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Demographics and Chemical Preservatives Used by Vegetable and Fruit Retailers Selected Across Markets in Lagos, Southwestern Nigeria

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ABSTRACT: Literatures show that thousands of Nigerians die yearly from poisoning stemming from the use of chemical preservatives in vegetables and fruits. Consequently, it is imperative to establish a routine assessment of these products in every region of the country. This study aimed to evaluate the safety of vegetables and fruits available in Lagos markets. Structured questionnaires were used to collect demographic information from 50 vegetable and fruit vendors within selected markets in Lagos. Additionally, information regarding types of chemical preservatives used was compiled. The survey results indicated that 32 (64%) of the participants were females, while 18 (36%) were males. Participants with no formal education were 2 (4%), primary education were 13 (26%), secondary education consisted of 24 (46%), and tertiary education consisted of 11 members (22%). 16 (32%) participants were of the Hausa tribe, 13 (26%) were Yoruba, 12 (24%) were Igbo, and the rest were sub-ethnic groups. 28 (56%) participants used natural methods, while 22 (44.00%) relied on chemical preservatives, primarily pesticides. Among the chemical users, gammalin-20 was employed by 6 (27%) participants, sniper by 4 (18%), aluminum phosphide by 4 (18%), DDT (otapiapia) by 3 (14%), carbide by 3 (14%), and brodifacum by 2 (9%). These findings underscore a substantial prevalence of chemical preservative usage in Lagos markets, posing significant health hazards to consumers. It is imperative to raise awareness among vegetable and fruit retailers and consumers about the risks associated with chemical preservatives.

KEYWORDS: Vegetables; fruits; chemical preservatives; gammalin-20; pesticides

1. Introduction

The significance of vegetables and fruits for human health has been acknowledged throughout history, gaining increased attention in recent times. This is attributed, in part, to the growing prevalence of diseases such as diabetes, high blood pressure, obesity, and cancer, which necessitate balanced diets wherein fruits and vegetables play a vital and cost-effective role [1,

2]. Furthermore, malnutrition is on the rise globally, especially in developing nations, and regular consumption of fruits and vegetables is recognized for alleviating nutritional deficiencies [3]. These foods are abundant sources of essential nutrients, including vitamin A, vitamin B6, vitamin C, potassium, calcium, folate, and magnesium [4]. Additionally, they offer valuable fiber and non-nutrient phytochemicals such as phytates, phenols, tannins, saponins, and oxalates, known to combat inflammation, cancer, oxidative stress, high blood pressure, and hyperlipidemia [1].

Their importance is emphasized by dietary guidelines, such as the Nutritional Pyramid, recommending five servings of fruits and vegetables daily for good health [5]. The Food and Agriculture Organization [6] also advises that adults should consume at least 400 g of these foods daily, enhancing immune function and helping prevent diabetes, obesity, cardiovascular diseases, and cancer [5]. Vegetables and fruits, being perishable, have limited post-harvest shelf-life, requiring preservation to remain marketable, edible, and nutritious. Chemical preservation has become a favored choice to achieve this, with North America and Asia-Pacific leading in chemical preservative production [7]. When applied within recommended concentrations and guidelines, chemical preservatives inhibit microbial growth, preserving food quality and value [8]. Commonly used chemical preservatives for vegetables and fruits include nitrates, sulfites, sodium benzoate, propyl gallate, and potassium sorbate [9]. Unfortunately, concerns about the health effects of these chemicals are escalating. Benzoates, for example, are suspected of causing allergies, asthma, and skin rashes; sorbic acid/sorbates may induce urticaria and contact dermatitis; sulfites can lead to headaches, palpitations, allergies, and even cancer; and nitrites and nitrates have been linked to stomach cancer [10]. Worldwide, there are about 385 million cases of unintentional chemical preservative poisoning annually, resulting in approximately 11,000 fatalities [11].

In Nigeria, vegetables and fruits are cultivated and consumed in substantial quantities, with approximately 15.7 million tons of vegetables sold in 2020 [11]. Commonly consumed vegetables include tomato, pepper, amaranthus, roselle, fluted pumpkin, okra, jute leaves, carrots, baobab leaves, while fruits comprise oranges, mangoes, pawpaw, guavas, and pineapples, among others. Beyond nutrition, these products provide income for farmers and retailers. Regrettably, many farmers and retailers use chemical preservatives indiscriminately, often with unapproved chemicals, particularly pesticides, raising concerns [13].

Pesticides employed as preservatives in the country include carbaryl, aldrin, dimethoate, cypermethrin, malathion, rhodamine B, lambda cyhalothrin, eltamethrin, endosulfan, toxaphene, chlordane, hexachlorobenzene, parathion, dichlorvos, and chlorvos [12, 14]. These pesticides have been associated with gastrointestinal problems, respiratory diseases, infertility, endocrine disruption, genetic mutations, neurological dysfunction, obesity, diabetes, and other metabolic disorders, in addition to various acute effects [15, 16]. Foodborne diseases claim over 200,000 lives annually in Nigeria, some of which result from pesticide-contaminated food consumption [17]. In 2020, a single community in Benue State recorded over 270 deaths from pesticide poisoning [18]. A survey by the Alliance for Action on Pesticides in Nigeria [19] revealed that 80% of the pesticides frequently used by small-scale farmers were hazardous.

The health hazards posed by these pesticides have imposed a substantial economic burden, estimated at around US$ 3.6 billion per annum [17]. To reverse this trend, prioritizing food safety in Nigeria is imperative, with a particular focus on pesticide poisoning through the consumption of vegetables and fruits. This can be achieved through the implementation of

health policies and awareness campaigns related to vegetable and fruit preservation. However, before the measures can be put in place, it is essential to determine the demographic characteristics of pesticide users and the types of pesticides used by vegetable and fruit vendors in every locality. This study was designed to assess the demographics and chemical preservatives used by vegetable and fruit vendors in Lagos, Nigeria, the country's most populous city with significant agricultural and consumer activities.

2. Materials and Methods

2.1. Description of the study site.

Lagos, a mega-city, boasts a population estimated to range from 16 to 21 million people [20]. Geographically situated in the South-Western region of Nigeria, it lies between longitudes 2°42'E and 32°2'E, and latitudes 6°22'N and 6°2'N (Figure 1) [21]. This state shares its boundaries with Ogun State of Nigeria to the east and north, while the Republic of Benin borders it to the west. Lagos experiences abundant rainfall, with a brief dry season occurring from December to February.

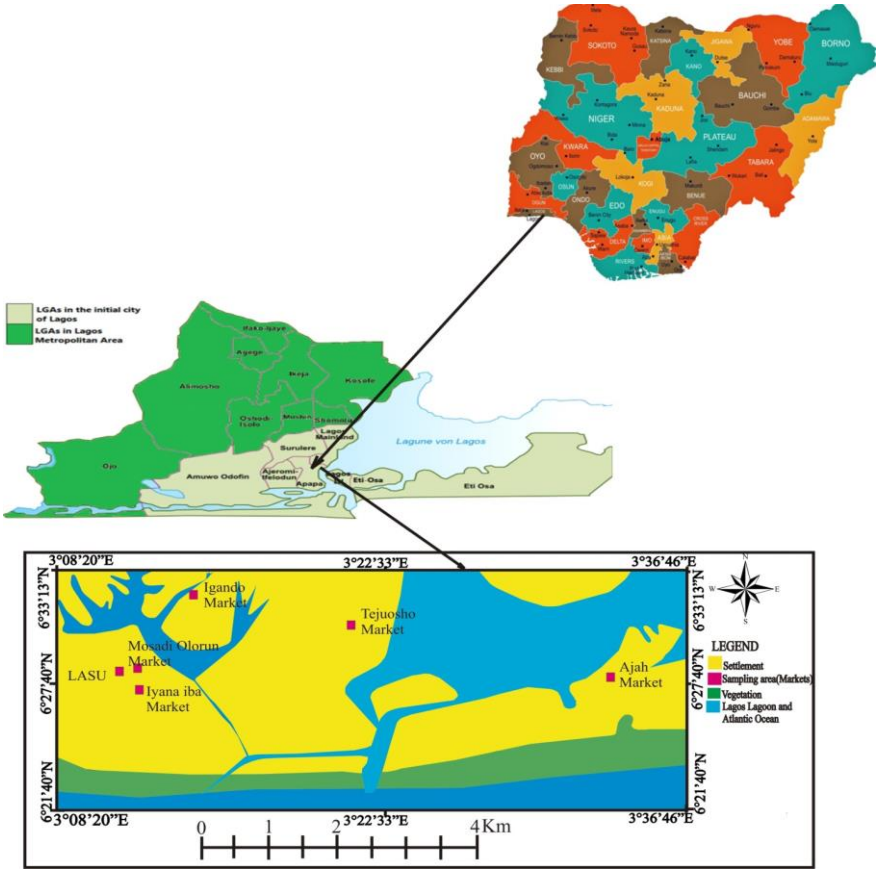

Figure 1. Map of the study areas.

The city's vegetation predominantly comprises freshwater swamp forest and mangrove swamp forest. The inhabitants of Lagos primarily consist of Yoruba, Igbo, and Hausa, the major ethnic groups in the country. However, the city is home to diverse representations of other ethnic groups. Lagos holds a prominent status as a crucial economic hub in Africa, being the most populous and industrialized city in Nigeria and serving as a major entry and exit point for the country. Much like any other place, vegetables and fruits are consumed in substantial

quantities within the city. Therefore, monitoring the safety of these foods is essential to mitigate potential health consequences.

2.2. Study population and data collection.

Consent was obtained from fifty (50) randomly selected vegetable and fruit vendors in Lagos markets. The participants included ten (10) from Mosadiolorun Market in Ojo, ten (10) from Igando Market, two (2) in close proximity to Lagos State University in Ojo, four (4) at Iyana-Iba Market in Ojo, seven (7) from Tejuosho Market in Yaba, and seventeen (17) from Ajah Market in Lagos Island. Structured questionnaires, categorized into sections A and B, were employed to collect pertinent information from the participants. Section A encompassed demographic characteristics, such as gender, educational level, and ethnicity, while section B focused on the methods of preservation (natural or chemical) and the types of chemicals employed.

2.3. Criteria for selection of participants.

The inclusion criteria for participants in the study are as follows: (1) participants must have provided their consent to take part in the study, and (2) participants must have been engaged in the sale of fruits or vegetables for a minimum of one year to ensure they possess sufficient knowledge of how these products are preserved in the markets. Conversely, the exclusion criteria are: (1) participants who did not grant their consent for participation in the study were excluded, and (2) individuals who have recently started selling vegetables and fruits were excluded, as they may not have acquired adequate knowledge about the preservation of these products.

2.4. Ethics approval and consent to participate.

This study was approved by the ethical committee of the National Open University of Nigeria, Lagos. The guidelines for conducting research on humans as outlined by the committee were followed. Participants also gave their consent before the study began.

2.5 Data analysis.

Results were shown in percentages and frequency distribution tables.

3. Results and Discussion

3.1. Gender distribution of the participants.

Table 1 presents the gender distribution of the selected fruit and vegetable vendors in Lagos markets. Of the respondents, 18 (36%) were males, while 32 (64%) were females. This finding is consistent with previous studies, such as Akanle et al. [22], who observed a higher representation of females among vegetable vendors in markets in Ibadan, Oyo State, Nigeria. Dijkxhoorn et al. [23] also reported that the informal vegetable retail sector in Nigeria is primarily dominated by females. A study conducted by Olowa and Olowa [24] among vegetable and fruit vendors in Shomolu areas of Lagos revealed a similar trend of female predominance. In the southern region of Nigeria, which encompasses the areas studied in this research, males tend to engage in more lucrative businesses rather than the sale of fruits and

vegetables. This explains the prevalence of females in the current study. However, according to Chetna et al. [25] and Wang et al. [26], females generally possess less knowledge of pesticide usage and exhibit lower awareness of the health risks associated with pesticides compared with males. This lack of awareness may contribute to the indiscriminate use of pesticides in the study areas.

Table 1. Gender distribution of the participants.

Gender	Frequency	Percentage (%)
Male	18	36
Female	32	64
Total	50	100

3.2. Educational qualifications of the participants.

The educational qualifications of the respondents are outlined in Table 2. Respondents with no formal education constituted 2 (4%), those with primary education numbered 13 (26%), those with junior secondary education were 3 (6%), those with senior secondary education comprised 21 (42%), and those with tertiary education accounted for 11 members (22%). This finding aligns with Olowa and Olowa [24], who reported a prevalence of individuals with primary and secondary education among vegetable and fruit vendors in Shomolu, Lagos. Mukaila et al. [27] also reported a similar prevalence of primary and secondary education holders among vegetable vendors in Enugu, Nigeria. In a study conducted by Tijani et al. [28] on the level of awareness of pesticide use and safety issues among vegetable farmers in Borno, Nigeria, it was found that the majority of the farmers had a secondary education according to standard Western education norms. Selling vegetables and fruits typically does not require specific educational qualifications or skills, which may explain the preponderance of individuals with lower educational backgrounds in this study. However, this lower educational level suggests that sellers may have limited knowledge of pesticide application and its associated health consequences.

Table 2. Educational qualifications of the participants.

Education qualification	Frequency	Percentage (%)
No formal education	2	4
Primary education	13	26
Junior secondary education	3	6
Senior secondary education	21	42
Tertiary education	11	22
Total	**50**	**100**

3.3. Ethnicity of the participants.

Table 3 depicts the ethnic distribution among the participants, with 16 (32%) participants from the Hausa ethnic group, 13 (26%) from the Yoruba, 12 (24%) from the Igbo, and 3 (6%) from the Tiv. Additionally, the Igala, Obudu, Egbe, Obubra, Calabar, and Ogoja tribes each had 1 (2%) participant. The prevalence of the Hausa, Yoruba, and Igbo ethnic groups can be attributed to their status as the three major ethnic groups in Nigeria, with significant populations in every city. Moreover, the majority of vegetables, especially onions, peppers, and tomatoes, are sourced from the northern part of the country, explaining the dominance of the Hausa (northerners) among the vendors. The substantial number of Yoruba participants may be linked to the fact that Lagos is their native homeland, and they also engage in cultivating various

vegetables and fruits within the city, particularly in local gardens. Meanwhile, the Igbo participants are prominent among vegetable sellers in Lagos due to the cultivation of vegetables like fluted pumpkin in the eastern part of the country, which are then transported to Lagos. In the study by Olowa and Olowa [24] in Shomolu, mentioned previously, the Yoruba, Igbo, and Hausa ethnic groups comprised the majority of vegetable and fruit vendors. However, in the cited study, the Yoruba were the majority, followed by Igbo and Hausa. The preponderance of Hausas among the vendors may have adverse effects on the safety of the vegetables and fruits because the literacy rate in the northern region is relatively lower, potentially leading to indiscriminate chemical application and limited awareness of health consequences.

Table 3. Ethnic distribution among the participants.

Tribe	Frequency	Percentage (%)
Igbo	12	24
Hausa	16	32
Igala	1	2
Yoruba	13	26
Tiv	3	6
Obudu	1	2
Egbe	1	2
Obubra	1	2
Calabar	1	2
Ogoja	1	2
Total	**50**	**100**

3.4. Methods of fruit and vegetable preservation by the participants.

Methods of fruit and vegetable preservation by the participants are detailed in Table 4. 28 (56%) participants utilized natural methods, while 22 (44%) resorted to chemicals. As shown in Table 5, among the 22 participants using chemicals, 6 (27%) employed Gammalin-20, 4 (18%) utilized sniper, 4 (18%) applied aluminum phosphide, 3 (14%) used DDT (commonly known as otapiapia), 3 (14%) used carbide, and 2 (9%) utilized brodifacum. This data suggests that a substantial portion of vegetable and fruit vendors in Lagos rely on chemical preservatives, raising concerns about potential health hazards for consumers. Gammalin-20, an organochlorine pesticide, has been linked to biochemical, hematological, and histopathological abnormalities, resulting in lung, liver, and pancreatic diseases [29]. Sniper, also known as dichlorvos, has been demonstrated to cause histopathological and biochemical damage, oxidative stress, DNA damage, respiratory diseases, multiorgan damage affecting the brain, liver, and kidneys, and may even lead to cancer and instant death [30, 31]. DDT, an abbreviation for dichlorodiphenyltrichloroethane, is an endocrine disruptor that can induce DNA and histopathological damage, tumors, and has been associated with breast cancer, high blood pressure, infertility and liver diseases [32]. Carbide is suspected of causing cardiovascular dysfunction, diabetes mellitus, and an increase in pro-inflammatory cytokines like TNF-α and IFN-γ, resulting in DNA damage, cancer, hematological and biochemical abnormalities [33, 34]. Brodifacum can cause neurological effects, histopathological, biochemical and hematological damage, and immune suppression, and has been linked to internal bleeding, organ failure, paralysis, and coma [35, 36]. Exposure to aluminum phosphide can alter physiological and histological parameters, leading to lung, kidney, and liver damage, congested heart failure, and low blood pressure [37]. Consistent with the current study, Njoku

et al. [38] detected pesticides used as preservatives in vegetables and fruits obtained from markets in Lagos, Nigeria. Adekalu et al. [39] also reported the use of gammalin-20 and sniper by some vegetable farmers in Lagos and Ogun State, Nigeria. Omayajowo et al. [40] found pesticides such as atrazine, clothianidin, omethoate, and oxamyloxime in vegetables and fruits collected from markets in Lagos. Moreover, Oyeyiola et al. [41] detected organochlorine pesticides, particularly dichlorodiphenyldichloroethylene (p,p'-DDE), in Cameroon and chili peppers and fruits obtained from markets in Lagos.

Table 4. Methods of fruits and vegetables preservation by the participants.

Mode of Preservation	Frequency	Percentage (%)
Natural	28	56
Chemical	22	44
Total	**50**	**100**

Table 5. Chemicals used by the participants to preserve fruits and vegetables.

Chemicals	Frequency	Percentage (%)
Gammalin-20	6	27
Sniper	4	18
DDT (otapiapia)	3	14
Carbide	3	14
Brodifacum	2	22
Aluminum phosphide	4	18
Total	**22**	**100**

4. Conclusion

The results clearly indicate that the majority of vegetable and fruit vendors in Lagos markets are female, with a primary or secondary school educational background. These vendors predominantly belong to the Hausa, Yoruba, and Igbo ethnic groups, in that order. Natural preservation methods, such as storing in cool places, shielding from direct sunlight, and sprinkling with lime water, are primarily used by the participants. However, a significant portion of the participants also resort to chemical preservatives like gammalin-20, sniper, DDT (otapiapia), carbide, brodifacum, and aluminum phosphide. Consequently, the consumption of these fruits and vegetables can pose health risks to consumers. In light of these findings, it is imperative for public health agencies, such as the Ministry of Health, and non-governmental organizations like the Nutrition Society of Nigeria, to educate vegetable and fruit vendors about the health implications of using chemicals, particularly pesticides, as preservatives. Furthermore, these agencies should provide effective and safe preservative techniques, particularly those involving natural methods and technology. Achieving this goal may entail direct engagement with the vendors, organizing seminars and workshops, and launching awareness campaigns through print and electronic media, among other strategies. It is important to acknowledge that the limited education levels of many vendors may present a challenge to the success of these educational efforts. In addition to addressing the issue of fruit and vegetable preservation, similar studies, like the present one, should be extended to other food products sold in Lagos markets, especially perishable crops or foods. This is crucial because other pesticides or toxic chemicals not covered in this study may be in use. Expanding the scope of investigation will contribute to a broader understanding of chemicals that require public awareness campaigns. Further research should also explore natural preservation

methods for foods not covered in this study, as these techniques can be applied to various food products, particularly vegetables and fruits.

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Conflict of interest

The authors declare no conflict of interest.

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