A SMOKED MINCED TILAPIA PRODUCT WITH ENHANCED KEEPING QUALITIES

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Abstract

A stable and palatable smoked tilapia product with enhanced keeping qualities was prepared from minced tilapia flesh. The minced flesh was modified with a mixture of salt and sodium tripolyphosphate and stabilized with potassium sorbate. Products, smoked prior to reforming into sheets and hot-smoking at 70°C to moisture contents of 25 percent and 45 percent and stored at 20°C at a relative humidity of 76 percent, were stable against mould growth for at least 60 days with the addition of the potassium sorbate. Smoking to these moisture contents at a maximum temperature of 70°C did not significantly reduce the nutritional value of the protein as measured by available lysine values.

INTRODUCTION

In many parts of the world, the problem of preserving fish rapidly and inexpensively still remains a major deterrent to fully utilizing local fishery resources. Where there is a lack of freezing and canning facilities, salting, drying and smoking still represent the most convenient but not always the most satisfying ways of preserving fish. It is estimated that where modern facilities do not exist, 50 percent of the fish that is salted and/or dried is lost either to decomposition or rodent and insect infestation (Cutting, 1962; Denaut, 1975). Highly salted fish can also have the disadvantage of not being universally accepted, particularly when it needs to be desalted prior to use (Del Valle *et al.*, 1968). In Nigeria, smoking is a popular method for preserving some species of fish, eg., tilapia. This freshwater species is hard-smoked (generally whole) to a brittle consistency and consumed directly as soups and stews. In humid tropical climates even hard-smoked products are subject to the usual losses incurred by insect and microbiological attack.

In one form or another, salted, dried and smoked fish are widely accepted and would contribute more to food needs if their losses during the various stages of distribution could be reduced. In the work presented here, we take advantage of some of the virtues of basic processing techniques in producing, from blended, minced flesh, a smoked product whose organoleptic characteristics can be modified to suit regional preferences but which still retains enhanced keeping qualities and is amenable to simple packaging procedures.

MATERIALS AND METHODS

Fish

Tilapia (*T. aureus*) were reared in 90-gallon circular tanks maintained at temperatures ranging from 75 to 85°F (24 to 30°C). The fish were fed for 9 months on a wet pelletized diet consisting primarily of mill run (wheat by-products) (Table 1) and reared to a size of 150-500 grammes.

Table 1

Composition of tilapia diet

Composition	Percent of diet
Mill run (wheat by-products)	47.0
Fish meal	11.7
Corn distillers solubles	4.6
Wheat germ	4.0
Tuna viscera	7.8
Choline chloride (70%)	0.2
Vitamin, mineral mix[a/]	1.0
Water	23.7

a/ Halver, 1972

Processing and preparation for smoking

The fish were headed, eviscerated, washed and minced by passing through a Yanigiya flesh separator[1/]. The yield of flesh was 45 percent. The proximate composition of the minced flesh was 79.1 percent moisture, 17.9 percent protein, 2.0 percent fat, and 1.1 percent ash. The minced flesh was partially solubilized with salt and sodium tripolyphosphate (NaTPP) by addition of 10 ml of a solution containing 10 g of salt, 2 g of NaTPP and 1.1 g of potassium sorbate per 100 ml per 100 g of fish. The flesh was then mixed in a Hobart food mixer[1/] or a Waring Blender[1/] for 2 minutes. Prior to smoking, the modified flesh was moulded into sheets by filling into a wooden mould (20 x 15 x 0.5 cm).

Smoking

The formed tilapia sheets were placed on a zinc-coated wire mesh (1 cm) screen and smoked at 30°C for 2 hours and then at 70°C, for an additional 3 hours. At that time the moisture content was about 40 percent. Smoking at 70°C, for 12 hours reduced the moisture content to about 25 percent.

Humidification of the products

The smoked fish were subdivided into pieces that could be passed through 0.3 cm mesh screening for determining the effect of storage at various relative humidities. Three to five grammes were placed in polystyrene Petri dishes (15 x 90 mm) and equilibrated in desiccator jars at 20°C. Saturated salt solutions were used to produce the various levels of constant relative humidity (Rockland, 1960) in the jars. The absorption isotherm was prepared by first equilibrating the samples for 12 days at 0 percent RH in a vacuum desiccator (LaPuza, 1966) and then re-equilibrating at various relative humidities.

The equilibrium moisture content was determined by analysis of samples held in a vacuum oven (737 mm Hg, 70°C) to constant weight (Rockland, 1960).

Available lysine

Available lysine was determined (Carpenter, 1960) in raw, smoked and heated tilapia to provide an estimate of the reduction of nutritional value of the protein during processing.

1/ Trade names referred to in this publication do not imply endorsement of commercial products.

RESULTS AND DISCUSSION

Product characteristics

Modifying the minced fish with the salt and NaTPP produced homogenous cohesive mass that could be formed easily into shapes of desired dimensions. Smoking to a moisture content of about 45 percent produced a pliable but hard pellicle that resisted crumbling when handled. This product had a chewy consistency resembling beef jerky. At 25 percent moisture, the product acquired a brittle characteristic resembling the smoked whole product currently consumed in Nigeria. Although decreasing the moisture content from 45 to 15 percent increased the fat content to about 4.0 percent and 8.0 percent respectively, only slight evidence of rancidity was detected in the product during storage.

Neither product was excessively salty to the taste. The product smoked to 45 percent moisture contained about 2.5 percent salt and that smoked to 25 percent moisture about 3.4 percent salt. Salt in the aqueous phase of the product with 45 percent and 25 percent moisture content was about 5.3 percent and 12.0 percent, respectively. This relatively low moisture content coupled with the high salt and sorbate contents in the water phase should make these products relatively stable against bacteriological attack. Although the resistance of these products to spoilage bacteria was not investigated, visual signs of microbial growth were not evident during storage up to 60 days when held at ambient temperatures of 20-25°C and at a relative humidity of 76 percent.

Effect of potassium sorbate on mould growth

Unpackaged products, which had not been treated with potassium sorbate and had been smoked to a moisture content of 45 percent, were extremely liable to attack by mould. Typically, uninoculated products showed visible evidence of mould growth after 4 to 5 days of storage at ambient temperature (23°C). However, products smoked to about 25 percent moisture content and kept in polyethylene (2 mil) bags and Scotchpack containers (laminated polythylene/polyester) had visible mould growth after 14 days of storage at ambient temperature

The effect of potassium sorbate in inhibiting mould growth in unpackaged products was demonstrated by holding the products in controlled humidities for 60 days. The results of these experiments are given in Table 2. Untreated products smoked to a moisture content of 45 percent showed mould growth after 5 days when held at an RH of 44 percent and in 4 days when held at RH 76. With sorbate no mould growth was observed for 60 days at an RH of 44 percent and for 52 days at RH 76 percent. With no added sorbate, products smoked to a moisture content of 25 percent showed no mould for 20 days when stored at 44 percent RH but when stored at an RH of 76 percent mould growth appeared after 5 days of storage. The same products containing sorbate showed no mould growth for at least 60 days when held at 44 percent and 76 percent RH. These results demonstrate the effectiveness of sorbate in the products, particularly in humid climates when RHs of 76 percent and over are frequently encountered.

Table 2

Effect of potassium sorbate on the growth of mould in smoked tilapia flesh modified with salt and sodium tripolyphosphate and stored at 23°C at relative humidities of 44 and 76 percent.

Treatment	Initial Moisture (%)	First observation of mould growth at:	
		RH 44% (Days)	RH 76% (Days)
No sorbate	45	5	4
With sorbate[a/]	45	>60	>60
No sorbate	245	20	5
With sorbate[b/]	24	⩾60	⩾60

a/ 0.25% sorbate in product after smoking

b/ 0.37% sorbate in product after smoking

The ability of the smoked product to absorb moisture and thereby to increase its susceptibility to microbiological spoilage in shown in Figure 1. The absorption isotherm shows that the product will equilibrate to a moisture content ranging from 20 to 25 percent. A surface equilibrium moisture in excess of 30 percent might quickly be established in areas of high RH but even at this relatively high moisture level, our data show that the product is stable to mould growth.

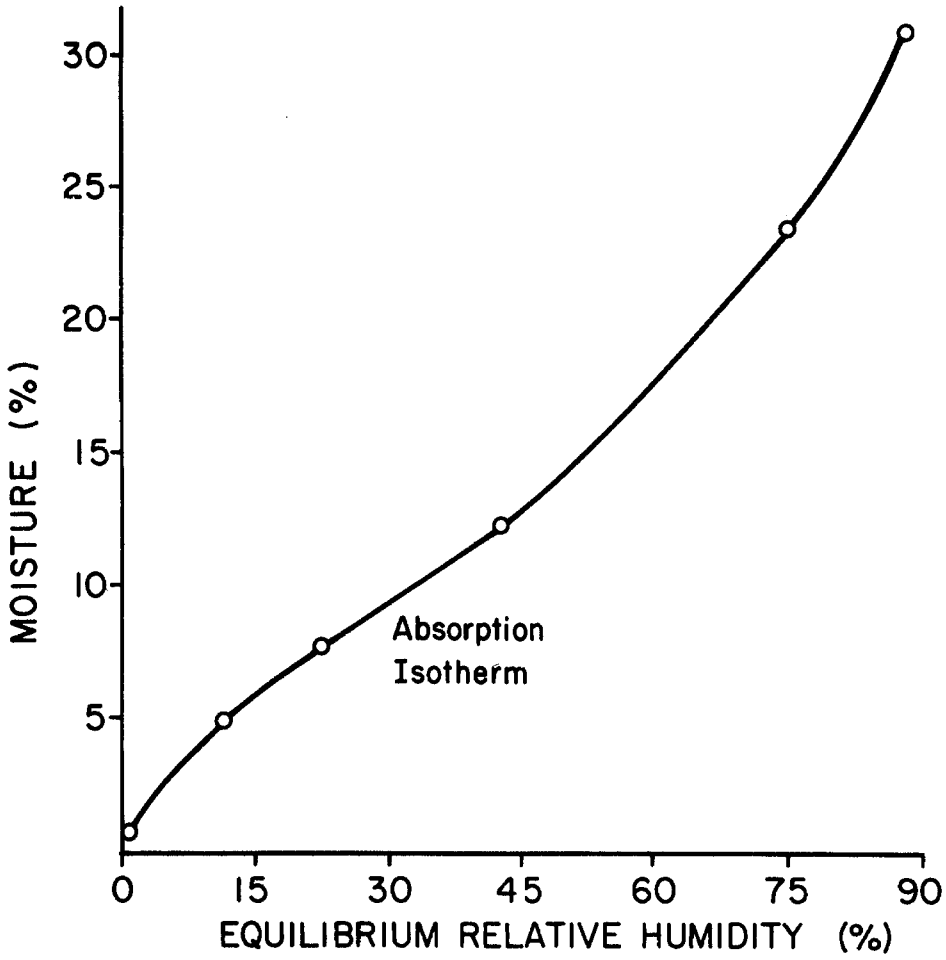

Figure 1 — Moisture absorption curve for smoked minced tilapia modified with salt and sodium tripolyphosphate.

Effect of smoking on available lysine

An assessment of the nutritional quality of the protein in the smoked product was made by determining available lysine before and after smoking. The data presented in Table 3 shows that smoking to moisture content of 52 percent reduced the available lysine by 17.7 percent and there was an additional slight reduction in avail-available lysine before and after smoking. The data presented in Table 3 shows that smoking to a moisture content minced tilapia was heated in an air oven at a temperature simulating that used in smoking, the available lysine was reduced by only 8.9 percent. When liquid smoke was added to the product before heating, lysine was again

reduced by 17.8 percent indicating that reactive substances in both the natural smoke and the liquid smoke react with the epsilon amino group of the lysine. Even with these losses, the amount of available lysine in the final smoked product is equivalent to that of many animal proteins and in excess of most cereal proteins; this indicates no significant reduction of the nutritional quality of the protein.

Table 3

Effect of heating and smoking on the available lysine content of tilapia flesh modified with salt and sodium tripolyphosphate

Treatment	Moisture (%)	Available lysine (g/16 g N)	Loss in available lysine resulting from treatment (%)
Raw	79	8.77	–
Smoked	52	7.22	17.7
Smoked	22.6	7.11	18.9
Heated a/	22.0	8.0	8.9
Heated b/	22.0	7.2	17.8

a/ Air oven 70°C for 16 hours

b/ With liquid smoke

CONCLUSIONS

Our work suggests that advantage can be taken of the technology of minced fish preparation and the preservation properties of smoking, salting, and sorbate addition to produce a smoked tilapia product with enhanced keeping qualities. Minced tilapia products with 2 percent added salt and smoked to moisture contents of approximately 25 and 45 percent were organoleptically acceptable for at least 60 days when stored at relative humidities as high as 76 percent. Control samples stored under similar conditions were considered spoiled due to mould growth after 4 days. The processing conditions used in our experiments showed that the maximum loss of available lysine was approximately 18 percent. Modification of the products with NaTPP and salt coupled with the simple preservation techniques of smoking and salting and the addition of sorbate also allows for adjusting the physical and the organoleptic properties of the products to suit regional taste and preferences. Packaging the product in simple film pouches such as polyethylene would offer some protection against slow changes in atmospheric humidity, but the primary function of packaging would be to protect against animal and insect infestation.

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