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Full Length Research Paper

Microbiological quality of catfish (*Clarias gariepinus)* smoked with Nigerian Stored Products Research Institute (NSPRI) developed smoking kiln

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Abstract

The microbial quality of cat fish (*Clarias gariepinus)* smoked with Nigerian Stored Products Research Institute (NSPRI) developed smoking kiln was assessed. Raw fish samples were purchased and cleaned before smoking in the kiln designed and constructed by the institute. Potato dextrose agar and nutrient agar were used for the mould/yeast and bacteria load of the smoked fish respectively while appropriate selective media were used for the isolation of the enteric organisms. The total bacteria count was 2.0 x 10^{-4} *cfug* and 0.7 x 10^{-4} *cfug* for mould/yeast. The result showed that no *Pseudomonas, Escherichia coli or Salmonella species* was found on the smoked fish. Generally the total bacteria count was higher than the mould/yeast count. The sensory evaluation of the smoked fish showed that the fish was generally acceptable in taste and flavour. In conclusion, *C. gariepinus* smoked with NSPRI developed smoking kiln is of high microbiological standard and suitable for human and livestock consumption.

Keywords: Catfish, Smoking kiln, Bacteria, Mould, Yeast, Enteric organisms.

INTRODUCTION

The production and consumption of fish in Nigeria has been a major source of animal protein which has competed favorably with meat. Cat fish (*Clarias gariepinus)* has been reported to be a very important freshwater fish in Nigeria. It has enjoyed wide acceptability in most parts of the country because of its unique taste, flavor and good texture. It is widely distributed, extensively cultivated in ponds. Fish is one of the best sources of proteins, vitamins and minerals and are essential nutrients required for supplementing both infant and adult diets (Abdullahi *et al*., 2001).

In Nigeria, it has also been noticed that fish is eaten fresh, preserved or processed (smoked) and form a much-cherished delicacy that cuts across socio-economic, age, religious and educational barriers (Adebayo-Tayo *et al*., 2008). As earlier reported, the microbial flora associated with freshly harvested fish is principally a function of the environment in which the fish are caught and not of the fish species; hence, the indigenous microbial populations of fish can vary significantly (Shewan 1961). A similar report on fish confirmed that, fish because of their soft tissues and aquatic environment are extremely susceptible to microbial contamination. Millions of bacteria, many of them potential spoilers, are present in the surface slime, on the gills and in the intestines of live fish, although the flesh itself is normally sterile. Bacterial growth and invasion on the fish are prevented by the body's natural defense system during life but after death the defense system breaks down and the bacteria multiply and invade the flesh (Abolagba and Uwagbai, 2011). Poor post-harvest technology (handling, preservation and processing) have been reported earlier to have the ability to cause unhealthy situation resulting in massive spoilage. An estimate of 40% postharvest losses of total

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fish landings have been reported in Nigeria (Akande,1996). (Mayboom 1974) similarly reported that 15% of the total fish catch in Kainji Lake is lost because of spoilage and breakage between the sources of supply and the consumers. (Saliu, 2008) also reported that fish spoilage in Nigeria is influenced to a large extent by high ambient temperatures, considerable distances of landing ports to points of utilization and poor as well as inadequate infra-structure for post-harvest processing and landing. According to (Geoff *et al*., 1991) bacterial spoilage is characterized by softening of the muscle tissue and the production of slime and offensive odors. Several methods have been adopted to preserve fish both for long and short time usage,among the several methods of long term preservation of fish, smoking has been reported as perhaps the simplest method which does not require sophisticated equipment or highly skilled workers (Olayemi *et al*., 2011). Smoking is a century old method of food preservation. Fish smoking is one of the traditional fish processing methods aimed at preventing or reducing postharvest losses. Smoking involves heat application to remove water and it inhibits bacterial and enzymatic actions of fish (Kumolu Johnson et al., 2009, Abolagba and Melle,2008).Earlier authors (Olokor *et al.,* 2007, Sengor *et al*., 2004, Eyo, 2001, Horner, 1997, Olley *et al*., 1988 and Clucas, and Ward 1996) also noted that apart from giving the product a desirable taste and odor, smoking provides a longer shelf-life through its anti-bacterial and oxidative effect, lowering of pH, imparting desirable colorations as well as accelerating the drying process and acting as antagonist to spoilage. However, smoking is the most popular method of fish processing (Olley *et al*., 1988).Traditionally, report has shown that fish is smoked in pits or on raised smoking “tables” where the control of heat is difficult and at times impossible, (Afolabi, 1984) Also, the smoked fish would often be exposed to dust and heavy microbial contamination during the process of traditional smoking which gives the final products high microbial load even immediately after smoking, this agrees with the findings of (Abolagba and Iyeru, 1988) who reported that lack of proper smoking and proper hygienic handling of smoked fish products would result in a very high microbial load and open flame smoking of fish has been noted to produce cancer promoting compounds in the body. In an attempt to reduce the problems often encountered during smoking, Nigeria Stored Products Research Institute (NSPRI) fish smoking kiln was developed. Due to handling and the exposure to the environment during and after smoking, smoked fish often comes out with heavy microbial load after smoking therefore. This research is thus aimed at studying the microbial quality of *C. gariepinus* smoked in NSPRI designed and constructed smoking kiln.

MATERIAL AND METHODS

Description of NSPRI kiln

The smoking kiln is rectangular in shape of dimension 60 x 60 x 120 cm in depth, width and height respectively. The structure has an internal wall made of galvanized iron (GI) sheet, lagged with 2.54 cm asbestos particles and covered with ½ in plywood. It has a unit compartment for drying, heating and smoking with removable four trays made from 25.81 cm square wire mesh placed on 2.54 cm angle iron. The structure was incorporated with three axial fan powered by ten 1.5 V battery to increase air supply to the heating chamber. The heating chamber was also made up of two sections which may be used together or independently, they are the heat producing section which can produce heat using charcoal, coal or coconut shell; and the smoke producing section using sawdust. Four of the ½ in diameter pipe exits were also provided at the top of the structure to aid the escape of water vapour during the smoking process while 6 of the ½ in diameter pipe were provided for air inlets. The structure works by burning charcoal to produce heat for the drying of the fish and by burning sawdust to generate smoke which imparts desired aroma and color to the smoked fish. The structure may be used to dry the fish alone without smoking and vice versa, (Olayemi *et al*., 2011).

Fish processing

Sixty seven freshly harvested Catfish (*Clarias gariepinus*) aged six months were obtained from Fagam Farm through Kano State Department of Fisheries in Kano State, Nigeria. All were killed, beheaded, eviscerated and washed thoroughly. They were brined using a teaspoon of salt per fish. They were packaged into NSPRI Fish boxes which were insulated and the fish to ice in ratio 1:1 and were transported to the laboratory for further treatments. The fish smoking kiln was operated by first loading charcoal into the heat chamber, preheating for some minutes, and then loading the salted pieces of fish onto the trays in its central chamber. The kiln was closed for some time to allow the smoking to take place. The capacity was 100 kg per barge. The smoking time, temperature and ambient conditions were monitored during the smoking operations.

The smoking was terminated when the fish were properly dried after 15 (Olayemi et al., 2011). The smoked samples were allowed to pass through a reactivation period of three days to allow for sporulation of any spore which may be present or germination of any distressed vegetative cells before they were analyzed for total microbial load, presence of yeast/mould and indicator organisms like *E. coli and Salmonella species*. The sensory evaluation was also conducted using nine

unit hedonic scales conducted by six semi trained panels who were members of staff of the institute.

Microbial analysis

One gram (1g) representative sample was obtained aseptically from the muscle of the smoked catfish samples. The samples were grounded and serial dilutions (10^{-1}- 10^{-4}) of the homogenized samples were made using sterile distilled water. All chemicals used were of analytical grade and supplied by Sigma Co. (St Louis, USA). Each analysis was carried out in triplicates. All microbial analysis were done following the methods prescribed by (A.O.A.C., 2000).

Total Plate Count (TBC)

This was done using the pour plate method of (A.O.A.C. 2000). One milliliter of the serially diluted samples was taken in duplicates and plate count agar was poured at 40^0C on the plates. The samples and the medium were properly mixed, allowed to set and incubated at 35^0C and 37^0C for 24h. The number of colonies on the plates was counted. The colonies were sub cultured to get pure cultures which were further screen for the presence of indicator organisms as described below;

***Escherichia coli* count**

This was done using MacConkey agar, the plates were incubated at 35^0C and 37^0 C for 24h. Colonies with pinkish red growth having a metallic sheen or reflection confirms the presence of *E. coli*

***Salmonella* count**

Samples for detection of salmonella were plated out on brilliant green Agar. The plates were incubated at 35^0 C and 37 0 C for 24h. Reddish white colonies with a pinkish zone confirmed the presence of *Salmonella sp*.

Pseudomonas count

This was done using Citrimide Agar. The plates were incubated at 35 0C and 37 0C. Colonies with whitish appearance which fluorescence confirmed the presence of *Pseudomonas.*

Yeast and mould Counts

This was done by plating out serially diluted samples on Yeast and mould Agar at room temperature (30- 35^0C) for 72hours.

RESULTS AND DISCUSSION

The design of the NSPRI constructed smoking kiln ensures that the fish was properly smoked within 15 hours at 700C. The moisture content of the fish was drastically reduced as shown by the reduction in weight and moisture content before and after smoking (Table 2). Since dryness of 7.3% was obtained from 78.7% initial moisture content after 15hours of drying, it implies that the drying rate of the catfish using the kiln was 4.76% moisture per hour. The difference in moisture content after smoking is a confirmation of the fact that *C. gariepinus* has high water content which predisposes it to high microbial spoilage if not well preserved after harvest. The moisture content of the smoked fish which was 7.3% falls within the allowable limit (6-8%) for Smoked dried fish as this is of paramount importance in preventing spoilage during storage and it enhances the shelf life of the smoked fish, this observation is in agreement with the findings of (Salan *et al*., 2006) and (Kumolu Johnson *et al* 2009) who reported that spoilage of fish resulting from the action of enzymes and bacteria can be slowed down by the addition of salt as well as reduction in moisture through sun drying or smoking .The total mean bacteria count was 2.0 x 10^3 colony forming unit per gramme of the fish sample, this value falls within the maximum recommended value of bacteria count for good quality fish products which is 5 x 10^5 colony forming unit per gramme according to (ICMSF, 1986) and the Microbiological Guideline for Ready to –eat – Food which is < 10^6 (Microbiological Guideline for Ready to –eat – Food 2007). The result also indicated that there was no contamination with enteric organisms by handlers during smoking as there was no coliform found after smoking. The absence of *E. coli* and *Salmonella* species which are indicative organisms indicating contamination by microorganisms from enteric origin further confirms the effectiveness of the smoking kiln. The smoking kiln and the techniques involved were such that do not allow the fish smokers to have direct contact with the fish during smoking. According to (Eyo, 2001) microbial action plays a large part in the spoilage of fish and fish products. Fish smoking in NSPRI developed kiln has been able to effectively reduce this main source of spoilage. It was also noticed that *Pseudomonas*, an opportunistic bacteria in food spoilage and infection (Talaro,2009) was not found on the smoked fish. The value of yeast/ mould recorded after smoking was found to falls within the acceptable limit of acceptable number of colony forming unit of mould/yeast of smoked fish (ICMSF, 1986) and the Microbiological Guideline for Ready to –eat – Food, 2007) (Table 1). The sensory evaluation as shown in Table 3 was conducted by six semi-trained panelist

Table 1. Microbial analysis of smoked dried catfish

Total bacteria count	*E.coli*	*Salmonella spp*	*Pseudomonas spp*	Yeast /mould
2.0 X 10^4	0.0 x 10^4	0.0 x10^4	0.0 x10^4	0.7 x10^4

Table 2. Fresh/ dried weight and moisture content of catfish

Sample	Total weight (g)	Mean weight (g)	Moisture content
Fresh catfish	19284	332.48±62.91	78.70
Dried catfish	5076	87.52±17.25	7.30

Table 3. Sensory evaluation

S/N	Parameter	Scores
1.	Smell	6.63
2.	Texture	6.90
3.	Colour	7.78
4.	Taste	6.75
5.	General acceptance	7.02

who are also members of staff of the institute on a 9 point hedonic scale of smell, texture, colour taste and general acceptance showed that, the fish were in good quality and standard conditions as expected in Nigerian smoked fish products.

CONCLUSION

Considering the result above the NSPRI developed smoking kiln could be used effectively to achieve smoked fish products free from microbial and dust contaminants from the smoking environments and the fish handlers during the smoking process. However more microbial analysis should be carried out to ascertain the durability and the best storage condition and material for the smoked fish. Also more work should be done to identify the organisms found and recorded in the result of the total microbial count to confirm that they are not producers of microbial toxins like Staphylococcus toxin which could constitute harm upon consumption or use in animal feed.

APPRECIATION

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