

# BACTERIOLOGICAL AND SENSORY PROPERTIES OF SMOKE-DRIED FISH STORED AT AMBIENT TEMPERATURE.

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## Abstract

The bacterial load and sensory characteristics of four species of fish (viz., *Alestes nurse*, *Labeo pseudocoubie*, *Synodontis omias* and *Tilapia zillii*) subjected to smoke-drying and stored at ambient temperature for four weeks were evaluated. The moisture content of fresh fish was reduced drastically to levels ranging from 9 to 17% due to the smoking process. Changes occurred in the moisture content of the product during storage but most significantly during the first week when the samples all attained contents below 10% except for *S. omias* which had a slightly higher value. Smoke-drying reduced the bacterial counts of all the samples in the order of approximately 2 log units, but counts increased appreciably during the storage period attaining almost a 2-fold increase during the first week of storage and remained high thereafter. Sensory scores for smoke-dried fish were generally good for colour, smell, dryness, and general appearance. All the sensory parameters remained acceptable during the entire storage period although the range of scores for smell and dryness were of a higher magnitude than for colour and general appearance. Based on these observations it is suggested that subjecting the fish to additional smoke drying once every week would significantly increase their keeping quality.

Key words: Temperature, fish, smoke-drying, keeping- quality.

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## INTRODUCTION

Fish is an important source of protein and is widely consumed by coastal and inland populations throughout the world. It is however, extremely perishable and requires proper handling and suitable processing and storage conditions to retard deterioration. The proportion of fish marketed fresh in Nigeria is negligible and ranges from about 5% in the Lake Chad District to 15% in the Niger - Benue River Systems (Osuji, 1997). Unsold fresh fish is often smoke-dried and stored at ambient temperature as freezing facilities are unavailable in many of the fishing communities. Apart

from the impartation of desirable flavour characteristics to food, hot smoking causes dehydration and produces chemical constituents which react with the food component to inhibit microbial growth (Ayes *et al.*, 1980). Microorganisms of public health importance have been associated with raw and processed sea food. Wu and Salunke (1978) showed that mould growth occurred frequently on dry shrimps and that a fairly high percentage of the moulds were capable of producing mycotoxins. Hyytia *et al.* (1999) reported a high genetic biodiversity among *Clostridium botulinum* type E strains isolated from fresh fish and fishery products. The technique of smoke-drying can be

utilized to greatly extend the shelf-life of fish and eliminate pathogens.

The quality of smoke-dried fish sold in markets in Nigeria vary widely since there are as yet no quality standards for the product. Presently, there is a lack of information in the literature about changes in the quality of smoke-dried fish during storage and such information is necessary for the development of standards and for quality control purposes. This study was therefore undertaken to investigate the bacteriological and sensory characteristics of smoke-dried fish stored at ambient temperature.

## MATERIALS AND METHODS

### Raw Materials

Four species of fish caught at Shiroro Lake, Niger State, using set gill nets and cast nets were selected for the study. These were *Alestes nurse*, *Labeo Pseudocoubie* *Synodontis omias* and *Tilapia zillii* and they had an average length of 25cm. The samples were transported in ice to the laboratory.

TABLE I

Moisture Content And Total Viable Counts (TVC) of Fresh Fish and Freshly Smoke-dried Fish

Fish Species	Sample type	Moisture %	TVC $\log_{10}$ cfu/g
<i>Alested nurse</i>	Fresh	70.1	5.6
	Freshly Smoked	17.3	3.9
<i>Labeo pseudocoubi</i>	Fresh	76.4	6.5
	Freshly Smoked	15.9	4.6
<i>Synodontis omias</i>	Fresh	80.0	6.5
	Freshly Smoked	14.3	4.0
<i>Tilapia zillii</i>	Fresh	78.2	5.8
	Freshly Smoked	9.05	4.0

### Smoke Drying

The fresh fish were gutted, washed and smoke-dried using a traditional smoking kiln for 6 to 8 hours. The smoked fish were stored at room temperature ( $28 \pm 2^\circ\text{C}$ ) for 0 - 4 weeks. The same species of smoke-dried fish were purchased from different markets in Minna, transported to the laboratory in sterile polythene bags and kept at  $4^\circ\text{C}$  until analysis.

### Moisture and Bacteriological Analysis

Moisture content was determined by AOAC standard methods (AOAC, 1980).

Twenty grammes of fish muscle were each homogenised with 180ml sterile distilled water for 3min. Tenfold serial dilutions were prepared and pour-plated in nutrient agar plates. The plates were incubated at  $27 \pm 1^\circ\text{C}$  for 5 days before the enumeration of colonies.

### Sensory Assessment

The colour, smell, dryness and general appearance of the fish samples were evaluated by 6 panelists who were randomly selected from the University community. The samples were assessed using a modification of the scoring system described by Huss (1988), where 5 = excellent, 4 = good, 3 = fair, 2 = poor and 1 = unacceptable.

### Data Analysis

A paired sample t-test was used to compare the mean TVC values of the fresh and freshly smoke-dried fish samples.

## RESULTS AND DISCUSSION

### Moisture Content and Total Viable Counts

The moisture content and bacterial counts of the fresh and smoke-dried fish are shown in Table 1. Among the fresh fish samples,

*Synodontis omias* and *Alestes nurse* had the highest and lowest moisture contents respectively. Smoke-drying reduced the moisture content of all the samples drastically. The values obtained for freshly smoked fish ranged from 9 to 17%. Maembe (1962) noted that smoke-dried fish having a moisture content exceeding 20% would spoil within 5 days.

The total viable counts for the fresh fish varied between 5.6 and 6.5 log<sub>10</sub> cfu/g. These counts were comparable with the bacterial count reported for fresh boque fish (*Boops boops*) (Koutsoumaris and Nychas, 1999). Smoking reduced the bacterial load of the samples appreciably and reductions in bacterial counts were in the order of approximately 2 log units test of significance using the paired-sample test showed that the observed reduction in bacterial counts after smoke-drying are highly significant. The calculated t-value of 10.97 greatly exceeds the tabulated value of t for 3 degrees of freedom and p = 0.002. The total viable counts obtained in this study for freshly smoked fish were similar to the counts reported for hot-smoked salmon (Ayres *et al.*, 1980). High bacterial counts could have significant public health implications in addition to the problems of poor quality and rapid deterioration. Botulism has specifically been associated with improperly processed smoke-dried fish (Hobbs, 1976).

Generally, moisture content of stored smoke-dried fish samples was lower than the content in freshly heat-processed fish (Fig. 1). It was further observed that the two species with moisture content exceeding 15% showed drastic loss of moisture during the first week of storage while those having lower moisture content remained at the same level during this period. A plausible explanation for this observation relates to the fact that the two species which lost moisture also showed dripping of water especially during the first two days following heat treatment. After 2 weeks of storage, the moisture contents of the samples had stabilised the bacterial load of fish but storage at ambient

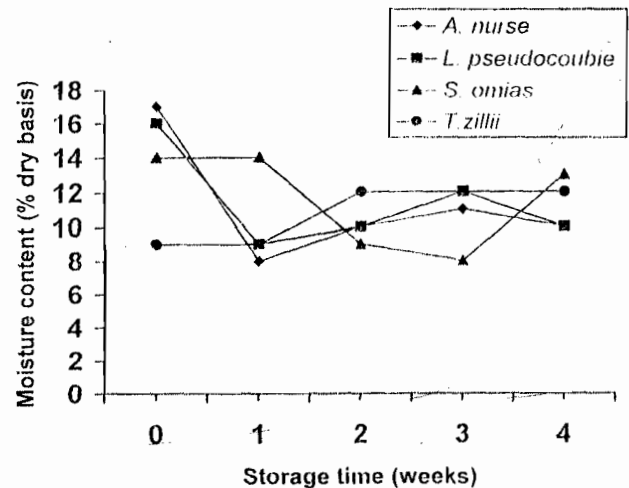


Fig. 1 Changes in moisture content of smoke-dried fish during storage at ambient temperature

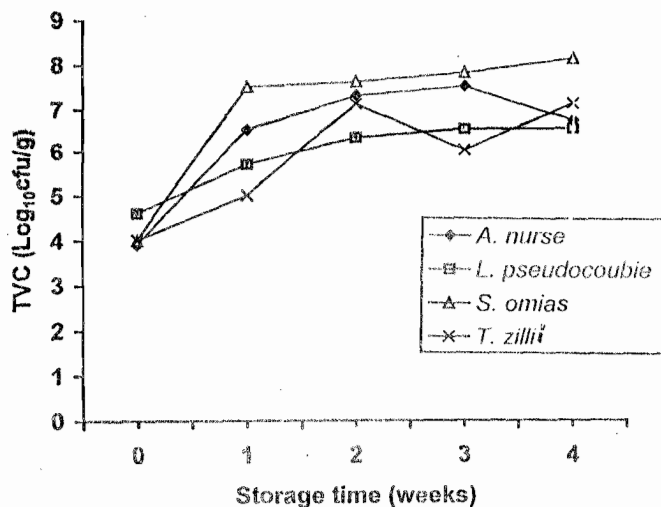
temperatures resulted in bacterial counts often exceeding the initial counts for fresh fish. Although the precise relationship between water activity and moisture content is not known, it has been observed that at the alarm water content of smoke-dried fish (the maximum water content at which no microbial growth occurs) water activity has a value of 0.70. To attain this level of safety, the water content of smoke dried fish should not exceed 13 percent (Sikoki *et al.*, 1997).

It was further observed from our results that after four weeks of storage, two species namely *S. omias* and *T. zillii* had already exceeded the alarm water content and both species had begun to show rapid increase in bacterial growth. In the two remaining species where moisture content was well below the alarm level, bacterial growth was either stable or slightly decreasing as in the case of *L. pseudocoubie*.

Under these conditions, it would be possible to increase the shelf life of these fish if they are subjected to additional smoke-drying for some one to three hours after every one week of

**Table 2** Average Scores for Sensory assessment of stored freshly smoke-dried fish and market samples

Fish Species	Storage Period weeks	Colour	Smell	Dryness	General Appearance
<i>Alestes nurse</i>	0	3.5	3.7	3.5	3.9
	1	3.8	3.2	3.6	3.2
	2	3.6	3.6	3.6	2.8
	3	3.8	3.2	3.5	2.9
	4	3.3	3.2	3.7	2.9
<i>Labeo pseudocoubi</i>	0	3.5	3.9	3.8	3.5
	1	3.7	3.5	3.6	3.2
	2	3.6	3.5	3.7	3.0
	3	3.6	2.8	4.0	3.2
	4	3.5	2.9	3.7	2.8
<i>Synodontis omias</i>	0	4.0	4.0	4.2	3.8
	1	3.7	3.6	4.2	3.9
	2	3.7	3.2	4.0	3.5
	3	3.7	3.2	3.7	3.3
	4	3.6	4.0	3.7	3.4
<i>Tilapia zillii</i>	0	3.8	4.0	4.0	3.8
	1	3.5	4.0	3.7	3.5
	2	3.6	3.0	3.3	2.7
	3	4.0	3.0	3.6	3.2
	4	3.7	3.2	4.1	3.3



**Fig. 2** Changes in total viable counts for smoke-dried fish during storage at ambient temperature

storage since this period coincides with the commencement of rapid bacterial growth and the resumption of increased moisture content.

In the case of bacterial counts; the smoke-dried fish samples generally showed an increase during storage (Fig. 2). For all the samples evaluated, bacterial counts increased sharply within the first week of storage and then increased gradually until the fourth week except for *T. zillii* which showed a slight decrease between the second and third weeks of storage.

#### Sensory Quality of Smoke-dried Fish

The Sensory Scores for freshly smoke-dried and stored fish samples are shown in Table 2. Variations in the scores for colour and dryness of samples during storage were minimal ranging from 3.3 to 4.0 and 3.3 to 4.2, respectively. On the other hand, the range of scores for smell and

general appearance of all the samples was higher than the corresponding values for colour and dryness; ranging from 2.8 to 4.0 and 2.7 to 3.9, respectively.

The results presented here indicate that the smoke-drying process significantly reduced at about 10% and storage beyond this period had minimal effect on moisture. The maximum moisture content for fish samples stored for four weeks was 13% and was obtained for *S. omias*.

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