Volume 3, Issue 3, 2020 ISSN: 2617-4588
DOI: https://doi.org/10.31058/j.edu.2020.33004

# An Appraisal of Microbiological Qualities and Loads of "Fufu" in Selected Licensed and Non-Licensed Chop Bars in the Central Region of Ghana

**Patience Owusua Annoh[1*], Juliana Tawiah[2], Gifty Akorfa Darkwah[3], Philomena Arthur[4]**

[1] Department of Technical and Vocational Education and Training, Seventh Day Adventist College of Education, Koforidua-Asokore, Ghana
[2] Department of Technical and Vocational Education and Training, Ola College of Education, Cape Coast, Ghana
[3] Department of Technical and Vocational Education and Training, Mount Mary College of Education, Somanya, Ghana
[4] Department of Vocational Education, Saint Louis College of education, Kumasi, Ghana

## Email Address

bordohlity@yahoo.co.uk (Patience Owusua Annoh)
*Correspondence: bordohlity@yahoo.co.uk

**Received:** 1 February 2020**; Accepted:** 16 April 2020**; Published:** 18 May 2020

## Abstract:

The study examined microbiological qualities and loads of "fufu" in selected licensed and non-licensed Chop Bars in the Central Region of Ghana. A guided observation schedule (ICOSFUP) was used to record unhygienic practices from the chop bars. Specimens of source of water for turning "fufu", mortar, pestle, "fufu" and water for turning "fufu" were analysed for total heterotrophic bacteria, yeast and mould, total coliform bacteria, faecal coliform bacteria, and E. coli on Nutrient Agar, OGYE Agar, M-Endo Agar, MacConkey Faecal Coliform Agar, and Hichrome Agar respectively. Both the Multiple Tube Fermentation and Membrane Filtration methods were used for the analysis. It was found out that water used for turning "fufu" made the strongest unique contribution (Beta = 0.485) to the microbial contamination of "fufu". All the microbiological parameters tested for far exceeded their standardized limits in "fufu" (16.5-5983.25 cfu/1ml/100ml). Findings of the study indicated that there is high amount of microbial contamination in "fufu" being sold and consumed in Cape Coast metropolis. The study recommended that, the Ghana Tourism Authority and Cape Coast chop bar owners Association should at regular intervals, collect and test "fufu" specimens from licensed and non-licensed chop bars to determine the microbial loads in the "fufu" to reduce the possible sources of contamination in "fufu" preparation in the metropolis.

## Keywords:

Appraisal, Microbiological, Qualities, Loads, "Fufu", Chop Bars, Ghana

## 1. Introduction

Foods prepared or eaten outside the home are less expensive, cooked in just a matter of minutes, and very much accessible [1]. This gives low-income earners the opportunity to afford food, helps people to do away with the difficulty in preparing food at home, gives people many new choices in the food to eat and affords them the joy of eating foods of ethnic delicacy. Despite these advantages with foods prepared and served outside the home, those foods are usually highly contaminated or face a greater risk of contamination [2]. surveillance and monitoring by a number of countries indicates that food-borne illness is increasing around the world [2]. As such issues on contaminated foods have become a global concern, especially with the increase in the number of food vendors and joints. Thus advises that with recent increases in events concerning the contamination of various foods, it is important to know and understand the sources and mechanisms (practices) of food contamination [2].

With the belief that the catering industry is the primary source of food-borne outbreaks, report shows that, increase in food vending outlets, particularly the traditional catering establishments, accounted for the increase in food contamination cases in the country [3]. The New Harmonised Standards for Accommodation and Catering Establishment by the Ghana Tourism Authority classified traditional catering under the informal catering sector [4]. The sector encompasses all traditional catering establishments such as drinking bars, snack bars, wayside catering, home catering and chop bars. Chop bars, as part of the traditional catering establishments, are noted to serve local foods, including "fufu" (pounded boiled starchy root and plantain) with soup, "akple" (a fermented maize and cassava dumpling) with okro soup, "waakye" (boiled rice and beans), "kontomire" stew and boiled plantain or yam, stew and boiled rice, fried fish with pepper sauce and kenkey, and a lot more.

"Fufu" is a traditional dish that goes through several stages during its preparation. Again, it is highly patronised by several people, both literates and illiterates and so the problem of examining the particular points of contamination becomes even more relevant for public health. Statistics shows that sicknesses due to food contamination are prevalent in Cape Coast Metropolis more than any other district of the Central Region [5, 6]. Questions which keep arising include the following: After the staples are boiled and allowed to cool, how safe is "fufu" from the time pounding starts to when it is completed? How clean are the mortars and pestles? How clean is the source of water and also the water used for turning "fufu"? What is the microbial load of the finished "fufu" at the time it is served to people?

A Study conducted on Sources of Microbial Contamination of "Fufu" Production in Ghana: Selected Licensed and Non-licensed Chop Bars in Cape Coast Metropolis and published in American Journal of Food Science and Health postulated that there was high amount of contaminated "fufu" being sold and consumed in Cape Coast [7 ]. Source of water for pounding "fufu", specimen from the mortar and pestle, and water for turning "fufu" were found to be the possible sources of contamination of "fufu" produced in chop bars in the Cape Coast Metropolis. Practices such as the use of untreated water to turn "fufu", improper washing of mortar and pestle, and improper washing of hands before pounding and turning "fufu" contributed significantly to the unwholesomeness of "fufu" [7].

However, the microbiological qualities and loads of "fufu not examined. It was in line with this concern, coupled with the prevalence of food-borne diseases in the metropolis that this study was undertaken as a follow up, to examine of microbiological qualities and loads of "fufu" in selected licensed and non-licensed chop bars in the

Central Region of Ghana. The study sought to answer these research questions- (1) How are the microbial loads of "fufu" from the selected licensed chop bars different from those non-licensed ones? (2) To what extent do microbiological qualities of "fufu" specimen from the selected chop bars meet acceptable Ghana and international food standards?

## 2. Review of the Literature

The preparation stage of "fufu" involves the transformation of raw foodstuffs into consumable foods. Cooking involves systematic manipulation of foods using a variety of methods that involve physical, chemical and water content changes [8]. Food preparation requires energy, skills and resources to perform preparation activities within the traditions of a particular culture's cuisine. Many household preparation techniques have parallels in the methods used in food processing with both stages manipulating foods using physical processes to transform raw materials into food products.

"Fufu" is a staple food of the people of the West and Central Africa [9]. It is a thick paste of porridge usually made by boiling starchy root vegetables in water and pounding with a large mortar and pestle until the desired consistency is reached. In Western Africa, "fufu" is usually prepared from yam (Disorea species), cassava (Manihot esculenta crantz), plantain (Musa paradisiaca AAB), and cocoyam (Xanthosoma species). "Fufu" can also be made from semolina, rice, or even instant potato flakes. In Ghana, "fufu" is often made from cassava and plantain.

The tools and equipment needed in pounding "fufu" include mortar, pestle, and bowl for keeping water for turning "fufu" and many more. Other things that have direct contact with the "fufu" include water, the hand of the one turning the "fufu", the napkins or towels used when pounding the "fufu", the one who stands to pound the "fufu" and the serving bowl. The raw materials, tools and the personnel having direct contact with the "fufu" can be sources through which "fufu" can be contaminated [10]. This is because they may be carrying biological, chemical or physical hazards that can cause food-borne diseases.

A book titled "Ghana: Cultures of the world" affirmed that, the dish is carried out using traditional methods such as peeling, boiling (with the starch granules partially gelatinised), and pounding (beating the base substance in a mortar with a wooden pestle). After boiling the staples, they are fetched with the bare hands one after the other and placed in the mortar and crushed with a pestle. It is later turned over by hand lubricating intermittently between beatings with water until the desired texture is reached. The beating causes the starch granules to break down and imbibe water, causing the mass to become soft, sticky and elastic. At the desired level of stickiness and softness, the product is shaped into forms and served [9].

Pounding "fufu" is a tedious and time consuming undertaking. The turning with hand during pounding may not be done under hygienic conditions and this may contaminate the "fufu" and cause food-borne illnesses since it is usually consumed cold. To avoid the manipulation of the "fufu" with bare hands, a "fufu" making machine is available on the market, using a blender action to prepare the sticky mass [11]. A food processor with a powerful motor can also be used to prepare the product, provided the cooked tubers are first mashed and crushed. The rapid movement of the processor blades breaks down the starch granules, and gives the same effects of stickiness and softness desired in the traditionally pounded "fufu" [11].

The processing technology has been developed for the production of flours from yam, cassava and other tubers, and plantain, in the production of instant "fufu". The instant "fufu" flours prepared from predominantly fresh peeled pieces of tubers are precooked, disintegrated and dried. The dried products are milled, sifted to separate the fibre and blended (added) with some levels of pure starch in order to give the flour the desired elasticity and stickiness when reconstituted into paste as "fufu" [12]. In contexts where poverty is not an issue, or where modern appliances are readily available, a food processor should be used by everybody to minimise fatigue and also as much as possible reduce the level of microbes in the "fufu".

In Western and Central Africa, the commonest way of eating "fufu" is to serve a mound of "fufu" along with a sauce or thin or thick soups made from okro, fish, meat, tomato, pepper [9]. The diner pinches off a small ball of "fufu" and makes an indentation with the thumb. This reservoir is filled with sauce, and the ball is eaten. In Ghana and Nigeria, the ball is often not chewed but swallowed whole by most people who eat it. Notably it has to go through Stages of preparation before it can be consumed.

Receiving raw staples is the first stage in the preparation of "fufu". Potential biological, physical and chemical hazards during receiving of ingredients for preparing "fufu" include contamination, spoilage, rapid bacterial growth and the presence of foreign objects. All these can occur during harvesting, transporting, and marketing and also in the type of equipment that the staples may be stored or packed in. The rapid bacterial growth continues to be hazardous during storage of the raw ingredients for "fufu" and therefore must be controlled during storage. The preparation of raw ingredients before cooking should also be controlled especially when peeling, cutting and washing. It also captures the use of water, knives, other cutting materials and the bowls for storing water for use [11].

Cooking is the next stage in "fufu" preparation. Usually there is little worry during this stage since cooking or boiling staples at 100oC kills most bacteria present. However, undercooking may not kill all bacteria in food [13]. Pounding the cooked staples for the "fufu" can be harmful. Contamination may originate from the food handler's hand, container for keeping water for turning "fufu", water, mortar and pestle. Furthermore, the use of cold water for turning "fufu", not washing hands with soap and clean water before turning "fufu", not sanitising food preparation surfaces and tools before and after their use, not complying with sanitation and personal hygienic rules and practices may cause an increase of microbial load in "fufu" [11].

Serving of the "fufu" is also a necessary stage in "fufu" preparation. The "fufu" has to be transferred from the mortar to a serving dish or container. The transfer may result in contamination if the dish or container is not clean or sanitised well. This comes about through the use of unclean and unsanitised dishes, containers and utensils. To prevent the "fufu" from sticking to the bowl, some water is poured or sprinkled into the bowl. This can also be a source of contamination.

Coliforms are a group of different kinds of bacteria, which suggest that, there are a number of subsets within the coliform group. Coliform bacteria are employed as the indicator organism mostly used in bacterial food analysis. They are easily found in animal faeces especially of human origin; soil and raw surface water [14]. They are rod-shaped Gram negative organisms which ferment lactose with the production of acid and gas when incubated at 35-37 ℃. The presence of bacteria from each progressively smaller subset heightens the concern that disease-causing organisms may also be present in the food.

The total coliform test is used as the starting point for determining the biological quality of food and their presence in a water sample, presuppose that a disease organism may possibly be present [15]. The use of total coliform test as an indicator may be for cost effectiveness, since it may be costly and almost impracticable to test for every type of disease-causing organism. Typical general of coliform (include *Citrobacter*, *Enterobacter*, *Hafnia*, *Klebsiella*, *Serratia*, *Faecal coliform* and *Escherichia coli* (*E.* coli) [16]. Faecal coliform falls under the total coliform family; it inhabits the intestine of mammals and has a relatively short life span compared to other coliform bacteria and serves as an indication of contamination by sewage [17]. Their presence could be related to improper disposal of sanitary waste. Faecal-specific indicator bacteria such as *E. coli* are the parameters of first importance in monitoring faecal pollution. Of all the biological parameters, *E. coli* is the most preferred faecal coliform used to analyse food, because it gives indication of faecal contamination. Additionally, *E. coli* does not reproduce in the environment. Consequently, it is considered to be the species of coliform bacteria that is the best indicator of faecal pollution and the presence of pathogens [14, 17]. However, since complete identification of *E. coli* is complex and time consuming, an alternative to counting *E. coli*, most often than not, is for researchers to identify and enumerate faecal coliform in the different samples.

Escherichia coli (E. coli) is a rod-shaped member of the coliform group and can be distinguished from most other coliforms by its ability to ferment lactose at 44 ℃ in the faecal coliform test, and by its growth and colour reaction on certain types of culture media. They are naturally found only in the intestines of mammals, including humans. The main source of *E. coli* in food is through recent contact with human or animal waste. A research study on effective and culturally acceptable water storage in Zimbabwe: Maintaining the quality of water: argued that traditionally, the presence of *E. coli* in foods is an indication of faecal contamination of food or water [18]. Organism's characteristic of faecal contamination are usually used as a proxy measure of faecal contamination in food, rather than directly assessing the presence of pathogens. It must be noted that not all strains of *E. coli* are harmful [19]. While some strains of the bacteria are pathogenic and can cause serious illness in humans, others especially those naturally found in the gut of humans and animals, are harmless [16, 20-21]. *E. coli* have an incubation period of 12-72 hours with the optimal growth temperature being 30-37 ℃.

Heterotrophs are those micro-organisms that use organic compounds for most or all of their carbon requirements [22]. Since they cannot make their own food, heterotrophs break down organic compounds to meet their carbon requirements [22, 23]. Heterotrophs include bacteria, yeasts and moulds, this clearly shows that, heterotrophic plate count (HPC) is a microbial method that uses colony formation on culture media to approximate the levels of heterotrophic flora. HPC does not however, give an indication of the types of organisms present or their sources [24]. A study done by World Health Organization noted that, the results obtained using an HPC test are not an accurate assessment of total heterotrophic concentrations, but instead, are indications of culturable organisms present [24]. Ingestion of heterotrophic bacteria, via drinking-water and food, does not pose any public health risk [25]. However, opportunistic pathogens within the heterotrophic flora constitute a health risk for immuno-compromised individuals, including the very young. For example, some species of *Pseudomonas* can become serious secondary pathogenic invaders in post-operative infections, in burn cases, and in the very young [24]. It was reported by Health Canada that "opportunistic pathogens" that may be recovered among HPC micro-biota include

strains of *Pseudomonas aeruginosa*, *Acinetobacter spp.*, *Aeromonas spp.*, and *Klebsiella pneumonia*, to mention a few. Notwithstanding the fact that these organisms are pathogenic, no association has been found with any of these with gastrointestinal infection through the waterborne route among the general population [26].

Fungi and spore producing organisms are both beneficial and harmful to humans. These plant-like organisms cannot manufacture their own food and must therefore live within or on other organisms [27]. A fungus breaks down the body of the plant or animal it lives on, turning it into starch or sugar that the fungus can absorb. This process, called decomposition, provides the fungus with the energy necessary to survive and reproduce. A fungus reproduces by forming reproductive cells (spores). When the spores settle on a proper medium for their nutrition, they begin to grow and to decompose it. They play an essential role in the manufacture of cheese, yoghurt, soy sauce, enzymes, vitamins and certain drugs and antibiotics. Fungi on the other hand can cause serious health hazards for example, ring-worm and athlete's foot [27]. Fungi can grow under all conditions unlike bacteria. Prevention of fungi growth is therefore necessary because mycotoxins are rather stable and cannot be destroyed by heat [28]. Yeasts, moulds and mushrooms are all types of a life-form called a fungus.

Optimal growth will take place in an environment that is dark, moist, and warm. Moulds grow where there is little moisture [27]. The fact that mould growth has occurred does not necessarily mean that food is unwholesome to eat. However, the presence of mould growth is usually a reliable indication that the food is old or has been stored in poor conditions. Moulds will grow on all types of food. In order to prevent mould, it is best to have an environment with extremes of hot or cold, plenty of light, and a lack of moisture. Refrigeration is one way of preventing mould, as is heating a substance. Heat kills fungi, and cold either slows moulds down to a state of dormancy or kills them. Adding preservatives to food substances are another way of preventing mould growth.

Yeasts are the largest of the micro-organisms but are still single cells, and some produce spores [29]. In foods these micro-organisms attack basically all food components; sugars, starches, cellulose, fats and protein of which the raw staples for preparing "fufu" is no exception. Depending on the food and the micro-organism, the action on food could be to produce acids, making the food sour, or produce alcohol. Some micro-organisms produce gas, making the food foamy; still others produce unwanted pigments or toxins.

Food standards establish requirements for the safety and quality of food. However, unless a food standard is part of food regulations, it is not a legal requirement. Penalties for offenders usually include fines, imprisonment, and closure of premises where there is risk of contamination. A study by Ghana Standard Authority [GSA] and Australia/New Zealand postulated that, there are requirements for food preparation in order to make it safe for consumption [30,31]. GSA cautions that raw materials (cassava, plantain, cocoyam or yam pieces) for "fufu" preparation shall be fresh, mature and clean. The raw materials shall also be free from rot, pest infestation, other diseases and any foreign or extraneous materials.

Ghana Standard Authority indicated under section 3.2.2 of the food safety practices and general requirements in Ghana law, the owners of food businesses are responsible for making sure that people who handle food and the people who supervise these works should have the skills and knowledge to handle food safely [30]. The only exception to this requirement was for charitable or community fund raising events, which sell food

that are not potentially hazardous or that are properly cooked and eaten straightaway. The skills and knowledge requirement was included in the standards to ensure that staff handle food correctly and that it remains safe to eat. Staffs are also required to identify the likely sources and practices that cause food contamination as well as control measures for food contamination. It is clear from the above that every population requires protection from economic fraud and health hazard resulting from unwholesome foods. Food laws serve as the pillars of food control systems and are therefore important to every nation [30].

Ghana Standard Authority has caution that, "fufu" and "fufu" flour shall not contain any substances originating from micro-organisms in amounts which may present a health hazard; "fufu" should not contain E. coli, Staphylococcus and Salmonella [30]. Table 1 presents the details of the Microbiological requirements [30,31].

***Table 1.*** *Microbiological Requirements (Ghana/International Standards).*

| Parameters | Ghana | WHO Guidelines | Method |
|---|---|---|---|
| Total coliform cfu/100ml | 0 | 0 | APHA 9222A |
| Faecal coliform cfu/100ml | 0 | 0 | APHA 9222D |
| *E. coli* (cfu/100ml) | 0 | 0 | APHA 9260F |
| Total heterotrophic cfu/1ml | 500 maximum | 0 | APHA 9215B |
| Mould cfu/ml | 0 | 0 | APHA 9610A |
| Yeast cfu/ml | 0 | 0 | APHA 9610B |

Food Laws and Regulations in Ghana:

The wholesomeness of food is a matter of interest to both government and the citizenry of every country. On the part of government, this concern is evidenced by the enactment of laws to regulate the activities of food handlers. The legal requirements for food safety and food quality have been established by many national governments, with the objective of protecting consumers and ensuring that foods are fit for human consumption. These requirements are contained in food laws and regulations, the scope of which varies across countries. In Ghana, the pursuance of the 1981 Provisional National Defence Council Establishment Proclamation (PNDCL 3035) of the Food and Drugs Law of 1992 was promulgated. The law prohibits the sale of unwholesome, poisonous and adulterated food. Additionally, it takes into account the sale of food under insanitary conditions, which makes the food vulnerable to contamination. Moreover, the law stipulates that food must be manufactured under supervision and that sale of unwholesome food is tantamount to an offence punishable by a fine, imprisonment or at worse closure of promises.

The sale of food in Ghana is controlled through licensing and regular inspection in order to ensure the safety and quality of the food [32]. The only deviation may be the food safety training and assessment of prospective food handlers. Officers of the controlling authority from hygienic point of view conduct initial inspection and once license is issued, foodservice operators are under obligation to meet mandatory provisions of the local authority by-laws. There is the Accra Street Market By-law under the Accra Town Council Ordinance of 1943, which has provisions that enhance the safety of food sold to the public. The Cape Coast Municipal Authority indicated environmental sanitation, maintenance of premises, drainage of waste water, and solid waste management by-laws as possible aspects of food safety [33].

A book titled "Street food situation in Ghana" revealed that not only were the metropolitan by-laws outmoded, they were also not in harmony with current trends in the street food business [32]. Ntiforo stressed that, the laws were not effectively

enforced due to inadequacy of trained staff properly equipped for that task [32]. However, any ideal food control system should include effective enforcement of mandatory requirements achieved through regular inspection programmes [34]. Food and Agriculture Organisation further indicated that the implementation of any food law requires a qualified, trained, efficient and honest food inspection service, because inspectors are the key functionaries who have day-to-day contact with the food industry. A programme that is reactive and enforcement-oriented rather than preventive and holistic in its approach to reducing the risk of food-borne illness results is also not considered worthwhile [34].

## 3. Methodology

The study adopted an experimental research design. The experimental research design allows researchers to test for the effect of changes in an independent variable on a dependent variable. Experimental research design is useful for scientific or laboratory studies [35]. The independent variables used in this research were various processes "fufu" undergoes, whilst the dependent variable was the level of microbial load in "fufu". This helped to ascertain the critical control points for microbial infestation

The population for the study comprised traditional catering establishments in the Cape Coast Metropolis. The traditional catering establishments were of two classes, that is licensed, and non-licensed. According to the records available at the Ghana Tourism Authority, there are 35 traditional catering establishments in the Cape Coast Metropolis [36]. These comprised 18 licensed, and 17 non-licensed catering establishments.

The sample size used for the study was four chop bars made up of two licensed and two non-licensed chop bars. A proportionate calculation of 20% was then applied on these groups to arrive at four and three bars respectively. The 20% proportionate calculation was based on where key informants are used, 20% of the sample is adequate [37].

The instrument considered for the study was guided observation schedule. An assessment tool from the International Code of Hygienic Practice for street food vending was adopted, modified and code-named instrument for collecting data on safety practices in "fufu" production (ICOSFUP) [38]. A guided observation schedule (ICOSFUP) was used to record unhygienic practices from the chop bars. Specimens of source of water for turning "fufu", mortar, pestle, "fufu" and water for turning "fufu" were analysed for total heterotrophic bacteria, yeast and mould, total coliform bacteria, faecal coliform bacteria, and E. coli on Nutrient Agar, OGYE, Agar, M-Endo Agar, MacConkey Faecal Coliform Agar, and Hichrome Agar respectively.

Statistical Product for Service Solutions (SPSS) software Windows version 16.0 was used to analyse the data. The specimen collected were analysed using two analytical methods (multiple tube fermentation and membrane filtration). Two different statistical analytical methods were used for the analysis of the specimen collected. These were Multiple Tube Fermentation (MPN) which uses USEPA test method and Membrane Filtration (MF) which uses APHA test method as its specific procedure. The choices of two analytical methods were based on the fact that Membrane Filtration is highly sensitive and has the ability to detect small numbers of organisms. The parameters tested for at the Ghana Water Company, Cape Coast, were total coliform, faecal coliform, E. coli, temperatures of "fufu" and the moisture contents in the "fufu" whiles the Water Research Institute, Accra also tested for total coliform, faecal coliform, E.

coli, total heterotrophic, moulds and yeasts. The analysis was done by using the means of the results. Regression analysis and laboratory results were used to examine the critical control points of microbiological parameters in "fufu" production.

## 4. Findings and Discussions

### *4.1. Microbial Loads of "fufu" from the Selected Licensed Chop Bars Different from Those Non-Licensed Ones*

The question sought to assess the differences between the microbiological loads of "fufu" produced in licensed and non-licensed chop bars. A cross examination between the two groups of chop bars was conducted using the membrane filtration method (cfu/ml) as against multiple tube fermentation (MPN/ml). The results are presented in Table 2.

From Table 2 non-licensed Chop Bar 'D' recorded the highest mean level of total coliform contamination with 6832 cfu/100ml, followed by licensed Chop Bar 'A' with 5130 cfu/100ml, while licensed Chop Bar 'B' and non-licensed Chop Bar 'C' recorded 1445 cfu/100ml, and 1070 cfu/100ml respectively. Table 2 further shows that the licensed chop bars recorded higher mean numbers of colony forming units for faecal coliform, E. coli and yeast than the non-licensed chop bars, while the non-licensed chop bars had higher total coliform, total heterotrophic and mould than the licensed chop bars.

***Table 2.*** *Mean Number of Colony Forming Units (cfu/1ml and 100ml) for Microbiological Parameters from "Fufu" Specimen in the Chop Bars.*

| | Chop Bars | | | | |
|---|---|---|---|---|---|
| | Licensed | | Non-licensed | | Experimental |
| Microbiological parameters | A | B | C | D | E |
| Total coliform | 5130 | 1445 | 1070 | 6832 | 0.6 |
| Faecal coliform | 44 | 45 | 10 | 41 | 0.0 |
| *E. coli* | 27 | 15 | 6.0 | 18 | 0.0 |
| Total Heterotrophic | 6668 | 4604 | 4804 | 7857 | 0.5 |
| Mould | 253 | 1.0 | 382 | 720 | 0.5 |
| Yeast | 1192 | 384 | 5.0 | 485 | 0.0 |

A paired sample t-test was used to assess whether there were significant differences in the reduction of microbiological parameters in "fufu" by licensed and non-licensed chop bars. Table 3 presents the null hypothesis analysis:

$H_0$: There is no significant difference in the microbial load of "fufu" served in the selected licensed and non-licensed chop bars.

$H_1$: There is significant difference in the microbial load of "fufu" served in the selected licensed and non-licensed chop bars.

The analysis in Table 3 reveals a microbial load mean of 3301.3 for licensed chop bars and a mean of 3705 for non-licensed chop bars. A t-value of .8914 and a significant value of .1450 were recorded. Summarily, ($t$ [70], $p > 0.05$), is not a significant result. This means that statistically there is no difference in microbial load in "fufu" between licensed and non-licensed chop bars. This result supports the null hypothesis that there is no significant difference in the microbial load in "fufu" served in selected licensed and non-licensed chop bars. In other words, the differences in the level of microbiological parameters in "fufu" production in licensed chop bars were not significantly different from the recorded microbiological parameters in non-licensed

chop bars. This finding could be attributed to the fact that both licensed and non-licensed bars employ the same practices in the preparation of "fufu". Also accounting for the study result is lack of proper regulation to monitor the activities of the licensed chop bars.

***Table 3.*** *t-Test analysis of differences in Microbial Load of "Fufu" served in the selected Licensed and Non-Licensed Chop Bars.*

| Chop bars | N | Mean | T | Sig (two-tailed) |
|---|---|---|---|---|
| Licensed | 40 | 3301.3 | .8914 | .1450 (NS) |
| Non-licensed | 30 | 3705 | | |

*p > .05; NS = not significant*

The study result has implications for the institution of laid down regulations and criteria to be met by chop bar operators before their bars are licensed. Regular monitoring (announced and unannounced) of the activities of these bars to ensure strict compliance to hygienic practices in the preparation of "fufu" will go a long way to reduce microbial loads in "fufu". Those found culpable of laid down practices need to be sanctioned appropriately.

### *4.2. Microbiological Qualities of "Fufu" Specimen from The Selected Chop Bars*

The question focused on the extent to which the microbiological quality of "fufu" specimen met acceptable standards stipulated by Ghana and Australia/New Zealand. The aim was to examine the total quality of the "fufu" prepared from the selected chop bars. According to GSA (2009) and Australia/New Zealand (2002), food ("fufu") shall not contain any substances originally from micro-organisms in amounts which may present a health hazard. Details of the results from test mean in "fufu" are presented in Table 4.

From Table 4, the test mean of total coliform of "fufu" was 3619.25 cfu/100ml. This test mean should not be noticed in food [30, 31]. Level of faecal coliform by the membrane filtration technique was 35.0 cfu/100ml which also exceeded the acceptable level of load of 0 cfu/100ml. The results pointed out that the test mean levels of E. coli recorded in "fufu" from the selected chop bars was 16.5 cfu/100ml, contrary to Australia/New Zealand and GSA contention that E. coli is not prevalent in "fufu". This revelation implies that "fufu" from the selected chop bars were contaminated with E. coli. The presence of E. coli in foods is an indication of faecal contamination of food or water. The presence of total heterotrophic bacteria was 5983.25 cfu/1ml which exceeded Ghana standard of 500 cfu/1ml for potable water.

***Table 4.*** *Comparisons between Ghana/International Standards and Test Mean Number of Colony Forming Units for TH (cfu/1ml) and other Microbiological Parameters (cfu/100ml) in "Fufu" from selected Licensed and Non-Licensed Chop Bars.*

| Microbiological parameter | Ghana/International standard (cfu/1ml and cfu/100ml) | Test mean (cfu/1ml and cfu/100ml) |
|---|---|---|
| Total coliform | 0/0 | 3619.25 |
| Faecal coliform | 0/0 | 35.0 |
| *E. coli* | 0/0 | 16.5 |
| Total Heterotrophic (TH) | 500/0 | 5983.25 |
| Mould | 0/0 | 339 |
| Yeast | 0/0 | 516.5 |

In addition, it was mandatory that "fufu" shall not contain any count for yeast and mould [30,31]. However, the laboratory tests of the "fufu" specimen from the selected chop bars recorded means of 339 cfu/1ml, and 516.5 cfu/1ml for mould and yeast, respectively.

However, excess coliform bacteria such as total coliform and faecal coliform in food cause salivation, nausea, vomiting, retching, abdominal cramps and diarrhoea [27]. A similar supported the current study that, the consumption of foods containing E. coli pathogens can cause diarrhoea and haemolytic uraemic syndrome [18]. The results from Table 4 showed that all the microbiological parameters far exceeded their standardized limits in "fufu" from the selected chop bars in the Cape Coast Metropolis. The implication is that the "fufu" from the selected chop bars were not safe for human consumption. Deliberate efforts are therefore required by all the stakeholders such as food vendors, Ghana Standards Authority, Food and Drugs Board, Cape Coast Metropolitan Assembly, Ghana Tourism Authority, and the Public Health Department of the District Health Directorate and WHO to put in efforts and measures to help control the levels of microbiological contaminations in the "fufu" production process. There was a contention that, total food quality can be achieved by adhering to safety requirements is anything to go by, then all stakeholders should help bring food vendors to book when they fail to adhere to safety standards [39].

## 5. Conclusions and Recommendations

All the microbiological parameters far exceeded their standardized limits in "fufu" from the selected chop bars in the Cape Coast Metropolis and thus did not meet acceptable standards. Operators of both licensed and non-licensed chop bars were found to engage in three topmost food handling practices (using untreated water to turn "fufu" (86%), improper washing of mortar and pestle (79%) and improper washing of hands before pounding and turning "fufu" (71%) that predisposed the food to microbial contamination.

It is recommended that, the Cape Coast chop bar owners Association should organize quarterly training programme such as in-service training courses, seminars and workshops on the hygienic standards to be practised and maintained at all chop bars for their members so as to meet the microbiological qualities of "fufu" in Ghana and the international arena.

It is also recommended that, the Ghana Tourism Authority should, at regular intervals, collect and test "fufu" specimens from licensed chop bars to determine the microbial loads in the "fufu". The results will help to institute measures to reduce the possible sources of contamination in "fufu" preparation in the metropolis.

## Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

## References

[1] Rande, W.L. Professional food service. New York, NY: John Wiley & Sons, Inc., 1996.

[2] Lelieveld, H.L.M. Sources of contamination. In H.L.M. Lelieveld (Ed.). Hygiene in food processing, Cambridge: Woodhead Publishing Ltd., 2003; pp. 61-75.

[3] Oti-Mensah, M.A. Catering made easy. Accra: Martmag Publications, 2005.

[4] Ghana Tourism Authority. Minimum requirements for licensing of traditional catering establishments. 2010.

[5] Ministry of Health. Monthly out-patients' morbidity. 2010.

[6] Ghana Broadcasting Corporation. Ghana-Cholera. Available online: http://www.gbcghana.com/index.php?id=1.34047 (accessed on 24 October 2019).

[7] Tawiah, J.; Annoh, O.P.; Darkwah, A.G. Sources of Microbial Contamination of "Fufu" Production in Ghana: Selected Licensed and Non-licensed Chop Bars in Cape Coast Metropolis. *American Journal of Food Science and Health,* 2019, 5(3), 112-12.

[8] Gisslen, W. Professional cooking (3rd ed.). New York, NY: Wiley, 1995.

[9] Levy, P. Ghana: Cultures of the world. New York, NY: Marshall Cavendish Corporation, 1999.

[10] Opare-Obisaw, C.; Asante, I.K.; Annan, E.K. Sensory characteristics of "fufu" prepared with cassava roots (Manihot Esculenta Crantz) stored in polyethylene sacks. *International Journal of Consumer Studies,* 2004, 28(1), 14-17.

[11] Jackson, E.A. South of the Sahara: Traditional cooking from the lands of West Africa. London: Fantail, 1999.

[12] Kordylas, J.M. Processing and preservation of tropical and sub-tropical foods. Hongkong: ELBS Macmillan, 1991.

[13] Lugosi, P. Campus foodservice experiences and student wellbeing: An integrative review for design and service interventions. *International Journal of Hospitality Management,* 2019, 1-18.

[14] klomanov, I.A. Appraisal and assessment of world water resources. *Water International,* 2000, 25(1), 11-32.

[15] New Hampshire Department of Environmental Services. Interpreting the presence of coliform bacteria in drinking water: An environmental report. Hampshire: Department of Environmental Services, 2010.

[16] Todar, K. Pathogenic "E. coli". Online Textbook of Bacteriology. University of Wisconsin–Madison Department of Bacteriology, 2007.

[17] Berg, S.C.; Rice, E.W.; Karlin, R.J.; Allen, M.J. Escherichia coli: The best biological drinking water indicator for public health protection. *Applied and Environmental Microbiology Journal,* 2000, 88, 1068-1168.

[18] Mazengia, M.S.; Chidavaenzi, M.; Bradley, M. Effective and culturally acceptable water storage in Zimbabwe: Maintaining the quality of water. *Journal of Environmental Health,* 2002, 64, 15-18.

[19] Levy, K.; Nelson, K.L.; Hubbard, A.; Eisenberg, J.N.S. Rethinking indicators of microbial drinking water quality for health studies in tropical developing countries: Case Study in Northern Coastal Ecuador. American Journal of Tropical Medicine Hygiene, 2012, 86(3), 499-507.

[20] Centre for Disease Control. Escherichia coli. National Centre for Emerging and Zoonotic Infectious Diseases. Available online: http://www.cdc.gov/ecoli/index/html (accessed on 15 May 2019).

[21] Food Standards Agency. A report of the study of infectious intestinal disease in England, 2000.

[22] Singleton, P.; Sainsbury, D. Dictionary of microbiology and molecular biology (3rd ed.). West Sussex, Chichester: Smith-John Wiley & Sons, Ltd., 2001.

[23] Safe Drinking Water Foundation. Heterotrophic plate count. 2007. Available online: http://www.who.int/water_sanitation_health/dwq/en/ HPC2.pdf (accessed on 15 May 2019).

[24] World Health Organization. Heterotrophic plate counts and drinking-water safety. London: IWA Publishing, 2003.

[25] Colford, J.M.; Rees, J.R.; Wade, T.J.; Khalakdina, A.; Hilton, J.F.; Ergas, I.J.; Burns, S.; Benker, A.; Ma, C.; Bowen, C.; Mills, D.C.; Vugia, D.J.; Juranek, D. D.; Levy, D.A. Participant blinding and gastrointestinal illness in a randomized, controlled trial of an in-home drinking water intervention. *Emerging Infectious Diseases*, 2002, 8, 29-36.

[26] Health Canada. Guidelines for Canadian drinking-water quality: Guideline technical document bacterial waterborne pathogens, current and emerging organisms of concern. Ontario, Canada: Health Canada, 2006.

[27] Prescott, L.M.; Harley, J.P.; Klein, D.A. The influence of environmental factors on microbiological growth (4th ed.). New York, NY: McGraw-Hill Companies, Inc., 1999.

[28] Moreau, C. Moulds, toxins and food. Chichester: John Wiley & Sons. New Hampshire Department of Environmental Services. Interpreting the presence of coliform bacteria in drinking water: An environmental report. Hampshire: Department of Environmental Services, 2000.

[29] Parker, R. Introduction to food science. New York, NY: Delmar Learning, 2005.

[30] Ghana Standards Authority. Quality requirements for food. 2009.

[31] Australia/New Zealand. (2002). Australian New Zealand microbiological limits for food. Available online: www.foodstandards.gov.au (accessed on 20 December 2019).

[32] Ntiforo, A. Street food situation in Ghana. Accra: Institute of Statistical, Social and Economic Research, 2001.

[33] Cape Coast Municipal Authority. Local government bulletin. Cape Coast: Cape Coast Municipal Assembly, 2000.

[34] Food and Agriculture Organisation. Important food issues. Available online: http://www.fao.org/pdf (accessed on 9 July 2019).

[35] Fowler, F.J. Survey research methods. New York, NY: Sage Publications, 1993.

[36] Lelieveld, H.L.M. Sources of contamination. In H. L. M. Lelieveld (Ed.). Hygiene in food processing. Cambridge: Woodhead Publishing Ltd., 2003; pp. 61-75.

[37] Creswell, J.W. Research Design: Qualitative, Quantitative and Mixed Methods, 2016.

[38] Approaches (6th ed.). Los Angeles: Sage Publications. MacArthur, R. L., & Abane, A. M. Compliance with food safety measures by traditional caterers in the Cape Coast Metropolis. *International Journal of Home Economics*, 2010, 2, 141-152.

[39] Crosby, P.B. Quality is still free: Making quality certain in uncertain times. New York, NY: McGraw-Hill Book Company, 1996.