INTRODUCTION OF SIMPLIFIED GRADING SYSTEM FOR THE PRODUCTION OF HYGIENIC SMOKED FISH BY PROCESSORS FOR GHANAIAN PREMIUM MARKETS

[INTRODUCTION D'UN SYSTÈME DE CLASSEMENT SIMPLIFIÉ POUR LA PRODUCTION DE POISSONS FUMÉS HYGIÉNIQUES PAR DES TRANSFORMATEURS POUR LES MARCHÉS PREMIUM DU GHANA]

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Abstract

Development of appropriate usable standards must target the population it should address. Ghanaian smoked fish processors are minimally educated and therefore not conversant with stringent international standards for production of hygienic fish using the Hazard Analysis Critical Control Points (HACCP) System. A reduced and graduated grading system, beginning with Class One for the award of a recognition certificate, was proposed for use by processors operating the Ahotor oven. Processors' activities at their premises will be monitored from fish receipt, along the value chain, to the packaged and labelled product. An easily understandable checklist to guide processors in providing safe fish was developed in order to access traditional markets and supermarkets in Ghana. Premium markets that are patronized by Ghanaians and foreign nationals were targeted to receive packaged fish approved by an audit team that will certify adherence to all requirements on the checklist. Monitoring and evaluation by a combined team from the Food and Drugs Authority, Ghana Standards Authority and the Fisheries Commission will be instituted. Successful processors will be issued labels depicting Class One status, to be stuck on all packaged fish, so as to alert consumers of use of hygienic procedures in production. This will boost consumer confidence and patronage. Developing a checklist for such markets will critically address criteria such as environmental hygiene, layout of premises, personnel hygiene, water quality, storage, pest control, waste management, cleaning programmes, packaging, transportation, recall and traceability as well as batch identification. Subsequently, processors who satisfy the Class One status will proceed to higher training to reach Class Two which has more stringent measures and will afford processors to export the fish to the African sub-region. To attain the last status, Class Three, will therefore entail processors reaching a level that will allow them to access international markets like the European Market.

Key words: Healthy fish, grading standard, class One, smoked fish, Ahotor oven, microorganisms, polycyclic aromatic hydrocarbons, human health risks

Résumé

L'élaboration de normes utilisables appropriées doit cibler la population à laquelle elle devrait répondre. Les transformateurs de poisson fumé ghanéens sont peu instruits et ne maîtrisent donc pas les normes internationales strictes pour la production de poisson hygiénique en utilisant le système HACCP (analyse des risques et maîtrise des points critiques). Un système de classement réduit et gradué, commençant par la classe Un pour l'obtention d'un certificat de reconnaissance, a été proposé aux transformateurs qui utilisent le four Ahotor. Les activités des transformateurs sur leurs sites seront surveillées depuis la réception du poisson, le long de la chaîne de valeur, jusqu'au produit emballé et étiqueté. Une liste de contrôle facilement compréhensible pour guider les transformateurs dans la fourniture de poisson sain a été développée afin d'accéder aux marchés traditionnels et aux

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supermarchés au Ghana. Les marchés privilégiés qui sont fréquentés par les Ghanéens et les ressortissants étrangers étaient ciblés pour recevoir du poisson emballé approuvé par une équipe d'audit qui certifiera le respect de toutes les exigences de la liste de contrôle. Le suivi et l'évaluation par une équipe conjointe de l'Autorité des aliments et des médicaments, de l'Autorité des normes du Ghana et de la Commission des pêches seront mis en place. Les transformateurs qui réussissent recevront des étiquettes représentant le statut de Classe Un, qui seront collées sur tous les poissons emballés, de manière à alerter les consommateurs de l'utilisation de procédures hygiéniques dans la production. Cela stimulera la confiance des consommateurs et le patronage. L'élaboration d'une liste de contrôle pour ces marchés portera sur des critères tels que l'hygiène environnementale, l'hygiène du personnel, la qualité de l'eau, le stockage, la lutte antiparasitaire, la gestion des déchets, les programmes de nettoyage, l'emballage, le transport, le rappel et la traçabilité ainsi que l'identification du lot. Par la suite, les transformateurs qui obtiennent le statut de classe Un suivront une formation supérieure pour atteindre la classe Deux, qui comporte des mesures plus strictes et qui permettra aux transformateurs d'exporter le poisson vers la sous-région africaine. Afin d'atteindre le dernier statut, classe Trois, les transformateurs devront rejoindre un niveau qui leur permettra d'accéder aux marchés internationaux comme le marché européen.

Mots-clés: poisson sain, norme de classement, classe Un, poisson fumé, four Ahotor, microorganismes, hydrocarbures aromatiques polycycliques, risques pour la santé humaine

1. INTRODUCTION

The fishery sector is important to Ghana in several ways. Ghanaian consumers obtain nutritious protein source from fish, income and employment for a significant number of people, many in remote rural or coastal communities who have few other income generation opportunities available. According to FAO, (2016), Ghanaians consume about 90% of its landed catch and the total fish production from Ghanaian fisheries is roughly 400,000 metric tonnes, with fish imports averaging 600,000 tonnes per year. In terms of the overall economy, the fisheries sector is estimated to account for at least 4.5 percent of GDP – more than half of that of cocoa. Ghana's fisheries sector also provides employment for an estimated 2.2 million people.

Furthermore, a majority of Ghanaians are regular consumers of fish, with an estimated annual consumption of 23 kg per person, three kilograms higher than the world average. The sector makes a very significant contribution to food security; not just animal protein but essential micronutrients such as Vitamin D, essential fatty acids, and iodine. About 70 to 80 percent of fish that is consumed in Ghana is processed via artisanal smoking and drying in various forms of ovens, prior to sale. About 60 tonnes of smoked fish is also being exported to the EU per annum.

Fish smoking in Ghana involves the application of traditional methods that have little consideration for hygienic handling of fish. During the bumper season, processors process in large quantities and therefore are unwilling to pay attention to hygienic ways of processing. Sanitation is an important issue especially in some coastal and inland fishing communities, where there are no basic amenities such as potable water for use. Thus with the limited resources available, processors are unable to meet good hygiene practices (GHP).

Processing also involves the use of traditional fish smoking stoves, which adds very high levels of polycyclic aromatic hydrocarbons (PAHs) to the processed fish. Polycyclic aromatic hydrocarbons (PAHs) are organic chemical compounds found in oil, tar and coal deposits. They are also by-products of fuel combustion. As a result they are found in smoked food products.

Poor product quality and unhygienic handling practices are a major concern in the local fish processing industry. Chemical and Microbiological contamination can occur at multiple points through the value-chain, through the processing, storage and sales of fish in poorly kept and unhygienic surroundings. The current smoking and drying techniques available have limitations that deserve greater attention in order

to significantly improve small-scale fishers' livelihoods and respond effectively to product safety challenges – especially linked to controlling contamination by Polycyclic Aromatic Hydrocarbons (PAH), which poses public health hazard (Kwarteng and Samey, 2016).

The Sustainable Fisheries Management Project in collaboration with the Fisheries Commission, Food Research Institute of the Center for Scientific and Industrial Research (CSIR) and Ghana Standards Authority has carried out a comprehensive research on microbiological profiles and PAH deposits on fish and also carried out a 2 year technology development program towards the development of the improved Ahotor fish smoking oven, which is fuel efficient and has very low records of PAH deposits compared to the existing stoves.

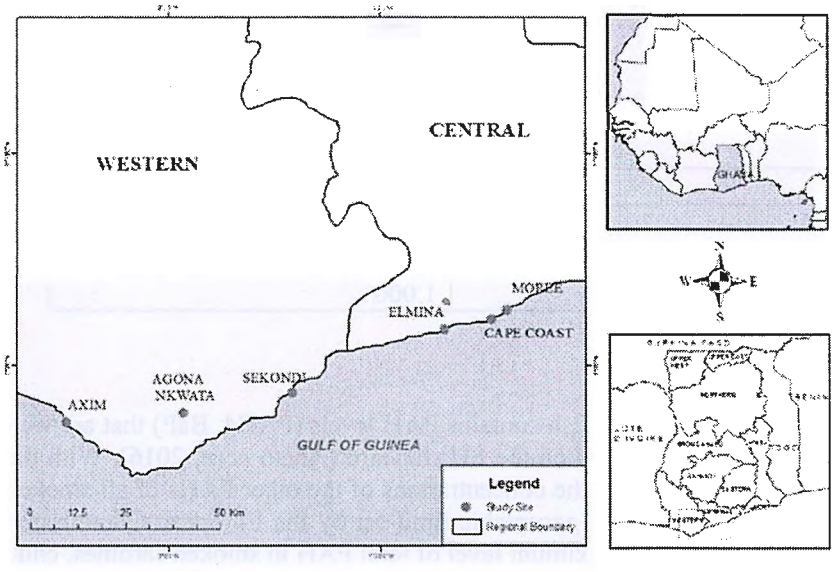
The main objective of this study is to provide scientific evidence on smoked fish production to guide the promotion of improved processing methods, product quality, packaging, labelling and marketing to significantly increase the value of smoke/dried fish products and shelf life, allowing better penetration to domestic markets, where demand is strong, as well as to neighbouring countries.
Specific objectives comprise:

- Assess the risk that the processors and consumers are exposed to through processing and consumption of smoked fish.
- Develop a simplified grading system attainable by processors.

2. METHODOLOGY

Three species of fish (Fresh, smoked and salted) namely sardines (*Sardinella aurita*), chub mackerels (*Scomber japonicus*) and anchovies (*Engraulis encrasicolus*) were obtained in August 2016 from six (6) coastal towns in the Western and Central Regions of Ghana namely Axim, Agona Nkwata, Sekondi; Elmina, Cape Coast and Moree respectively. This is expressed in Fig 1, as attached. The sample collection sites were landing beaches, fish processing sites and some local markets. The fresh fish samples were collected from the landing beaches and the smoked and salted fish were collected from the processing sites and market centers. All smoked fish samples were hard smoked on the Chorkor oven using hard woods. The fish samples were placed on ice and sent to the laboratory where they were stored at -80°C for laboratory analyses, to control Microbial action (Aheto *et al*, 2016).

Figure 1. Geographic locations of study sites



Source: Centre for Coastal Management, 2017

The Microbial analysis was performed at the Microbiology laboratory, Food Research Institute (CSIR), according to guidelines provided by the Nordic Committee on Food Analysis Method (NMKL) and the International Standards Organization Method (ISO). The tests performed on the 17 fish samples (Smoked=10; Salted=2; Fresh=5) collected are as follows; *Bacillus cereus* count was tested using NMKL 67 2010; *Staphylococcus aureus* count was tested using NMKL 66 2009; for *Listeria monocytogenes* count was tested with ISO 11290-11996; *Clostridium perfringens* count was tested using ISO 79372004; *Vibrio* count, was tested using ISO 21872-12007; Aerobic plate count was tested using NMKL 862013; Coliform count was tested using NMKL 442004; *E. coli* count was tested using NMKL 1252005; Moulds and Yeast count was tested using ISO 21527-11996 and Enterococcus count was tested using NMKL 652011. This is expressed in Table 1.

Table 1. Microbiological tests performed on fish samples

Test performed	Reference method
Bacillus cereus Count	NMKL672010
Staphylococcus aureus count	NMKL 66 2009
Listeria monocytogenes Count	ISO 11290-1 1996
Clostridium perfringens Count	ISO 7937 2004
Vibrio Count	ISO 21872-1 2007
Aeorobic Plate Count	NMKL 86 2013
Coliform Count	NMKL 44 2004
E. coli Count	NMKL 125 2005
Moulds and Yeast Count	ISO 21527-1 1996
Enterococcus Count	NMKL 65 2011

The PAH tests were conducted at the Pesticide Residue Laboratory of the Ghana Standards Authority. Sixteen different PAH components were tested on the 20 fish samples (19 smoked- Sardinella, Chub Mackerel, Anchovies and 1 Fresh fish) collected (Aheto *et al*, 2016). These are Naphtalene, Acenaphthalene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a) anthracene, Chrysene, Benzo (b) fluoranthene, benzo (a) pyrene, Indeno (1,2,3-c,d) pyrene, Dibenzo (a,h) anthracene, Benzo (g,h,1) peryene. The toxicity equivalent factors applied are expressed in Table 2.

Table 2. Toxicity Equivalency Factors (TEFs)

PAH	TEF (USEPA, 1993)
chrysene	0.001
benz(a)anthracene	0.100
benzo(b)fluoranthene	0.100
benzo(k)fluoranthene	0.010
benzo(a)pyrene	1.000
indeno(1,2,3-cd)pyrene	0.100
dibenz(a,h)anthracene	1.000

3. RESULTS AND DISCUSSION

According to the outcome of the research smoked fish contains PAH levels (PAH4, BaP) that are well above those recommended for human health, based on the EU standard (Aheto *et al*, 2016). With the exception of naphthalene which was not detected, the concentrations of the other PAHs of all smoked fish sampled in the study exceeded the maximum acceptable limit set by the European Commission (BaP2µg/kg; PAH 12 µg/kg). For example, the maximum level of total PAH in smoked sardines, chub marckerel and anchovies recorded in this work was quite elevated as compared to that reported in literature (BaP , PAH 1155.7 µg/kg to 443.4 µg/kg), for chub mackerel (BaP10.6 µg/kg to 72.4 µg/kg; PAH 14200.7 µg/kg to 3372 µg/kg) and Anchovies(BaP 41 µg/kg to 62.9 µg/kg) (GSA, 2016).

The results are alarming (as presented in Table 3 and Table 4), suggesting that smoked fish on the Ghanaian market are unwholesome for human consumption. The elevated levels could be attributed to a number of factors including the type of firewood (hard or soft wood), the type of stove used in smoking, the type of fish (fatty or dry), type of smoking (soft or hard) and many other factors. Kawamoto *et al* (2007) explains that, hard wood such as acacia has higher lignin content and therefore results in higher levels of PAH in the smoke produced from the combustion process, thus soft wood such as sugar cane bagasse are safer. Unfortunately the soft woods are not able to provide the fire power needed and thus are used as additives, in fish smoking. Also, inferring from the statement of Stolyhwo and Sikorski, (2005) it may be said that the fish samples were heavily smoked (hard smoking needed to preserve the fish for a longer period, takes longer duration whereas soft smoking is a shorter smoking period) using traditional kiln with wood fire, thus the elevated levels recorded. Essumang *et al*, (2012) also confirms the concept of fish type, asserting that, heavily smoked fatty fish samples such as mackerel usually tend to accumulate high levels of PAH.

Also the microbiological tests identified the presence of bacteria, moulds and yeast on the smoked fish. High levels of coliforms were detected, and they were beyond the tolerable limits (Table 2). Also, the detection of *E-coli*, implies some level of fecal contamination in the smoked fish, which may be contacted during handling and processing of the fish throughout the production chain. Other microbes detected, as shown in Table 3, are *Enterococcus* sp., *Bacillus cereus*, *Staphylococcus aureus* and *Clostridium perfringens*. These were within the tolerable limits, (CSIR-FRI, 2017).

The study also concluded that the relatively high microbial load in fresh, salted and smoked fish including bacteria, moulds and yeasts concentrations and the equally high PAHs levels recorded in smoked fish, point to serious threat to public health and highlight the urgent need to intensify education on hygienic and best processing practices of fish within the Ghanaian context.

The USAID funded Sustainable Fisheries Management Project, (SFMP) in response to these issues, developed an improved fish smoking oven; the Ahotor oven which is much effective at reducing the levels of PAH on smoked fish and provides a healthy environment for processing (Pemberton-Pigot *et al*, 2016). In addition, the project is collaborating with a team of government agencies relevant to food safety, towards the development of a recognition scheme which will enhance the production and trade of healthy fish in the Ghana. The main objectives of these interventions is to make available safe fish for Ghanaian consumers and also to empower smoked fish processors to improve upon their livelihoods through addition of value to their products.

THE SIMPLIFIED GRADING SYSTEM

A Multidisciplinary Stakeholder Committee has been formed, with the aim of developing a simplified grading system for regulating the smoked fish market in Ghana. The Committee consists of representatives from Ghana Standards Authority, Fisheries Commission, Food Research Institute of CSIR, Food and Drugs Authority, National Fish Processors and Traders Association, FAO Ghana, University of Cape Coast, University of Ghana, SNV Netherlands Development Organisation and other local partners of the SFMP (Samey and Tibu, 2017).

The grading system would be achieved by establishing the standards and levels of PAHs and micro-organisms in the smoked fish that would be tolerable for human consumption. Some people eat smoked fish without further processing like boiling, heating or cooking. However, PAHs and some microorganisms on the smoked fish can have carcinogenic and other health complications on the consumer. Moreover, boiling does not eliminate the PAHs in fish, so its levels needto be reduced right from the smoking process. There is a need to ensure that fish sold for public consumption is wholesome. It was understood that it is not appropriate to immediately conform to European standards, which are quite high and may be unattainable, thus the need for gradual change.

Over the year, the team has reviewed existing standards available for regulating smoked fish on the Ghanaian market. The Hazard Analysis and Critical Control Points (HACCP) standard was an ideal standard that could be adopted for the purpose of regulating the market but the guidelines are quite unattainable with the current level of knowledge of the processors, thus the need to step down or simplify the regulation to make it more attainable which will serve as a preparatory grounds for the processors to access the HACCP certification. The system will be a voluntary recognition scheme where successful processors will be awarded with a recognition certificate, and a predetermined quantity of labels for branding their products.

Under the Class 1 recognition scheme, the operations of the various processors would be audited, per the Class 1 standards expressed in the attached checklist, by GSA, FDA and FC; and if the results are satisfactory, they would be accredited. Certification deals with a lot of documentation as proof of steps being followed to comply with laid down standards. However, the processors at this moment do not do much documentation and it would take a gradual process to get them to that level of documentation. In view of this, the certification process has been put into a two-step approach:

- Class 1 (Award of Certificate of Recognition for smoked fish processors)
- Class 2 (HACCP)

Table 3. Microbial profiles of smoked, salted and fresh fish samples

Microorganism	**Microbial load (cfu/g) of fish samples in various states**																
	Smoked (n= 10)										Salted (n = 2)		Fresh (n = 5)				
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17
Aerobic Plate Count	9.2x103	2.1x104	2.9x104	9.1x103	1.5x104	1.4x104	9.5x104	4.3x104	1.5x104	1.4x104	1.6x103	1.7x103	2.4x104	2.2x103	2.8x103	1.7x104	1.8x105
Coliform Count	<10	<10	176	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	48	20	40	40
E. coli	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Listeria monocytogenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Enterococcus sp.	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bacillus cereus	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Staphylococcus aureus	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Salmonella spp.	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Clostridium perferingens	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Vibrio	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Moulds	80	30	<10	<10	<10	60	<10	20	<10	<10	<10	<10	130	<10	20	60	<10
Yeasts	2.1x103	<10	3.8x103	<10	<10	2.1x103	<10	<10	<10	<10	<10	<10	2.5x103	<10	60	10	<10

ND : Not Detected

Table 4. Polycyclic Aromatic Hydrocarbon (PAH) levels in smoked and fresh fish samples

	PAH concentrations (µg/Kg) in various fish samples																			Mean	Std Dev	Var
	Sardines (n = 9)									Chub Mackerels (n = 8)								Anchovies (n = 3)					
PAH	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T			
NAP	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ACA	143.8	155.8	271.5	405.8	315.2	440.1	461.6	159.7	244.8	210.9	362.1	354.1	306.2	478.6	204.2	157.1	ND	150.3	319.6	165.1	279.3	114.2	13055.6
ACE	12.4	19	37.8	52.8	47.1	38.5	82.5	21.1	26.8	26.5	37.1	29.2	34.6	51.9	3.2	22	ND	17.4	41.7	25.8	33	17.8	317.1
FLU	5.9	11.5	233.5	300.1	208.2	214.2	386.4	105.8	140.8	150.1	197.1	186.2	183.5	305.2	21.5	20.1	ND	143.3	206.1	185.1	168.7	104	10822.9
PHE	395.4	512.2	1012	1290	1198	613.2	1728	529.3	819.1	759.6	1109.9	547.1	1048.2	1201.5	652.2	499.5	ND	682.8	1104.2	1101.1	884.4	351.9	123261
ANT	288.5	420.1	727.3	917.1	848.5	443.2	1220	372.5	84.5	110.5	129.2	396.9	748.6	864.5	468.1	362.4	ND	480.4	786.2	783.1	550.1	310.7	96545
FLT	56.2	88.5	143	116.2	132.1	82.5	141.3	26.3	66.7	100.7	311.4	62.1	114.5	105.2	66.2	57.2	ND	92.3	135.2	109.1	105.6	59.6	3548.1
PYR	56.8	89.3	142.8	115.8	132.1	81.2	141.1	23.2	66.8	100.6	311.1	61.4	114.4	105.8	67.1	58.2	ND	90.1	134.1	109.2	105.3	59.6	3559.3
BAA	47.4	82.9	123.1	71.1	54.3	47.8	107.7	8.7	12.5	111.7	156.8	14.7	44.9	87.8	69.1	84.2	ND	100.3	141.6	139.3	79.3	44.4	1967.9
CHR	49.3	85.1	141.7	72.1	142.8	50.8	49.5	5.7	105	108.3	149.2	16.7	51.9	94.1	71.8	93.7	ND	107.7	152.1	61.8	84.7	43.1	1857
BBF	40.9	3.1	30.1	1.5	53.2	26.7	37.1	25.6	40.7	57.1	73	16.2	1.4	1.9	1.6	3.1	ND	50.4	3.6	2.6	24.7	23.1	535.3
BKF	27.5	29.6	27.3	18.5	45.1	21.5	32.4	23.6	41.7	45.6	74.4	10.4	34.2	35	18.8	28.6	ND	40.1	61.6	40.2	34.5	15.3	234.1
BAP	28	30.4	27.7	18.5	45.8	21.9	32.8	24	42.9	46.3	72.4	10.6	34.3	35.4	19	30.8	ND	40.7	62.9	41	35	15.1	228.6
IND	1.3	1.1	1.1	1.1	11.9	1.7	6.1	3.1	7.6	8.4	15.2	1.9	1.4	1.5	ND	1.1	ND	2.6	4.6	2.1	3.9	4.1	17.3
DAA	1.8	1.6	1.5	1.2	16.4	2.3	8.3	4.2	10.4	11.5	20.7	2.6	2	2.1	ND	1.6	ND	3.5	6.3	2.9	5.3	5.7	32.3
BGP	1.4	1.1	1.1	1.1	16.1	1.9	8.5	4.3	10.5	11.7	21.1	2.1	1.6	1.5	ND	1.1	ND	3.6	5.9	2.5	5.1	5.8	34.4
Total	1157	1531	2922	3383	3267	2088	4443	1337	1721	1859.5	3040.7	1712.2	2721.7	3372	1662.8	1420.7	ND	2005.5	3165.7	2770.9	2399	905.6	820078

The only fresh fish sample; Nd: Not detected (below the detection limit of 1.0 µg/Kg) NAP = Naphthalene; ACA = Acenaphthalene; ACE = Acenaphthene; FLU = Fluorene, PHE = Phenanthrene; ANT = Anthracene, FLT = Fluoranthene; PYR = Pyrene; BAA = Benzo(a)anthracene; CHR = Chrysene; BBF = Benzo(b)Fluoranthene; BKF = Benzo(k)Fluoranthene; BAP = Benzo(a)Pyrene; IND = Indeno(1,2,3-c,d)Pyrene; DAA = Dibenzo(a,h)anthracene; BGP = Benzo(g,h,i)perylene

DESCRIPTION OF THE CLASSES

'Class 1' deals with issuing the processor with a certificate of recognition, to indicate that the processor is processing the fish under hygienic conditions. The 'Class 1' looks at the implementation of basic requirements as expressed in the checklist, such as hygienic handling of fish, a clean kitchen and processing site/environment, to ensure that fish processed would not be contaminated by microorganisms along the entire value chain, and the use of the Ahotor stove to reduce the levels of PAHs in the processed fish. The processor should also have passed a Business Development Training program that would be facilitated by Fisheries Commission (Samey and Tibu, 2017). This class is to help processors get a form of certificate to enhance their business while they work towards keeping proper documentation for subsequent/higher certification. The class looks out for basic prerequisite conditions of processing fish like, effective handwashing, use of potable water for washing fish, use of Personal Protective Equipment (PPEs) etc. Since there isn't much documentation at this level, assessment of the processor will be done based on facilities available and the processors ability to demonstrate how the various activities are carried out.

Class 2 is when HACCP have been implemented in the processor facilities. HACCP stands for Hazard Analysis and Critical Control Points. It is a systematic preventive approach to food safety from biological, chemical, and physical hazards in production processes that can cause the finished product to be unsafe, and designs measurements to reduce risks to safe levels. HACCP is an international standard that works on seven principles to ensure that food products are safe for consumption, right from obtaining the raw material through the processing channel and finally to the consumer. The FTT fish smoking oven is required for this class as processors are required to upgrade their kitchens into a standard compliant fish processing facility and carry out all the standard required documentations and traceability guidelines.

THE CLASS 1 OPERATIONAL PROCESS

According to Samey and Tibu, (2017), a detailed checklist has been developed based on the HACCP guidelines and CODEX Alimentarius The process was led by the Ghana Standards Authority. The checklist provides guidelines on the following thematic areas, Environmental Hygiene, Personal Hygiene, Layout of premises, Water Quality, Storage, Pest Control, Cleaning programs, Waste management, Packaging, Transportation and Batch Identification.

Fish smokers will be trained and coached on the guidelines and on best practices to build their capacity to be able to process and market fish to the 'Class1' standard. This will also involve the upgrade of their kitchens and training for all workers supporting the processing activity. Important aspects and actors of the processing value chain will also be included in the trainings, especially the fishermen. How they handle the fish on sea and at the landing site must also be regulated to some extend to ensure the supply of healthy fresh fish for the processors.

Zonal Fisheries officers will be trained as auditors who will carry out the initial auditing at the community level and report to the Certification Committee. Where a fish processor thinks she qualifies for the 'Class 1' certification, she/he will apply through a partner organisation, NAFPTA executives or the Zonal fisheries officer present in the area. The officer will in turn audit the facilities and smoking process of the fish processor, according to the checklist and submit a report to the Certification Committee that will comprise representatives from FC, FDA, FRI and GSA. GSA shall be an independent verifier in the process. The Committee will make a decision based on the outcome of both reports. The flow diagram is presented in Figure 2.

4. CONCLUSION

SNV Netherlands Development Organisation under the USAID funded Sustainable Fisheries Management Project seeks to pilot this approach in selected coastal fishing communities from November 2017 to May 2018. Depending on the success of the pilot stage and available funding the

project will upscale to the inland fishing communities. Awareness creation and market development will be an integral part of the process to ensure the provision of an enabling environment for the production and trade of healthy fish. It is expected that, awareness of consumers will increase demand for safe fish thus encouraging processors to adopt the new technologies and techniques of processing/smoking fish.

The Ministry of Fisheries and Aquaculture Development and the Fisheries Commission has so far adopted both the improved Ahotor oven and the Recognition scheme and are willing to implement them as part of their work program.

5. RECOMMENDATIONS

- More education should be given to risks associated with PAHs and fishmongers must be sensitized on best practices on handling fish.
- The advantage of using soft wood as firewood and the right type of stove for smoking of fish as a way to reduce the levels of PAHs in smoked fish should be highly emphasized.
- Widespread awareness creation targeting consumers; to ensure ready demand for the healthy fish.
- Thorough piloting of grading system to understand all possible challenges, especially with traceability issues.
- Regulation of the smoked fish market by regulatory bodies.
- Commitment of the regulatory bodies to the simplified grading system
- The need for donor organisations to fund the large scale promotion of the simplified grading system.

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