# Assessment of Cassava Flakes Quality and Hygiene Practices among Workers in Cassava Flakes Processing Factories in Ilorin West Local Government Area Kwara State Nigeria

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## ABSTRACT

Cassava (Manihotesculenta Crantz)is a major root crop in the low land tropics and much of sub humid tropics and its starchy roots are sources of dietary food energy (high calories) for more than 500 million people worldwide. **Aim:** This study assessed the quality of cassava flakes and the hygiene practices of workers in selected cassava flakes processing factories in Ilorin west LGA.

**Methodology:** a descriptive cross sectional study involving laboratory analysis which was used to assess the hygiene practices and the level of contaminants in cassava flakes. The study population comprised of all workers of the selected cassava flakes processing factories, a multi-stage sampling technique was used in the selection of respondent and collection of sample for the study. The instruments used for data collection was an interviewer administered questionnaire.

**Result:** A total of 220 cassava flakes processors were interviewed to assess the level of knowledge, attitude and practices on cassava flakes hygiene. During the interview, 211 cassava processors responded appropriately while 9 respondents declined. The age distribution of the cassava flakes processors increased as the age class increased excluding the drop in frequency at 60 and above, while a lot of the respondents 72(34.1%) are within the ages of 50 - 59. There are more females 163(77.3%) than males 48(22.7%) respondents in cassava flakes processing factories. 128(60.7%) agreed that Food borne illness can be prevented by good processing of cassava flakes, 111(52.6%) agreed that good processing hygiene of the cassava flakes processors can prevent food poisoning while 95(45.0%) agreed that Obtaining more knowledge on cassava safety is not a solution to food safety problems. This study also revealed that 203(96.2%) agreed that processing activity is time consuming and strenuous, 145(68.7%) agreed that inadequate access to potable water is a constraint to proper hygiene. The bacteria isolated from this samples were; Staphylococcus aereus, Bacillus cereus, Pseudomonas spp, Eucherichia coli. The highest level of cyanide in this study is 7.30mg/HCN/kg, while the lowest is 2.0 mg/HCN/kg.

**Conclusion:** It was revealed in this study that the constraints to hygiene practices by the cassava processors includes; Processing activity is time consuming and strenuous, inadequate access to potable water, lack of finance to purchase modern equipment, scarcity of freshly harvested cassava roots, lack of waste disposal facility, non-availability of processing facilities, fluctuation in market prices, investments costs for the more efficient technologies are high. Direct observation of hygiene among processors in the factories revealed that their hygiene practices concerning environmental sanitation were poor.

**Keywords:** Cassava flakes, Hygiene Practices, Bacteria Isolated

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# BACKGROUND

Worldwide, the growing concern due to the increase in the world population is food security, because of the alarming concern of disease outbreaks caused by the consumption of contaminated food and food products, which led to unprecedented global interest in agriculture (Orji et al., 2016).

The global food crisis has worsened an already precarious food situation because when food is in short supply, people are more concerned about satisfying hunger than the safety of the food. The etiological agents include various pathogenic bacteria, parasites and viruses. Chemical contaminants are becoming increasingly important. Human factors, including unhygienic practices and deliberate contamination, environmental factors, such as unsafe water, unsafe waste disposal and exposure of food to insects and dust, undercooked food, and prolonged storage of cooked food without refrigeration, are the main predisposing factors. WHO's position is that food safety must be recognised as a public health function and access to safe food as a basic human right (Mensal et.al., 2012).

Cassava (Manihot esculenta Crantz)is a major root crop in the lowland tropics and much of sub humid tropics, and its starchy roots are sources of dietary food energy (high calories) for more than 500 million people worldwide (FAO, 2008). It is processed into Garri, fufu, lafu, tapioca, lebu, kokote and pupuru, and can be consumed in various forms: boiled, soaked, baked or fried. It is processed to detoxify the toxins present and in order to preserve it and in order to preserve it. There are several reasons for processing cassava: processing cassava serves as a means of reducing or removing the toxic substances, such as cyanide glycoside; processing as a means of preservation brings out varieties of product with different characteristics and thus creates variety in cassava diets (Jakayinfa et al., 2007).

Garri, a product of cassava, is consumed by millions of people in the West African sub-region and also in Nigeria in particular, irrespective of ethnicity and socio-economic class. Production and handling methods have not been standardized resulting in a product with varying quality and safety indices, hence varying public health concerns (Ogeihor et al., 2007). An increasing intake of soaked garri or dry garri as snacks is an added practice that exposes the population to health risk due to the microbial status and heavy metals present in garri products (Orji et al., 2016). The post processing handling of garri, such as spreading on the bare floor or mat for cooling before final sieving and packaging for marketing, display in open bowls in open markets and sale points, transporting it from rural to urban areas, potentiates contamination by various groups of microorganisms and may predispose a public health hazard (Ogeihor et al., 2005). Microbiological quality of garri processing establishments should be thoroughly examined throughout the production areas, and regular appraisal of the techniques used is necessary (Thoha et al., 2012).

In a study conducted by Olapadeet al., (2014), on microbiological quality of fermented cassava (Garri), the microorganisms isolated were: Salmonella spp…, Klebsiella spp…, Pseudomonas spp.., Bacillus spp.., Clostridium spp.., Fusarium spp.., Aspergillus spp., Penicillium spp.., Rhizopus spp.., Staphylococcus spp.., and clostridium spp. There may be food borne illnesses as a result of contamination by these microorganisms and heavy metals which includes; Lead, Cyanide and Mercury. There have been occasional reports of death, several abdominal upsets and other discomforts following the consumption of garri in some communities. This is due to the fact that there is increasing demand for garri and this makes some commercial centers to process in a hurry without allowing for sufficient fermentation to cause appreciable cyanide reduction (Babalola, 2014). Cyanide reduces the oxygen supply to all the cells of the body and attacks every vital organ of the body (Angela, 2017). Therefore, is imperative to assess the quality of cassava flakes, hygiene practices of cassava flakes processors and also the level of contamination of cassava flakes in the Ilorin west LGA, Kwara state.

# METHODOLOGY

## Study Area

This study was carried out in Ilorin West LGA of Kwara State, Nigeria. Ilorin, the capital of Kwara State, North Central Nigeria, is a town located between the Northern and Southern parts of Nigeria at a distance of about 302 km north of Lagos and 475 km south of Abuja, Federal Capital Territory (FCT). There are three(3) Local

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Government Areas (LGAs) in the entire Ilorin metropolis: Ilorin East, Ilorin West and Ilorin South with their headquarters at Oke-Oyi, Warah and Fufu respectively.

**Study Design**

This study is a descriptive cross sectional study involving laboratory analysis which was used to assess the hygiene practices and the level of contaminants in cassava flakes.

**Sampling Techniques**

A multi-stage sampling technique was used in the selection of respondent and collection of sample for the study.

**Stage 1: A simple random sampling by balloting without replacement was used to select** 4 Factories in Ilorin west LGA.

**Stage 2:** A systematic sampling technique was used to select required number of respondents in each selected factory. This is done by using the list of processors in each factory.

**Stage 3:** Proportional allocation was used. The total number of respondents in each factory was divided by the allocated proportion of the total sample size to obtain the sampling interval (K). The first respondent were selected randomly after which the $K^{th}$ interval was used, using the list of the processors in the factory until the desired sample size is recruited for each selected factory.

**Method of Data Analysis**

Data was analyzed by the use of statistical package for Social sciences, version 21.

The study used descriptive statistics, which involves tabulating, summarizing and describing data. After data collection, the questionnaires were thoroughly checked for completeness, accuracy and uniformity of the information was obtained. Then the raw data collected from the field are organized and coded for analysis. Chi square statistical test was used to determine the relationship between the

knowledge and practice of food hygiene among cassava flakes processors. A 95% confidence level was used and $P \leq 0.05$ was considered statistically significant. Data was summarized and presented with the use of charts and cross tabulation. Relevant interpretations, discussions and recommendations were drawn from the analyzed data

**Ethical Considerations**

Ethical approval was obtained from the Institution Research Ethics Directorate of Kwara State University, Malete, and all human-related procedures were performed in accordance with the institutional guidelines. Informed consent was presented to all participants, and participation was voluntary; confidentiality was ensured, and respondents were informed of their right to withdraw at any time.

**Consent to publish:** Not Applicable

**Laboratory Analysis**

**Preparation of samples**

Sample was prepared by adding it into a test tube containing sterile water for dilution. Mac Conkey Agar (13g), was diluted with 250ml of water and the solution was sterilized with an autoclave for 1hr. it was left to cool at body temperature. The warm Mac Conkey Agar was poured into petri dishes. For inoculation, 1ml of the diluted solvent was instilled into the mac conkey Agar. Incubation was done for 72hrs for bacteria growth respectively at $37^0$c

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**Enumeration and identification of microorganism isolated**

Colony count at the expiration of incubation time was with digital colony counter (Gallekamp England). Total microbial population was expressed as colony forming units per gram ($CFug^{-1)}$of sample. Pure cultures of isolates were obtained by repeated subculture on nutrient agar and were stored on slants at $4^{o}c$ until characterized. Characteristics bacteria isolate were identified based on colonial morphology microscopy and biochemical test (Holt et al., 1994).

## RESULTS

**Respondents' Socio-economic Variable**

Table 1

| **Items** | **Adeta** | **Ita Amo** | **Agbo-oba** | **Ogidi** | **Total** |
|---|---|---|---|---|---|
| | n=65(%) | n=41(%) | n=30(%) | n=75(%) | n=211(%) |
| | | | | | |
| Male | 9(13.8%) | 12(29.3%) | 8(26.7%) | 19(25.3%) | 48(22.7%) |
| Female | 56(86.2%) | 29(70.7%) | 22(73.3%) | 56(74.7%) | 163(77.3%) |
| **Total** | **65(100%)** | **41(100%)** | **30(100%)** | **75(100%)** | **211(100%)** |
| | | | | | |
| Yoruba | 57(87.6%) | 36(87.8%) | 27(90%) | 69(92.2%) | 189(89.6%) |
| Hausa | 1(1.5%) | 0(0%) | 1(3.3%) | 1(1.3%) | 3(1.4%) |
| Igbo | 7(10.7%) | 5(12.2%) | 2(6.7%) | 5(6.7%) | 19(9.0%) |
| **Total** | **65(100%)** | **41(100%)** | **30(100%)** | **75(100%)** | **211(100%)** |
| | | | | | |
| Single | 6(9.2%) | 0(0%) | 8(26.7%) | 14(18.7%) | 28(14.1%) |
| Married | 27(41.5%) | 23(56.1%) | 12(40%) | 30(40%) | 92(44.0%) |
| Separated | 7(10.7%) | 4(9.8%) | 4(13.3%) | 9(12%) | 24(11.5%) |
| Widowed | 22(33.8%) | 13(31.7%) | 6(20%) | 19(25.3%) | 60(28.4%) |
| Divorced | 2(3.07%) | 1(2.4%) | 0(0%) | 2(2.7%) | 5(2.4%) |
| Total | 64(98.4%) | 41(100%) | 30(100%) | 74(98.7%) | 209(99.1%) |
| Non-response | 1(1.5%) | 0(0%) | 0(0%) | 1(1.3%) | 2(0.9%) |
| **Total** | **65(100%)** | **41(100%)** | **30(100%)** | **75(100%)** | **211(100%)** |
| | | | | | |
| No Formal Education | 29(44.6%) | 18(43.9%) | 15(50%) | 18(24%) | 80(37.9%) |
| Primary | 15(23.07%) | 9(22%) | 7(23.3%) | 23(30.7%) | 54(25.6%) |
| Secondary | 20(30.8%) | 13(31.7%) | 8(26.7%) | 33(44%) | 74(35.1%) |
| Tertiary | 1(1.5%) | 1(2.4%) | 0(0%) | 1(1.3%) | 3(1.4%) |
| **Total** | **65(100%)** | **41(100%)** | **30(100%)** | **75(100%)** | **211(100%)** |

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**Figure 1**

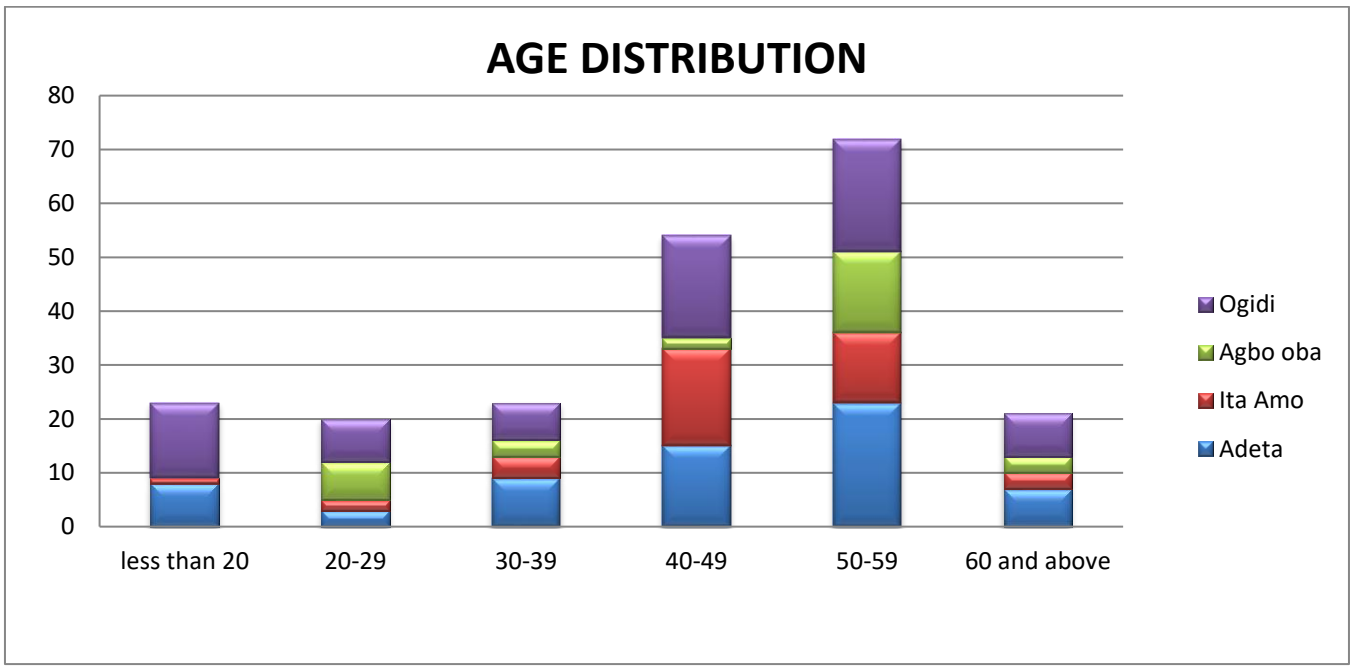


Figure 2

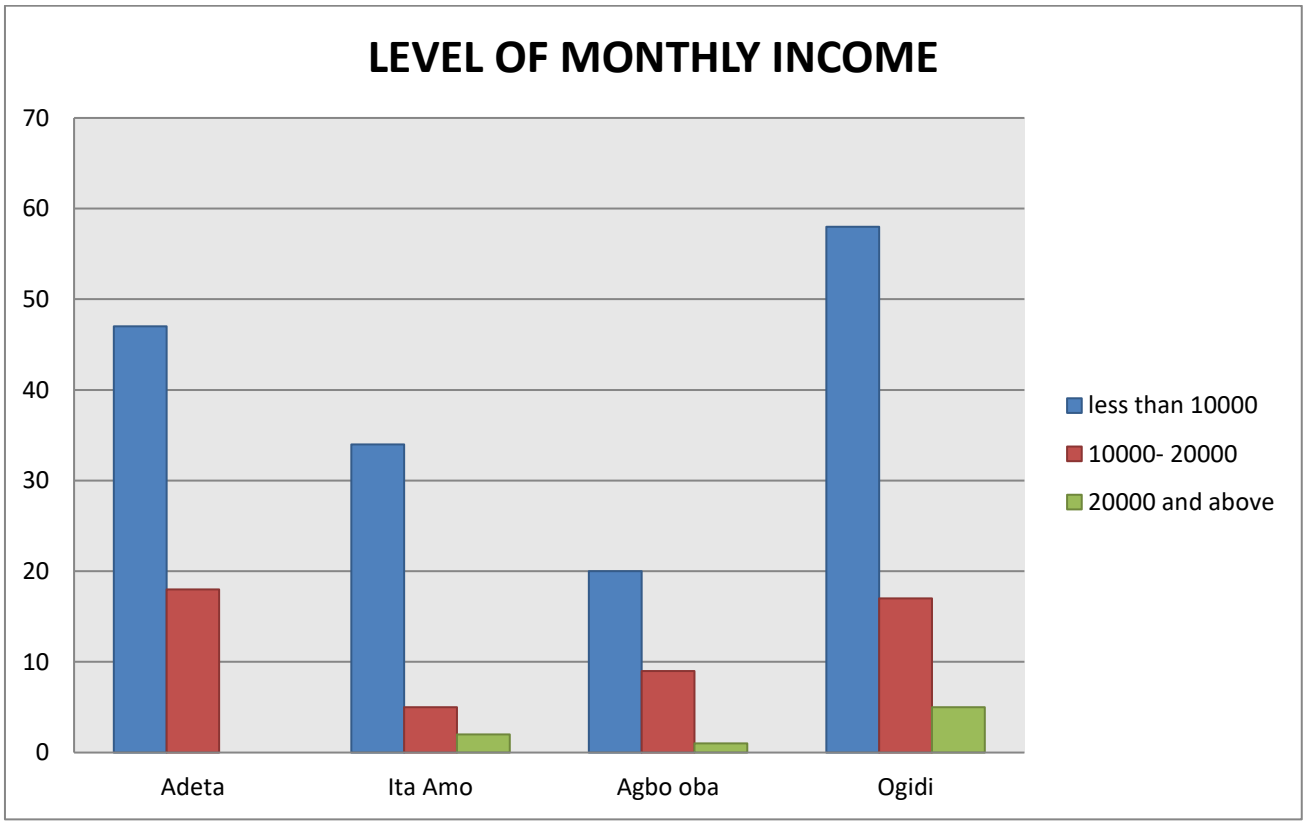


Table 2: Respondent's Knowledge Related to Cassava Flakes

| Variable | Items | Adeta | Ita Amo | Agbo-oba | Ogidi | Total |
|---|---|---|---|---|---|---|
| | | n=65(%) | n=41(%) | n=30(%) | n=75(%) | n=211(%) |
| **It is absolutely necessary to follow all the processing steps during cassava flakes production in order to reduce the risk of food poisoning** | Yes | 49(75.4%) | 28(68.3%) | 28(93.3%) | 63(84%) | 168(79.6%) |
| | No | 12(18.5%) | 8(19.5%) | 1(3.3%) | 6(8%) | 27(12.8%) |
| | I don't know | 4(6.2%) | 5(12.2%) | 1(3.3%) | 6(8%) | 16(7.6%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |

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| | | | | | | |
|---|---|---|---|---|---|---|
| **The floor and all the utensils used during the processing of cassava flakes must be kept clean and tidy at all times** | Yes | 46(70.8%) | 23(56.1%) | 23(76.7%) | 43(57.3%) | 135(64.0%) |
| | No | 18(27.7%) | 14(34.1%) | 6(20%) | 29(38.7%) | 67(31.8%) |
| | I don't know | 1(1.5%) | 4(9.8%) | 1(3.3%) | 3(4%) | 9(4.2%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| **Washing of peeled cassava enhances its quality and safety** | Yes | 28(43.1%) | 2(4.9%) | 19(63.3%) | 28(37.3%) | 77(36.5%) |
| | No | 36(55.3%) | 39(95.1%) | 9(30%) | 46(61.3%) | 130(61.6%) |
| | I don't know | 1(1.5%) | 0(0%) | 2(6.7%) | 1(1.3%) | 4(1.9%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |

For the four factories, 168(79.6%) agreed that it is absolutely necessary to follow all the processing steps during cassava flakes production in order to reduce the risk of food poisoning. 135(64.0%) that the floor and all the utensils used during the processing of cassava flakes must be kept clean and tidy at all times while 130(61.6%) disagreed that washing of peeled cassava enhances its quality and safety.

Table 3:

| **Variable** | **Items** | **Adeta** | **Ita Amo** | **Agbo-oba** | **Ogidi** | **Total** |
|---|---|---|---|---|---|---|
| | | n=65(%) | n=41(%) | n=30(%) | n=75(%) | n=211(%) |
| **It is necessary to process cassava root immediately after harvesting** | Yes | 28(43.1%) | 14(34.1%) | 14(46.7%) | 36(48%) | 92(43.6%) |
| | No | 32(49.2%) | 27(65.9%) | 16(53.3%) | 36(48%) | 111(52.6%) |
| | I don't know | 5(7.7%) | 0(0%) | 0(0%) | 3(4%) | 8(3.8%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| **Cyanide is a poisonous substance that can be found in cassava** | Yes | 2(3.1%) | 1(2.4%) | 7(23.3%) | 8(10.7%) | 18(8.5%) |
| | No | 57(87.7%) | 32(78%) | 22(73.3%) | 56(74,7%) | 167(79.2%) |
| | I don't know | 6(9.2%) | 8(19.5) | 1(3.3%) | 11(14.7%) | 26(12.3%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| **Grating cassava plays a major role in reducing its Cyanide content** | Yes | 4(6.2%) | 0(0)% | 10(33.3%) | 5(6.7%) | 19(9.0%) |
| | No | 55(84.6%) | 34(82.9%) | 17(56.7%) | 62(82.7) | 168(79.6%) |
| | I don't know | 6(9.2%) | 7(17.1%) | 3(10%) | 8(10.7%) | 24(11.4%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |

Furthermore, from the table 2d above- 111(52.6%) respectively disagreed that it is necessary to process cassava root immediately after harvesting**.** 167(79.2%) disagreed that Cyanide is a poisonous substance that can be found in cassava while 168(79.6%) disagreed that Grating cassava plays a major role in reducing its Cyanide content

Table 4:

| **Variable** | **Items** | **Adeta** | **Ita Amo** | **Agbo-oba** | **Ogidi** | **Total** |
|---|---|---|---|---|---|---|
| | | n=65(%) | n=41(%) | n=30(%) | n=75(%) | n=211(%) |
| **Fermentation has effect on the level of cyanide content of cassava** | Yes | 25(38.5%) | 1(2.4%) | 13(43.3%) | 12(16%) | 51(24.1%) |
| | No | 35(53.8%) | 32(78%) | 16(53.3%) | 53(70.7%) | 136(64.5%) |
| | I don't know | 5(7.7%) | 8(19.5%) | 1(3.3%) | 10(13.3%) | 24(11.4%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| **Pressing of cassava mash after grating has effect on the quality of cassava flakes** | Yes | 53(81.5%) | 38(92.7%) | 25(83.3%) | 65(86.7%) | 181(85.8%) |
| | No | 10(15.4%) | 3(7.3%) | 3(10%) | 6(8%) | 22 (10.4%) |
| | I don't know | 2(3.1%) | 0(0%) | 2(6.7%) | 4(5.3%) | 8(3.8%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| **Cross contamination can be prevented by using non rusting knives and grater** | Yes | 24(36.9%) | 28(68.3%) | 26(86,7%) | 36(48%) | 114(54.0%) |
| | No | 31(47.7%) | 8(19.5%) | 4(13.3%) | 27(36%) | 70(33.2%) |
| | I don't know | 10(15.4%) | 5(12.2%) | 0(0%) | 12(16%) | 27(12.8%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| | Yes | 58(89.2%) | 30(73.2%) | 29(96.7%) | 67(89.3%) | 184(87.2%) |

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| | | | | | | |
|---|---|---|---|---|---|---|
| **Mash fermentation should be for a minimum of 3 days and a maximum of 5 days** | No | 5(7.7%) | 8(19.5%) | 1(3.3%) | 5(6.7%) | 19(9.0%) |
| | I don't know | 2(3.1%) | 3(7.3%) | 0(0%) | 3(4%) | 8(3.8%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |

This table reveals that 136(64.5%) disagreed that Fermentation has effect on the level of cyanide content of cassava. 181(85.8%) agreed that Pressing of cassava mash after grating has effect on the quality of cassava flakes. Also 114(54.0%) agreed that cross contamination can be prevented by using non rusting knives and grater while 184(87.2%) agreed that Mash fermentation should be for a minimum of 3 days and a maximum of 5 days.

Table 5:

| **Variable** | **Items** | **Adeta** | **Ita Amo** | **Agbo-oba** | **Ogidi** | **Total** |
|---|---|---|---|---|---|---|
| | | n=65(%) | n=41(%) | n=30(%) | n=75(%) | n=211(%) |
| **Removing water from cassava mash is a good food safety practice** | Yes | 62(95.4%) | 37(90.2%) | 29(96.7%) | 68(90.7%) | 196(92.9%) |
| | No | 0(0%) | 0(0%) | 0(0%) | 3(4%) | 3(1.4%) |
| | I don't know | 3(4.6%) | 4(9.8%) | 1(3.3%) | 4(5.3%) | 12(5.7%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| **Roasting and drying is a means of making cassava mash safe for consumption** | Yes | 51(78.5%) | 41(100%) | 28(96.7%) | 65(86.7%) | 185(87.7%) |
| | No | 14(21.5%) | 0(0%) | 2(6.7%) | 10(13.3%) | 26(12.3%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| **Drying of mash on a raised platform help to prevent the contamination of the product** | Yes | 22(33.8%) | 16(39.0) | 11(36.7%) | 24(32%) | 73(34.6%) |
| | No | 41(63.1%) | 25(61.0) | 18(60%) | 45(60%) | 129(61.1%) |
| | I don't know | 2(3.1%) | 0(0%) | 1(3.3%) | 6(8%) | 9(4.3%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |

From the table 2f above it shows that 196(92.9%) respectively agreed that Removing water from cassava mash is a good food safety practice. Also 185(87.7%) agreed that Roasting and drying is a means of making cassava mash safe for consumption while 129(61.1%) disagreed that Drying of mash on a raised platform help to prevent the contamination of the product.

Table 6: Hygiene Practices of Respondents in the Cassava Processing Factory

| | | | | | | |
|---|---|---|---|---|---|---|
| | | n=65(%) | n=41(%) | n=30(%) | n=75(%) | |
| Do you wash your hands before and after peeling cassava? | Always | 36(55.4%) | 19(46.3%) | 21(70% | 40(53.3%) | 116(54.9%) |
| | most times | 12(18.5%) | 1(2.4%) | 1(3.3%) | 6(8%) | 20(9.5%) |
| | Sometimes | 14(21.5% | 17(41.5%) | 7(23.3%) | 25(33.3%) | 63(29.9%) |
| | Never | 3(4.6%) | 4(9.8%) | 1(3.3%) | 4(5.3%) | 12(5.7%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| Do you wash your hands with water after using the toilet? | Always | 40(61.5%) | 19(46.3%) | 25(83.3%) | 44(58.7%) | 128(60.6%) |
| | most times | 16(24.6%) | 3(7.3%) | 0(0%) | 9(12%) | 28(13.2%) |
| | Sometimes | 8(12.3%) | 17(41.5%) | 4(13.3%) | 20(26.7%) | 49(23.2%) |
| | Never | 1(1.5%) | 2(4.9%) | 1(3.3%) | 2(2.7%) | 6(3.0%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |

For table above, 116(59.9%) always wash their hands before and after peeling cassava. While 128(60.6%) always wash their hands with water after using the toilet.

Table 7:

| **Variable** | **Items** | **Adeta** | **Ita Amo** | **Agbo-oba** | **Ogidi** | **Total** |
|---|---|---|---|---|---|---|
| | | n=65(%) | n=41(%) | n=30(%) | n=75(%) | n=211(%) |
| | Always | 0(0%) | 2(4.9%) | 0(0%) | 0(0%) | 2(1.0%) |
| | most times | 2(3.1%) | 1(2.4%) | 1(3.3%) | 3(4%) | 7(3.3%) |

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| | | | | | | |
|---|---|---|---|---|---|---|
| Do you work when you have diarrhea? | sometimes | 14(21.5%) | 26(63.4%) | 10(33.3%) | 30(40%) | 80(37.9%) |
| | never | 49(75.4%) | 12(29.3%) | 19(63.3%) | 42(56%) | 122(57.8%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| Do you work when you have lesion in your hands? | Always | 3(4.6%) | 5(12.2%) | 1(3.3%) | 5(6.7%) | 14(6.6%) |
| | most times | 15(23.1%) | 8(19.5%) | 3(10%) | 22(29.3%) | 48(22.9%) |
| | sometimes | 15(23.1%) | 14(34.1%) | 7(23.3%) | 26(34.7%) | 62(29.3%) |
| | never | 32(49.2%) | 14(34.1%) | 19(63.3%) | 22(29.3%) | 87(41.2%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |

From the table above it shows that 122(57.8%) never work when they have diarrhea. While 87(41.2%) never work when they have lesion in their hands.

Table 8: Hygiene Practices of Respondents in the Cassava Processing Factory

| **Variable** | **Items** | **Adeta** | **Ita Amo** | **Agbo-oba** | **Ogidi** | **Total** |
|---|---|---|---|---|---|---|
| | | n=65(%) | n=41(%) | n=30(%) | n=75(%) | n=211(%) |
| Do you cover your hair during frying and grating of cassava? | Always | 48(73.8%) | 29(70.7%) | 24(80%) | 55(73.3%) | 156(73.9%) |
| | most times | 12(18.5%) | 2(4.9%) | 1(3.3%) | 13(17.3%) | 28(13.3%) |
| | sometimes | 2(3.1%) | 7(17.1%) | 0(0%) | 6(8%) | 15(7.1%) |
| | never | 3(4.6%) | 3(7.3%) | 5(16.7%) | 1(1.3%) | 12(5.7%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| Do you wear personal protective clothing at work? | Always | 4(6.2%) | 7(17.1%) | 3(10%) | 8(10.7%) | 22(10.4%) |
| | most times | 4(6.2%) | 2(4.9%) | 0(0%) | 2(2.7%) | 8(3.8%) |
| | sometimes | 18(27.7%) | 8(19.5%) | 3(10%) | 7(9.3% | 36(17.1%) |
| | never | 39(60%) | 24(58.5%) | 24(80%) | 58(77.3%) | 145(68.7%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |

It is shown that in Table 4c above that 156(73.9%) always cover their hair during frying and grating of cassava while 145(68.7%) never wear personal protective clothing at work.

Table 9: Factors Affecting Hygienic Practices of Respondents

| | | | | | | |
|---|---|---|---|---|---|---|
| | | n=65(%) | n=41(%) | n=30(%) | n=75(%) | |
| Processing activity is time consuming and strenuous | Yes | 65(100%) | 38(92.7%) | 26(86.7%) | 74(98.7%) | 203(96.2%) |
| | No | 0(0%) | 0(0%) | 4(13.3%) | 1(1.3%) | 5(2.4%) |
| | I don't know | 0(0%) | 3(7.3%) | 0(0%) | 0(0%) | 3(1.4%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| The nature of the safety practices is inconvenient | Yes | 57(87.7%) | 38(92.7%) | 26(86.7%) | 69(92%) | 190(90.0%) |
| | No | 4(6.2%) | 0(0%) | 4(13.3%) | 5(6.7%) | 13(6.2%) |
| | I don't know | 4(6.2%) | 3(7.3%) | 0(0%) | 1(1.3%) | 8(3.8%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| Inadequate access to potable water is a constraint to proper hygiene | Yes | 50(76.9%) | 36(87.8%) | 5(16.7%) | 54(72%) | 145(68.7%) |
| | No | 15(23.1%) | 2(4.9%) | 25(83.3%) | 21(28%) | 63(29.9%) |
| | I don't know | 0(0%) | 3(7.3%) | 0(0%) | 0(0%) | 3(1.4%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |

From the table 5a above, 203(96.2%) agreed that processing activity is time consuming and strenuous. While 190(90.0%) also agreed that the nature of the safety practices is inconvenient. 145(68.7%) agreed that inadequate access to potable water is a constraint to proper hygiene

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IV April 2026

Table 10:

| **Variable** | **Items** | **Adeta** | **Ita Amo** | **Agbo-oba** | **Ogidi** | **Total** |
|---|---|---|---|---|---|---|
| | | n=65(%) | n=41(%) | n=30(%) | n=75(%) | n=211(%) |
| Lack of finance to purchase modern equipment | Yes | 35(53.8%) | 24(58.5%) | 13(43.3%) | 49(65.3) | 121(57.4%) |
| | No | 27(41.5%) | 6(14.6%) | 17(56.7%) | 23(30.7%) | 73(34.6%) |
| | I don't know | 3(4.6%) | 11(26.8%) | 0(0%) | 3(4%) | 17(8.0%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| Scarcity of freshly harvested cassava roots | Yes | 11(16.9%) | 8(19.5%) | 5(16.7%) | 20(26.7%) | 44(20.9%) |
| | No | 53(81.5%) | 30(73.2%) | 25(83.3%) | 55(73.3%) | 163(77.3%) |
| | I don't know | 1(1.5%) | 3(7.3%) | 0(0%) | 0(0%) | 4(1.8%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| Lack of waste disposal facility | Yes | 61(93.8%) | 31(75.6%) | 11(36.7%) | 58(77.3%) | 161(76.3%) |
| | No | 4(6.2%) | 8(19.5%) | 19(63.3%) | 17(22.7%) | 48(22.7%) |
| | I don't know | 0(0%) | 2(4.9%) | 0(0%) | 0(0%) | 2(1.0%) |
| | Total | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100) |

Table 5b reveals that 121(57.4%) agreed to lack of finance to purchase modern equipment and 163(77.3%) disagreed to scarcity of freshly harvested cassava roots while 161(76.3%) respectively agreed that lack of waste disposal facility.

Table 11:

| **Variable** | **Items** | **Adeta** | **Ita Amo** | **Agbo-oba** | **Ogidi** | **Total** |
|---|---|---|---|---|---|---|
| | | n=65(%) | n=41(%) | n=30(%) | n=75(%) | n=211(%) |
| Non availability of processing facilities | Yes | 49(75.4%) | 32(78%) | 18(60%) | 56(74.7%) | 155(73.4%) |
| | No | 16(24.6%) | 2(4.9%) | 12(40%) | 14(18.9%) | 44(20.9%) |
| | I don't know | 0(0%) | 7(17.1%) | 0(0%) | 5(6.7%) | 12(5.7%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| Fluctuation in market prices | Yes | 50(76.9%) | 26(63.4%) | 30(100%) | 60(80%) | 166(78.7%) |
| | No | 15(23.1%) | 9(22.0%) | 0(0%) | 12(16%) | 36(17.0%) |
| | I don't know | 0(0%) | 6(14.6%) | 0(0%) | 3(4%) | 9(4.3%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |
| Investments costs for the more efficient technologies are high | Yes | 37(56.9%) | 27(65.9%) | 25(83.3%) | 48(64%) | 137(64.9%) |
| | No | 7(10.8%) | 2(4.9%) | 2(6.7%) | 9(12%) | 20(9.5%) |
| | I don't know | 21(32.3%) | 12(29.3%) | 3(10%) | 18(24%) | 54(25.6%) |
| | **Total** | 65(100%) | 41(100%) | 30(100%) | 75(100%) | 211(100%) |

It is indicated by table 5c above that 155(73.4%) respectively agreed that non availability of processing facilities. 166(78.7%) agreed that fluctuation in market prices while 137(64.9%) agreed that investments costs for the more efficient technologies are high.

**Laboratory Result**

Table 12: Mean Microbial Load $cfug^{-1}$and Coliform count CFU/ML

| Factory | Total Aerobic Plate Count | Coliform count |
|---|---|---|
| Agbo oba | $2.75 \times 10^2$ | $1.8 \times 10^{3s}$ |
| Adeta | $2.21 \times 10^2$ | $1.9 \times 10^3$ |
| Ogidi | $3.04 \times 10^2$ | $1.2 \times 10^3$ |
| Ita Amo | $2.04 \times 10^2$ | $1.9 \times 10^3$ |

The total aerobic plate count of garri samples collected from Ogidi revealed the highest count $3.04 \times 10^2$ followed by Agbo oba $2.75 \times 10^2$ and the lowest TAPC was gotten from Ita Amo. The lowest coliform count was gotten

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IV April 2026

from Ogidi with prevalence of $1.2 \times 10^3$ and the highest was gotten from Adeta and Agbo oba $1.9 \times 10^3$ respectively

Table 13: Biochemical Characteristics for Bacteria Isolates.

| GR | MO | IND | MRT | VP | CIT | CAT | OXI | COA | LAC | SUC | MAN | PROBABLE ORGANISM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| + | _ | _ | _ | + | _ | + | _ | + | + | + | _ | Staphylococcus aerus |
| + | + | _ | _ | + | + | + | + | _ | + | + | _ | Bacilus cereus |
| _ | + | + | + | _ | _ | + | _ | _ | + | + | + | Escherichia coli |
| _ | + | + | _ | + | + | + | + | + | _ | + | + | Pseudomonas spp |

**Key:** GR (Gram Reaction), MO (Motility), IN(Indole), MRT(Methyl Red Test), VP (Voges Proskauer), CIT (Citrate), CAT (Catalase), OXI (Oxidase), COA (Coagulase), LAC (Lactose), SUC(Sucrose), MAN(Mannitol), _ Negative reaction, + Positive Reaction.

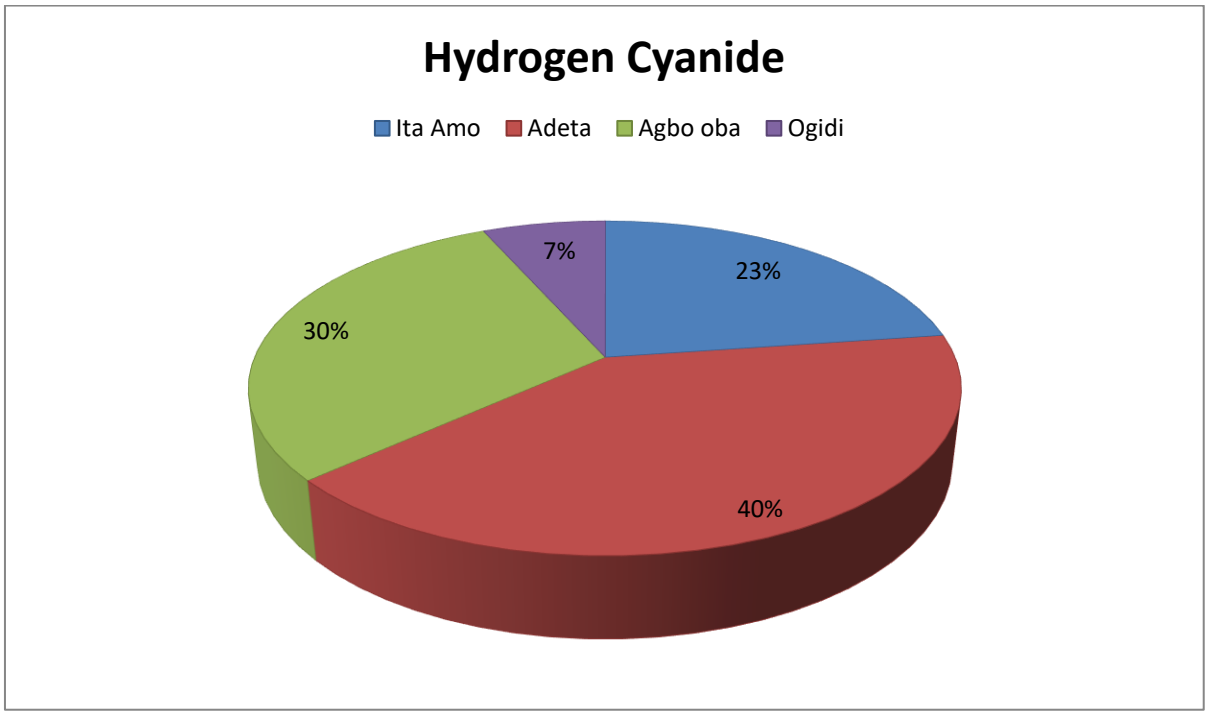
The analysis of garri sample collected revealed the presence of Staphylococcus aerus, Bacilus cereus, Escherichia coli and Pseudomonas spp

Table 14: Hydrogen Cyanide Analysed

| Sample code | HCN (mg/kg) | Percentage (%) |
|---|---|---|
| Ita amo | 4.10 | 23 |
| Adeta | 7.30 | 40 |
| Agbo oba | 5.40 | 30 |
| Ogidi | 2.20 | 7 |

The table above revealed that Adeta processing factories has the highest level of cyanides 7.30 and Ogidi has the lowest level of cyanide

Figure 3



ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IV April 2026

# DISCUSSION

**Socio- Economic Characteristics of Respondents:**

Out of 211 respondents who participated in this study, the age distribution of respondents increased as the age class increased excluding the drop in frequency at 60 and above, while a lot of the respondents 72(34.1%) are within the ages of 50 – 59 which conforms that majority of the respondents are above reproductive age. This is different from a study conducted by Thomas and Philip (2015) in their study on assessment of food safety practices among cassava processors in selected rural communities of Oyo state, Nigeria, where the majority of the respondents were in the age group of 31- 40 years. There are more females 163(77.3%) than males 48(22.7%) respondents in cassava flakes processing factories. This is similar to a study by Aluh et al.,(2017) on Knowledge, attitudes and practices of food hygiene among mobile food vendors in a Nigerian rural settlement where most respondents were female 192(94.1). And also agree with the study by Thomas and Philip (2015) where most of the respondents were female 147(95%). This implies that there were more female that are engaged in food handling than male. This is a validation of the female natural tendency to be engaged in food processing. This also implies that any processing interventions targeted at women in the quest for food safety practices will consequently impact positively on households to achieve reduction in processing related food contamination.

Most of the respondents across the factories were married 92(44.0%), this is similar with the study carried out by Isara et.al (2017) on the Food hygiene and safety practices of mobile food vendors in Benin City, Nigeria, where majority of the respondents were married 155(62.0%). Most of the respondents 80(37.0%) had no formal education. This agrees with the study carried out by Thomas and Philip (2015) where most of the participants 63(40.9%) had no formal education. This findings is different from the study by Isara et al (2017) where most of the respondent 139(55.6%) had secondary education. This different maybe be explained by the fact that most of the respondents were in their late 50s and couldn't have access to education during their early stage.

Most of the respondents in the four factories level of income were less than 10,000 with an approximate of ratio one (1). This is in contrast with the study carried out by Thomas and Philip (2015) where majority of the respondents 98(63.6%) earn more than 10,000. Though the job was stressful, but the workers payment was low. In the course of this study, it was revealed that only the head of the factories earn more than 10,000.

In the four factories, we have more respondents with their year of experience to be less than 9years 109 (51.7%). This is similar with the study by Isara et al (2017) where majority of the respondents 122(48.8%) had experience less than 5years and in contrast with the study by Thomas and Philip (2015) where majority of the respondent 57(43.5) had an experience of above seventeen years. Most of the respondents in the four factories have never had any training on food hygiene; 67(31.8%). This is in contrast with the study by Aluh et al (2017) where 214(60.78%) have had training on food hygiene. This finding also tally with study done by Omemu and Oloyede (2014) on Assessment of the hygiene practices and the incidence of enteric bacteria in food handlers in small business in an urban area in Abeokuta, where majority 88% of the food handlers had no training about food hygiene.

**Knowledge on Cassava Flakes Hygiene.**

Most of the respondents 134(63.5%) agreed that cassava flakes hygiene is when its endured ensure that cassava flakes is handled, processed and stored in a way and manner that will prevent it from contamination. For the respondents knowledge regarding personal hygiene, 140(66.4%) agreed that washing of hands always before handling and processing of cassava flakes can reduce the chances of transmitting food borne illnesses. 158(74.9%) agreed that packaging and storing of cassava flakes after processing must be done only in clean and tidy, 169(80.1%) agreed that personal and environmental hygiene should be strictly observed during processing of cassava flakes while 134(63.5%) agreed that washing and cleaning the processing equipment before and after use affects the safety of cassava flakes.

This is almost similar with the study carried out by Lahiru et al.,(2016) to assess the knowledge and practices of food hygiene among food handlers in plantation sector, Sri Lanka, where 59.6% of the food handlers had good knowledge of food hygiene and safety. However, 88% of them confirmed that they wash hands with soap after defecation. 188 (58%) had awareness of food borne illnesses.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IV April 2026

In this study, 168(79.6%) agreed that it is absolutely necessary to follow all for the processing steps during cassava flakes production in order to reduce the risk of food poisoning. 135(64.0%) agreed that the floor and all the utensils used during the processing of cassava flakes must be kept clean and tidy at all times while 130(61.6%) disagreed that washing of peeled cassava enhances its quality and safety. 111(52.6%) respectively disagreed that it is necessary to process cassava root immediately after harvesting**.** 167(79.2%) disagreed that Cyanide is a poisonous substance that can be found in cassava while 168(79.6%) disagreed that Grating cassava plays a major role in reducing its Cyanide content. 136(64.5%) disagreed that Fermentation has effect on the level of cyanide content of cassava. This is similar to the study carried Thomas and Philip (2015) whereby the respondents 153(99.4%) agreed that fermentation has no effect on the level of cyanide in cassava and 152(98.7%) disagree that a poisonous substance known as cyanide can be found in cassava. The result shows that most processors unintentionally carry out activities that help remove the harmful content in cassava roots, but are not really aware of the presence of a poisonous substance called cyanide in cassava roots.

Also, 181(85.8%) agreed that Pressing of cassava mash after grating has effect on the quality of cassava flakes. Also 134(52.0%) respectively agreed that Cross contamination can be prevented by using non rusting knives and grater while 184(87.20%) agreed that Mash fermentation should be for a minimum of 3 days and a maximum of 5 days. This is in contrast with the study carried out by Thomas and Philip (2015) whereby 143(92.9%) of the respondents disagree on the need that mash fermentation should be for a minimum of 3days and a maximum of 5days, 151(98.1%) also disagree that using non rusty knives and grater can help prevent cross contamination, 143(92.9%) of the respondents disagree that pressing of cassava mash after grating has effect on the quality of cassava flakes. Though in this study, the knowledge on cassava food safety was acceptable, many of the respondents does this as following the normal processes and not as a way of enhancing cassava flakes safety and hygiene.

**Attitude of Respondents on Cassava Flakes Hygiene**

In this study, 128(60.7%) agreed that Food borne illness can be prevented by good processing of cassava flakes, 111(52.6%) agreed that good processing hygiene of the cassava flakes processors can prevent food poisoning while 95(45.0%) agreed that Obtaining more knowledge on cassava safety is not a solution to food safety problems. Also 105(49.8%) never had a comprehensive medical checkup before they were employed as a worker. This is different from a study carried out by Aluh et.al.,(2017), where the periodic medical exam of the respondent was 124(60.78%)

The respondents 87(41.0%) agreed that Knowledge on cassava flakes hygiene benefits both their work and personal life. 108(51.2%) agreed that mouth should be covered during sneezing or coughing when processing an unprotected cassava flakes. This is in contrast with the study by Thomas and Philip (2015) where majority of the respondents 64(41.6%) strongly disagree that good processing hygiene of the cassava flakes processors can prevent food poisoning, 100(64.9%) strongly disagree that obtaining more knowledge on cassava safety is not a solution to a safety problems. Also 112(53.1%) agreed that It is of a great burden to ensure safe processing practices during cassava flakes production while 74(35.1%) are undecided on if the adequate provision of appropriate, suitable, clean and protective clothing is necessary during cassava flakes processing This is in contrasting with the study conducted by Akabanda et al.,(2017)on Food safety knowledge, attitudes and practices of institutional food-handlers in Ghana, whereby about 60% of respondents indicated that using caps, masks, protective gloves and proper clothing can minimize the risk of food contamination, which is a positive attitude reported by majority of the respondents.

**Hygiene practices of the Respondents**

From this study, 116(59.9%) always wash their hands before and after peeling cassava. While 128(60.6%) always wash their hands with water after using the toilet. 122(57.8%) never work when they have diarrhea. While 87(41.2%) never work when they have lesion in their hands. Also, 156(73.9%) always cover their hair during frying and grating of cassava while 145(68.7%) never wear personal protective clothing at work,95(45.0%) never wear clean clothes during processing in which they believe cassava processing is a dirty job that doesn’t require changing of clothes. 107(50.7%) always cut their nails often.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IV April 2026

This is similar to the study by Akabanda et al; (2017) on Food safety knowledge, attitudes and practices of institutional food-handlers in Ghana, in which majority of respondents (93.6%) agreed that knives and cutting boards should be properly sanitized to prevent cross contamination of foods. Respondents also agreed that individuals with abrasions or cuts on their fingers or hands should not touch unwrapped foods (87.2%). The majority (88.1%) of food-handlers were aware that food should not be handled with long and painted fingernails. It also concur with the study by Isara et.al., (2017) on the Food hygiene and safety practices of mobile food vendors in Benin City, Nigeria majority of respondents 143 (57.3%) properly covered their hair, Hand washing before and after handling food was practiced by 115(46.0%). The utensils used were considered clean in majority217 (86.8%) of the food vendors but minimum 47(18.8%) kept long finger nails,

Thus, the general practice of the food handlers towards food hygiene was not entirely satisfactory. Safe handling and preparation of food and good hygienic practices are an essential part of any strategy to improve the safety and quality of cassava flakes.

**Factors Affecting Hygiene practices among Cassava Flakes Processors**

This study also revealed that 203(96.2%) agreed that processing activity is time consuming and strenuous. While 190(90.0%) also agreed that the nature of the safety practices is inconvenient. 145(68.7%) agreed that inadequate access to potable water is a constraint to proper hygiene. 121(57.4%) agreed to lack of finance to purchase modern equipment and 163(77.3%) disagreed to scarcity of freshly harvested cassava roots while 161(76.3%) respectively agreed that lack of waste disposal facility. 155(73.4%) respectively agreed that non availability of processing facilities. 166(78.7%) agreed that fluctuation in market prices while 137(64.9%) agreed that investments costs for the more efficient technologies are high.

**Bacterial Analysis:**

The bacteria isolated from this samples were; Staphylococcus aereus, Bacillus cereus, Pseudomonas spp, Eucherichia coli. This is similar to the study conducted by Isichei and Imiere, (2017), on Assessment of the Impact of Processing Environment on the Microbial Quality of Garri Processing. The microorganisms isolated during the study were s Staphylococcus aureus., Salmonella sp., Escherichia coli, bacillus sp., Pseudomonas sp., Aspergillusniger and penicillium sp. It also concur with study conducted by Olapade et al., (2014), on microbiological quality of fermented cassava (Garri), the microorganism isolated were; Salmonella spp…, Klebsiellaspp…, Pseudomonas spp.., Bacillus spp.., clostridium spp.., Fusarium spp.., Aspergillus spp., Penicillium spp.., Rhizopus spp.., Staphylococcus spp.., and clostridium spp. Although the microbial load counts with the exception of coliform counts are within acceptable standard limits (ICMSF, 1996), the presence of B. cereus and S. aureus calls for concern because some strains of these organisms are known to be toxigenic and have been implicated in food borne intoxication (Mensah et al., 1999; Oranusi et al., 2007), their presence therefore calls for concern. B. cereus is common environmental contaminants while S. aureus is of human origin, their presence could therefore be from the food handlers, utensils and the environment. The processing of garri for consumption often involve mild or no heat treatment, the toxins from B. cereus and S. aureus if and when elaborated in food are heat stable, the consumption of contaminated garri could therefore portend a potential risk to consumers. The presence of coliform which is an indication of faecal contamination could be attributed to lack of personal hygiene of handlers as well as the poor sanitary condition of the processing/display environments.

**Cyanide Analysis**

The highest level of cyanide in this study is 7.30 mg/HCN/kg, while the lowest is within 2.0 mg/HCN/kg. This is does not concur with the study conducted by (Ajifolokun, 2018) on Physico Chemical Characteristics and Storage Stability of Breadfruit and Cassava Co-Fermented into Garri Analogu where the highest was 13.72 mg/HCN/Kg while the lowest content was 8.1 mg/HCN/Kg Moreover, the cyanide levels are below the detrimental level of 10 mg/kg (WHO 1965). These products could therefore be considered safe with regard to cyanide poisoning.

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# CONCLUSION

This study revealed the knowledge on cassava flakes hygiene was adequate though their knowledge about the processing steps involving the level of toxic substance in cassava known as cyanide was low. Most processors unintentionally carry out activities that help remove the harmful content in cassava roots, but are not really aware of the presence of a poisonous substance called cyanide in cassava roots.

Their attitude towards cassava flakes hygiene and their hygiene practices were inadequate. The response was due to the respondents' belief that their personal hygiene had nothing to do with cassava flakes safety. The factories also lack personal protective clothing which is the responsibility of the management to make adequate provision. The pre-employment medical checkup was low in the sense that the processors believed that medical checkup does not correlate with the safety of the food being produced.

Vast array of bacteria isolated from the garri processed in these factories portend alarming danger posed by consumption of garri sold in this study area. This is likely to be associated with poor processing, post processing, handling practices such as spreading on the floor, mat and sometimes on high density polyethene, after frying to allow it to cool before sieving into finer grains. Though the bacteria load is still within the permissible level, the products from these factories are considered safe.

Even though the processors ignorantly followed the processing steps, the level of cyanide in the cassava flakes was within the permissible level of the standard set by the world Health organization.

For effective checkmating, strict application and implementation of quality control, quality assurance, good manufacturing practice and the hazard analysis critical control point principles will help to ensure the safety of Garri consumed by several people in Ilorin west LGA.

The socio- economic characteristics of the respondents wasThis study found that while processors had adequate knowledge about the hygiene of cassava flakes, their understanding of cyanide and its processing steps was limited. Many processors unknowingly performed steps that reduced harmful content but were unaware of cyanide's presence.

Their attitudes and hygiene practices were inadequate, influenced by the belief that personal hygiene did not affect cassava flakes safety. The lack of personal protective clothing and low rates of pre-employment medical checkups further compromised safety.

Bacteria isolated from the garri sold in this area pose a significant risk, largely due to poor processing and handling practices, despite the bacteria load being within permissible levels. Even so, cyanide levels in the cassava flakes were within acceptable limits set by the World Health Organization.

To ensure safety, strict implementation of quality control and hygiene practices is essential. The socio-economic characteristics of the respondents did not have a uniform relationship with their knowledge of hygiene. Only age, educational level, and ethnic group showed significant links, while other factors like sex and educational status had no significant impact on hygiene practices among processors. not entirely dependent on the knowledge of processors on cassava flakes hygiene because only the Pvalue for Age (0.000), Educational level(0.003), and Ethnic group (0.000) has significant dependence on knowledge of processors on cassava flakes hygiene. Also, the socio economic characteristic was not entirely dependent on the hygiene practices among respondent because some of the chracteristics, Age (pvalue 0.95), educational status (0.468) and sex (0.14) has insignificant dependence on the hygiene practices among cassava flakes processors.

# RECOMMENDATION

This study recommend that the government should facilitate increasing knowledge of correct food safety and hygiene practices through awareness campaigns and sensitization that will drive home the importance of food safety practices. Government and non-government agencies' effort in this direction will advance cassava food

safety in Nigeria. The health workers should also embark on a regular food control monitoring and evaluation of processors on their food safety practice and hygiene should be encouraged.

**Funding Declaration:** There was no Funding for this study

**Clinical Trial Number:** Not applicable.

**Human Ethics and Consent to Participate declarations:** Not applicable.

**Declaration Section;**

- **Ethical approval**: Ethical approval was obtained from the Institution Research Ethics Directorate of Kwara State University, Malete, and all human-related procedures were performed in accordance with the institutional guidelines.

- **Consent to participate:** Informed consent was presented to all participants, and participation was voluntary; confidentiality was ensured, and respondents were informed of their right to withdraw at any time.

- **Consent to publish:** Not Applicable

**Data Availability Statement:** The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

**Author Contribution declaration:** Islamiyyat Olaronke Agoro conceptualized and designed the study, coordinated data collection, conducted fieldwork, and drafted the initial manuscript. Bilewu O. Olaolu contributed to the study design, supervised the research process, and provided critical revisions to the manuscript. Andrew O. Deborah participated in data analysis, interpretation of laboratory findings, and manuscript editing. Adedapo Adejumo contributed to the laboratory analysis, validation of results, and review of the final manuscript.

**Competing Interest declaration:** No Competing Interest

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