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EFFECT OF PROCESSING AND STORAGE METHODS ON THE SHELF LIFE AND INCIDENCE OF INSECT PESTS ON SMOKED FISH

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ABSTRACT

The effect of processing and storage methods on the shelf life and incidence of insect pests on stored smoked fish was carried out on two types of fishes, *Tilapia* sp and *Clarias* sp. Two samples were used; one sample of already smoked *Clarias* obtained from Oba's market, Akure. The other sample (*Tilapia* and *Clarias*) obtained fresh and hygienically smoked instantly in the laboratory. These samples were packed in different packaging materials; polythene, aluminium foil, plastic container, and carton and stored at low (refrigeration) and ambient temperatures. For the period of 90 days of storage, the sample that was processed in the laboratory did not show any pest infestation, while the already smoked fish obtained from the market showed infestation with *Dermestes* after ten days of storage for all the packaging materials. Low temperature storage proved to be the best storage techniques for all the packaging materials. The samples stored in carton at the ambient temperature were better than those of other materials.

Keywords: processing, packaging materials, infestation, storage methods.

INTRODUCTION

The importance of protein in the diet of man cannot be overemphasised, hence man has been trying all means possible to see that this is made available. Fish is one of the cheapest source of animal protein which is very important in human and animal diet. It contains important minerals needed by the body such as calcium, iron, iodine and vitamins. Fish forms about 3% of the world's food supply (Kilgour, 1986). Artisanal fisheries are the most popular in the major riverine areas such as coastal areas or near lake, estuaries or rivers in tropical developing countries. In many cases, these fisheries are responsible for between 50 – 70% as a nation's catch. In Senegal for example, artisanal fisheries provided 60% of national landings. In Peru, the artisanal fisheries supply 80% of fish for human consumption (United Nations Development Fund for Women, UNDFW, 1988).

The quality of any stored products is influenced by the quality of the raw material and handling during processing. Fish is an extremely perishable food commodity. Fish, being a low-acid food which supports the growth of microorganiosms needs careful handling and rapid processing is essential. It can be spoilt through improper handling, autolytic spoilage and attack by bacteria, fungi, insects, mites, birds and other animals. However, of all these agents of fish spoilage, insect infestation is the most serious (Frank, 1977). The longer the processor leaves the fish before processing in conditions favourable for spoilage (high moisture, ambient temperature, and high humidity), the greater the losses. There are two stages of insect infestation namely the relatively short period when different species of flies infest the wet fish and the second is the long term when different species of *Dermestes, Chysomyia* and *Necrobia* infest the dried or drying fish (Kordyl, 1977). The most important insect pest of dried fish is the beetle, *Dermestes* spp (Osuji, 1974, Proctor, 1977). Under the most adverse conditions, losses due to beetles infestation have been estimated at around 50% (FAO, 1981). In order to prevent contamination and spoilage, fish can be processed (Osuji, 1974). Packaging materials also affect the storage ability of fish.

This study examines the effect of proper handling, instant processing, different packaging materials and storage methods on the shelf life and incidence of insect pests on smoked fish.

MATERIALS AND METHODS

General Materials

The already smoked fish, *Clarias* spp was obtained from Oba's market, Akure, Nigeria, while fresh living samples of *Clarias* spp and *Tilapia* spp were obtained from Igbotu in Ilaje Local Government of Apoi, Igbokoda area, Ondo State. Nigeria. The fishes were captured with fish net.

Other materials included a thermometer, wood and charcoal as sources of fuel, and the smoking chamber (a modified Kiln).

The packaging materials included;

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Table 1 – Observations on hygienically smoked Tilapia Fish.

Days After Packaging (DAP)	Method of Storage	Packaging materials	Colour Change	Inference
	Refrigeration	H D P	Bright yellow	Well stored
27 – 41	Open shelf	H D P	Brown	Not very well stored due to condensation
	Open shelf	Carton	Brownish-yellow	Well stored
	Open shelf	Aluminium foil	Brownish-yellow	Well stored
	Open shelf	Plastic container	Brownish-yellow	Well stored
	Refrigeration	H D P	Bright yellow	Well stored
55 – 69	Shelf	H D P	Brown	Mouldy
	Shelf	Carton	Pale brown	Traces of fungi spot
	Shelf	Aluminium foil	Bright yellow	Trace of fungi
	Shelf	Plastic container	Bright yellow	Traces of fungi
	Refrigeration	H D P	Bright yellow	Very well stored
83 – 92	Shelf	H D P	Brown	Mouldy
	Shelf	Carton	Pale brown	Traces of fungi
	Shelf	Aluminium foil	Bright yellow	Traces of fungi
	Shelf	Plastic container	Slightly yellow	Traces of fungi

HDP – High Density Polythene

(a) Plastic containers with lids which are resistant to shock, moisture and air.
(b) High density polythene (HDP) which is thick, and strong and less flexible, heat sealable and provides a reasonable barrier to moisture.
(c) Paper cartons which are weak, easily damaged by water and have very low barriers to gaseous exchange and moisture, but absorb oil from fish.
(d) Aluminium foil which is heat resistant, a barrier to light, water, gases and chemical or biological contaminants. It is used for wrapping fast foods.

EXPERIMENTAL PROCEDURE

General Preparation

The fish obtained were washed with clean water to remove dirt, and surface microfauna from the fish skin. The smoking process commenced immediately after the fish were killed.

The smoking chamber consist of a metal bowl containing charcoal and wood cut into small pieces and supported with cement blocks. A wire gauze, on which fish were arranged and covered, was placed on top of the metal bowl. Fire was set on the woods and charcoal and the fish were smoked with temperature check range of 55 – 65^{0}C for five days. They were then left in the open to cool and later packaged into different packaging materials – the carton, plastic container, aluminium foil and high density polythene bags. This was replicated twice for each material. A set of these was stored under ambient temperature fluctuating between 28^0 and 31^{0}C, on the laboratory shelf while another set was packed in polythene and stored in the refrigerator at 8±2^{0}C.

A second set, this time, of already smoked *Clarias* obtained from the market was also treated as above. The smoking was done in the laboratory screened from insects.

Moisture Content and pH determination

The moisture content and pH of the fish were determined after smoking shortly before the commencement of the experiment and after the experiment. The moisture content was determined as follows:

Table 2 – Observations on hygienically smoked Clarias Fish.

Days After Packaging (DAP)	Method of Storage	Packaging materials	Colour Change	Inference
	Refrigeration	H D P	Bright yellow	Well stored
	Shelf	H D P	Light yellow	Well stored
27 – 41	Shelf	Carton	Light yellow	Well stored
	Shelf	Aluminium foil	Light yellow	Well stored
	Shelf	Plastic container	Light yellow	Well stored
	Refrigeration	H D P	Yellow	Well stored
	Shelf	H D P	Yellow	Slight traces of fungi
55 – 69	Shelf	Carton	Yellow	Slight traces of fungi
	Shelf	Aluminium foil	Yellow	Slight traces of fungi
	Shelf	Plastic container	Yellow	Spots of fungi
	Refrigeration	H D P	Bright yellow	Well stored
	Shelf	H D P	Brownish yellow	Rancidity has set in slight mould
83 – 92	Shelf	Carton	Light brown	Slightly mouldy
	Shelf	Aluminium foil	Slightly brown	Fairly good
	Shelf	Plastic container	Light yellow	Traces of fungi

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A clean and labelled crucible that has been oven-dried at 80°C and later left in dessicator for 30 minutes was weighed (w_1). Two grams of the ground sample of fish was added into the crucible and weighed (w_2). The crucible containing the sample was opened and transferred to the oven and heated at 105°C for 3 hours. The crucible was brought out of the oven into the dessicator and allowed to cool for 1 hour.

The cooled crucible with the content was weighed (w_3) (AOAC, 1990).

Weight of wet sample = $w_2 - w_1$

Weight of dry sample = $w_3 - w_1$

$$\text{Moisture Content (\%)} = \frac{(w_2 - w_1) - (w_3 - w_1) \times 100}{(w_3 - w_1)}$$

on dry weight basis.

To determine the pH, fish samples were ground to powder and soaked in distilled water. The pH value was read using pH meter and litmus paper was used to compare the value.

Sensory evaluation was carried out on the samples for organoleptic test.

Colour

Was obtained through visual observation of the samples.

Taste and Smell

The sample that appeared to store well through visual observation were given to five people to smell and taste. The records of the assessment of these people were taken.

Texture

This was based on the susceptibility of the samples to grinding using mortar and pestle in the laboratory. The samples were felt through the fingers.

RESULTS

Tables 1-3 show the result of hygienically smoked *Tilapia* and *Clarias* fish, and already smoked *Clarias* fish bought from Oba's market. There was no insect infestation in those fish samples processed in the laboratory but there were traces of moulds and fungi after 55 days packaging (DAP), for those kept under ambient

temperature using all the packaging materials. However, those kept in the refrigerator stored very well without traces of moulds. In the *Tilapia* fish processed in the laboratory, the taste and smell was good throughout the duration of storage and the texture of ground fish was brittle except for those kept in High Density Polythene containers at ambient temperatures which became slightly mouldy and rancid and texture, spongy at 55 DAP till the end of the storage period (Table 1). Also in the *Clarias* fish processed in the laboratory, the test and smell were good throughout the duration of storage and brittle except in those kept in HDP, carton and plastic containers which became rancid and spongy after 83 DAP (Table 2). However, there was no insect infestation.

In the already smoked *Clarias* obtained from the market, insect infestation was noticed at about 10 DAP with larvae of *Dermestes maculatus* invading the tissue and operculum and this continued until adults emerged at 38 DAP after degrading the fish. The taste and smell were fairly good at 10DAP but deterioration set in after 24DAP when the fish became mouldy and rancid except in those kept in the refrigerator. The

Table 3 – Already Processed (smoked) *Clarias* bought from Oba's Market.

Days After Packaging (DAP)	Methods of storage	Packaging materials	Colour change	Texture	Insect emergence	Inference
	Refrigeration	H D P	Bright yellow	Slightly brittle	None	Appears well stored
	Shelf	H D P	Brown	Spongy	None	Oxidation has taking place
	Shelf	Carton	Bright yellow	Spongy	Larva in the tissue and operculum	Infestation with larva has started.
10	Shelf	Aluminium foil	Bright yellow	Slightly brittle	None	Well stored
	Shelf	Plastic container	Brownish	Spongy	None	Deterioration has set in.
	Refrigeration	H D P	Bright yellow	Brittle	None	Well stored
	Shelf	H D P	Brown	Spongy	None	Deterioration has set in
24	Shelf	Carton	Bright yellow	Spongy	Larva in tissue and operculum	Invasion of gut, operculum and tissue with larva.
	Shelf	Aluminium foil	Yellow	Slightly brittle	Larva emergence	Invasion of gut, operculum and tissue with larva.
	Shelf	Plastic container	Brown	Spongy	Larva emergence	Invasion of tissue by larvae.
	Refrigeration	H D P	Yellow	Brittle	None	Well stored
	Shelf	H D P	Brown	Spongy	Larva of *D. maculates*	Infestation by larvae has started
38	Shelf	Carton	Yellow	Spongy	Adult *D. maculatus* emerge	Highly infested with *D. maculatus*
	Shelf	Aluminium foil	Yellow	Turning to power	Adult *D. maculatus* emerge	Highly infested with *D. maculatus*
	Shelf	Plastic container	Brown	Turning to power	Adult *D. maculatus* emerge	Highly infested with *D. maculatus*

HDP – High Density Polythene

Table 4 – Moisture Content and pH

Sample	Initial Moisture Content	Final Moisture Content	Initial pH	Final pH
Clarias				
Fridge	10%	10%	7.80	7.10
Plastic (shelf)	10%	34%	7.80	6.50
Carton	10%	33%	7.80	6.80
Aluminium foil	10%	20%	7.80	6.90
Polythene	10%	40%	7.80	6.90
Tilapia				
Fridge	10%	10%	7.15	6.60
Plastic (shelf)	10%	30%	7.15	7.60
Carton (shelf)	10%	40%	7.15	5.00
Aluminium foil	10%	16%	7.15	5.20
Polythene	10%	50%	7.15	8.10
Already processed *Clarias* from the market				
Fridge	12%	14%	7.50	6.00
Plastic (shelf)	12%	38%	7.50	6.50
Carton (shelf)	12%	44%	7.50	6.30
Aluminium foil	12%	27%	7.50	5.40
Polythene	12%	31%	7.50	6.00

texture was also spongy in those with moulds and only brittle in those under refrigeration. Moulds started appearing here at 24 DAP and the growth of mould was more pronounced than in those hygienically smoked in the laboratory.

Table 4 shows that there was an increase in moisture and a decrease in pH especially for those kept under ambient temperatures. These conditions favoured the growth of mould.

DISCUSSION

Fish is processed in order to prevent contamination and spoilage (Bostock *et. al.*, 1987; Clucas, 1981) since fish spoilage leads to loss of stored fish and consequent reduction of fish available for consumption (Agbolagba *et. al.*, 1996). In this study, fresh fish (*Clarias* spp and *Tilapia* spp) processed in the laboratory showed no insect infestation for more than three months using different packaging materials and different storage conditions, although there were traces of moulds in those stored under ambient temperature after 55DAP. The already smoked fish obtained from the market showed infestation by insects within 10 days of packaging and there was an abundance of mould growth in those stored under ambient temperatures. This may be due to improper handling, poor processing and unhygienic conditions to which they were exposed. Osuji (1974) observed that fish specimens even when taken from the same fish heap, showed varying degrees of infestation by *Dermestes maculatus* and *Necrobia rufipes*. All the fish samples kept in the refrigerator stored very well in terms of taste, smell, texture and appearance.

All the packaging materials appeared good depending on the conditions of storage. The carton absorbs oil from the fish, absorbs water in case of condensation and serves as a barrier to light and allowed air movement. This probably accounted for the low rate of mould growth and low rancidity in the fish stored in it when compared to other packaging materials. Properly sealed carton is a good packaging material for storage provided it is not too densely packed (UNDFW, 1988). Aluminium foil proved to be a good packaging material because it is impervious to light, gas and water and hinders rancidity.

There was an increase in moisture content probably due to condensation at ambient temperatures and a decrease in pH at the end of the experiment. This may be the cause of growth of mould on the fish. The sample in the refrigerator did not gain moisture. Fish is highly perishable and this necessitates its processing and preservation especially in the tropics with high temperature and moisture which favour the growth of spoilage agents.

In conclusion, the shelf life of any stored product is determined by the state of the product prepared for storage. Therefore careful harvesting, proper hygienic handling, instant processing, and packaging of smoked fish prevent insect infestation before storage especially by *D. maculatus* and *N. rufipes*.

Whenever possible, low temperature storage of fish should be encouraged since it is better than storage at ambient temperatures. All the packaging materials tested here appeared good provided the characteristics of each is taken into consideration and the environment that will aid its use as a good packaging material is created. Smoking to dryness ensures good storage at ambient temperature or in the refrigerator.

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