Journal of Healthcare and Life-Science Research
Vol. 4, No. 9, 2025 ISSN: 2181-4368

KNOWLEDGE OF FOOD PRESERVATION AND PRACTICES AMONG PERISHABLE FOOD VENDORS IN BUEA HEALTH DISTRICT, SOUTH WEST REGION OF CAMEROON

Annotation:

Introduction: Food preservation (FP) is important in the food industry, particularly for vendors who sell perishable foods. Some vendors cannot access `up-to-date preservation technology and rely on traditional methods. This study aimed to assess the knowledge and identify the practices and challenges perishable food vendors face in preserving food within the Buea Health District (BHD), South West Region of Cameroon.

Methods: A cross-sectional study was carried out using an explanatory design of both quantitative and qualitative approach carried out from November 2023 to July 2024. It involved random sampling of some 400 food vendors (vegetables/fruits, meat/poultry, seafood, egg) who were issued pretested questionnaire for the quantitave design and 40 key informants who were purposefully selected for Iin-depth interviews for the qualitative design. Quantitative data was analysed using SPSS version 26 with the p-value < 0.05 for significance. while the qualitative data was analysed thematically using NVivo software.

Results: The results showed that women 254 (63.5%) dominated food vending in the BHD, and most vendors had secondary educational levels 226 (56.5%). Of the vendors sampled, 45.5% had a good knowledge of FP with the following associated factors: having a secondary education [adjusted odds ratio (AOR) = 3.04: 1.40-5.31, p=0.001], being above 40 years of age (AOR = 2.40: 1.80-4.41, p=0.026), more than five years of experience (AOR = 1.50: 1.01-3.21, p=0.031). Most vendors practice FP, with the most common methods being air drying (52.3%), refrigeration (45.2%), limited exposure to air/sunlight (31.4%) and smoking (28.1%). Results also show that 92(23.3%) of vendors used chemical preservatives to preserve their food, with 30(7.5%) using formalin. The factors associated with formalin use were university education, being single, meat vending, and insufficient knowledge of food preservation. Most vendors indicated they faced challenges preserving their food, the most prominent challenges being the risk of food contamination 306(76.9%), the cost of preservation 236(59.0%), time constraints (53.6%), and limited space (32.1%).

Conclusion: The findings revealed the vendors had limited knowledge of food preservation and practised mostly traditional preservation methods with some recorded unsafe practices, while observing risk of contamination and high cost of preservation as the main challenges. Providing food vendors with adequate information on preservation techniques and best practices can ensure the distribution of safe food products and increase food security and profitability among the vendors.

Keywords:

Buea Health District (BHD), Food, Food preservation (FP), Food vendors, Perishable.

Information about theauthors

Malika Esembeson [3,4,5], ***Nene Kaah Keneh*** [1,2,3], ***Naiza Monono Ngowo*** [3,6,7], ***Tendongfor Nicholas*** [3,4,8]

[1] *Department of Microbiology and Parasitology, Faculty of Science, University of Buea, Cameroon*

[2] *Laboratory for Emerging Infectious Diseases, Faculty of Science, University of Buea, Cameroon.*

[3] *Department of Public Health and Administration, School of Health Sciences, Biaka University Institute Buea, Cameroon.*

[4] *Department of Public Health and Hygiene, Faculty of Health Science, University of Buea, Cameroon.*

[5] *General supervisor, Regional Hospital Buea, South West Region, Cameroon.*

[6] *Department of Pediatrics, Regional Hospital Limbe, South West Region, Cameroon.*

[7] *Department of Internal Medicine and Paediatrics, Faculty ofHealth Sciences, University of Buea, Cameroon*

[8] *HOD, Department of Public Health and Hygiene, Faculty of Health Science, University of Buea, Cameroon*

1. Background

Food preservation (FP) aims to maintain the desired properties of food for as long as possible, transitioning from an art to an interdisciplinary science (1). Food, whether of plant or animal origin, contains various nutrients and is prone to spoilage due to physical, chemical, or microbial activities, which can alter its nutritional value, colour, flavour, and texture (2, 3, 4). The main goal of FP is to extend the shelf life of food while preserving its original qualities.

Historically, understanding food preservation methods was crucial for civilisation (5). Ancient methods (mostly physical) like drying, freezing, chilling, pasteurisation, and chemical preservation are still widely used (2). Modern advancements have introduced new technologies such as irradiation, high-pressure technology, and hurdle technology (6, 7).

Food preservation has become a highly interdisciplinary field, involving different stages from cultivation to distribution. A combined approach is beneficial for preserving food during production and processing (6, 8). Food vendors, who sell in various settings, need to be aware of the effective preservation methods to meet their consumers' demands and reduce waste of their food items (9). This is especially crucial for perishables and semi-perishables, which spoil quickly. Preservation methods focus on inactivating or inhibiting microorganisms and preventing recontamination, with food safety as the top priority (2, 3, 4, 10). Understanding these methods and their impacts is vital for health and economic reasons. Food vendors face various challenges in their practice of preserving food, most of which vary with the preservation method used, and a common challenge is the spoilage of food and the cost of preservation (11, 12).

In Africa, there is limited information on food vendors' knowledge of food preservation, with most reports focusing on food safety and hygiene instead (13). Studies show that food handlers often learn preservation methods from informal sources like neighbours and family 14). Various preservation practices are used across different countries, including drying (14, 15), using preservatives (16, 17, 18, 19, 20), smoking (16, 21), and fermentation (22). Food vendors, especially in underdeveloped countries,

face challenges such as: lack of preservation skills (14), food spoilage (15, 23, 24), and high preservation costs (23, 24).

Food preservation is vital in agriculture as it stabilises the food supply, reduces waste, and boosts economic opportunities for farmers and vendors. Thus, helps avoid losses, promotes efficient production, and allows the sale of value-added products, enhancing income and sustainability. Food preservation is also vital in public health as the health and well-being of consumers of preserved food can be related to the FP practices of the food vendors, handlers and farmers.

Food preservation is essential for preventing spoilage, extending shelf life, and ensuring food safety and quality. Perishable food vendors often use various preservation methods to keep their products fresh, but some of these methods can be harmful to consumers. A report from the Guardian Post newspaper on August 23, 2023, highlighted the illegal use of formalin, a hazardous chemical, to ripen and preserve food in Cameroon, and authorities seized chemically ripened plantains at the Mvog Ada Market in Yaoundé (25).

The use of artificial preservatives and certain physical preservation methods (26, 27), such as irradiation and electrical discharge, raises serious public health concerns, as they have been linked to diseases like cancer, heart conditions, and allergies (6, 28, 29). Additionally, unsafe food preservation practices can harm a country's economy. Following a crackdown on traders using formaldehyde in Dschang (Western Cameroon), Gabon’s Food Security Agency tightened border controls to test food imports from Cameroon. These unsafe practices not only threaten public health but also pose risks to food exports and economic stability. The above reports raised concerns regarding food preservation practices in Cameroon; as such, the study focused on identifying methods used by vendors in preserving perishable foods in the Buea Health District of Cameroon, the challenges they face, and their knowledge of preservation techniques.

2. Materials and methods

2.1 Research design

The study was a descriptive cross-sectional study using an explanatory approach of data collection, combining quantitative (use of pre-tested questionnaire) and qualitative methods (with the use of in-depth interviews).

2.2. Study area and population

This study was carriedout from November 2023 to June 2024 in Buea, the Fako division of the South West Region (SWR) of Cameroon, located on the West of the Central African subregion. Buea, the capital of the SWR of Cameroon, is located at 4°09'97.20" N and 9°14'27.60" E. Buea is situated on the eastern slope of Mount Cameroon, an active volcano standing about 4010 meters high, and spans an area of 870 km² (30). As a historic and cosmopolitan town, Buea had an estimated population of around 300,000 in 2013, comprising diverse demographics (31). The town experiences two seasons (dry and rainy) with an equatorial climate and annual rainfall ranging from 3000 mm to 5000 mm. Despite the high rainfall, Buea faces significant water shortages, especially during the dry season, partly due to its rapidly growing population, as at least 7,000 people relocate to Buea each year, according to the municipal council statistics (30). Additionally, the town's drainage and waste management systems remain underdeveloped (32). Buea shares boundaries with Mutengene to the south, Mount Cameroon to the west, and Ekona to the east. The BHD comprises seven health areas (Bokwango, Bova, Buea Road, Buea Town, Molyko, Muea, and Tole) (Figure 1), with an estimated population of about 200,000 inhabitants, constituting essentially the Bakweri indigenes (30).Buea habors thousands of internally displaced persons due to the socio-political unrest.

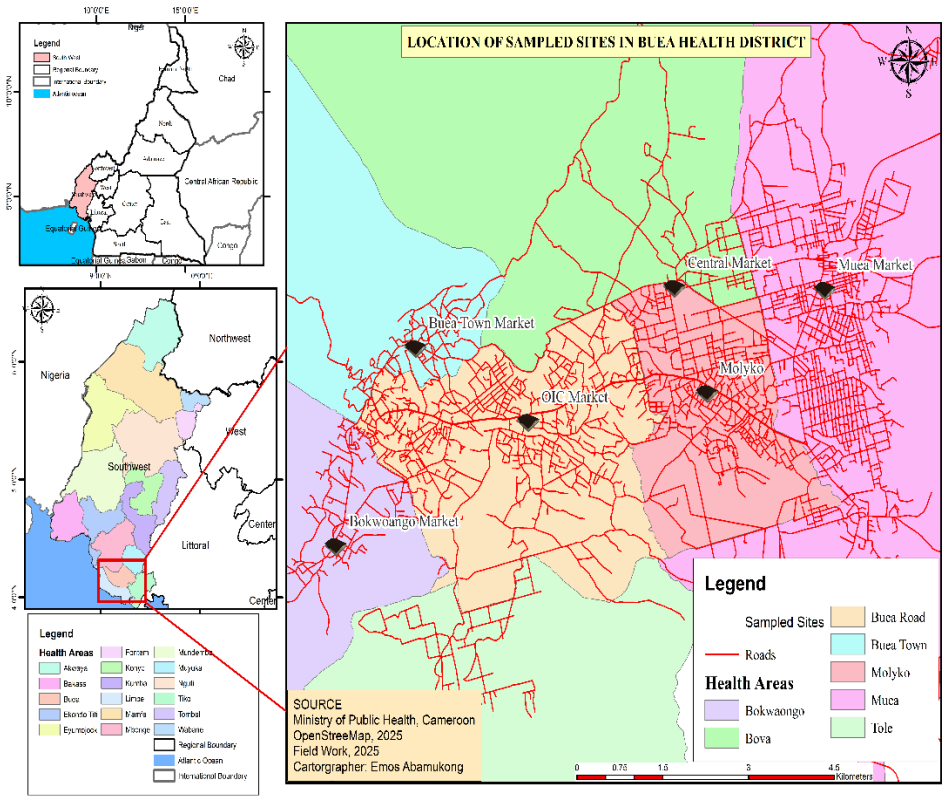

Figure 1: The map of Buea Health District locating the markets of the study area.

Study population

The study population involved people who have been selling perishable foods (vegetables, fruits, seafoods, meat and poultry products) for at least six months within the Buea Health District and have consented to take part to the study after the study was explained to them.

Sample size determination

The sample size for the quantitative section was calculated based on the estimated prevalence of 50% of food preservation method usage by vendors of perishables in Buea Health District, with a 95% confidence level and a 5% margin of error. The sample size for the quantitative aspect of this study was calculated using the formula for calculating sample size for descriptive studies in an infinite population greater than 10,000 (33), which gave a minimum of 384 participants. For the qualitative section, ensuring the representation of different food products, 40 vendors were purposively selected for the in-depth interviews (IDIs).

Sampling technique

Out of the 10 markets identified in Buea, 6 were randomly selected without replacement and probability proportionate to size was calculated as follows: OIC (90/400), Muea (110/400), Central market (88/400), Buea Town (51/400), Bokwango (42/400), Molyko (19/400). Using convenient sampling, pre-tested questionnaires were issued to 220 participants from the vegetables and fruits vendors, 81 meat/poultry vendors, 49 seafood vendors and 50 egg vendors. Data collection with a comprehensive explanation of the study was ensured. Some 40 key informants for in-depth interviews from selected food vendors and stakeholders, such as market managers to explore their perceptions, experiences, and challenges of food preservation from the 6 markets selected in Buea Health District,. based on their availability, relevance and diversity of perspectives.

Data collection tools

The quantitative component consisted of a section A, to collect information on their socio-demographic characteristics, section B, knowledge, section C, practices of food preservation and section D, the challenges faced in preserving food items. The qualitative component consisted of in-depth interview (IDI) guide and audio recordings.

Data Analysis

The study used statistical package for social sciences (SPSS) version 26.0 (SPSS Inc., Chicago, IL, USA) software to perform descriptive and inferential statistics on the quantitative data.

The Knowledge was scored (questions with correct answers were given one, and wrong answers were given zero), and respondents with an average and more (> 6 of 12) correct responses were graded as having good knowledge on food preservation. Descriptive statistics were used to calculate the prevalence of food preservation practices and the proportion of the different challenges faced by the food vendors in food preservation, and a bivariate (Fisher's exact test) was used to determine the factors associated with the practices. All associations were tested at $p<0.05$ of significance.

NVivo software was used to carry out thematic analysis of the qualitative data (recordings of the IDIs) using a deductive-inductive approach to identify and code the main themes and sub-themes from the transcripts of the various responses of the food vendors.

Ethical considerations

The study adhered to the ethical principles of respect, beneficence, and justice, ensuring that the participants were informed about the purpose, procedures, and benefits of the study. Confidentiality and anonymity were respected. No harm or discomfort occurred during the data collection and analysis. With the help of an introductory letter (Appendix D), an administrative clearance from the South West Regional Delegation of Public Health Buea (Appendix E), and an ethical clearance from the Institutional Review Board (IRB) of the Faculty of Health Sciences, University of Buea (Appendix F) were obtained. Access into each market was granted by the market managers verbally upon presentation of clearances.

3. RESULTS

3.1 Socio-demographic characteristics of respondents

The socio-demographic characteristics of the 400 perishable food vendors selected from 6 sites in the BHD showed that. the mean age of the participants was 34.9 (SD±3.9) years. Of the 400 vendors sampled, 254 (63.5%) were females, 03 (0.7%) had no formal education, and 140 (35.0%) were married. Most of the perishable food vendors were recruited from the Muea market (27.5%), OIC Market (22.5%) and Central Market (22.0%). Close to one-third of the vendors had a monthly profit of less than 50,000 FCFA. The majority, 305 (76.3%) of the participants, had sold for less than five years. Most of the perishable food vendors sold vegetables/fruits 220 (55.0%) and meat/poultry 81 (20.2%) (table 1).

Table 1: Socio-demographic characteristics of the respondents

Variables	Frequency	Per cent (%)
Age (in years)		
21 – 40	44	11.0
31 – 60	237	59.2
>60	119	29.8
Total	**400**	**100.0**
Gender		
Male	146	36.5
Female	254	63.5
Total	**400**	**100.0**

Level of education		
No formal education	03	0.8
Primary	90	22.5
Secondary	226	56.5
Tertiary	81	20.2
Total	**400**	**100.0**
Marital status		
Married	140	35.0
Single	211	52.7
Divorced/Widowed/Separated	49	12.3
Total	**400**	**100.0**
Market		
OIC (Buea road)	90	22.5
Muea	110	27.5
Central	88	22.0
Buea Town	51	12.7
Bokwango	42	10.5
Molyko	19	4.8
Total	**400**	**100.0**
Income level [FCFA]		
Less than 50,000	129	32.2
50,000 – 100,000	192	48.0
More than 100,000	79	19.8
Total	**400**	**100.0**
Longevity [years] in the business?		
0 – 5	305	76.3
6 – 10	76	19.0
11+	19	4.7
Total	**400**	**100.0**
Perishable food type		
Vegetables/Fruits	220	55.0
Meat/Poultry	81	20.2
Seafood	49	12.2
Egg	50	12.6
Total	**400**	**100.0**

3.2 Knowledge on food preservation

3.2.1 Knowledge of perishable food vendors on food preservation

Almost all, 395 (98.7%) participants had heard of food preservation. The main sources of information on food preservation were self-study 343 (86.8%), school 132 (33.4%), and peer learning 89 (22.5%). The most reported meanings of food preservation were increasing the shelf-life of foods 171 (43.3%) and making the food attractive 76 (19.2%). Of the 400 perishable food vendors sampled, only 38 (9.6%) had ever received any training on food preservation. The most reported signs of food spoilage after preservation were unpleasant smell (50.9%) and discolouration of food (52.4%). Only 15 (3.8%) of the participants knew that gas production is a key sign of food spoilage (table 2).

Table 2: Knowledge of perishable food vendors on food preservation

Knowledge	Answer	
	Frequency	**Per cent (%)**
Vendors who have heard of food preservation		
Yes	395	98.7
No	05	1.3
Total	**400**	**100.0**
Vendors's source of information on food preservation*		
School	132	33.4
e-learning (online)	02	0.5
Peer learning	89	22.5
Conferences/Events	00	0.0
Self-study	343	86.8
Total	**395**	**100.0**
Vendor's choice of food preservation definition		
Increasing the shelf-life of foods	171	43.3
Slowing the natural process of decay	58	14.7
Adding artificial products to slow decay	41	10.4
Keeping food safe for consumption	54	13.7
Making the food attractive	71	17.9
Total	***395***	***100.0***
Vendors who have received any training on food preservation		
Yes	38	9.6
No	357	90.4
Total	**395**	**100.0**
Key signs of food spoilage after preservation*		
Unpleasant smell	201	50.8
Discolouration/Mold growth	207	52.4
Change in texture	194	49.1
Off-taste	181	45.8
Gas production	15	3.8
Vendors' idea on disorders due to consumption of spoiled food *		
Diarrhoea	394	99.7
Fever	00	0.0
Abdominal cramps	00	0.0
Abdominal pains	81	20.5
Vomiting	205	51.9
Nausea	196	49.6
Perceived sufficient knowledge on food preservation		
Yes	182	45.5
No	218	54.5
Total	**400**	**100.0**

**** multiple response questions***

3.2.2 Overall knowledge of perishable food vendors on food preservation

Of the 400 perishable food vendors sampled, 182 (45.5%) had a good knowledge of food preservation (correctly answered at least seven questions on a scale of twelve) (Figure 2).

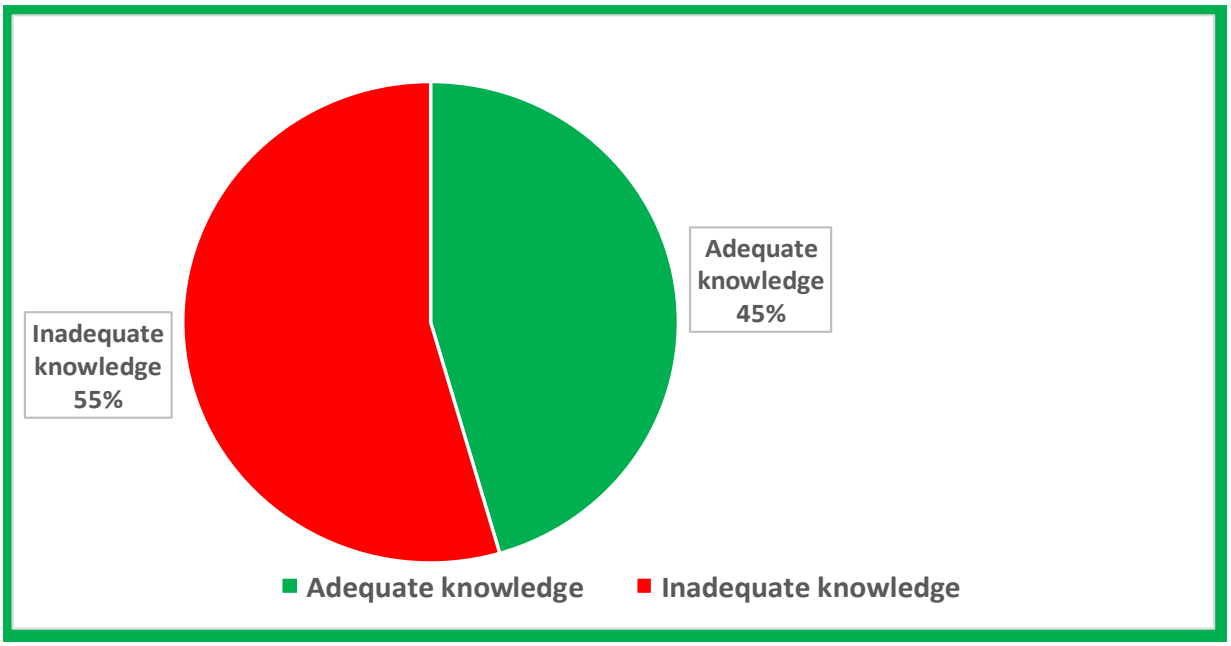

Figure 2: Overall knowledge of perishable food vendors on food preservation

3.2.3 Socio-demographic determinants of good knowledge on food preservation

Three socio-demographic factors (age, educational level, and longevity in service) were significantly associated with good knowledge of vendors on food preservation methods. Older (above 40) vendors were 2.4 times more likely to have good food preservation knowledge than their younger counterparts (AOR=2.40: 1.80-4.41, p=0.026). Vendors with an A-level certificate were 3.04 times more likely to have good food preservation knowledge than their counterparts with FSLC (AOR=3.04: 1.40-5.31, p=0.001). Vendors with more than five years of experience were 1.50 times more likely to have good food preservation knowledge than their counterparts with less than five years of experience (AOR=1.50: 1.01-3.21, p=0.031), (table 3).

Table 3: Socio-demographic determinants of good knowledge on food preservation

Characteristics	Knowledge		AOR (95%CI)	p-value
	Yes	No		
Age				
21 – 30	21 (47.7)	23 (52.3)	1	
31 – 40	92 (38.8)	145 (61.2)	0.74 (0.51-2.30)	0.211
41+	69 (58.0)	50 (42.0)	2.40 (1.80-4.41)	0.026*
Level of education				
Primary	29 (31.2)	64 (68.8)	1	
Secondary	122 (54.0)	104 (46.0)	3.04 (1.43-5.32)	0.001*
Tertiary	31 (38.3)	50 (61.7)	1.10 (0.89-1.99)	0.357
Longevity in years				
0 – 5	130 (42.6)	175 (57.4)	1	
6 – 10	45 (59.2)	31 (40.8)	1.50 (1.01-3.02)	0.031*
11+	07 (36.8)	12 (63.2)	0.90 (0.59-1.87)	0.543

*significant at p<0.05

3.3 Practices Regarding Food Preservation among Perishable Food Vendors

3.3.1 Food preservation methods used by perishable food vendors

Of the 400 perishable food vendors sampled, 392 (98.0%) indicated preserving their food items. The most common food preservation methods reported by the participants were: air drying or flooring 205 (52.3%), refrigeration 177 (45.2%), limited exposure to air/sunlight 123 (31.4%) and smoking 110 (28.1%) (Figure 3).

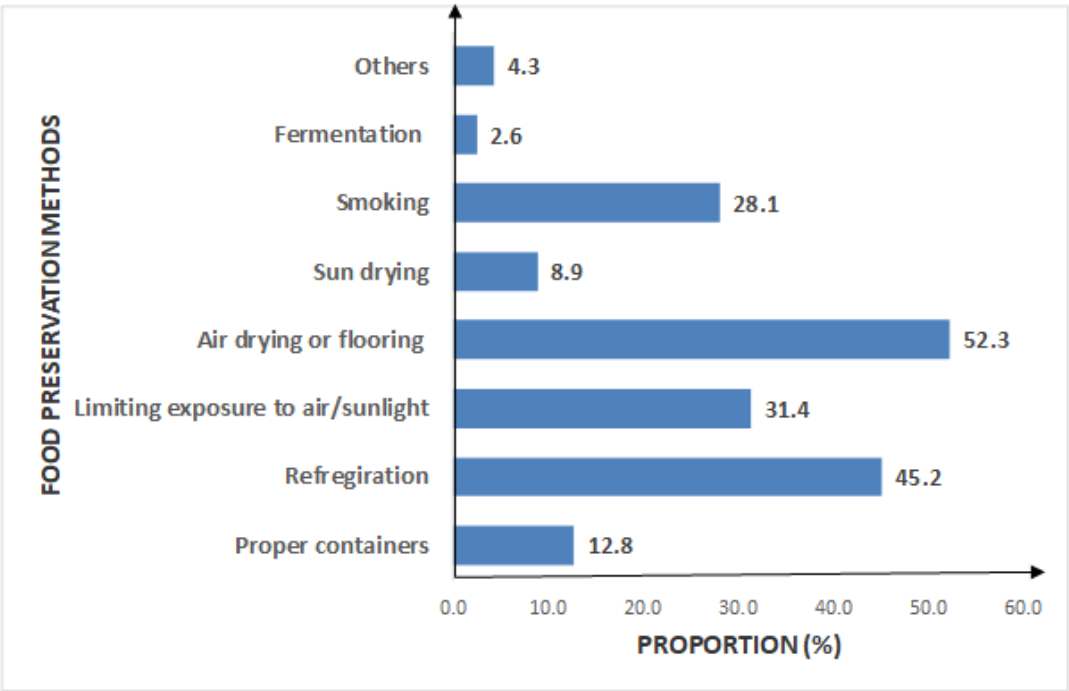

Figure 3: Food preservation methods used by perishable food vendors in the BHD

3.3.2 Use of additives or preservatives among food vendors

Of the 400 perishable food vendors sampled, 93 (23.3%) indicated using additives or preservatives to conserve their food. Out of these 93 participants, 7 (7.5%) used formalin and 86 (92.5%) used table salt (Figure 4).

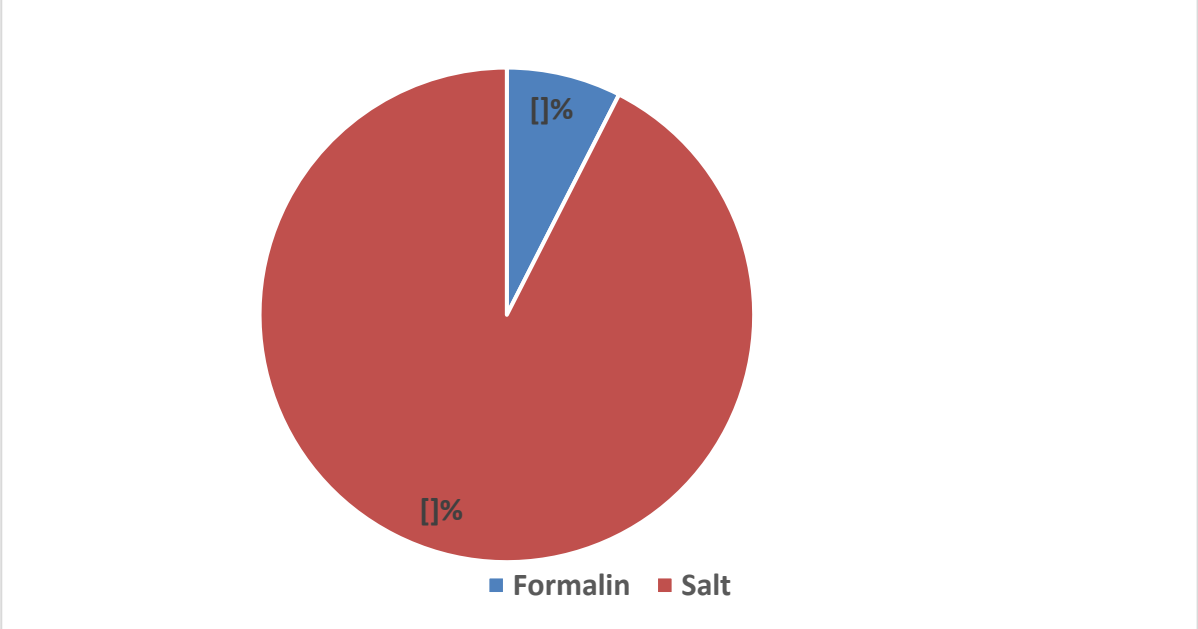

Figure 4: Use of additives or preservatives among food vendors

3.3.3 Duration of preservation among perishable food vendors in BHD

Of the 392 food vendors who preserved food, the majority, 134 (34.2%) of the participants preserved their food for more than a week, while 110 (28.1), and 107 (27.2%) preserved theirs for 3 – 4 days and 1 – 2 days respectively (Figure 5).

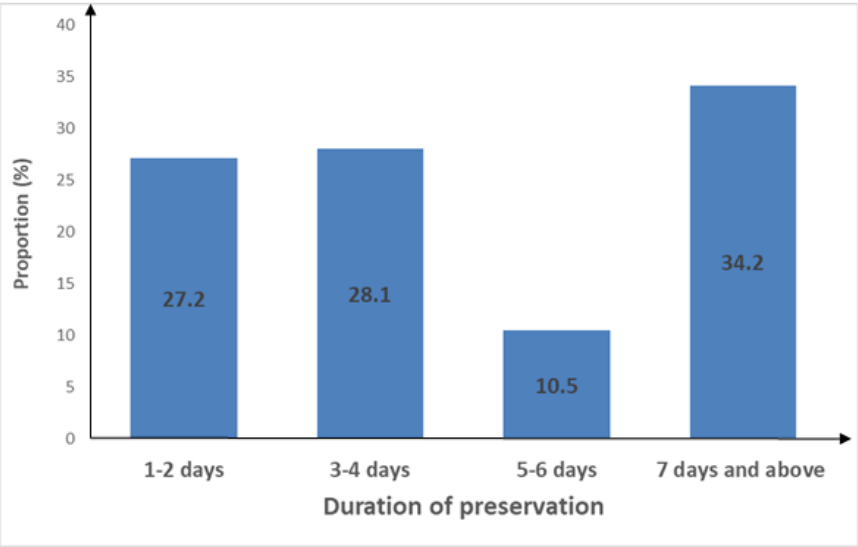

Figure 5: Duration of food preservation among food vendors

3.3.4 Factors associated with the use of formalin preservatives among food vendors

Four factors were significantly associated with using formalin among food vendors: educational level, marital status, type of food sold and knowledge on food preservation. Food vendors who attended university were more likely to use formalin than their counterparts with FSLC (8.6% versus 0.0%, p=0.020). Single food vendors were more likely to use formalin than their married counterparts (5.0% versus 0.0%, p=0.031). Food vendors who sold meat were more likely to use formalin than those who sold vegetables/fruits (8.6% versus 0.0%, p=0.031). Food vendors with insufficient knowledge of food preservation were more likely to use formalin than those with sufficient knowledge of food preservation (3.2% versus 0.0%, p=0.031) (table 4).

Table 4: Factors associated with the use of formalin preservative

Characteristics	Use of formalin		Fischer's Exact value	p-value
	Yes	No		
Level of education				
Primary	0 (0.0)	93 (100.0)	32.03	0.020*
Secondary	0 (0.0)	226 (100.0)		
Tertiary	7 (8.6)	74 (91.4)		
Marital status				
Single	7 (5.0)	133 (95.0)	20.34	0.031*
Married	0 (0.0)	211 (100.0)		
Divorced/widow	0 (0.0)	49 (100.0)		
Type of food sold				
Vegetables/Fruits	0 (0.0)	220 (100.0)	19.05	0.031*
Meat/Poultry	7 (8.6)	74 (91.4)		
Seafood	0 (0.0)	49 (100.0)		
Egg	0 (0.0)	50 (100.0)		
Knowledge on food preservation				
Sufficient	0 (0.0)	182 (100.0)	23.90	0.022*

Insufficient	7 (3.2)	211 (96.8)		

*significant at p<0.05

3.3.5 Changes observed after food preservation among food vendors in BHD

Of the 392 vendors who preserved their food, 355 (90.6%) observed changes in their food following preservation. The most reported changes observed post preservation were changes in changes in texture 229 (64.5%), flavour 205 (57.7%) and colour 137 (38.6%) (Figure 6).

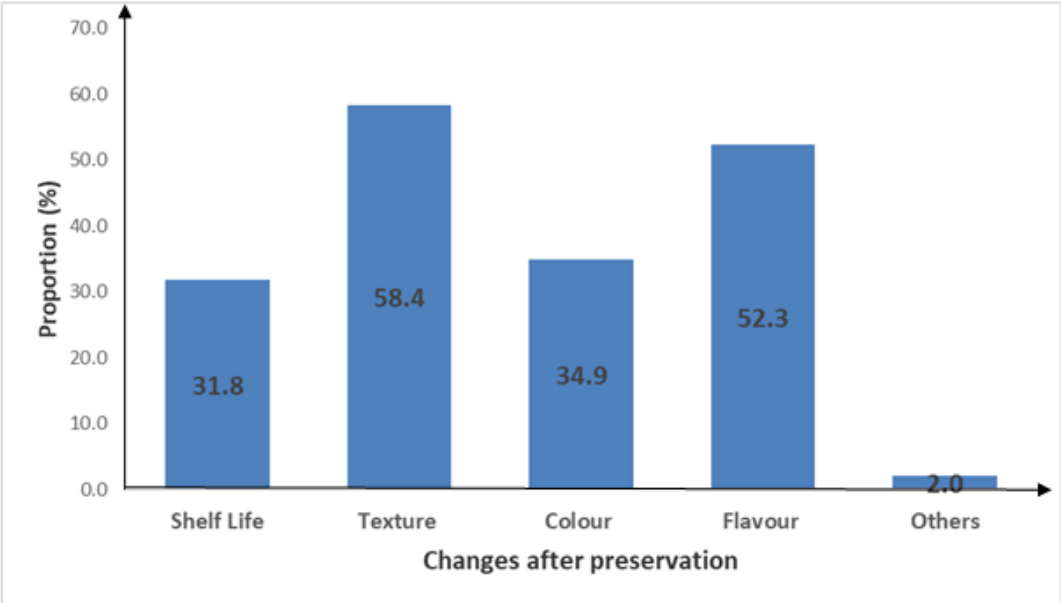

Figure 6: Changes observed in the food after food preservation

3.4 Challenges faced in the preservation of food by food vendors in BHD

3.4.1 Challenges faced by food vendors in the preservation of food

Of the 392 perishable food vendors who preserved their food, 390 (99.5%) indicated they faced challenges preserving it. The most prominent challenges were the risk of food contamination 300 (76.9%), cost of preservation 230 (59.0%), time constraints 209 (53.6%), limited space 125 (32.1%) and power outage 95 (24.4) (Figure 7).

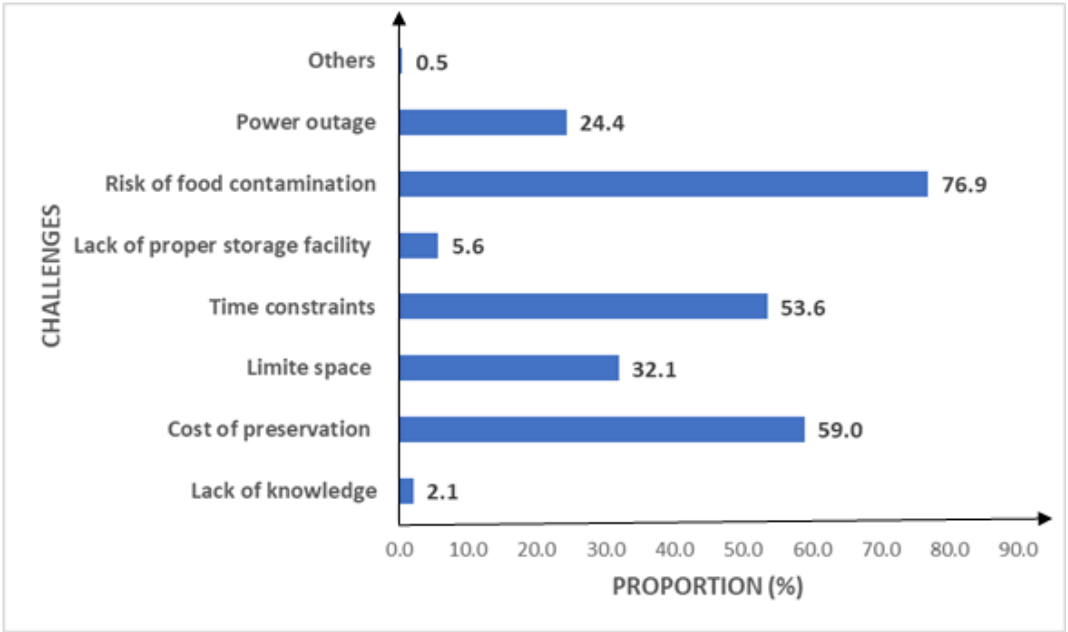

Figure 7: Challenges faced by food vendors in the preservation of food

3.4.2 Duration of challenges faced during food preservation

Of the 390 perishable food vendors who reported challenges, 102 (26.2%) of them encountered challenges uncountable times while preserving their food items. The majority 125 (32.1%) of the food vendors encountered challenges 1 – 2 times a week (Figure 8).

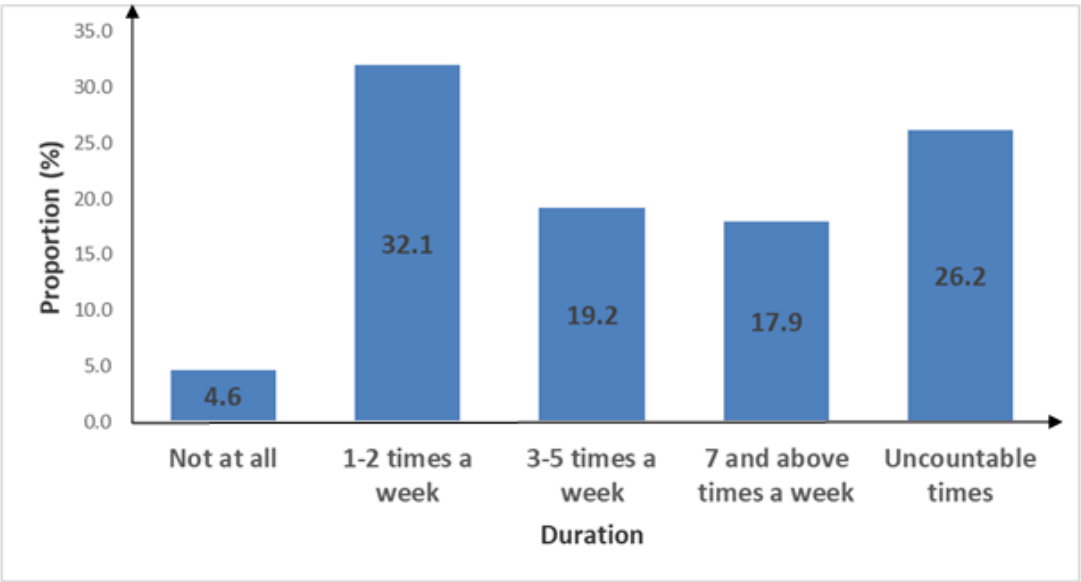

Figure 8: Duration of challenges faced during food preservation

3.5. Results from qualitative data obtained from food vendors

3.5.1 Knowledge of food vendors regarding perishable food preservation

Many participants reported that they had not received any training on the various food preservation techniques and were sure, their mostly traditional practices were bound to be inadequate. Thus, they requested to be informed or trained on the various available methods they could use to preserve their foods. These findings are illustrated in the quotes below;

"…… I learned how to store my vegetables by myself from the traditional methods that we grew up with, like drying ……" (Female, 29 years, Buea Town Market).

"… … 'the only method of preserving meat that I know is through drying and refrigeration; if I knew other methods, I would have been using them. I think the government should train us on the various ways of storing our foods and meat……" (Male, 37 years, Muea Market).

"…… I think you people from the university who are studying medicals should come and teach us on the preservation of perishable foods ……" (Male, 20 years, Bokwango).

Many participants reported that they hardly saw people from hygiene and sanitation or veterinary doctors coming to inspect food in the market and around. This illustrates that supervision and inspection of foods in Buea is grossly sub-optimal. These findings are illustrated in the quotes below;

"… … People just add any kind of chemicals to foodstuffs nowadays since the inspection of food and meat is not done properly ……" (Female, 33 years, OIC Market).

"… … Those veterinary doctors don't usually come here. Even when they come, they end at the slaughterhouse, and people just carry any kind of meat from their fridges to the market ……" (Male, 20 years, Muea Market).

3.5.2 Practices of food vendors regarding perishable food preservation

Generally, the perishable food vendors' knowledge of food preservation was associated with the kind of perishable foods sold. Their preservation practices varied and were consistent with the type of

perishable food sold. The most cited food preservation methods were refrigeration, drying, smoking, airing, sorting, and transformation, which were generally good. The following quotes illustrate these findings;

"… … I use the traditional methods like drying, so I usually slice the vegetables and dry them if I want to preserve them … …" (Female, 29 years, Buea Town Market).

"… … yes, I have heard of food preservation, and since I sell fish, I mostly store or preserve the remaining fish in a deep freezer. When there is no light for a long time, I smoke the fish; I also limit the quantity of fish I sell,I sell what I can manage……" (Female, 34 years, Muea Market).

"… … yes, I have heard of food preservation, and since I sell vegetables, I mostly store or preserve the remaining vegetables by spreading them in the open air. We have sheds in the market which we use to spread and 'water' the remaining vegetables ……" (Female, 37 years, OIC Market).

"…… yes, I have heard of food preservation, and as I sell meat, I mostly store or preserve the remaining meat in a deep freezer. When there is no light for a long time, we use a generator to power our deep freezers, although it is expensive……" (Male, 20 years, Buea Town Market).

"… … most times, I sell all my vegetables since I am cheaper than my colleagues. If some vegetables happen to remain, I select the ones that are starting to get bad, trim the strange-looking portions and keep them separately. I keep the vegetables in these handmade baskets with big holes; this will make the vegetables stay again for more days without getting bad……" (Male, 37 years, Muea Market).

"…… I am not very old in this business. I harvest these vegetables from my farm, and if I don't sell all of them, I open them up, sprinkle water on them, and spread them on the floor for air to pass through them. I make sure I do not put much water on the vegetables or allow water from the rain to touch them during the rainy seasons, else the vegetables will all rot……" (Female, 27 years, OIC Market).

"… … I usually use plastics for fish smoking, I use them alongside firewood as they burn easily and sustain the fire for a longer time, ensuring the fish gets dry faster. Additionally, this saves me from spending more money on firewood, as firewood is quite expensive in Buea around where I live … …" (Female, 32 years, Buea Town Market).

Although most of the practices regarding food preservation were consistent with the World Health Organisation norms, a few participants reported poor food preservation practices. The poor food preservation practices were mostly seen in the areas of meat, plantains and vegetables. A few participants reported the use of substances like low concentrations of formalin, colourings and other unknown chemicals to preserve meat. This is illustrated in the quotes that follow;

"… … Sometimes we go for months without light, and we have difficulties preserving our meat. There is this chemical that we sometimes add so that the meat will not have a bad smell. My boss just gives me small quantities of the chemical to add to the meat. I don't know the name of the chemical……" (Male, 27 years, Muea Market).

"… … When we notice that the meat has started changing colour and there is no light, we add a very small quantity of formalin to help keep the meat in a good state until the next day.……" (Male, 41 years, Buea Town Market).

"… … I usually use formalin for air drying fish, especially during sunny days, this chemical prevents flies from coming to the fish, as such the fish dries without getting spoiled … …" (Male, 39 years, Central Market).

A few participants reported the use of substances (most of whose real names the local vendors didn't know) to precipitate or catalyse the ripening of fruits like pears, bananas, and plantains.

"… … I usually add/rub some chemical or wood ash to my pears and banana so that it ripens faster. When I have an important delivery to make, I ensure that the banana ripens on the day……" (Female, 24 years, Muea Market).

"… … When I don't get ripe plantain from the bush market, I am forced to add this chemical that accelerates ripening. I always think it's safe since it does not touch the inside……" (Male, 21 years, Bokwango).

A few participants reported the use of colourants and preservative substances on pork.

"… … When the pork has a dark colour, I usually add a chemical which they call colour to make it bright (having a pinkish colour) and have a good smell ……" (Male, 24 years, Molyko Street).

"… … When we have leftover pork, I have to add this 'colour' to make it look attractive and remove the odour ……" (Male, 21 years, Muea Market).

3.5.3 Challenges faced by food vendors in the preservation of perishable foods

Generally, the main challenges faced by food vendors in preserving perishable foods were power failure or electricity shortage, lack of education on food preservation and inadequate supervision or control. The constant interruption of electricity was the main challenge faced by food vendors in preserving perishable foods. The following quotes illustrate these findings;

"… … 'Massa', these light and transformer issues in Buea are making it difficult for us to store and preserve our meat. You know, meat can get bad if the light is constantly going on and off ……" (Male, 37 years, Molyko).

"… … This electricity 'wahala' in Buea has made me add some chemicals to the fish I sell so that it does not go bad ……" (Male, 20 years, Muea Market).

"……. My greatest challenge is the spoilage of the fish. This is my business, and I have been selling for almost 10 years. Still, due to the electricity shortage in Buea, which causes the fish to spoil, I buy quantities based on the demand I have or anticipate, to avoid losses. I usually buy just ice and put it into the fish when I purchase them. So I make sure I sell all in a day……." (Female, 40 years, Muea Market).

"……since I preserve the vegetables I sell by drying, I mostly face challenges during the rainy seasons where there is little or no sunlight ……" (Female, 29 years, Buea Town Market).

4.1 DISCUSSION

4.1.1 Discussion on socio-demographic characteristics of participants

The participants of this study recorded the mean age of the participants as 34.9 (SD±3.9) years, indicating that most of the populations involved in food vending in BHD were young adults (persons in their mid-age). This is slightly higher than a study conducted among food vendors in Sokoto, Nigeria (34), where most of the vendors were between the ages of 15 – 29 years, and similar to the findings of studies carried out in Ilorin, Nigeria (35), where a majority of the respondents were in their mid-age and within the range of 30 – 39 years and a study in Buea and Kumba city councils of Cameroon (36). These age groups form the economically active population, and their participation in the food trade may reflect the District's high unemployment levels.

A higher percentage of females participated in this study, suggesting that females are more interested in food vending, which they depend on as their means of complementing family income, and may also have been more accessible for participation in the study. This result was similar to reports obtained in several studies: in Cameroon (36), in Sokoto, Nigeria (37), and in a rural settlement study in Imo state, Nigeria (38). Similar to studies conducted in Ilorin (35), Jos and Owerri of Nigeria (39, 40) reported that most females were food vendors. The majority of female food handlers in this study may be because women are more involved in food preparation and serving in our society.

The study subjects were mostly persons with secondary school education, suggesting the low educational level of the vendors is not only the case in Buea, as reported in another study carried out in Cameroon (36), but also consistent with a series of related studies in Imo state (38) and Port Harcourt, Nigeria (41) where most of the food vendors had a secondary school education and which concurs with findings from other studies in other African countries(39, 40), but contrary to findings in studies carried out in Sokoto (34) where majority of the food vendor had primary education. However, the food vendors surveyed in Nairobi, Ghana, Western and Northwestern Nigeria had no formal education (37, 42, 43, 44).

More than half of the respondents in this study were unmarried, similar to reports by a survey in Sokoto on food vendors, which recorded 67.0% of singles (37), and in Imo state, Nigeria, 35.0% married respondents (38). This could be related to the cultural practices in most African countries, where the activities of married women are mostly limited to home environment-related activities. Contrary to our study, a similar study in Port Harcourt where 59.4% recorded were married (41).

Close to one-third of the vendors in this study had a monthly profit of less than 50,000 FCFA. This lower profit could be attributed to food losses due to food spoilage due to improper information on food preservation practices and small-scale food vending, as the vendors purchase just the quantity of food they can manage.

The majority of the food vendors had been in business for less than ten years, indicating a low turnover rate in the industry, thus leading to migration into other businesses or a trend of new entrants dominating the market. This was similar to reports in similar studies in Sokoto, Port Harcourt and Kenya (37,41,45).

Most of the perishable food vendors sold vegetables/fruits and meat/poultry, which may suggest a common preference or market demand for these types of food items among vendors or consumers in the studied area.

5.1.2 Discussion on knowledge of perishable food vendors on food preservation

This study reported that almost all participants had heard of food preservation, though just about half of them had an overall good knowledge of food preservation, showing the food vendors were in search of ways to preserve their food, as most of the knowledge was gained through self-study. This indicates that there is a need to educate the public, especially people engaged in food vending, on food preservation and its practices.

The main sources of information on food preservation were self-study, contrary to a similar study on farmers, where their knowledge on food preservation was mainly from neighbours/friends /relatives/ family (14). Very few vendors have ever received any training on food preservation due to their low educational level, thus emphasising the need to create diverse education platforms to educate people on food preservation. The most reported meanings of food preservation were for increasing the shelf-life of foods and for making the food attractive; this also indicates a limited knowledge of food preservation by the food vendors in BHD.

The food vendors in this study had never been involved in any form of training on any food handling or related practices and showed a desire to attend training; this was contrary to a similar study carried out in Port Harcourt, Nigeria (41), where a majority of food handlers attended regular food safety training.

Older (above 40 years old) vendors were more likely to have good knowledge of food preservation than their younger counterparts. This could be that as the person advances in age, they tend to gain more knowledge. Vendors with an A-level certificate were more likely to have good food preservation knowledge than their counterparts with FSLC; this is because the higher one gets in education, the more exposed the person is to diverse information, in which food preservation may be among.

Vendors with more than five years of experience were more likely to have good knowledge of food preservation than their counterparts with less than five years of experience; this may suggest that the more experience the food vendors have, the more they seek to know how to preserve their food.

5.1.3 Discussion on practices regarding food preservation among perishable food vendors

The most recorded preservation methods were air drying or flooring and limited exposure to air/sunlight for vegetables, refrigeration for meat, poultry products and fish, and smoking for fish and meat. It was noted that the different food preservation practices were based on the type of foods being sold.

A similar study on commercial fish handlers reported smoking, sun drying, chilling, and freezing as a preservation method for fresh fish in Zambia (23), with smoking being the most used method, as it was deemed cheaper, less time-consuming, and reduces microbial growth thereby giving fish/ the food long shelf life besides adding a nice flavour. This was contrary to our study, where air drying/flooring was the most common method, as most of the vendors sold vegetables/fruits. In this study, the majority of the food handlers used the smoking method to preserve their fish and meat due to a lack of proper cold storage facilities. This was similar to studies on fresh fish preservation in Cameroon (16), Zambia(23) and Nigeria(46).

In this study, about a quarter of vendors indicated that they used additives or preservatives to preserve their foodstuff, similar to findings of Obioma and Inumanye in Nigeria (41), where more than half of the respondents made use of chemicals as food additives (potash, drugs, sodas and detergent to avoid spoilage during processing and improve palatability. Many studies in Cameroon have reported the use of natural preservatives (essential oils and chemicals, specifically sodium benzoate) in preserving foods (fish and beef pies) (16, 20, 47). This study's report was contrary to the findings in northern Ethiopia (24) and Zambia (23), where no chemicals were used during fish preservation at any stage. Generally, this can be attributed to the limited knowledge on both short- and long-term benefits and consequences of applying some chemicals on fish, meat, and other foods for preservation. Moreover, the application of chemicals in food is increasingly receiving public concerns about food safety(48).

Of the participants who used additives to preserve food, very few used formalin. Studies in Bangkok (49), Malaysia (50) and Nigeria (41) detected the illegal addition of formaldehyde to fresh fish by fishermen and/or food vendors.

In 1859, formaldehyde (common names include formalin, formic aldehyde, paraform, and formol) was discovered, and it was the simplest aldehyde in terms of chemical structure (18). Formaldehyde (CH_2O) is a colourless gas at ambient temperature with an irritating smell. In liquid form, Formaldehyde, commonly known as "formalin", is a low-cost chemical and is used in some parts of the agriculture sector for preservative and disinfectant purposes (50, 51). Formaldehyde is also used in the sugar industry to inhibit bacterial growth during juice production (18).

The illegal addition of formalin to extend the shelf life is a common problem reported in many countries (18, 52). It is one of the major adulterations that occur in different types of food, with reports of use in fish and seafood (19), fruits and vegetables (53), fruit juice (51), mushrooms (54) and milk (55) to extend the shelf life. Formaldehyde is present in the environment via different routes, i.e., natural [forest fire] and anthropogenic activities (smoking tobacco, wood burning) (56). The formaldehyde concentration in the environment depends on atmospheric conditions such as temperature, humidity, and wind (57). A human can be exposed to formaldehyde in two ways: inhalation (outdoor and indoor) and ingestion. Long-term exposure may cause serious and chronic health effects like neurotoxicity, cellular change, pulmonary function damage, hematotoxicity, reproductive toxicity, genotoxicity, and carcinogenesis (56). Formaldehyde formalin is classified as a group 1 human carcinogen in its monograph by the International Agency for Research on Cancer (IARC) (58). The United States Department of Health and Human Services (DHHS), National Toxicology Program (NTP) listed formaldehyde in their report on carcinogens (ROC). Moreover, they indicated that nasopharyngeal

cancer, sinonasal cancer, and lymphohematopoietic cancer, specifically myeloid leukaemia, among individuals with higher measures of exposure to formaldehyde (58)

Most participants preserved their food for more than a week, while only 26.7% preserved theirs for 1 – 2 days; this indicates a great need for these vendors to be informed on proper and safe food preservation practices, as they are into the practice.

The study showed a significant association between socio-demographic characteristics: educational level, marital status, type of food sold and knowledge on food preservation and unwholesome food preservation ($p>0.05$). This report was similar to a study by Azanaw and colleagues (59), who reported that marital status was statistically associated with food safety practices. In this study, single food vendors were more likely to use formalin than their married counterparts, similar to Azanaw and colleagues' (59) reports. This was contrary to the studies carried out in Nigeria (41, 60), which recorded no significant difference in food safety practices among food vendors based on sex, age, and level of education. Contrary to a study in another part of Nigeria (59), which showed a significant relationship between educational qualification and the safe practices of food handlers.

Findings in this study showed that food vendors who had attended university were more likely to use formalin (unsafe food practice) than their counterparts; this indicated that a higher standard of education did not guarantee good preservation practice since food preservation was not a course learned in the university, but an aspect which everyone could be educated or trained on. Food vendors who sold meat in this study were more likely to use formalin compared to those who sold vegetables/fruits; this could be because meat has a concise shelf life compared to vegetables/fruits, thus tempting vendors to go for an easier way to preserve meat.

Food vendors who had sufficient knowledge of food preservation were more likely to use formalin compared to those who had insufficient knowledge of food preservation, indicating a circulation of poor food preservation practices among the vendors in BHD, thus a need for the education of food vendors and the public as a whole on good and healthy food preservation practices. Azanaw and colleagues (59) reported that food safety training, supervision by health professionals, and knowledge are statistically associated variables with food safety practices. Some studies(41, 59) have reported that most food handlers with regular food safety training still exhibit unsafe practices; this may be attributed to irregular supervision by health professionals found in this study. Thus, regular supervision by health professionals can awaken safety consciousness among food handlers, whether trained or untrained, as no one would want to be caught unawares.

Most of the vendors sampled in this study observed changes in their food following preservation. The most reported changes observed post-preservation were changes in texture, changes in flavour and changes in colour, showing that the vendors mastered the qualities of the food they sold and can easily detect changes that occur in the food.

In the interviews, vendors reported using "small quantities" of formalin [a group 1 carcinogen by the International Agency for Research on Cancer (IARC) classification] (58, 61) on meat and fish to mask/slow spoilage. Unknown to them, some of these chemicals have standard procedures of use, which if not followed, will be dangerous to the vendor's health. For example, formalin solution is volatile; thus, it can emit gases that revert to its gaseous state at ambient temperature, and such gases can be inhaled by the user if the user is not putting on an N95 face/nose mask and/or shield. This chemical is noted to have dangerous effects on the human body. This increases consumer exposure to formaldehyde residues and exposes vendors occupationally, especially without the use of N95masks. Given the increased cancer incidence and related mortality in Cameroon (62), chronic low-dose exposure from these foods may multiply the risk.

Chemicals often used in West/Central Africa for artificial ripening include calcium carbide, ethylene powder, or other industrial agents not meant for food (63). Calcium carbide may contain arsenic and phosphorus impurities, both linked to cancer risk (64). Accelerated ripening can also increase fungal

growth and aflatoxin contamination, which is strongly associated with liver cancer (already one of the top killers in Cameroon due to hepatitis B/C co-burden). It could sustain high hepatocellular carcinoma rates and add to gastrointestinal cancer incidence.

Vendors also reported the burning of plastics during fish smoking. Burning plastics releases polycyclic aromatic hydrocarbons (PAHs), dioxins, and furans, which are potent environmental carcinogens linked to lung, skin, and digestive tract cancers (65). Smoking itself already introduces PAHs; adding plastics intensifies the risk. This could contribute to rising cancers in Cameroon, especially oesophageal, gastric, and colorectal cancers.

Without regular hygiene/veterinary oversight, as reported in this study, contaminated or chemically treated products would circulate freely. Consumers may face repeated low-level exposure to carcinogens. Lack of enforcement allows unsafe practices to persist, increasing population-wide risk.

Liver, stomach, colorectal, and oesophageal cancers are significant contributors to mortality in Cameroon (66). Many of these are linked to dietary carcinogen exposure. The interview data suggest both occupational and dietary carcinogen exposure pathways in Buea markets, patterns likely mirrored in other regions. Given the projected +158% increase in cancer cases by 2050, continued unsafe preservation practices could accelerate the incidence of: digestive cancers (liver, stomach, colorectal), respiratory cancers (nasopharyngeal, lung), and haematological cancers (linked to formaldehyde).

5.1.4 Discussion on the challenges faced by the food vendors regarding food Preservation

In this study, most of the vendors indicated that they faced challenges preserving their food. The most prominent challenges were the risk of food contamination, thus spoilage, the cost of preservation, time constraints, limited space, and power outages. Among the challenges faced by the participants in this study on preserving food, commercial fish handlers in Zambia (23) also faced food spoilage. The lack of cold storage facilities was a major challenge reported by the fishers as the fishers had to depend on their own or rented facilities, which may lead to them incurring higher costs, especially during times of electricity power cuts (23, 24), thus concurring with this study which reported cost of preservation and power outage as one of their challenges faced in preserving food. These vendors encountered challenges countless times while preserving their food items, thus portraying a great need for education and the introduction of more affordable and accessible food preservation methods in the BHD.

The interview data mentioned frequent electricity shortages, which may lead to higher food spoilage possibilities, thus, a probable increase in cancer incidence due to a higher chance of the use of unregulated chemical preservatives by food vendors as means to reduce spoilage**.** Without affordable, safe preservation options (e.g., cold chain, solar dryers), vendors are incentivised to use cheaper, hazardous methods. Inadequate cold chain management for fish/meat also increases bacterial contamination, which in some cases (e.g., *Helicobacter pylori*) is indirectly linked to an increased risk of gastric cancer.

5.2 CONCLUSION

The food vendors in BHD have inadequate FP knowledge; thus, interventions are needed to improve their understanding of FP. Our research outcomes are relevant to the country's ability to achieve Sustainable Development Goals (SDG) 1 (no poverty), 2 (zero hunger) and 3 (good health and well-being) by 2030; if food vendors can practice safe FP practices, this will limit food losses, thus increasing food security, increase their profits and turnover on investments, and ensure good health for all.

Conflict of Interest

The authors declare no conflict of interest regarding the publication of this paper

Corresponding author: Malika Esembeson (ekememalika@yahoo.com)

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