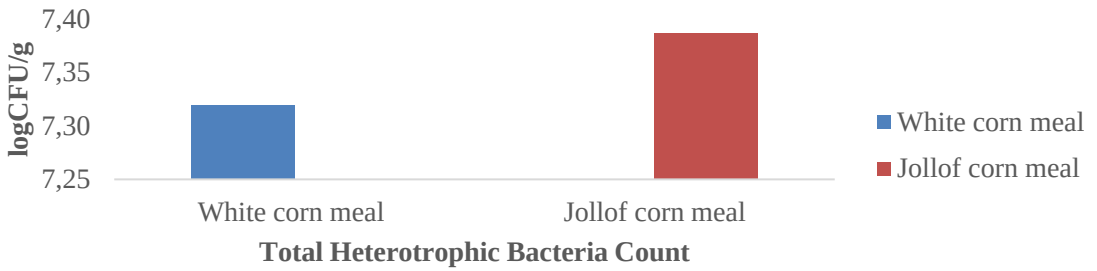

Figure 2. Mean total heterotrophic bacteria count of bacteria isolated from white and Jollof corn meal (Agidi)

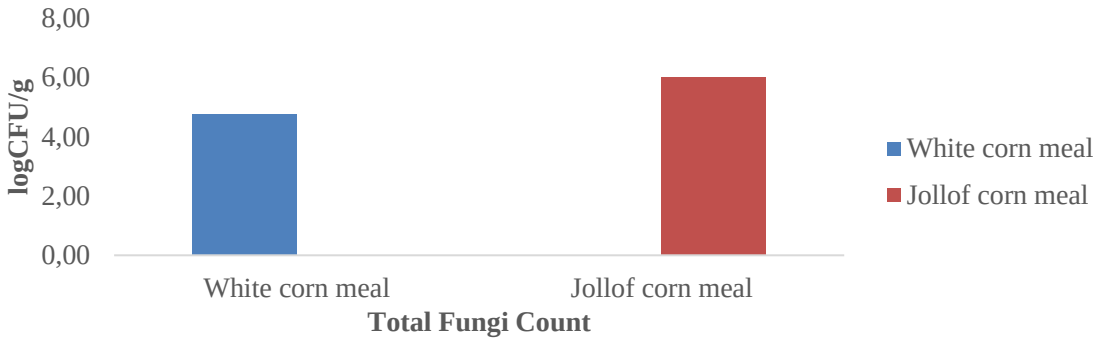

Figure 3. Mean total fungi count of fungi isolated from white and Jollof corn meal (agidi)

Figure 4. Mean total *Staphylococci* count of bacteria isolated from white and Jollof corn meal (agidi)

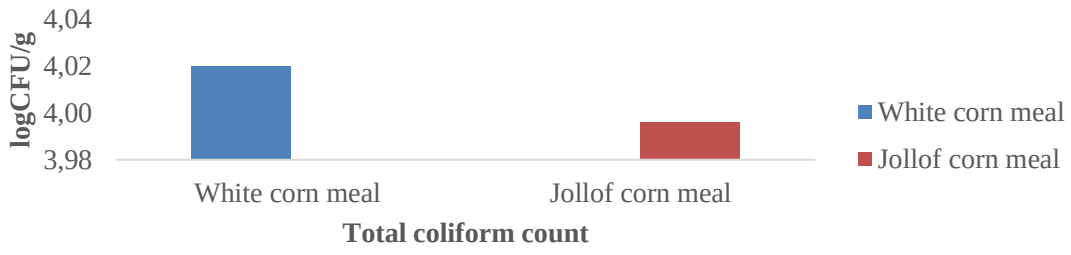

Figure 5. Mean total coliform count of bacteria isolated from white and Jollof corn meal (agidi)

Figure 6. Mean total *Escherichia coli* count of bacteria isolated from white and Jollof corn meal (agidi)

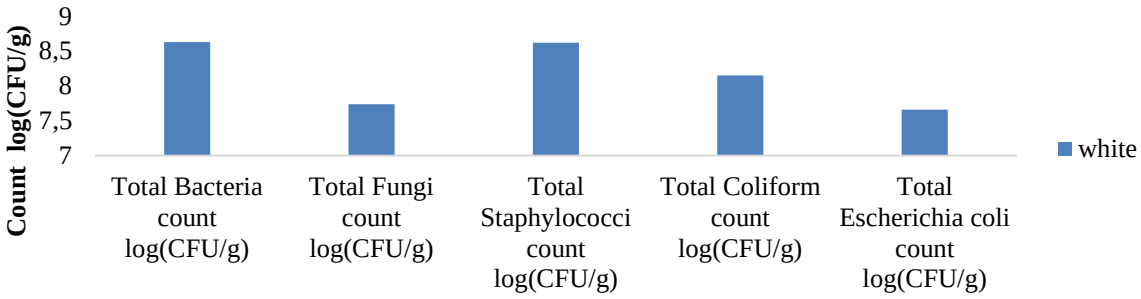

Figure 7. Microbial counts of the Organism isolated for white corn meal (Agidi)

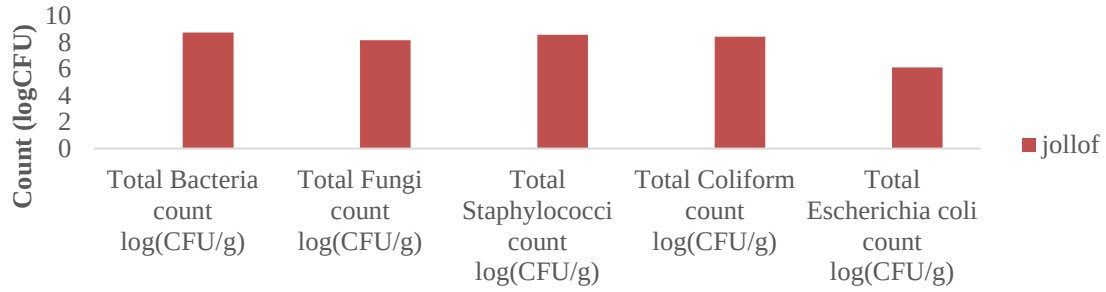

Figure 8. Microbial counts of the Organism isolated for Jollof corn meal (agidi)

Percentage (%)

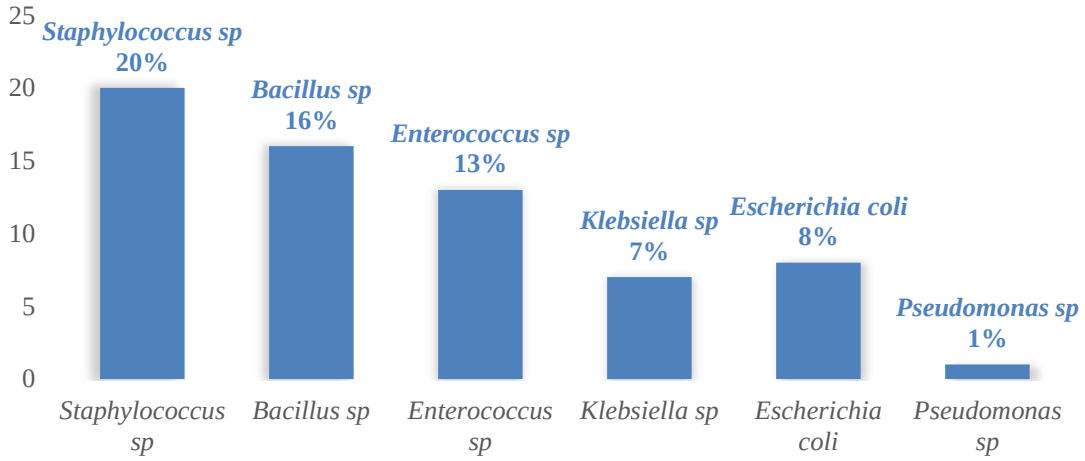

Figure 9. Percentage occurrence of all bacteria isolated from corn meal (agidi)

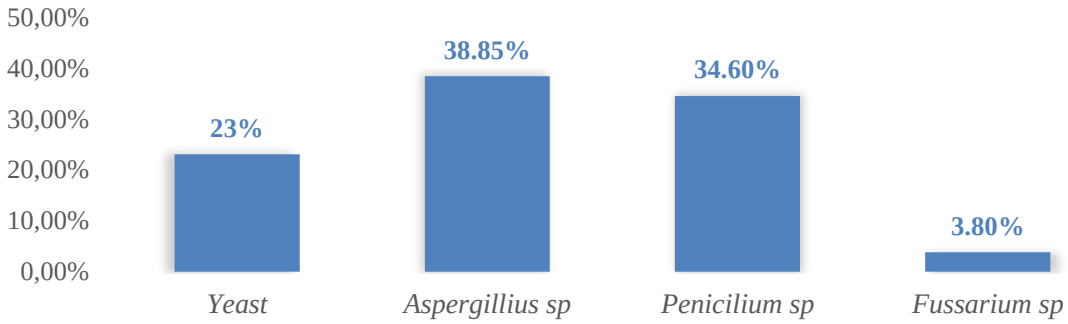

Figure 10. Percentage occurrence of all fungi isolated from corn meal (agidi)

Table 1. The Organism isolated from white and Jollof Corn meal (Agidi)

Sample code	Probable organism isolated
White corn meal (Agidi)	
1	*Staphylococcus* sp, *Bacillus* sp, *Enterococcus* sp, *Aspergillus* sp
2	*Bacillus* sp, *Staphylococcus* sp, *Escherichia coli*
3	*Enterococcus* sp, *Escherichia coli*, *Aspergillus* sp, *Penicillium* sp
4	*Staphylococcus* sp, *Bacillus* sp, *Escherichia coli*, *Enterococcus* sp, *Penicillium* sp
5	*Staphylococcus* sp, *Escherichia coli*, *Klebsiella* sp
6	*Staphylococcus* sp, *Bacillus* sp, *Enterococcus* sp, *Aspergillus* sp,
7	*Staphylococcus* sp, *Bacillus* sp, *Enterococcus* sp, Yeast
8	*Staphylococcus* sp, *Bacillus* sp, *Aspergillus* sp
9	*Bacillus* sp, *Enterococcus* sp, *Escherichia coli*
10	*Staphylococcus* sp, *Enterococcus* sp, *Klebsiella* sp, *Pseudomonas* sp, *Aspergillus* sp
11	*Staphylococcus* sp, *Klebsiella* sp, Yeast
12	*Staphylococcus* sp, *Escherichia coli*
13	*Escherichia coli*, *Enterococcus* sp, *Aspergillus* sp
14	*Staphylococcus* sp, *Fusarium* sp
15	*Staphylococcus* sp, *Klebsiella* sp, *Aspergillus* sp
Jollof corn meal (Agidi)	
1	*Staphylococcus* sp, *Enterococcus* sp, *Bacillus* sp, Yeast, *Penicillium* sp
2	*Staphylococcus* sp, *Enterococcus* sp, *Klebsiella* sp, *Bacillus* sp, *Aspergillus* sp
3	*Staphylococcus* sp, *Bacillus* sp, *Enterococcus* sp, *Penicillium* sp
4	*Staphylococcus* sp, *Bacillus* sp, *Klebsiella* sp, *Penicillium* sp
5	*Staphylococcus* sp, *Bacillus* sp, *Enterococcus* sp, *Escherichia coli*, *Aspergillus* sp, Yeast
6	*Bacillus* sp, *Penicillium* sp
7	*Bacillus* sp, *Staphylococcus* sp, *Penicillium* sp, Yeast
8	*Staphylococcus* sp,
9	*Staphylococcus* sp, *Enterococcus* sp, *Bacillus* sp, *Klebsiella* sp, *Aspergillus* sp, *Penicillium* sp, Yeast
10	*Penicillium* sp
11	*Staphylococcus* sp, Bacillus sp, *Escherichia coli*, *Klebsiella* sp, *Penicillium* sp
12	*Staphylococcus* sp, *Enterococcus* sp, *Escherichia coli*, *Klebsiella* sp, Yeast
13	*Staphylococcus* sp, *Escherichia coli*, *Klebsiella* sp, *Penicillium* sp
14	*Staphylococcus* sp, *Escherichia coli*, *Klebsiella* sp, *Penicillium* sp
15	*Staphylococcus* sp, *Escherichia coli*, *Klebsiella* sp,

Table 2. Percentage frequency of bacteria isolated from white corn meal (Agidi)

Organism	Frequency	Percentage
Staphylococcus sp	12	31.58%
Bacillus sp	7	18.42%
Enterococcus sp	8	21.05%
Klebsiella sp	4	10.53%
Escherichia coli	6	15.79%
Pseudomonas sp	1	2.63%
Total	38	100%

Table 3. Percentage frequency of Fungi isolated from white corn meal (agidi)

Organism	Frequency	Percentage
Yeast	2	16.67%
Aspergillus sp	7	58.33%
Penicillium sp	2	16.67%
Fusarium sp	1	8.33%
Total	12	100%

Table 4. Percentage frequency of bacteria isolated from Jollof corn meal (agidi)

Organism	Frequency	Percentage
Staphylococcus sp	13	30.95%
Bacillus sp	9	21.43%
Enterococcus sp	6	14.29%
Klebsiella sp	8	19.05%
Escherichia coli	6	14.29%
Total	42	100%

Table 5. Percentage frequency of Fungi isolated from jollof corn meal (agidi)

3.2. Physiochemical Analysis

Physiochemical parameters of this study's Corn meal (Agidi) samples were analyzed pH titrable acidity.

3.3. pH analysis

The pH of white and Jollof corn meal (agidi) samples was examined. It can be seen in Figure 11.

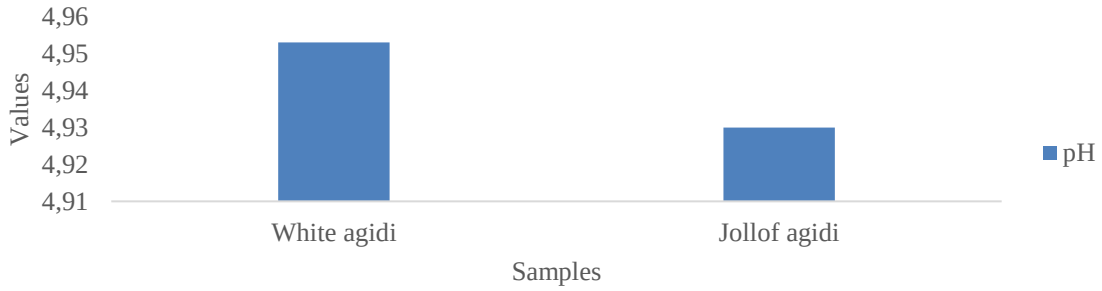

Figure 11. Mean pH of white and Jollof corn meal (agidi)

3.4. Titratable acidity

The Titratable acidity of white and Jollof Corn meal (Agidi) samples was examined. From the analysis, it was observed that the Titratable acidity of both white and Jollof Corn meal (Agidi) ranged from 0.20 – 0.40. It can be seen in Figure 12.

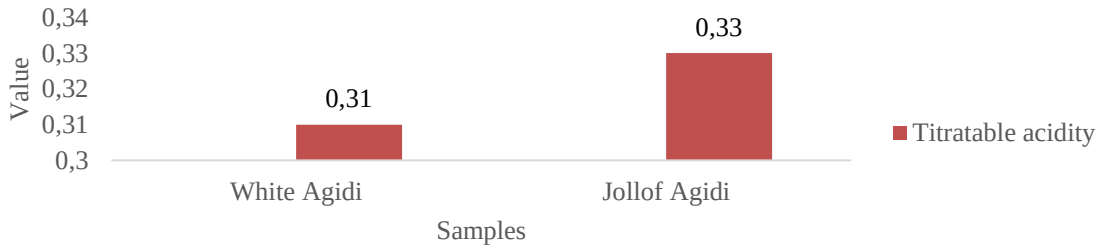

Figure 12. Titratable acidity of white and Jollof corn meal (agidi)

3.5. Moisture content of White and Jollof Corn meal (Agidi)

The moisture content of white and jollof Corn meal (Agidi) samples was examined. From the analysis, it was observed that the amount of both white and jollof corn meal (Agidi) ranged 85% – 87%. It can be seen in Figure 13.

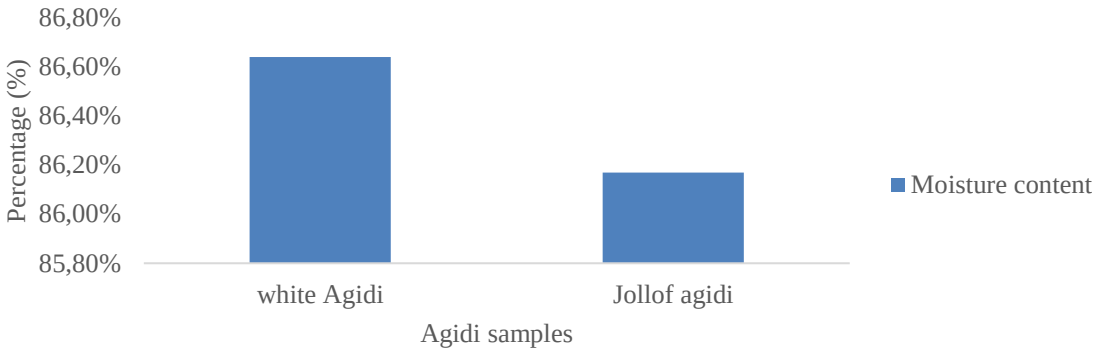

Figure 13. The moisture content of white and Jollof corn meal (agidi)

3.6. Discussion

3.6.1. Microbial quality of corn meal (agidi)

Figure 2 shows the Total Bacteria count for white corn meal (Agidi) ranged of 6.30 - 8.06 log cfu/g, while jollof corn meal ranged of 6.00 – 8.01 log cfu/g. There was a significant difference between the TBC of white corn meal and jollof corn meal ($p < 0.05$). Permissible limits for TBC vary depending on the type of food and can range from 10^2 to 10^6 CFU/gram. The results generated from this study exceeded the permissible limit of 5.00 Logcfu/g for bacteria in food, as stated by WHO.

Figure 3 presents the Total Fungi count ranged of 6.00 – 7.13 log CFU/g for white Corn meal (Agidi) and 6.30 – 7.59 log CFU/g for jollof corn meal (agidi). This finding indicates that there were more fungi counts in the jollof corn meal (agidi) ($p < 0.05$). When compared to the white Corn meal (agidi). The fungal count in the study showed that some of the products exceeded the permissible fungal limit in food of 4 - 6.00 Log CFU/g by the World Health Organization (WHO). However, some were within the permissible limits.

Figure 4 shows the Staphylococci count for White corn meal (agidi) samples ranged of 6.0 – 8.2 logcfu/g. There was a significant increase in the Staphylococci count, which ranged of 6.48– 8.01 logcfu/g in jollof white corn meal (agidi) ($p < 0.05$) as shown Figure 3.

Figure 5 presents the coliform count ranged of 6.00 – 7.96 logcfu/g for the white corn meal (agidi) and the coliform count in jollof corn meal (agidi), which ranged of 7.20 – 7.75 logCFU/g ($p < 0.05$). However, there was more Escherichia coli in Jollof corn meal than in the white corn meal (Agidi).

Figure 6 presents the Escherichia coli count, which ranged of 6.30 – 7.29 logCFU/g, for white corn meal (agidi) when compared to the Escherichia coli count of jollof corn meal (agidi), which ranged of 6.00 – 7.72 logCFU/g. These high values of contamination exceed the permissible limit. Coliform bacteria are indicators of fecal contamination and poor sanitation. Permissible limits for coliforms in food are typically set at 0 CFU/gram for certain ready-to-eat foods and low levels (e.g., <10 CFU/gram) for other foods. Permissible limits for E. coli in food are often set at 0 CFU/gram for ready-to-eat foods and low levels for different foods (e.g., <10 CFU/gram).

As indicated in the coliform count results, some of the cornmeal exceeded the acceptable coliform limit stipulated by the WHO of zero coliform count. Unhygienic conditions during the preparation of the corn meal commonly carried out using traditional processing methods are one of the possible sources of undesirable bacterial species in the product. Escherichia coli, which is isolated is usually found in the intestinal tract of humans, and clinically, it is the most frequent pathogen of the urinary tract. Its occurrence in the corn meal (agidi) is due to unhygienic processes adopted by food handlers. The presence of high coliform and Escherichia coli is traceable to fecal contamination from during preparation and the handling of the finished product, contaminated ingredients, poor hygiene practices, insufficient cooking, and an unsanitary environment.

Figure 7 and Figure 8 present the Microbial counts of organism isolated for white and Jollof corn meal. Bacteria isolated from White corn meal (agidi) include Staphylococcus sp, (31.58%), Enterococcus sp (21.05%), Bacillus sp, (18.42%), Escherichia coli (15.75%), Klebsiella sp (10.53%), and Pseudomonas sp (2.63%), as shown in Table 2. Comparing the bacterial isolated from the jollof corn meal (agidi), the bacterial isolates were similar in occurrence. The percentage of bacterial occurrence includes Staphylococcus sp, (30.8%), Bacillus sp, (24.6%), Enterococcus sp (20.0%), Escherichia coli (12.3%), Klebsiella sp (10.8%), and Pseudomonas sp (1.5%), as shown in Figure 4. Figure 8 shows the percentage of the organisms isolated from the corn meal samples.

The presence of pathogens in some foods is an indicator of food safety. Although small numbers of pathogens present in food represent a low risk, their existence can suggest a fault in the production and subsequent handling, which, if not monitored, could lead to serious health risks and implications. Bacillus sp.

in foods indicates the probability that some food aromas, such as spices (pepper), have been included after the main cooking processing. Staphylococcal species isolated from corn meal (agidi) samples can induce food-related illness. Staphylococcal food-borne disease is a major cause of food-borne disease globally due to endotoxins pre-formed by Staphylococcus aureus. Some microorganisms isolated from corn meal (agidi) have been reported to be associated with food spoilage and food poisoning. Numerous organisms cause food-borne diseases, including bacteria, fungi, viruses, and parasites. The presence of Staphylococcus sp. and Bacillus sp. in the corn meal (agidi) samples could be due to contamination arising from improper personal hygiene of the handlers and the utensils used for their production. However, their absence in other samples might be due to proper hygienic practices during their production, or they were eliminated by antimicrobial substances such as organic acids produced by lactic acid bacteria. The samples' relatively close range of microbial counts could be because they were made from the same substrate using the same or similar techniques. The bacterial isolates encountered in powdered maize-akamu and powdered maize-akamu fortified with breadfruit powder in different proportions include Staphylococcus sp., Bacillus sp., Pseudomonas sp.

Table 3 shows the fungi in white corn meal (agidi). The fungi isolated include Aspergillus sp, Yeast sp, Fusarium sp, and Penicillium sp. The percentage of occurrence was observed as Aspergillus sp (38.5%), Penicillium sp (34.6%), Yeast sp (23.1%), and Fusarium sp (3.8%). When comparing the samples, there were similarities in the fungi isolated. However, there was a slight difference in the percentage of occurrence for Jollof corn meal (corn meal (agidi), percentage occurrence was observed in Penicillium sp, (55.56%), Yeast sp, (27.7%), and Aspergillus sp. (16.67%) This result can be seen in Table 5.

Figure 9 shows the percentage of fungi isolated from the corn meal samples Various fungal species that have been implicated in previous studies as producers of aflatoxins in nature were isolated from this popular food source, Corn meal (agidi), being consumed in some communities in Nigeria. The occurrence of aflatoxigenic mold contamination in fermented cereal – 'corn meal (agidi)' samples could threaten public health. Generally, molds lead to significant economic losses and constitute a primary production of mycotoxins. Aspergillus sp. is widely incriminated as a contaminant of human foods, especially cereals. The presence of Aspergillus sp. is not only of economic importance but also represents a real health hazard. They can be of allergic, toxigenic, and pathogenic effects through the production of mycotoxins.

From the public health of view, Aspergillus sp., Fusarium sp., and related molds have been reported to cause diseases such as pulmonary aspergillosis, pulmonary allergy, mycotic keratitis, and skin infection. Isolated fungi like Aspergillus and Fusarium have been considered major factors in food spoilage, resulting in significant economic losses and public health hazards by producing varieties of mycotoxins that cause food poisoning. Some fungi are the most common environmental contaminants due to their ability to produce spores, which could be related to their existence in food samples. They have been implicated in many ready-to-eat foods like corn meal (agidi). Aspergillus sp. is known to deleterious mycotoxins under favorable conditions. So, their food existence must be treated cautiously. However, Aspergillus sp has been associated with various diseases, such as hypersensitivity, aspergillosis, otomycosis, and onychomycosis. The dry conidia produced by Aspergillus sp are easily dispersed in the air, leading to inhalation by humans and animals. The occurrence of Aspergillus sp. in the foods could be because they are spore formers. Contamination of foods could have resulted from inappropriate processing, incomplete heating, or secondary contamination via contact with contaminated equipment and utensils.

The most effective means to prevent aflatoxigenic mold contamination of 'corn meal (agidi)' is by applying strict hygienic measures during the processing. This study shows that the occurrence of relatively high levels of molds and aflatoxigenic fungi in corn meal (agidi) samples analyzed presents a high risk to consumers' health. It is therefore suggested that a statutory food regulating body dedicated to protecting public health and consumer interest in food safety and hygiene be established. And those in existence should be strengthened with appropriate resources. Its main function would be to take all reasonable steps to ensure that food products meet the high standards of food safety, and food handlers should observe necessary food production regulations and ethics.

3.6.2. Physiochemical quality of corn meal (agidi)

The pH of white and Jollof corn meal (agidi) samples was examined. From the analysis, it was observed that the pH of both white and Jollof Corn meal (Agidi) ranged from 4 – 6, as seen in Figure 10.

The low pH of some fermented foods could be attributed to the proliferation of microbial biomass, particularly lactic acid bacteria and yeast, which can utilize free sugars to produce organic acids. There was a possibility of higher lactic acid bacteria and yeasts. All the pH of the corn meal (agidi) samples were shown to be low acidic in nature, although most of the jollof cornmeal was moderately acidic. The reduction in pH in some fermented foods could be responsible for the elimination/reduction of bacterial pathogens under fermentation conditions.

The Titratable acidity of white and Jollof Corn meal (Agidi) samples was examined. The analysis showed that the Titratable acidity of white and Jollof corn meal (Agidi) ranged from 0.20 – 0.40%, as seen in

Figure 11. The titratable acidity (TTA) of cornmeal, also known as agidi, can vary depending on the variety of corn used, processing methods, and storage conditions. Generally, cornmeal tends to have a relatively low acidity compared to fruits or fermented foods. TTA measures the total amount of acid in a food sample, while pH indicates the acidity or alkalinity on a scale from 0 to 14, with seven being neutral. A lower pH value indicates higher acidity, while a higher pH value indicates lower acidity (or more alkalinity). However, the correlation between pH and TTA can vary depending on the specific composition of the food. The pH range suggests that cornmeal is slightly acidic to neutral. The TTA values for cornmeal would be influenced by factors such as the presence of organic acids and the degree of fermentation.

The moisture content of cornmeal (agidi) can vary depending on factors such as the processing method, storage conditions, and the initial moisture content of the corn used. For agidi, a Nigerian cornmeal often used to make a gelatinous pudding, the moisture content can vary depending on regional preferences and production methods. Moisture content is essential in determining cornmeal products' quality and safety. Too much moisture can lead to mold growth and spoilage, while too little moisture can result in a dry and unappealing product. Therefore, maintaining the proper moisture content is crucial during processing and storage. The results indicated a high moisture content in the corn meal, of which the white cornmeal moisture content was within the range of 85.90% to 86.67%, while that of Jollof cornmeal ranged from 85.90% to 86.19%. as presented in Figure 12. The high moisture content indicates a short shelf life of the product, which implies that the samples have poor storage potential as an available material for microorganisms to thrive.

4. CONCLUSION AND LIMITATION

Consumption of corn meal (agidi) samples with adequate nutritive value might promote the healthy status of the individual. Preparing corn meal (agidi) in a hygienic environment will reduce the risk of contamination by food pathogens. Possible bacteria and fungi can cause food-borne diseases, leading to profound health implications. Proper handling of corn meal (agidi) during production must be taken. This is to prevent contamination from environmental and human sources. Control measures to prevent bacterial cross-contamination of corn meal (agidi) require procedures for maintaining the hygienic quality of the processing environment and equipment. Applying of good agricultural, manufacturing, and storage practices together with the hazard analysis and critical control points (HACCP) system encompassing all stages of production, processing, packaging, and distribution will help ensure the microbial safety of corn meal.

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