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Socio-Economic Activities and the Sustainability of Fish Smoking in Small Communities: Insights from the Central Region of Ghana

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Abstract

This study explores the impact of fish processing activities on the socio-economic well-being of fish smokers along the coastal regions of Ghana's Central Region, to improve sustainability in fish processing and supply. Using a qualitative phenomenological research design, data was collected through purposive sampling from four fish smokers, each with over 20 years of experience and an average age of 55 years. Thematic analysis was employed to evaluate participants' perspectives on the fish processing industry. The findings revealed that the fish smokers predominantly processed herrings, mackerel, anchovies, and tuna sourced from the sea or cold stores, with smoking primarily done using the Chorkor oven. Despite variations in location or oven type, their operational practices were largely similar. Participants clearly understood their market dynamics, including clientele preferences and pricing strategies. However, key challenges included financial and labour constraints, along with erratic fluctuations in the price of raw fish. The study noted that improving hygienic practices could significantly enhance the shelf life of smoked fish, thereby boosting income and socio-economic prospects for fish processors. The results underscore the importance of addressing operational challenges in the fish processing industry while providing actionable insights for enhancing sustainability. Additionally, the study offers methodological recommendations and highlights strategies to improve smoked fish sales, contributing to a deeper understanding of the socio-economic impact of micro and small-scale fish-smoking enterprises.

Keywords: Chorkor and Ahotor Ovens, Central Region, Challenges, Fish Smokers, Ghana, Socio-economic well-being.

1. Introduction

Along the coastal regions of Ghana, fish smoking forms an essential socio-economic activity, generating income and creating employment opportunities for several coastal dwellers. Fish smoking is one of the major activities of women in the coastal zones (Sakyi et al., 2019). Due to its delicacy, flavour and aroma, smoked fish is one of Ghana's most consumed processed fish (Antwi, Beran, 2017). In addition to the coastal areas, smoking is also carried out in-land where fish used

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for smoking can either be obtained frozen from cold stores or fresh from other water bodies (Acosta-Alba et al., 2022). Indeed, fish smoking and its related activities contribute immensely to Ghana's economy, serving as a means of employment, financial gains and improved food security (Acosta-Alba et al., 2022).

Despite its importance, the fish-smoking industry in Ghana is largely unregulated; consequently, different oven types, wood fuels, and processing methods are employed (Avega, Tibu, 2017), leading to variabilities in fish quality. Also, the lack of cooling facilities onboard fishing boats/canoes and landing sites and inadequate know-how in fish post-harvest handling among processors compromise the quality of fish used for smoking. Also, poor processing and packaging techniques and storage facilities have led to the reduced quality of smoked fish from Ghana (Pemberton-Pigott, 2016). Thus, to ensure that the country attains the full economic potential from the fish smoking sector and to help improve the economic status of fish smokers, it is essential that factors that influence the cost of production, profit margins, preferences of consumers and other challenges are brought to the fore. It will even become more pertinent if the fish smokers propose these factors and strategies to mitigate them, as these will enhance adaptability when solutions are proffered.

Factors that are known to influence the cost of production and the profit margin of fish smokers include the source and type of fish, the type of oven used for smoking, and the facilities used to store both fresh and frozen fish (Okorley et al., 2004; Obodai et al., 2009; Sakyi et al., 2019). Within the coastal communities, fresh fish obtained directly from the sea is the major source of fish for smoking. When fresh fish is unavailable, frozen fish from cold-storage facilities are accessed for smoking. The differences in price between these two sources and the cost of transporting fish to the smoking area influence the cost of production (Kwadzo, 2022). Until recently, fishing was allowed all year round, ensuring the continuous availability of fish for smoking. However, since the introduction of the fallow period for fishing in 2016, which spans from July to August each year (Adom et al., 2019), the fishing period in Ghana has been classified as either open (allowed fishing period) or closed seasons (prohibited fishing period). The introduction of the closed season compels smokers to rely mainly on frozen fish for smoking, thus increasing the cost of production since frozen fish are usually sold at higher prices.

Among the ovens used for smoking in Ghana, the most popular is the Chorkor oven, developed more than 50 years ago to overcome the challenges associated with more traditional ovens such as the mud and barrel/drum ovens (Owusu, 2019). Studies, however, have shown that the Chorkor oven has low fuel efficiency and produces excessive amounts of smoke, raising safety concerns for both the users and consumers(Bomfeh et al., 2019; Pemberton-Pigott, 2016). This led to the development of new and improved ovens such as the Ahotor oven. The two ovens are shown in Figure 1 below.

Fig. 1. The Chorkor (Bomfeh et al., 2018) and Ahotor (Kubi, 2019) ovens

However, challenges related to low production capacities and installation costs continue to serve as a disincentive to smallholder fish processors (Kwarteng et al., 2017; Owusu, 2019). The lack of storage facilities limits the quantity of fish that can be procured for smoking and how long the smoked fish can be stored before use. In this case, only small quantities of fish can be

smoked at a time since any unsold smoked fish will spoil and lead to waste. Also, due to the limited shelf life of smoked fish, fish smokers are sometimes compelled to sell at much lower prices to prevent waste and losses (Okorley et al., 2004). In addition, there is no standardised system for smoking fish in Ghana. These present wide disparities in the quality of fish among smokers, increased rejection rates at international markets and price variations. Therefore, a procedure for fish smoking must be developed for nationwide adoption that can help enhance the quality of smoked fish. To this end, it is important to study the similarities and differences in the processing activities of fish smokers so that a standard processing method can be developed. Within the fish-smoking communities, associations can be formed among fish smokers to promote well-being and ensure compliance with existing national or traditional regulations (Sharma et al., 2010). In these associations, leaders are chosen to help promote and safeguard the association's activities, with age, years of experience, and sometimes financial status being considered as criteria for selecting the leaders. Hence, by interacting with these leaders, information relating to the fish-smoking activities of a particular community and the challenges faced by the smokers that influence their socio-economic well-being can be obtained. This study contributes knowledge to understanding the effects and potential issues that need to be addressed to improve the sustainability of the fish smoking businesses along the coastal regions, where fishing and fish processing activities are prominent.

2. Methods and Materials

Research Design

This study used a qualitative research design to examine the social environment from the viewpoint of individuals (Bryman, 2004). The social world consists of how members perceive and interact with the outside world. Among the different categories employed in qualitative studies, the phenomenological research design, which can be used to ascertain the experience of fish smokers, was employed in this study (Creswell et al., 2007). According to Heidegger (2005), phenomenological research design effectively brings out participants' experiences and perceptions. This design allows for different data collection methods, such as interviews, conversations, observations, focus meetings, and personal texts. According to Opie (2019), phenomenological research suspends a researcher's personal opinion and assumption about an issue and assumes the existence of a universal structure to make sense of people's experiences. This gives the researcher the chance to interpret participants' feelings, perceptions and beliefs in an unbiased manner. Thus, a phenomenological research approach was employed to thoroughly understand how fish smokers evaluate their socio-economic well-being.

Study Area

The Central region, which is one of 16 regions in Ghana, was selected for this study. The region lies to the country's southwest and shares boundaries with the Eastern Region to the northeast, the Ashanti Region to the north, the west with the Western Region, and the Greater Accra Region to the southeast. The Gulf of Guinea lies southbound in the region. With a total land area of 9830 km^2, the region has the longest coastline (150km) (Ministry of Food and Agriculture, 2020). The region has an annual temperature range of 24-34 ° C, with a bi-modal rain pattern (April to July being the major season and September to November being the minor rainy season) leading to an average rain of 800-1500 mm.

The Central Region has a population of about 2.9 million, accounting for 8.9 % of Ghana's population (Ghana Statistical Service [GSS], 2022). The average household size of the region is 6.6 %, with 3.2 and 3.4 % being urban and rural residents, respectively. With an average age of 24.4 years, the region is considered to have a youthful population. The major economic activity of the inhabitants of the region is fishing, mining and services (GSS, 2022).

Sample size and sampling technique

Purposive sampling was employed in this study based on the recommendation as the preferred sampling procedure for qualitative research (Palys, 2008). Leaders of fish smokers from Winneba (located in the Efutu Municipal District) and Elmina (situated in the Komenda/Edina/Eguafo/Abirem Municipal District) who form part of the Cerath Development Organization's Power to the Fishers Project (PFP) were selected. PFP is a European Union-funded community project aimed at improving the quality of smoked fish and enhancing livelihood by constructing improved smoking ovens for fish smokers in some selected communities. Participants selected for this study were group leaders of the PFP at both locations. Additionally, participants benefited from various training programs organised by different organisations, had long years of

fish smoking experience, were fairly educated, and were involved in the commercial production of smoked fish. Participants were also up-to-date with knowledge of the fish value chain. Leaders of two fish-smoking communities in Duakor and Savoy (located within the Cape Coast Metropolitan Area) who were not part of the PFP were also compared.

Data collection instruments and procedures

The data collection instruments used for the study were observation and an interview guide (face-to-face interviews), which covered questions on socio-economic characteristics, fish processing activities, marketing activities and challenges faced in fish processing. Interviews were audio-recorded and transcribed. Additionally, notes were taken during each audio recording. Prior to the interview, the aims and objectives of the study were verbally explained to each participant. A rapport was developed between the participants and the interviewer to build trust and cooperation through visits to the study locations before the interview. The respondents were given the freedom to decide to participate in the study. All interviews, which lasted from 30 to 45 min, were conducted in a conversational manner to promote dialogue rather than mere responses to questions.

The validity of the instrument was tested to reflect the truthfulness of the findings. For Creswell (2014), validity for qualitative research instruments emerges from the instruments' scores and interpretation. In this research, the internal (credibility) and external (transferability) were checked. The internal validity of the study instrument was checked by assessing the feasibility of replicating the study among other fish smokers. This was achieved through peer review checks of the instrument. The input received from the peer review was used as a guide in correcting the final instrument for grammatical errors and misleading or ambiguous questions.

Data analytical framework

The data collected was analysed using thematic analysis with the help of Microsoft Word software for qualitative data analysis. The thematic analysis was conducted following the framework outlined by Braun and Clarke (2006), which involves familiarisation with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report. The data analysis was based on the following themes:

1. Sources and types of fish and oven types used for smoking;
    a. Source of fish for smoking;
    b. Types of fish used for smoking;
    c. Oven types used for smoking;
2. Activities carried out by fish smokers;
3. Marketing activities of micro, small scale fish smokers;
    a. Pricing of smoked fish;
    b. Customer base;
    c. Shelf life of fish;
4. Challenges faced by fish smokers.

3. Results

Socio-demographic characteristics of the participants

The relevance of age among fish smokers is closely tied to their fish smoking experience and their ability to improvise and adopt different smoking practices. Age also plays a crucial role in determining the level of risk and investment a fish smoker is willing to commit. However, it was observed that many fish smokers either did not know their exact age or were unwilling to disclose it, with participants in this study reporting varying ages, with a miniumum age of 50 years and a maximum age of 67 years.

Table 1. Socio-demographic characteristics of the participants

Participants	Gender	Age	Years of fish smoking Experience (years)
1	Female	62	30
2	Female	55	30
3	Female	67	28
4	Female	50	30

As fish smokers advance in age, their experience is expected to improve, leading to the adoption of better processing practices, increased income levels, higher adoption rates of new technologies, and greater ease in adjusting to improved methods. In many communities, experience is considered as important as formal training, with most individuals learning fish smoking as a primary occupation through hands-on training provided by relatives or close associates.

For some respondents, fish smoking became an occupation due to a lack of employment opportunities, as they lacked the requisite skills and training to work in the formal sector. Over time, the income generated from fish smoking motivated them to continue as a business, thereby increasing their fish processing experience. In other cases, fish smoking experience arose from migration, driven by the need to support family income and improve livelihoods. For others, however, the experience of fish smoking was entirely accidental, occurring without prior intention but developing into a skill over time.

Smoking period

The period allocated for fish smoking within a week differed based on the geographical location. This was ascribed to existing traditional regulations, personal reasons and the demand/supply of smoked fish. In almost all the coastal communities of Ghana, fish smoking activities are low during July to August due to the close season policy implemented by the Ministry of Fisheries and Aquaculture (Apetorgbor, 2018). During this period, fish smokers depend on frozen fish from cold stores, which are mostly imported fish and are considered expensive. Regarding how often fish smoking is carried out, the opinions of participants were;

*"I smoke fish every day except on Tuesdays because I go to the seashore for new stock. I have my own canoes that land on Tuesdays, so I have to go check on them and bring the catch home. It is stressful, so I take Tuesdays off after getting home" [**Participant 1**].*

*"I do all my smoking weekly. I select a day and do all my smoking for the market depending on the availability of fish. During the close season, I smoke fish once a week, but in the open season, sometimes 3 or 4 times" [**Participant 2**].*

*"I do mostly smoke 30 pieces of fish a day. I do this to sell off my smoked fish faster than bearing additional storage costs" [**Participant 3**].*

*"I smoke three times a week. During the remaining days, I use it to sell the smoked fish since I do almost everything by myself" [**Participant 4**].*

Based on the responses, it can be surmised that the factors that influence how often fish is smoked include socio-economic status, the ability to keep the smoked fish from spoilage, and whether the smokers sell the fish directly on the market or hand over the smoked fish to third parties usually women retailers for sale.

Sources and types of fish and oven types used for smoking

Source of fish for smoking

Fish smokers in Ghana obtain their fish mainly from two main sources, depending on the season/month. During the closed season (July-August), frozen fish is preferred, while fresh fish is obtained directly from canoes and boats during the open season. This view is shared by participants as;

*"My source of fish for smoking is mainly from the sea. I have people who supply me with fish all year round. Sometimes during the close season, they move to other neighbouring counties to fish and supply me" [**Participant 1**].*

*"Because of my customers, I prefer fish directly from the sea. They say fish from the sea taste better and are fresher, so I have no choice but to meet their need. Sometimes the price is high, but they still buy it" [**Participant 3**].*

However, depending on the season, some smokers prefer a combination of both frozen and fresh fish to meet consumer demand. This ensures the availability of smoke fish throughout the year, as shared by a participant;

*"I use a combination of cold stored fish and freshly caught sea fish depending on the time of the year and the demand volumes I have to meet. In some cases, I smoke fish according to customer orders. The reason being that if you don't adjust, you will run out of business" [**Participant 2**].*

Types of fish smoked

The choice of fish used for smoking is dependent on the consumers' demand, the cost of obtaining fish, and the consistency of the supply of fish. A similar opinion is shared by a participant as;

*"I smoke mainly Eban (herring) due to its growing demand. Most customers use it for shito (black pepper) and preparation of various local dishes, so there is always demand. However, during the close season, getting it is very difficult. Thank God, herrings have a long shelf life, so I can keep them throughout the close season and sell at a higher price" [**Participant 1**].*

For some fish smokers, however, the preference is to smoke two or more varieties of fish to ensure profit despite the seasonal variations in fish catch and cushion income levels. As reported;

*"I smoke different types of fish like salmon, redfish, tuna and other types of fish. I smoke any kind of fish the fishermen bring as far as it is eaten by consumers. Sometimes, consumers are new to the fish type, but I convince them it is good. If you don't do that, business will suffer" [**Participant 2**].*

Oven types used for smoking

The most popular type of oven used for commercial fish smoking in Ghana is the Chorkor oven (Figure 1), which was built to improve over the more traditional metal drum oven. Challenges, however, associated with the use of the Chorkor oven have been reported, especially related to the excessive amount of smoke generated and the exhaustion of large quantities of firewood. This has led to the development of new and improved oven types, the most popular being the Ahotor oven (Figure 1). In congruence with this study's results, the fish smokers' decision to select an oven type depended on customer preference and market demands. This is articulated by a participant as;

*"I tried shifting from the Chorkor to Ahotor oven, but I realised consumers prefer the smoked fish from the Chorkor smoker due to the colour. Therefore, I am giving consumers what they want" [**Participant 2**].*

*"fish smoked with Ahotor smoker are drier and discoloured compared to Chorkor, which is oily and fresh" [**Participant 2**].*

*"I prefer the Chorkor to Ahotor oven because the Chorkor smokes fish faster" [**Participant 3**].*

*"I have both Chorkor and Ahotor ovens, but I mainly used the Chorkor oven for smoking fish, but if I consumer places an order and request that I use the Ahotor oven, then I will use it" [**Participant 3**].*

When the two participants who do not have the Ahotor oven were asked when they intend to procure it, their responses included;

*"I do not have money to buy the Ahotor oven, and I don't know why I should buy it because my customers have not requested that I use it" [**Participant 4**].*

*"Smoking fish using the Ahotor oven takes too long, so I don't have plans to procure one yet" [**Participant 1**].*

Activities carried out by fish smokers

The field visits revealed the activities of the participants as shown in Table 1.

The observations depict several similarities in the activities of the smokers from the sample acquisition stage to the packaging of the smoked fish. The fish smokers commonly purchased fish from the cold store facilities within their locality because fish was out of season. Additionally, similarities in the pre-smoking steps, such as the sorting, washing, draining and drying, were observed among the fish smokers. However, it was observed that to achieve a unique flavour for the smoked fish, additional steps, such as using mesh from neem tree leaves, were introduced.

The type of oven mostly used was based on the processing time and the consumers' preferences. The similarities in the activities of the smokers imply that it is possible to develop and implement a smoking process in Ghana that could be acceptable to all fish smokers.

Table 1. Activities of the fish smokers during fish processing

Date	Location	Activities
March 21, 2022	Duakor	1. Frozen fish was obtained from a cold store in the Abura community of Cape Coast, Ghana. 2. The price of the frozen fish at the cold store was ¢550.00 per box. 3. Fish stocked at the cold store was obtained from Tema and Accra at whole sale prices. 4. Transportation of fish to the smoking site was done using a salon car. 5. Smoking of fish at the facility began at 3 pm and was completed by 9 pm. 6. Smoking was carried out in the participant's own home. 7. The Chorkor oven was used for smoking fish. 8. Approximately 54 pieces of fish were smoked at a time. 9. The participant usually allowed the frozen fish to thaw under ambient conditions, followed by washing with tap water. The washed fish was transferred into plastic baskets to drain after which the fish was arranged on a wooden mesh of appropriately 90 cm x 90 cm for smoking. Firewood was then loaded into the vent of the Chorkor oven. On average, the mesh was turned every hour to allow for even smoking of the fish. After smoking, the mesh and the fish were allowed to cool to room temperature, and the fish were transferred into a woven basket lined with hard, brown paper to keep the smoked fish intact. 10. Some challenges that fish smokers encountered during the smoking process included the late start of smoking and difficulty in getting the required quantity and type of fish. 11. Round Mackerel fish was the frequently available type used for smoking.
23rd March 2022	Winneba	1. Frozen fish was obtained from a cold store in Winneba. 2. The price of fish at the cold store was ¢780.00 for two boxes. 3. Fish transportation was done using a commercial vehicle (Taxi). 6. Frozen fish in the cold store was obtained from Tema and Accra and was sold at retail prices. 7. In most cases, the cold store owners preferred to sell to members of the fish smokers associations than to individuals, especially because they could offer sales on credit. 8. Both the Chorkor and Ahotor ovens were used for smoking fish. 10. Smoking started at 10:10 am for both ovens and was completed by 1:00 pm or 1: 35pm for the Chorkor or Ahotor ovens, respectively. 10. Smoking was carried out at the PFP fish processing center. 11. A total of 200 pieces of fish were smoked, 100 for each smoking oven. 12. Atlantic club mackerel was used for smoking. 13. The process of fish smoking was comparable to the previously described process with the following modifications: thawed fish was washed with salted water. A fourth mesh was used to cover the fish during smoking to help retain the heat, which helped to decrease the smoking time. Smoking was faster for the Chorkor oven, requiring a more frequent turning of the mesh than for the Ahotor oven. After smoking, the mesh was placed on the ground to cool. The smoked fish was similarly packaged in plastic baskets lined with brown paper and appropriately labelled. 14. Among the observed challenges faced during the smoking process were the late start of smoking, difficulty in getting the required type and quantity of fish, activities of middlemen resulting in increased prices,

Date	Location	Activities
		and the suboptimal sanitary conditions in the smoking area.
March 24 2022	Elmina	1. Frozen fish was obtained from a local Elmina district, Central Region, Ghana market. 2. The price of fish at the cold store was ¢1200.00 for one and a half boxes of Atlantic Mackerel. The high price was partly due to the low number of cold stores located within the area. 3. Fish were transported by commercial vehicle (Taxi). 4. Frozen fish was obtained from Tema and Accra at wholesale outlets. 5. Both the Chorkor and Ahotor ovens were used for smoking. 6. Smoking started at 10 am for both ovens and was completed at 4 pm for Ahotor and 3:00 pm for Chorkor oven. 6. Smoking was carried out at the PFP fish processing center. 7. A total of 200 fish were smoked, 100 for each smoking oven. 8. The smoking process was similar to the previously described process with just a modification: approximately 35 pieces of fish were placed on each mesh. 9. Among the observed challenges faced during the smoking process were the late start of smoking and difficulty in getting the required type and quantity of fish.
28th March, 2022	Savoy	1. The Round Mackerel was used for the smoking at the participant's residence. 2. Apart from fish smoking, the participant sold frozen fish. 3. The price of the frozen fish was ¢750.00 per box. 4. The smoking process started at 7 am, and completed at 4 pm. The smoked fish was allowed to stay overnight to cool to room temperature. 6. The Chorkor oven was used for smoking, and the mesh was prepared from neem trees and broomsticks. According to the participant, the rationale for using neem as mesh is to moderate the effects of heat and smoke on the fish and to impact the aroma. The broomsticks were used to prevent fish from falling into the fire. 7. A total of 54 pieces of fish were smoked at a time by the participant. 8. The smoking process started with thawing and washing fish, draining using the plastic basket to allow water to seep and laying on neem tree branches as mesh (which were arranged in a circular order of appropriately 90 cm x 90 cm) for smoking. Firewood was placed in the Chorkor oven. On average, the fish was turned every 45 minutes, and some firewood was occasionally removed to control the heat. After the smoking process, the firewood was removed from the oven, and the smoked fish was allowed to cool while on the neem tree. 9. The participant indicated some challenges, including the high cost of frozen fish, the unhygienic nature of the smoking environment, and the long distance between the cold store and the smoking area.

Marketing activities of fish smokers

Pricing of smoked fish

Several factors, such as the cost of production, transportation, demand and supply, anticipated profits, and even the economic status of the individuals, can influence the cost of smoked fish in the communities in Ghana. According to the participants, the following are taken into consideration in determining the price of smoked fish;

*"Before I determine the price to sell my smoked fish, I consider the cost of labour, cost of fish, cost of firewood and cost of brown paper" [**Participant 4**].*

*"For me, I consider my profit margin and transportation cost" [**Participant 2**].*

*"I consider the type of fish" [**Participant 3**].*

The production cost of smoked fish accrues from the labour, water and electricity, materials such as mesh/net used, cost and quantity of firewood and other consumables such as brown paper

etc. In most instances, the production cost of smoking different types of fish are about the same due to the similarities in the processes employed. Differences can however, occur due to the cost of transportation and expected profit. Price differences can also be driven by the demand for smoked fish. According to the participants, the price charged were indicated as follows;

*"I sell per basket at a rate of ¢550.00. The size of the basket is the medium size. Sometimes when market is slow, I sell in smaller quantities like ¢15.00-200.00 per day" [**Participant 1**].*

*"I sell in small quantities like ¢15.00 and ¢20.00 mostly because people cannot afford the basket. However, for people who can buy the basket, I sell it to them at ¢600.00| [**Participant 2**].*

*"I use to sell in basket but I realise that I was not making much compared to the cost of production, so I started selling 100 pieces for ¢350.00" [**Participant 3**].*

*"I sell 5 pieces for ¢20.00 and above depending on the size of the fish" [**Participant 4**].*

Clientele base

For most fish smokers, the local market serves as the clientele base, although others move their products to other locations during the major market days with the aim of achieving higher revenues. In all cases, the clients include regular consumers, retailers or wholesale agents. Most consumers and retailers buy in small quantities while wholesalers buy in bulk, an assertion supported by the participants;

*"I sell mostly to retailers and wholesalers. I have market women friends in various parts of the country. So after smoking, I package and give it to a car to be delivered to them on market days, where they sell, and I give them commission on each basket sold. The left over I sell off to individuals at my local market" [**Participant 1**].*

*"I sell mostly to individuals, local retailers and the market women. But I have the plans to expand to other areas to sell" [**Participant 2**].*

*"I do the production here in Cape Coast and I sell it in Kumasi only. I do not sell here because the market is slow and the price is low, but in Kumasi the market moves faster and the price is like twice for a basket" [**Participant 3**].*

*"I sell to traders in Techiman, Mankessim and Accra. These areas are busy market areas for trading" [**Participant 4**].*

The responses show that the fish smokers have insight into the market dynamics, knowing who and where to sell their products to obtain high revenues. It is possible that such knowledge has been acquired through experience over several years of the fish smoking business. The assertion of bigger markets for fish in Kumasi and Techiman could be due to high population of the towns and their location being further away from the coastal regions.

Shelf life of smoked fish

Shelf life is the period after smoking within which the fish remains usable, fit for consumption or saleable. The type of fish spoilage that is mostly detected is caused by the growth of spoliage and pathogenic microorganisms on the surface of the fish. According to the participants, the techniques used to store smoked fish include:

*"After smoking I allow the smoked fish to cool then I cover it with trampoline and ensure its air-tight to take away all moisture" [**Participant 1**].*

*"After smoking I allow it to cool in open air, then I pack it into trays and put it in the freezer" [**Participant 2**].*

*"After smoking, I just put them in a basket and keep it at a cool, dry place" [**Participant 4**].*

In addition, reheating is done to ensure a longer shelf life, depending on the type of fish, as asserted by all participants;

*"My smoked fish can last about 3 months but when it is 2 months, I heat it again and, in that case, it can last for another 3 months" [**Participant 1**].*

Challenges faced by fish smokers

In this study, the challenges faced by fish smokers were reported as;

*"Since all my 30 years of fish processing, my major challenge has been the seasons affecting my price, especially during open season I record low sales due to the abundance of smoked fish on the market" [**Participant 1**].*

*"My major problem has to do with labour and financial constraints. At my age, carrying heavy firewood and other materials is hard, and when you hire people, they charge high prices that affect my profit margin" [**Participant 2**].*

However, in addition to the above, the good health and well-being of the operators contribute to the major challenges faced by a smoker. This is due to the direct contact of the eyes to smoke, which has an impact on vision/sight and, in some cases, affects the respiratory health of the operators. For one participant;

*"My major challenge is the smoke that affects my eyes, and also, the cost of transportation" **[Participant 4]**.*

4. Discussion

Socio-demographic characteristics of the participants

Fish-smoking communities in Ghana are considered to be mainly youthful, with active members within the age bracket of 18-50 years (Boohene, Peprah, 2012). It was observed that the leaders of the different fish-smoking communities were much older. This shows that age is considered important when choosing leaders in fishing communities because older people are considered mature, experienced, and able to command respect (Akparep et al., 2019).

The study responses show that people venture into fish smoking for varied reasons, although financial considerations are the major driver that keeps them in the sector. Also, people selected as leaders within the various fishing and smoking communities have considerable years (about 30 years) of experience. In general, however, Okorley et al. (2004) reported that most fish smokers' minimum years of experience was 10 years, which is much lower compared to the 17.5 years reported in Nigeria (Bolorunduro et al., 2005).

Smokers with high socio-economic status can smoke fish often and even select days to rest. Also, taking into consideration that the duration of storage after smoking has an influence on the quality of smoked fish, using appropriate storage facilities is essential. Thus, for smokers who cannot afford storage facilities, selling off smoked fish within the shortest possible time after smoking is essential. Hence, such smokers can prepare new fish for the market only after selling a previous batch, which directly influences the frequency of fish smoking.

Sources and types of fish and oven types used for smoking

Gordon et al. (2011) and Obodai et al. (2009) acknowledged that frozen fish and fresh fish obtained from the sea are the major sources of fish for smoking. The use of fish from these two sources is influenced mainly by the location of the smokers. A study conducted in northern Ghana showed that fish for smoking was mainly obtained from river bodies (Obodai et al., 2009). Thus, proximity to the sea influences the source of fish used for smoking.

Similar findings were reported by Bomfeh et al. (2019) and Sakyi et al. (2019), who reported that in Ghana, fish species such as tuna, herrings and mackerel are the most smoked fish types due to their availability and shelf life. Gradually, catfish, mostly cultured through freshwater and aquaculture, is gaining recognition among fish smokers, especially in the inland areas (Naylor et al., 2021).

The reports by Avega and Tibu (2017) and Owusu (2019) show that fish smokers continue to use the Chorkor smoker more than the Ahotor oven despite the health benefits of using the Ahotor oven. This shows that despite the benefits of the Ahotor oven in helping to reduce smoke levels, which can pose health hazards to both the smoker and consumer (through the occurrence of polycyclic aromatic hydrocarbons in the smoke fish) as well as reducing the excessive use of firewood in smoking (Avega, Tibu, 2017; Owusu, 2019), the usage of the Ahotor oven among fish smokers is quite low (Bomfeh et al., 2019; Essumang et al., 2013: Kwarteng et al., 2017). Hence, a combined effort of education and legislation by the relevant stakeholders will be required to help promote the usage of the Ahotor oven.

Marketing activities of fish smokers

Among the factors that influence the shelf life of smoked fish include the type of packaging, level of moisture, and temperature and humidity during storage (Adeyeye, 2018; Kumolu-Johnson, Ndimele, 2011). Storing smoked fish at lower temperatures limits the growth of microorganisms, while regulating humidity using appropriate packaging reduces the availability of moisture/water and air, limiting microbial growth (Adeyeye, 2018; Kumolu-Johnson, Ndimele, 2011). Although rudimentary, the preservation methods used by smokers are based on the general principles of food storage, which include avoiding rehydration, limiting air contact and low temperature (Arvanitoyannis, Kotsanopoulos, 2012). Such knowledge and techniques could have been acquired

through experience and training programs sometimes organised for fish smokers by relevant stakeholders. Thus, it is imperative to give more training on food safety and hygiene, as well as post-harvest handling of fish, to help improve fish smokers' operations and enhance their products' shelf life.

Challenges faced by fish smokers

Fish smoking is faced with several challenges, which can be external or internal to the smoking process. The external challenges may include financial constraints, market factors such as demand and supply, as well as post-harvest losses and transportation issues (Antwi, Beran, 2017). Also, the availability of raw materials (fish), firewood, and labour can hinder the productivity and performance of smokers, as well as revenue levels (Sakyi et al., 2019). According to Okorley et al. (2004) and Sakyi et al. (2019), fish smokers face financial resource constraints that limit their ability to sustain their business, leading to inconsistent income and the number of clients they can serve at a time. This issue is compounded by the unavailability of credit or loan facilities for fish smokers, which is mainly attributed to the high level of risk associated with fish smoking as a business.

Sakyi et al. (2019) further argue that fish smokers depend heavily on firewood and are likely to pay high prices to purchase them during rainy seasons. Alternatively, they walk longer distances to purchase firewood for their activity, thus increasing the cost of production and reducing the profit margins. Also, the inability of most fish smokers to own storage facilities limits the purchase and storage of fish in bulk quantities, especially during the open season, leading to the reliance on frozen fish with its associated transportation cost, thus affecting their profit margins (Okorley et al., 2004). Finally, prolonged exposure to smoke can lead to the acquisition of respiratory diseases, which can compromise the health and well-being of smokers (Weyant et al., 2022).

5. Conclusion

Examination of the activities of fish smokers along the coastal regions of the Central region and the impact on the socio-economic well-being revealed that fish smokers were mainly women who had little formal education with several years of fish smoking and sales experience as the main source of livelihood. The main types of fish smoked included herring, mackerel, anchovy, and tuna, which were obtained either from the sea or cold storage facilities, depending on the season and cost. Smoking of fish was done 3-4 times per week by mostly using the Chorkor oven because it is faster with fresher and more evenly smoked and flavoured fish than the Ahotor oven. The smoking process for fish was similar among the respondents, with only the use of neem leaves or broomsticks as the minor modifications for the mesh used.

The labour cost, type of fish and cost, firewood and the cost of transportation determined the price of smoked fish. The profits were higher when fish was sold in regions further away from the coast than those closer to the coastal regions. Traditional fish storage methods such as using a trampoline to obtain air-tight and a moisture-free condition, freezers or intermittent heating on smoke to improve the storage quality were used. The major challenges reported include the high cost of fresh fish, especially during the closed season, lack of financial support to expand the operations, and excessive exposure to smoke. Thus, it is imperative to make credit facilities available to fish smokers by the relevant stakeholders while advocating for improved ovens such as the Ahotor oven to help reduce the levels of smoke. In addition, the use of improved processing techniques to enhance the shelf life of smoked fish can help improve the socio-economic well-being of fish smokers.

6. Strengths and Limitations

The study provides valuable insights into the socio-economic well-being of fish smokers in the Central Region of Ghana by leveraging an in-depth qualitative phenomenological approach. This methodology allows for a nuanced understanding of the lived experiences, challenges, and opportunities in fish processing, enriched by the participants' extensive knowledge and over 20 years of experience. Additionally, the use of thematic analysis effectively highlights key areas for improvement, such as hygienic practices and market dynamics, offering practical recommendations to enhance the sustainability and profitability of the fish-smoking industry.

The study's small sample size, limited to only four participants selected through purposive sampling, restricts the generalizability of the findings to a broader population of fish smokers.

Furthermore, the focus on qualitative data may have excluded potentially useful quantitative insights, such as production scales or economic metrics, which could provide a more comprehensive understanding of the socio-economic impacts of fish-smoking activities.

7. Implications of the Study

The study makes significant contributions to the socio-economic literature by expanding on understanding the fish processing industry's dynamics, particularly in micro and small-scale enterprises. It provides new insights into how traditional practices like fish smoking influence livelihoods, gender roles, and market systems in developing countries. Furthermore, it contributes to sustainability and entrepreneurship theories by highlighting the relationship between resource use, technological adaptation (such as the Chorkor oven), and socio-economic well-being. The study also emphasises the value of qualitative approaches, particularly phenomenological research designs, in capturing lived experiences, offering a framework that can be applied to other informal economic activities in similar contexts.

Furthermore, the study offers actionable recommendations that can inform policy and practice. It identifies key challenges, such as financial and labor constraints, and suggests targeted interventions like financial support, training programs, and infrastructure improvements to address these issues. Improving hygienic practices to extend the shelf life of smoked fish is another important recommendation that can enhance processed fish's quality and marketability. The findings also emphasise the importance of market-driven strategies, as the fish smokers' understanding of their clientele and pricing dynamics can guide the development of business models that optimise sales and ensure fair pricing. Moreover, the study highlights the socio-economic role of fish smoking, particularly among women in coastal communities, and underscores the need for initiatives that empower these individuals through skill development, access to credit, and improved working conditions. By addressing both theoretical gaps and practical challenges, the study bridges academic inquiry with real-world applications, fostering a comprehensive approach to enhancing fish processors' livelihoods and ensuring the industry's sustainability.

8. Declaration

Consent for publication

Not applicable

Availability of data and materials

All data and materials used in this study are available upon request.

Conflict of interest statement

The authors declare that they have no competing interests.

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