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Demographic Characteristics of Fruit Sellers and Chemical Preservation Practices in Birnin Kebbi, Nigeria

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Abstract

Fruits in Birnin Kebbi, Nigeria, are often preserved using chemicals to extend their shelf life, maintain freshness, and enhance quality and taste. However, global concerns persist about the safety of these preservatives, particularly when applied indiscriminately. This study aimed to determine the demographic characteristics of fruit sellers in Birnin Kebbi and the preservatives they commonly use. Structured questionnaires were administered to 200 participants who provided informed consent. The results showed that 116 (58%) of the respondents were male, while 84 (42%) were female. Most participants (38%) were aged 18–25 years (76 individuals), followed by those aged 26–35 years (60 individuals, 30%). A significant proportion of participants (82; 41%) had no formal education, while 48 (24%) had primary education. The majority of participants (120; 60%) belonged to the Hausa ethnic group, and 156 individuals (78%) identified as Muslims. Marital status was evenly distributed, with 84 participants (42%) being single and 80 (40%) married. Regarding fruit preservation practices, watermelon was the most frequently preserved fruit, cited by 50 participants (25%), followed by oranges (42; 21%) and bananas (22; 11%). Among chemical preservatives, sulfite was the most commonly used, reported by 84 (42%) participants, followed by citric acid (36; 18%), sodium benzoate (28; 14%), calcium chloride (24; 12%), benzoic acid (18; 9%), and ethanol (10; 5%). Alarmingly, 95% of participants demonstrated inadequate knowledge of proper preservative application methods, raising concerns about potential health risks for consumers. These findings suggest that fruit preservation practices in Birnin Kebbi may expose consumers to health hazards. It is imperative to educate fruit sellers and consumers on the safe use of chemical preservatives, including appropriate concentrations and application techniques, to mitigate these risks and promote safer fruit consumption.

Keywords: Citric acid; Demographic characteristics; Preservatives; Questionnaires; Watermelon.

INTRODUCTION

Fruits are essential, vibrant, and nutrient-rich components of nature, bursting with flavors, textures, and colors that captivate the senses and nourish the body. Botanically, the term "fruit" refers to the mature ovary of a plant, including its seeds, covering, and any closely associated tissues, regardless of their edibility (Rejman *et al*., 2021). Common fruits like apples, pears, oranges, bananas, and grapefruits are readily available and widely consumed. From the tropical regions of the East to the orchards of the West, fruits have been cultivated, traded, and cherished for their unique qualities throughout history (Abdulmumeen *et al*., 2020).

With over 20,000 known species, fruits exhibit an astonishing diversity in shapes, sizes, and flavors (Rao, 2023). From the tiny, tangy cranberry to the large, juicy pineapple, each fruit offers a unique experience. Categories such as berries, citrus fruits, stone fruits, and tropical fruits showcase this remarkable variety. Beyond their culinary appeal, fruits are packed with health benefits. They are rich in antioxidants, fiber, and essential vitamins (e.g., A, C, and E), as well as minerals such as magnesium and potassium. At the same time, they are low in fats, saturated fatty acids, cholesterol, and sodium. These properties help combat chronic diseases such as diabetes and coronary heart disease, support digestive health, and promote healthy skin and hair (Park, 2021; Clemente-Suárez *et al*., 2023). Nutrients and phytochemicals in fruits have been found to lower blood pressure by improving endothelial function, enhancing baroreflex sensitivity, promoting vasodilation, and increasing anti-inflammatory activity (Zhao *et al*., 2017). For optimal health, the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) recommend that adults consume at least five servings of fruits and vegetables daily, excluding starchy vegetables (Wang *et al*., 2021). Beyond their nutritional and culinary significance, fruits hold cultural, spiritual, and symbolic meanings. They are integral to traditional medicine, rituals, and ceremonies, highlighting their profound influence on human society (Abdullahi *et al*., 2022).

Fruits are perishable and often require preservatives to maintain their freshness and quality during storage and transportation. Preservatives are substances used to prevent microbial growth, oxidation, and spoilage in food, pharmaceuticals, and other products, extending their shelf life and ensuring safety (Teshome *et al*., 2022). Historically, methods like salting, sugaring, and smoking were used to preserve food, while modern industries rely on synthetic additives for effective preservation. Fresh fruits, due to their high respiration rates, are particularly challenging to keep fresh under normal environmental conditions. After harvesting, water loss accelerates deterioration, leading to reduced quality. Proper storage and preservation are therefore essential to maintaining the postharvest quality of fruits (Imahori & Bai, 2024). Common preservatives used for fruits include nitrates, sulfites, sodium benzoate, propyl gallate, and potassium sorbate (Yahaya *et al*., 2023). However, concerns have been raised regarding the safety of these substances, often caused by inadequate knowledge of their application. For instance, indiscriminate benzoates application may cause allergies, asthma, and skin rashes; sorbic acid and sorbates can induce urticaria and contact dermatitis; sulfites are linked to headaches, palpitations, and allergies, and are suspected carcinogens, and nitrites and nitrates have been associated with stomach cancer (Yahaya *et al*., 2023).

Birnin Kebbi, a prominent city in northern Nigeria, is known for its diverse agricultural produce, including various fruits. To ensure the longevity and quality of these fruits, especially for storage and transportation, the use of preservatives is common. However, a review of the literature reveals no studies on the levels of understanding regarding preservative application or awareness of their health implications in the city. This lack of knowledge may contribute to the prevalence of certain diseases in the area. To address these challenges and mitigate the unintended health consequences of preservative use in Birnin Kebbi, there is an urgent need for health policies regulating the use of fruit preservatives. Additionally, raising public awareness about the risks associated with indiscriminate preservative use is critical. However, before implementing these measures, it is essential to document the demographic characteristics of fruit sellers and the types of preservatives used in the city. This study aims to determine the demographic characteristics of fruit sellers and their use of preservatives in Birnin Kebbi, Nigeria.

MATERIALS AND METHODS

Study design

This study utilized a descriptive cross-sectional design to collect data directly from individuals involved in fruit selling within the city. This approach allowed for detailed exploration and documentation of various fruit preservation methods, encompassing both traditional and modern techniques, as applied in the study area.

Study population and data collection

The study population comprised 200 individuals engaged in fruit farming and selling in Birnin Kebbi, Nigeria. Data collection was conducted through structured, face-to-face questionnaires. The questionnaire was divided into two sections: Section A focused on demographic information, including gender, educational level, and ethnicity while Section B addressed preservation methods (natural or chemical) and the specific chemicals used.

Fieldwork included visits to fruit planting sites and selling points across various locations in Birnin Kebbi. Participants with limited literacy skills received assistance to ensure their full comprehension of the questions. Respondents were encouraged to provide honest answers, with confidentiality emphasized to foster trust. Data collection spanned two weeks, ensuring adequate time to obtain comprehensive responses from all selected participants.

Eligibility criteria

Participants are those who provided written consent to participate in the study, and have been engaged in selling fruits for at least one year, ensuring they had adequate knowledge of preservation practices. Individuals who failed the set criteria were excluded.

Ethical approval and consent to participate

Ethical approval for the study was obtained from the Ethics Committee of the Federal University Birnin Kebbi, Nigeria. The research adhered to the ethical guidelines for studies involving human participants. Written informed consent was obtained from all participants prior to data collection. To protect participants' privacy, all data were anonymized and securely stored, with usage restricted to research purposes only. The study complied with the principles outlined in the Declaration of Helsinki, adopted in 1964 and most recently updated in October 2024, which provides ethical standards for research involving human subjects.

Data analysis

Data were analyzed using percentages and frequency distribution tables, employing Microsoft Excel (version 21 for Windows).

RESULT

Demographic characteristics of the participants

Table 1 presents the demographic distribution of the participants, including their gender, age, educational level, ethnicity, religion, and marital status.

The study included 116 male participants (58%) and 84 female participants (42%). The majority of the participants (38%) were within the age range of 18–25 years (76 individuals), followed by those aged 26–35 years (60 participants, 30%). Participants aged 36–45 years accounted for 17% (34 individuals), those aged 46–55 years made up 8% (16 individuals), and participants aged 56 years and above comprised 7% (14 individuals).

Regarding educational attainment, 82 participants (41%) had no formal education, while 48 (24%) had completed primary education. A total of 40 participants (20%) had secondary education, and 30 (15%) had attained tertiary education.

In terms of ethnicity, the majority of the participants were Hausa, comprising 120 individuals (60%). This was followed by Fulani (28 participants, 14%), Igbo (20 participants, 10%), Yoruba (16 participants, 8%), and Gwari (16 participants, 8%).

For religious affiliation, most participants (78%) identified as Muslims (156 individuals), while 11% (44 individuals) identified as Christians.

Regarding marital status, 84 participants (42%) were single, 80 participants (40%) were married, 16 (8%) were divorced, and 20 (10%) were widowed.

Table 1. Demographic characteristics of fruit sellers in Birnin Kebbi.

Gender	**Frequency**	**Percentage (%)**
Male	116	58
Female	84	43
Total	200	100
Age	**Frequency**	**Percentage (%)**
18-25	76	38
26-35	60	30
36-45	34	17
46-55	16	8
56	14	7
Total	200	100
Level of Education	**Frequency**	**Percentage (%)**
No formal education	82	41
Primary school	48	24
Secondary school	40	20
Tertiary Education	30	15
Total	200	100
Ethnicity	**Frequency**	**Percentage (%)**
Hausa	120	60
Fulani	28	14
Yoruba	16	8
Igbo	20	10
Gwari	16	8
Total	200	100
Religion	**Frequency**	**Percentage (%)**
Islam	156	78
Christian	44	22
Total	200	100
Marital Status	**Frequency**	**Percentage (%)**
Single	80	40
Married	76	38
Divorce	16	8
Widowed	28	14
Total	200	100

Most commonly preserved fruits

Figure 1 illustrates the most commonly preserved fruits in Birnin Kebbi. Watermelon was the most frequently preserved fruit, reported by 50 participants (25%), followed by oranges with 42 participants (21%). Bananas were preserved by 22 participants (11%), sweet melons by 20 participants (10%), apples by 18 participants (9%), pineapples by 16 participants (8%), tangerines by 14 participants (7%), and both pawpaw and strawberries by 12 participants each (6%).

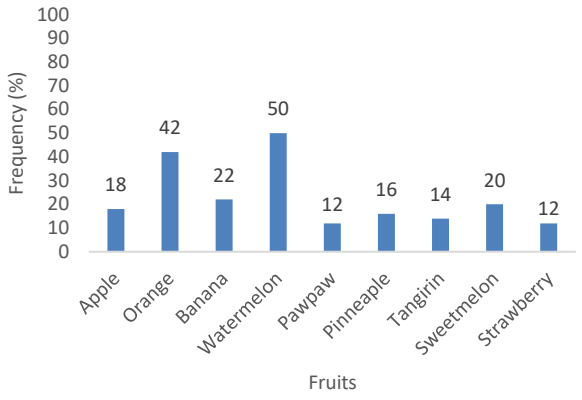

Figure 1. Most commonly preserved fruits in Birnin Kebbi.

Chemicals used to preserve fruits

Figure 2 illustrates the types of chemicals employed for fruit preservation in Birnin Kebbi. Among the 200 participants, 84 individuals (42%) reported using sulfites, 36 (18%) used citric acid, and 28 (14%) utilized sodium benzoate. Calcium chloride was used by 24 participants (12%), benzoic acid by 18 participants (9%), and ethanol by 10 participants (5%).

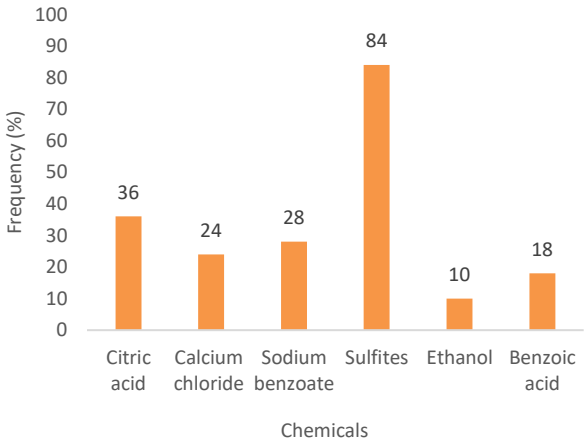

Figure 2. Chemicals used in preserving fruits in Birnin Kebbi.

Natural methods used to preserve fruits

Figure 3 illustrates the natural methods employed for fruit preservation in Birnin Kebbi. Among the 200 participants, 60 (30%) reported using salting, 52 (26%)

used drying, 36 (18%) relied on canning and freezing, and 16 (8%) utilized smoking.

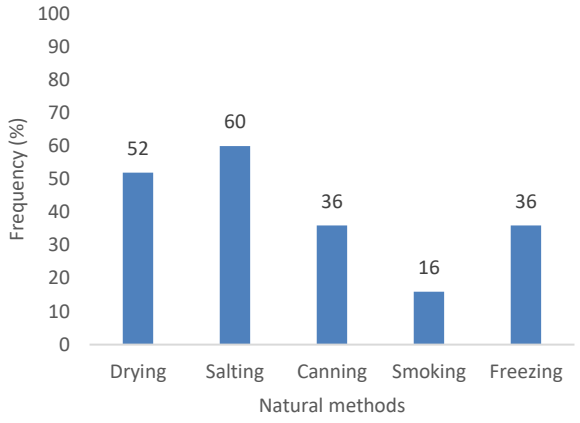

Figure 3. Natural methods used for preserving fruits in Birnin Kebbi.

Sources of knowledge about fruit preservation methods

Figure 4 illustrates how participants learned about fruit preservation methods. The majority, 88 participants (44%), acquired their knowledge through family and friends, followed by 64 participants (32%) who learned through formal education. Additionally, 48 participants (24%) gained knowledge from community workshops.

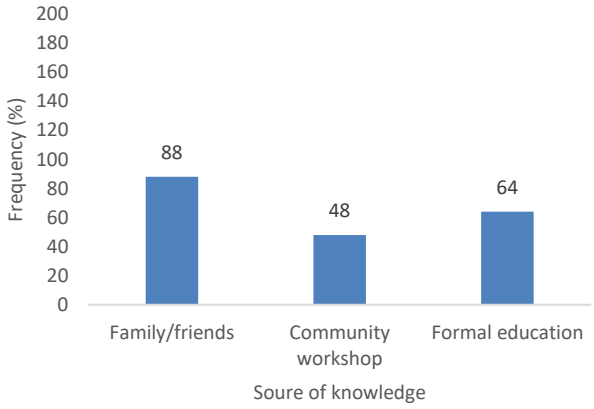

Figure 4. Sources of knowledge about fruit preservation methods.

Factors influencing the choice of fruit preservatives method

Figure 5 highlights the factors that influence the choice of the fruit preservation methods in Birnin Kebbi. The most commonly reported factor was the cost of the preservation method, cited by 80 participants (40%). This was followed by storage duration, reported by 48 participants (24%), ease of use by 42 participants (21%), availability of resources by 18 participants (9%), and taste by 12 participants (6%).

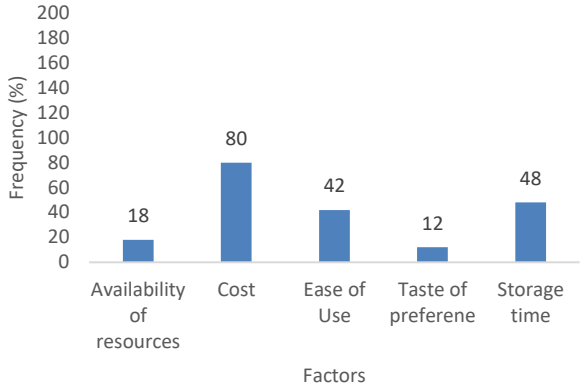

Figure 5. Factors influencing the choice of fruit preservative methods.

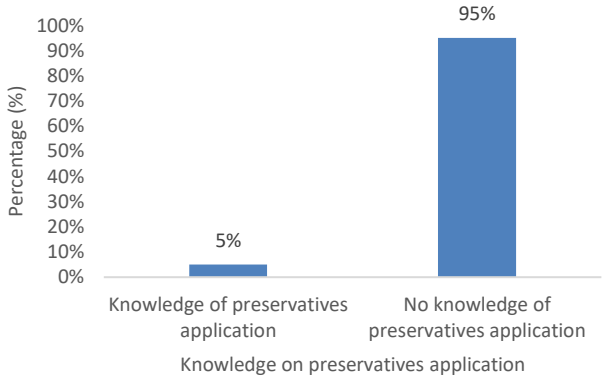

Figure 6. Knowledge on preservative application.

Discussion

In Birnin Kebbi, northwestern Nigeria, a variety of fruits are widely sold and consumed. However, due to their perishable nature, various preservation methods are employed in the city to extend the shelf life of fruits. Unfortunately, these preservatives are often applied indiscriminately, raising concerns about their potential negative health impacts. This study aimed to assess the demographic characteristics of fruit sellers in Birnin Kebbi and the types of preservatives commonly used.

The demographic data collected revealed that the majority of fruit sellers in Birnin Kebbi were male, aged between 18–25 and 26–35 years. Most sellers had no formal education or had completed only primary education. They were predominantly of Hausa ethnicity, Muslim by religion, and primarily single or married. The dominance of individuals aged 18–35 aligns with global trends, as this age group represents the majority of the workforce due to their youthfulness, agility, strength, and family responsibilities. This could explain why these age brackets dominate the fruit-selling business. In northern Nigeria, traditional gender roles often keep women indoors for domestic responsibilities, while men are expected to engage in income-generating activities, likely contributing to the predominance of male participants in this study. The lack of formal education among most fruit sellers may be attributed to the nature of the work,

which requires no specialized skills or education. The predominance of the Hausa ethnic group and Muslim religion reflects the demographic composition of the region, where these groups are the native population. However, a study conducted in Lagos by Yahaya *et al*. (2023) found that, despite Lagos being a Yoruba- and Igbo-dominated region, Hausa individuals represented the majority of fruit sellers. This suggests a cultural association between the Hausa ethnic group and the fruit-selling trade. The findings of this study are consistent with those of Danladi *et al*. (2023), who reported a predominance of males aged 20–35 years, married individuals, and those with lower levels of education among fruit sellers in Maiduguri Metropolis, northern Nigeria. Ajibade *et al*. (2023) also observed similar demographic patterns in Abuja, with males, married individuals, and youthful sellers (20–40 years) dominating the trade. However, a study by Orok *et al*. (2024) in Ado-Ekiti, southwest Nigeria, reported contrasting findings. In that region, females and individuals with tertiary education dominated the fruit-selling business. This divergence may be attributed to the higher levels of education in southwest Nigeria and greater gender equality, which allows women to engage freely in various occupations. Furthermore, fruit selling is perceived as a less strenuous and more "feminine" occupation in the region, which could explain the higher participation of women. Similarly, a survey by Ojewumi *et al*. (2021) in Abeokuta, southwest Nigeria, found that females, individuals aged 40–49 years, those with tertiary education, and married individuals accounted for the majority of fruit sellers.

The survey revealed that watermelon, oranges, bananas, sweet melons, apples, pineapples, tangerines, pawpaw, and strawberries, in that order, were the most commonly preserved fruits in the city. These fruits are widely available and consumed across Nigeria. Their high demand and frequent availability likely drive their preservation in Kebbi to meet consumer needs. Previous studies by Omoyajowo *et al*. (2018) and Petrikova *et al*. (2023) identified watermelon, oranges, tangerines, mangoes, bananas, apples, pawpaw (papaya), coconuts, pineapples, and guava as commonly consumed fruits in Nigeria.

In Kebbi, the most frequently used chemical preservatives were sulfite, citric acid, sodium benzoate, calcium chloride, benzoic acid, and ethanol. Natural methods employed included salting, drying, canning, freezing, and smoking. While limited literature exists on the types of chemicals used for fruit preservation in Nigeria, regional variations are evident. For instance, a study in Lagos, southwest Nigeria, by Yahaya *et al*. (2023) reported the use of chemicals such as gammalin-20, sniper, aluminum phosphide, DDT (otapiapia), and brodifacum. These regional differences in preservatives are likely influenced by factors such as cost and availability. Chemical preservatives extend fruit shelf life by inhibiting the growth of bacteria, fungi, and yeast and slowing oxidative chemical reactions. However, while natural methods are generally perceived as safer, the unregulated use of chemical preservatives may pose health risks to consumers. For example, sodium benzoate is considered safe at 5 mg/kg of body weight per day. Exceeding this limit may lead to digestive issues, skin changes, respiratory problems, reproductive abnormalities, liver and kidney disorders, and an increased risk of obesity (Walczak-Nowicka & Herbet, 2022). Calcium chloride, when consumed above 0.4%, can cause cardiac issues, kidney stones, gastric necrosis, neurological disorders, and embryological abnormalities (Bailone *et al*., 2022). Benzoic acid at high concentrations can result in skin irritation, eye damage, respiratory issues, lung diseases, immune dysfunction, and other side effects (Rokni *et al*., 2024). Citric acid exposure has been associated with inflammation-related conditions, including asthma, juvenile idiopathic arthritis, autistic spectrum disorders, and fibromyalgia (Sweis & Cressey, 2018). Ethanol, or ethyl alcohol, may lead to central nervous system depression, hypoglycemia, brain trauma, liver damage, and an increased risk of cancer (Wilson & Matschinsky, 2020). Sulfite is linked with dermatitis, hives, severe anaphylactic, asthmatic responses, and low blood pressure (Vally *et al*., 2009).

The majority of fruit sellers reported learning about preservation methods through family and friends, formal education, and workshops. Their choice of preservation methods was influenced primarily by the cost, storage duration, and ease of use. However, 95% of the sellers had limited knowledge of preservative application guidelines. This lack of awareness suggests that fruit consumption in the city might unknowingly pose health risks to consumers.

CONCLUSION AND RECOMMENDATIONS

The findings revealed that the demographic profile of fruit sellers in Birnin Kebbi is predominantly young, male, of Hausa ethnicity, and with minimal formal education, reflecting the cultural and socio-economic characteristics of the region. Commonly preserved fruits included watermelon, oranges, bananas, and sweet melons, among others, reflecting their high demand and widespread consumption in Nigeria. Chemical preservatives, such as citric acid, sodium benzoate, calcium chloride, benzoic acid, and ethanol, were frequently used alongside natural methods like salting, drying, canning, freezing, and smoking. While these methods extend the shelf life of fruits, the unregulated and potentially excessive use of chemical preservatives poses significant health risks to consumers. Additionally, the limited knowledge of preservative application guidelines among the majority of fruit sellers raises concerns about the safety of fruit preservation practices in the city.

Based on these findings, there is a need to educate fruit sellers and consumers on the safe use of chemical preservatives, including appropriate concentrations and application methods. Additionally, it is necessary to promote awareness of the potential health risks associated with excessive or unregulated use of chemical preservatives. Organizing workshops and training sessions for fruit sellers on alternative, safer, and more effective fruit preservation methods is imperative. Further research should be conducted to comprehensively assess the long-term health impacts of preservatives commonly used in fruit preservation. Regional differences in preservation practices need to be investigated to develop context-specific interventions.

Competing Interests: The Authours wish to declare without any uncertainty that there was no competing interest with regards to this work.

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