

Traditional Fish Smoking Among Artisan Processors in Lake Victoria Crescent, Uganda

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Abstract

Traditional fish smoking is among the fish preservation methods practiced in Uganda. This artisanal sector has promoted the availability of smoked fish (a source of cheap proteins) to consumers from local and regional markets. Despite sectors' popularity and demand for smoked fish, quality and safety issues alongside fish losses attributed to fish smoking, remain outstanding issues that require understanding of fish smoking practices in Uganda. Hence, this study examined the socio-economic characteristics, technologies and hygiene practices of processors in 14 landing sites around islands and shores of Lake Victoria crescent. A total of 104 structured questionnaires were administered through purposive sampling, supplemented by field observations, to collect data. The data was analyzed using descriptive statistics. The survey revealed that fish smoking was the most preferred method of fish preservation dominated by females (75%). In addition, rectangular brick/mud kilns were the most (85.6%) used type of kilns to smoke fish employing firewood from both soft and hard wood tree species as fuel. The main fish species smoked were; Nile perch (49.3%) and Tilapia (37.8%). Despite the inadequate hygienic handling practices during; transportation, preparation, smoking, storage and marketing of fish, the smoking flow diagram followed in Uganda was similar to the generic smoking procedure used in other countries. This indicated potential for fish quality improvement once proper measures are enforced. Hence, training, use of improved fish smoking technologies like Chorkor kilns, provision of soft loans among other interventions are recommended. Regardless, fish smoking business is still promising amidst enormous challenges reported.

Keywords

Fish Smoking, Processors, Preservation, Consumption, Quality, Kiln, Uganda

1. Introduction

Smoking has been among the traditional methods used to preserve fish globally for many years despite the introduction of modern techniques. This is due to characteristic aroma and taste imparted in smoked fish [1]. The biggest percentage of fish catch in the developing countries is smoke-dried [2]. Uganda in particular is among the countries whose local communities largely practice fish smoking more than other preservation methods. Smoked fish is said to attract good local and regional

markets [3]. However, its quality varies due to differences in applications for instance; additives, quantity of salt used or better still the temperature achieved during smoking [4]. Hence, safety issues arise due to modifications in this technique besides changes in customer preference [1]. Currently, improved fish smoking technologies like Chorkor kilns, have been designed to reduce fish losses mostly from microbial deterioration [5].

Clearly, fish processing technologies available in Uganda as

well as involved steps have not been documented. In addition, handling practices have been pinpointed in food value chains as one of the major threats to fish quality and/or safety [6]. Hence, understanding the handling practices among smoked fish processors in Uganda would contribute to fish safety or quality through incorporation of food quality management systems such as HACCP. This study was carried out in order to; (1) to describe the traditional smoking process/activities carried out by local processors around Lake Victoria, (2) to document handling practices and challenges faced by these fish smoking communities.

2. Materials and Methods

2.1. Study Area

The study was carried out from 14 landing sites around the islands and shores of Lake Victoria crescent (Figure 1). This study area was chosen because Lake Victoria contributes the largest proportion (over 60%) of the total national fish catch [7]. It is noteworthy to mention that, only landing sites where fish smoking was being carried out were purposively considered for the study.

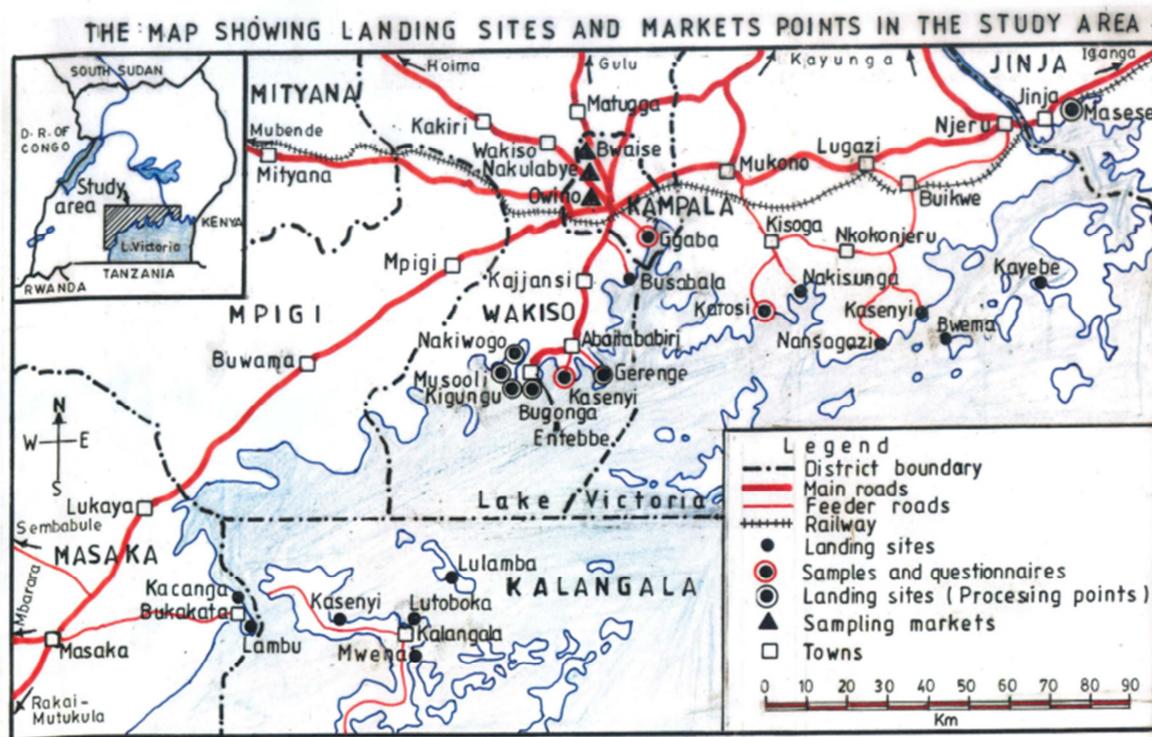


Figure 1. Landing sites around lake Victoria crescent of Uganda.

2.2. Research Design

The study was descriptive with a cross sectional survey design. The survey was aimed at collecting data from smoked fish processors on the existing fish smoking activities and handling practices in Uganda.

2.3. Sampling Strategy and Sample Size

The study populace consisted of smoked fish processors from the different landing sites around Lake Victoria crescent, Uganda. Multistage sampling was done to obtain fourteen landing sites and from each landing site, processors were selected based on snow ball approach. The sample size for the processors interviewed was determined using the formula by Bartlett *et al.* [8]. The formula suggests use of a population proportion in case there is no actual population of the respondents. Hence, due to lack of information on actual population of active processors attributed to absence of their umbrella organization, the formula below was used;

$$n_o = \frac{(t)^2 \times (p)(q)}{d^2}$$

Where;

n_o = the required sample size

t = Value for selected alpha level from normal distribution for confidence interval for 95% = 1.96

p = estimated population proportion (50%) because the actual population proportion was unknown

$$q = 1 - p (0.5)$$

d^2 = acceptable margin of error for proportion being estimated (maximum discrepancy between the sample and population proportion) of $\pm 10\%$

$$n_o = \frac{1.96^2 \times (0.5)(0.5)}{0.1^2}$$

$$n_o = \frac{0.96}{0.01} = 96$$

Therefore, a total number of about 96 respondents was required for the study. However, a slightly higher (104) sample size was used to negate possibility of low response rate since the study was sensitive to the smoked fish processors.

2.4. Data Collection Tools

Data on fish smoking activities and handling practices was collected using questionnaires as well as personal observation. Questionnaires were interviewer administered to respondents who were accessed using snowball approach. Snow ball approach was used to trace respondents due to sensitivity of the study since it was hard for the researcher to trace them.

2.5. Data Analysis

Collected data was cleaned and summarized into percentages, graphs, tables using excel spread sheet 2007 and then analyzed using Statistical Package for Social Scientists (SPSS) Software Version 18.0 (2010) employing Chi-square test.

3. Results and Discussion

3.1. Results

3.1.1. Respondents' Demographics and Landing Sites

The distribution of the respondents for this study from different landing sites is presented in Figure 2.

Majority of the respondents (38.5%) were in the age group of 31-40 years as presented (Table 1), most of whom, were females processors (75%) and only 25% males. There was no significant evidence of relationship between respondent's health testing and their sex ($P>0.05$).

Table 1. Age of respondents.

Characteristic	Responses (n=104)		
	Frequency	Percentage	
Age	<20	3	2.9
	21-30	34	32.7
	31-40	40	38.5
	41-50	22	21.2
	>50	5	4.8

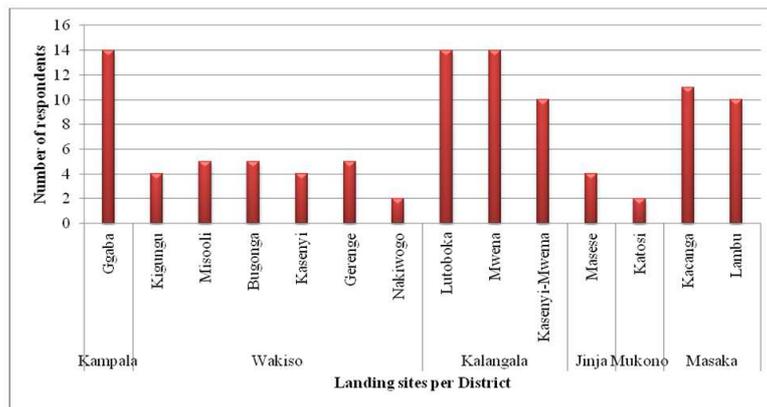


Figure 2. Landing sites visited from study area.

3.1.2. Species of Fish Smoked from Lake Victoria Crescent

Among the species of fish smoked, *Lates niloticus* (Nile perch) and *Oreochromis niloticus* (Tilapia) were the most commonly smoked compared to other reported fish species (Figure 3).

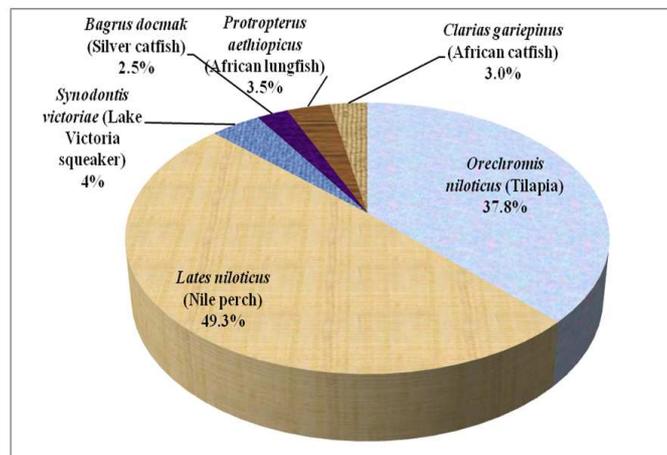


Figure 3. Fish species smoked at the study sites.

3.1.3. Smoking Kilns/Technologies and Skills Acquisition

The total number of kiln (alias ‘covers’ locally) types identified was four and this included; rectangular brick/mud kilns used by majority of the respondents (85.6%); Cut-out oil drum (7.7%), Chorkor kiln (4.8%) and underground kilns (1.9%) that was least used. There was no significant relationship between source of smoking skills and type of kiln used ($P>0.05$). Some processors built their kilns inside makeshift houses for fear to be arrested by fisheries agents. The study revealed that, there was no significant evidence of relationship between kiln type and duration of smoking ($P<0.05$).

Although smoking as a fish preservation method around Lake Victoria was mostly used, respondents were aware of other methods that included; sun drying (71.3%), deep frying (24.8%) and freezing (3.9%). In addition, most respondents (83.7%) were taught basic smoking skills from their fellow artisan processors, and some from relatives (14.4%). Only 1.9% had undergone special training by Italians. The study showed no significant relationship between source of smoking skills and fresh fish sorting as well as duration or storage time before smoking ($P>0.05$). It was also found out that, a slight majority of processors (59.6%) had health certificates that were administered by fisheries authorities with follow up medical checks whose frequency exceeded a month.

3.1.4. Parameters Used for Sorting Fresh Fish and Assessment of Smoked Fish Readiness

Various parameters were employed by processors to discern unspoiled from spoiled fresh fish. According to the study, 90.4% sorted normal fresh from spoiled fish while buying or before smoking. Similarly, they recognized readiness of smoked fish during the process of smoking (Table 2).

Table 2. Fish sorting and smoked fish readiness parameters.

Characteristic	Response	
	Frequency	Percentage
Fresh fish sorting		
Red gills	88	40.0
Firm muscle	32	14.5
Bright skin color	30	13.6
Swollen belly	27	12.3
Seaweed smell	25	11.4
Bright eyes	17	7.7
Belly Percussion	1	0.5
Fish readiness		
Brown skin color	65	33.9
Hardened muscle	57	29.7
Dripping	49	25.5
Weight reduction	10	5.2
Fish odor	6	3.1
Smoking duration	5	2.6

3.1.5. Fish Smoking Process

Activities associated with fish smoking can be categorized as pre-smoking, smoking and post-smoking. Pre-smoking activities included; transportation, reception and fish preparations like degutting, de-scaling, washing, salting and

drying. Smoking activities included; loading (hanging), covering and lighting the fire in the kiln. The post-smoking activities involved; un-hanging, packaging and storage of the fish. Generally, the processing steps or flow diagram observed during the study was as presented (Figure 4).

3.1.6. Pre-fish Smoking Activities

Majority of the respondents (51.9%) reported that it takes over four hours to transport fresh fish from fishing grounds to the smoking points, while for 33.7% it took two to four hours; and only 14.4% reported a duration of less than two hours. Fresh fish was mostly (54.8%) transported without ice while directly placed on the floor of canoes, 26.9% packed it in sacks without ice; while 14.4% reported transportation under ice in a container. Only 3.8% reported transportation in ice on boat floor.

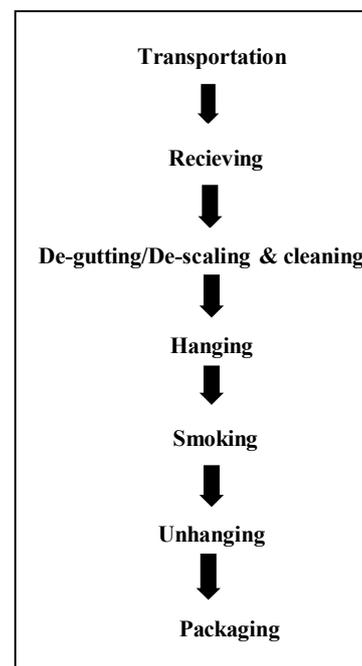


Figure 4. The fish smoking flow diagram for Uganda.

On the other hand, various fish transportation and holding materials used by processors were observed (Table 3). Fish preparation involved evisceration which was done by majority (83.7%) of fish processors while only 16.3% didn’t eviscerate it. More so, most of them (76.9%) were de-scaling fresh fish before smoking while 24.1% did not. Salting by brining method was only practiced by 1.9% of the respondents.

Table 3. Fish transportation to site and handling.

Practice/Characteristics	Frequency	Percentage
Holding materials to site		
Sacks /polythene bag	54	51.9
Bucket or basin	41	39.4
Tied or ropes	6	5.8
Wooden boxes	3	2.9
Handling on site		
On sacks/ iron mesh	49	47.1
In buckets or basins	48	46.2
On raised a structure	7	6.7

From study, most (76.0%) of the processors washed fish before smoking of whom 88.9%, used untreated water and only 1.3% used chemically treated water. The was used was

predominantly obtained from the Lake (Figure 5). Chi-square analysis indicated no significant relationship between drying of fresh fish before smoking and their washing ($P>0.05$).

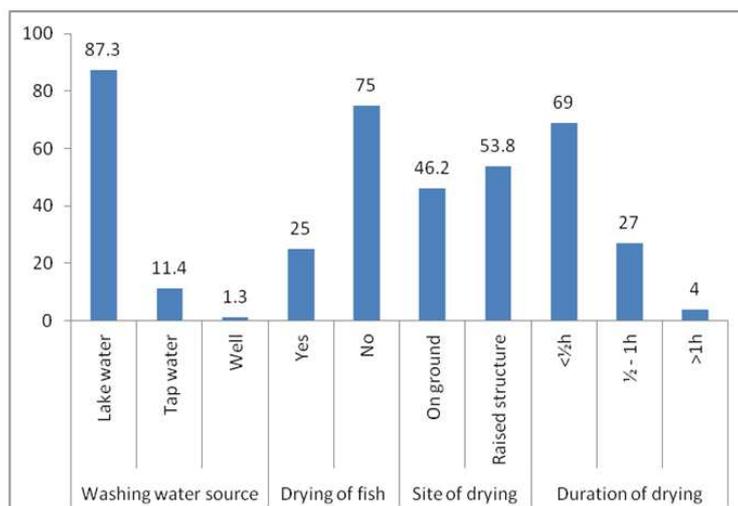


Figure 5. Pre-fish smoking activities observed during study.

3.1.7. Smoking and Post-smoking Practices

Fresh fish was loaded on iron meshes arranged in layers post-transient drying under the sun. The first layer of fish was arranged on in-built iron mesh followed by subsequent iron meshes on top of each other separated by a few small stones. The number of layers depended on the size of kiln and fish quantity. Pieces of iron sheets were used to cover the loaded kilns but some processors used papyrus mats and blankets to contain heat within the kiln.

It was also observed that, all respondents employed firewood as the fuel for fish smoking. Majority of respondents (52.9%) were unaware of tree species from which firewood was obtained; while 47.1% reported various tree species they routinely used. A number of tree species were mentioned with Mahogany (*E. angolense*), Eucalyptus (*Eucalyptus* spp.) and

Acacia (*N. buchananii*) appearing most frequent (Table 4).

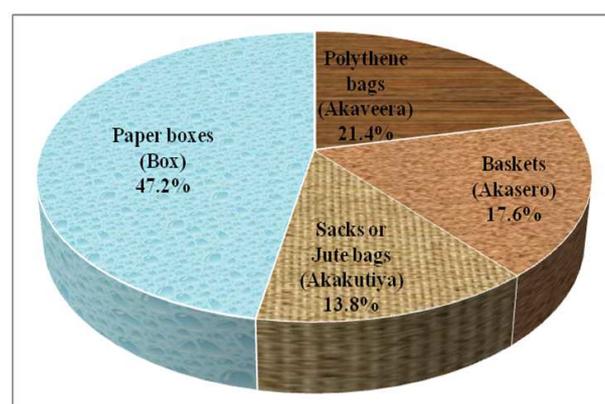


Figure 6. The types of packaging materials used by the processors.

Table 4. Plant species used for firewood.

Family name	Species name	English name	Luganda	Nature	Frequency
Meliaceae	<i>Entandrophragma angolense</i>	Mahogany	Mikusu	Hard	27
Myrtaceae	<i>Eucalyptus</i> spp.	Eucalyptus	Kalitunsi	Hard	17
Mimosaceae	<i>Newtonia buchananii</i>	Acacia	Empeweere	Hard	14
Anacardiaceae	<i>Mangifera indica</i>	Mango	Miyembe	Hard	13
Euphorbiaceae	<i>Alchomea cordifolia</i>	Christmas bush	Oruzibaziba	Soft	13
Rhamnaceae	<i>Maeopsis eminii</i>	Umbrella tree	Misizi	Soft	13
Moraceae	<i>Artocarpus heterophyllus</i>	Jack fruit	Fene	Soft	11
Bignoniaceae	<i>Makhamia lutea</i>	Makhamia	Misambya	Hard	10
Rubiaceae	<i>Coffea arabica</i>	Coffee	Mimwanyi	Hard	8
Moraceae	<i>Milicia exelsa</i>	African teak	Mivule	Hard	7
Moraceae	<i>Ficus natalensis</i>	Back cloth fig	Emituba	Soft	5
Myrtaceae	<i>Psidium guajava</i>	Common guava	Mipeera	Hard	5
Asteraceae	<i>Vernonia amygdalina</i>	Bitter leaf	Miruruza	Soft	4
Euphorbiaceae	<i>Sapium ellipticum</i>	Jumping seed tree	Emisasa	Soft	3
Lauraceae	<i>Persea americana</i>	Ovocado	Ovocado	Soft	3

From the finding, kilns were loaded with fish before lighting a fire. Most processors (52.9%) reportedly smoked fish for over four hours, while 38.5% smoked fish for two to

four hours and 8.7% did so for less than two hours. There was no significant relationship between drying fish and smoking duration ($P>0.05$). However, the relationship existed between

smoking duration and length of smoked fish storage time ($P < 0.05$). Most processors (78.0%) turned fish after more than half the total smoking duration while only 22.0% did so after half of total time. It was observed that processors may turn fish on the same day or the following day depending on the urgency of the orders from clients. Processors reported that some clients preferred lightly smoked (alias 'Muwotokwa') to smoke dried fish.

3.1.8. Post-smoking Activities

It was discovered that processors left smoked fish to cool and then un-hang it from kilns for packaging using various materials (Figure 6) before storage/sale.

Smoked fish was reportedly sold (59.6%) within one to two days post-processing while some (20.2%) sold it within a day. A few processors (20.2%) sold it beyond two days with an intention of selling in bulk. However, there was no significant relationship between smoked fish demand and storage ($P > 0.05$). Various categories of clients were involved in buying smoked fish from the processors (Table 5).

Table 5. Clientele categories for smoked fish.

Clientele category	Frequency	Percentage
Local retailers	98	69.0
Foreign retailers	8	5.6
Consumers	36	25.4

3.1.9. Challenges Among Smoked Fish Processors

Other than fish smoking activities and handling practices, processors reported a number of challenges to their business among which; confiscation of immaturely smoked fish (undersize fish), scarcity and/or high prices of fresh fish, and fluctuating market prices were mostly mentioned (Table 6). Other peculiar issues observed included; restricted smoking at some points, use of coffee powder which was claimed to prolong the shelf-life of smoked fish probably its mode of action should be investigated in future, salting of spoiled fish prior to smoking as well as methods of fire control in the kiln using; ash, water or soil.

Table 6. Challenges faced by smoked fish processors.

Challenges	Frequency	Percentage
Confiscation of immaturely smoked fish	62	27.2
Scarcity and/or high prices for fresh fish	38	16.7
Fluctuating market prices for smoked fish	26	11.4
Smoke and excessive heat effects	21	9.2
Multiple dues charged	17	7.5
Limited capital	16	7.0
Scarcity of firewood	14	6.1
Unpredictable weather conditions	13	5.7
Bad debtors and fish theft	11	4.8
Lack of proper smoking kilns (Cover)	5	2.2
Fish smell on transit to markets	5	2.2

3.2. Discussion

Traditional fish smoking around Lake Victoria crescent was largely dominated by females (75.0%). The dominance was probably due to freedom from cultural or religious restrictions

as well as financial and physical abilities to undertake the fish smoking business. A similar finding was also reported in Nigeria [9]. Hence, fish smoking has been described as a female business according to some researchers [10]. While women dominated the fish smoking activities, men were rather involved in fishing/catching fish with a few involved in both fishing and smoking. This deprived some potential women opportunity to participate in this affordable activity for a living since only the advantaged women would access fresh fish for smoking. Dominance of men in the fishing phase of the value chain could be attributed to access to fishing permits, some capital for men but also gender stereotype among the fishing community that women cannot fish or go to specific areas of the Lake. It is noteworthy to mention that, most of these processors were in the economically active age bracket of 21-40 years. This was in agreement with previous findings in Nigeria [5].

Furthermore, fish smoking was preferred to other methods and this was attributed to low costs of production, simple artisanal skills required, and high demand for smoked fish and a similar trend was also reported in the previous studies in Nigeria [3, 9, 10]. Other factors for preference of the fish smoking method such as; ease of the smoking process, shorter processing duration compared to sun drying, and feasibility for small fish quantities often acquired cannot be overemphasized. Nonetheless, processors were aware of other fish preservation methods, probably the above factors for smoking fish preference denied other methods the chance for their utilization. It was noted that, processors bought fresh fish from traders or fishermen at the landing sites which, made fish readily available although in fluctuating quantities. Similar findings were reported for artisan smoked fish processors in Ghana [11]. Fluctuating fish quantities was attributed to, reducing fish catch, and competition from frozen fish processing companies. Regardless, climatic change effects and environmental degradation around the waterbodies today could also be third party threats to fish catch. Fish catch fluctuation and competition have promoted a vice of smoking undersize fish. This has led to continued detention of processors, smoked fish confiscation and ban on fish smoking from some sites. In light of this, there is generally scarcity of smoked fish for local consumption despite its valuable role to consumer health [12]. In spite of smoked fish scarcity, there is still dominance of local retailers among the clientele segment purchasing smoked fish from processors for sale to urban population, particularly Kampala city. Predominance of local retailers meant that smoked fish was a big contributor to nutritional needs of Ugandans and warranted government intervention.

On the other hand, Nile perch (*L. niloticus*) and Tilapia (*O. niloticus*) being the predominant fish species smoked was probably attributed to their high catch from Lake Victoria compared to other species. Similarly, higher fish catch 46% and 38% for Nile perch (*L. niloticus*) and Tilapia (*O. niloticus*) respectively compared to other species were reported in previous studies [7]. Tilapia (*Oreochromis niloticus*) fish was also predominantly smoked in Nigeria although it was not the

case with *Chrysichthys nigrodigitatus* [13]. However, processors in Ghana mainly utilized *Sardinella* spp. and *Chrysichthys auratus* for smoking [11, 14]. Thus, probably processors from different countries smoked particular fish species depending on their catch or availability from the lake or water body.

Although, contamination and microbial growth prevention must be done promptly after catching fish [15]. This was generally not adhered to, since use of ice that minimizes microbial proliferation was generally not practiced. Another study had previously reported similar finding on fish destined for artisan processing [16]. Some other practices that favor microbial contamination and proliferation, such as long duration of transportation of fish to the landing sites; washing fish with untreated water, and fish handling from unhygienic surfaces, lack of salting were encountered and have been reported by some previous researchers [16, 17]. Poor fish handling was probably due to lack of formal training on hygienic fish handling. While salting provides additional preservative effect to pathogens [1], most processors didn't incorporate it in the smoking procedure save for some spoiled fish. However, the study revealed that degutting and de-scaling as part of fish preparation were being practiced as recommended for minimal microbial load and improved product consumption [5, 18]. Although majority did not pre-dry fresh fish, a few processors were doing so from raised structure/tables. A similar mode of pre-drying fish was also reported in Ghana [19]. Pre-drying under the sun for about an hour aimed at removing moisture and thereby prolonging shelf-life, preventing fish fragmentation and imparting a shiny skin appearance [19, 20, 21].

While processors loaded fish in layers on wire mesh with stones in between to reduce fish fragmentation, increasing layers or quantity in addition to turning of fish during smoking process still risked fish fragmentation and contamination from their hands. Additionally, materials used to cover loaded kilns were unhygienic and potential sources of contamination. Some researchers have recommended use of trays (chorkor kiln) reduced risks of fragmentation and contamination of [21]. However, the study indicated that rectangular brick/mud kilns were still widely used as compared to the improved technologies in West African countries such as Chorkor oven in Ghana [22]. Chorkor kilns have also been widely adopted in Gambia [21]. Wide use of rectangular mud kilns was significantly attributed to relatively low construction costs ($P < 0.05$) as well as simple operation skills required. However, cost of construction and adoption of improved technologies requires intensive awareness among smoked fish processors [5]. Nevertheless, presence of some Chorkor oven (4.8%) according to study, indicated possibility of adoption of this improved smoking technology. The technology would improve efficiency of smoking and quality of smoked fish [5, 22].

Furthermore, various species of trees were used for firewood and this indicated that the choice for firewood was based on availability rather than tree species just like the case for study in Ghana [14]. Most of the tree species used were the hard-wood type (Table 4) and a similar observation was

reported in Ghana [14]. However, the species of trees used for smoking fish from Uganda were quite different from those in Ghana and Gambia [21]. Utilization of unique tree species probably was attributed to their availability given different geographical or vegetational zones. By and large, hard-wood trees are recommended since soft-wood trees are associated with polymeric aromatic hydrocarbons which are carcinogenic or hazardous. In addition, charring of fish which was a challenge to some processors undermined fish quality. Nevertheless, some processors could control the amount of fire by; splashing water or sprinkling ash and soil on it. On the other hand, the temperatures (80-100°C) achieved for two to four hours during smoking was probably enough to destroy the microbes because it was equivalent to the recommended value for microbial destruction [15, 18]. However, most smoked fish seemingly had more moisture content no wonder these lightly smoked fish had a short shelf-life even when some could store it for bulk selling.

It was observed that, fish from the kiln is left to cool first before packaging to avoid moisture accumulation. Packaging was always done for easy handling during distribution and storage of smoked fish within the marketing chain [21]. However, it was observed that materials used including recycled jute bags, baskets or used paper cartons, were inappropriate and probably unsterile. Similarly, the use of baskets and jute bags was also reportedly common in Ghana [19] and Nigeria [9]. It is important to note that, the smoking flow diagram generated based on study, was generally similar to the generic smoking processes [18, 20]. However, what was peculiarly missing was brining and smoke drying for the Ugandan case. The smoking probably differed slightly from that practiced in other countries due to lack of formal training for artisan processors as most got skills from fellow artisan processors. Nonetheless, these processors had health certificates authorizing them to handle food without training on food handling practices. However, in countries like Ghana and Nigeria, government (extension agents) and research institutions have participated in skills delivery to processors for improved fish quality [5, 23].

Despite absence of formal smoking skills acquisition, processors were knowledgeable about various parameters used to detect fish freshness or spoilage and readiness of smoked fish. Incidentally, most frequently used parameters were similar to the recommended ones based on HACCP [18]. This increases probability of smoking good quality fish against the spoiled and contaminated fish with high spoilage or pathogenic microbes. Processors sorted their fresh fish which differed from previous reports of smoking spoiled fish [17]. They probably regarded all fish rejected or low grade for filleting as spoiled whereas may be rejection was based on size. It is however, important for food handlers to have a HACCP certificate after training for food safety or quality [24].

It was also noted that, the population of processors from the islands in Lake Victoria was bigger than those around the mainland shores. This was probably due to higher fish catch and freedom to smoke fish contrary to the situation at the shores that experienced restricted fishing and stiff competition

from fillet processing plants. This left majority of smoked fish processors with low quality/grade fish for smoking. Other challenges such as; confiscation of immature smoked fish (undersize), fluctuating catch/prices for fish, lack of capital for kiln construction and buying of fresh fish as well as occupational hazards particularly smoke and heat effects are still an unbearable thorn for this business. Similarly, these challenges were reportedly among major constraints affecting smoked fish processors [10, 23].

4. Conclusion

Artisanal fish smoking business in Uganda, is dominated by women primarily between the active ages of 21-40 years who operated their business on small scale basis. They basically buy fresh fish from men at the shores and smoke it for sale. Processors use kilns (mostly rectangular brick or mud kilns) as a major smoking equipment. Firewood from various tree species like; Mahogany (*E. angolense*), Eucalyptus (*Eucalyptus* spp.), Acacia (*N. buchananii*) among others depending on availability, is used as fuel for microbial destruction and moisture reduction. The processing steps for traditional fish smoking in Uganda were generally similar to those in other smoked fish processing countries. However, salting, drying, smoke-drying and proper hygiene practices along the value chain were glaringly wanting besides inadequate storage conditions. Nevertheless, there was a similarity in the process flow diagram with HACCP based generic flow, an indication that the processing process could be easily improved given the right interventions such as food management programs for instance HACCP systems from relevant authorities, use of better smoking kilns like chorkor kilns, financial support in form of credits to processors, provision of treated water and mass sensitization on personal hygiene and food safety.

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