Journal of Coastal Development
Volume 3, Number 3, June 2000 : 615-622

ISSN: 1410-5217
Accredited: 69/Dikti/Kep/2000

A COMPARISON OF PROXIMATE COMPOSITION AND MICROBIAL ASPECT OF BRINED AND UNBRINED MACKEREL (*Scomber scombrus)* SMOKED USING LIQUID AND OAK SAWDUST SMOKE

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ABSTRACT

Introduction : *Smoking of fish has changed its function nowadays from just the preservative task to flavoring and coloring. The method of smoking has also been developed from traditional, which had used a simple technology to the modern method. In recent years, preparation of liquid smoke manufactured from certain varieties of wood pyrolysates have been succesfully used as a substitute for the traditional smoking in a kiln.*

Material and methods : *The objective of this study was to compare the effect of cold smoking of mackerel fish on the proximate composition, water activity, salt content and microbial aspect of smoked fish treated using oak sawdust and liquid smoke either salted or un-salted. Sensory analysis was carried out by using score sheet organoleptic and hedonic test. Identification of pathogenic bacteria was done by API-20 E method. Factorial design was administered to compare the effect of traditional and liquid smoke method to brined and unbrined smoked fish.*

Result and Discussion : *The content of protein, lipid, water activity and salt of the two products were not significantly different ($p>0.05$). This means that the quality between two products were similar. Only moisture content of the products were very significantly different ($p<0.01$) caused by the phenomenon of osmosis between moisture of fish and brine. Study of liquid smoke treatment was found that liquid smoke was easier compared to oak sawdust smoke. It was also found that smoking reduces the number of colonies of bacteria. The number of colonies were about $1x10^3/g - 5x10^3/g$ after 2 day storage for unbrined smoked fish, while in brined smoked fish, no colonies were found after 3 day storage. Pseudomonas sp were present in both raw mackerel and the unbrined smoked fish sample, but were absent in the brined smoked fish.*

Keywords: smoke-kiln-sawdust-liquid smoke-mackerel fish

I. INTRODUCTION

Smoking of foods was originated in the beginning of civilisation as a method of food preservation. According to Baltes *et al* (1981) over 90.000 years old smoking chambers have been found in the northern of middle Europe. Burgess *et al* (1965) noted that treatment of fish product with smoke produces a certain amount of preservation in addition to flavouring, colouring and creating characteristic and pleasant aroma. Nowadays however, the purpose of smoking has changed particularly in developed country from the former preservative to the flavouring task.

In the recent years, preparations of liquid smoke manufactured from certain varieties of wood pyrolysates have been succesfully used as a substitute for

ISSN: 1410-5217
Accredited: 69/Dikti/Kep/2000

traditional smoking in a kiln (Teeny, 1982). Liquid smoke is easier to apply uniformity in flavour, colour and preservative action. Furthermore, liquid smoke minimises pollution and crude tar, and polycyclic aromatic hydrocarbon carcinogens have been removed. It may be applied in a variety of ways, such as injection, spraying or dipping. Liquid smoke can also cause an increase in protein biological value by generalised hydrolysis during storage. This increases the digestibility of essential amino acids. By using liquid smoke the problem of air pollution will be reduced and the product is more safe and healthy.

Addition of salt will reduces the water activity (Aw), removes some water and hence , microbial activity. The product will give a better yield and probably of better quality (i.e., have a longer shelf-life) than non-salted fish (Clucas and Ward, 1996). Salting can be applied by wet method (wet salting i.e. by placing the fish into saturated solution of salt/brine) or dry method (dry salting by direct addition of salt to the fish).

II. MATERIALS AND METHODS

2.1. Mackerel Fish

There were about 60 kg fish used in this experiment, divided to 5 parts. One part used for raw material analysis, two parts were smoked in the kiln treated brined and unbrined and two parts were smoked treated by liquid smoke (brined and unbrined).

2.2. Salt

The salt used in this work was manufactured table salt. According to Borgstorm (1961) there are three types of salts commonly used, i.e. solar, mined and manufactured. The solar salts normally carry large number of halopiles, but these are usually absent from both rock and manufactured salts.

2.3. Sawdust and Liquid smoke

Oak sawdust were used in this study. Aitken *et al* (1982) reported that oak is generally regarded as producing best flavour, although mahogany, pine and white wood have also been found to give satisfactory results. Liquid smoke has also been used, in order to obtain its effect to the fish. It offers an alternative to traditional method of smoking. The liquid smoke was supplied by ACP Ingredients, Agricultural and Chemical Products Ltd, Essex and commercially marked as TARISMOKE 10.

2.4. Processing method

The production of smoked mackerel fish involves apart from the smoking process itself and a preparatory operations (Figure : 1). The process are including : filleting and cleaning, salting or brining, drying and smoking and finally storing for further analysis. The brine used was ± 80% saturated.

2.5. Chemical Analysis

The crude protein content of raw fish and smoked fish were determined by the Kjeldahl method (EEC recommended method, 1969). Determination of total lipid was done by modified Bligh and Dyer method. Moisture content was done by using the EEC recommended method (1969). Water activity was measured by using Novasina Humetic Water Activitymeter type EEJA-3. The salt content was determined by titration

ISSN: 1410-5217
Accredited: 69/Dikti/Kep/2000

method using silver nitrate These chemical analysis procedure were cited fom Pomeranz and Meloan (1987).

2.6. Microbial Analysis

Identification was done by the API-20 E method as recommended by Austin (1991) and motility test was carried out to examine the motility grow of bacteria as recommended by Collins and Lyne (1984).

2.7. Sensory Analysis

Sensory test were done by 10 untrained panelist members but familiar with smoked fish and its quality attributes. The hedonic score sheet used was produced by Torry Research Station (1991).

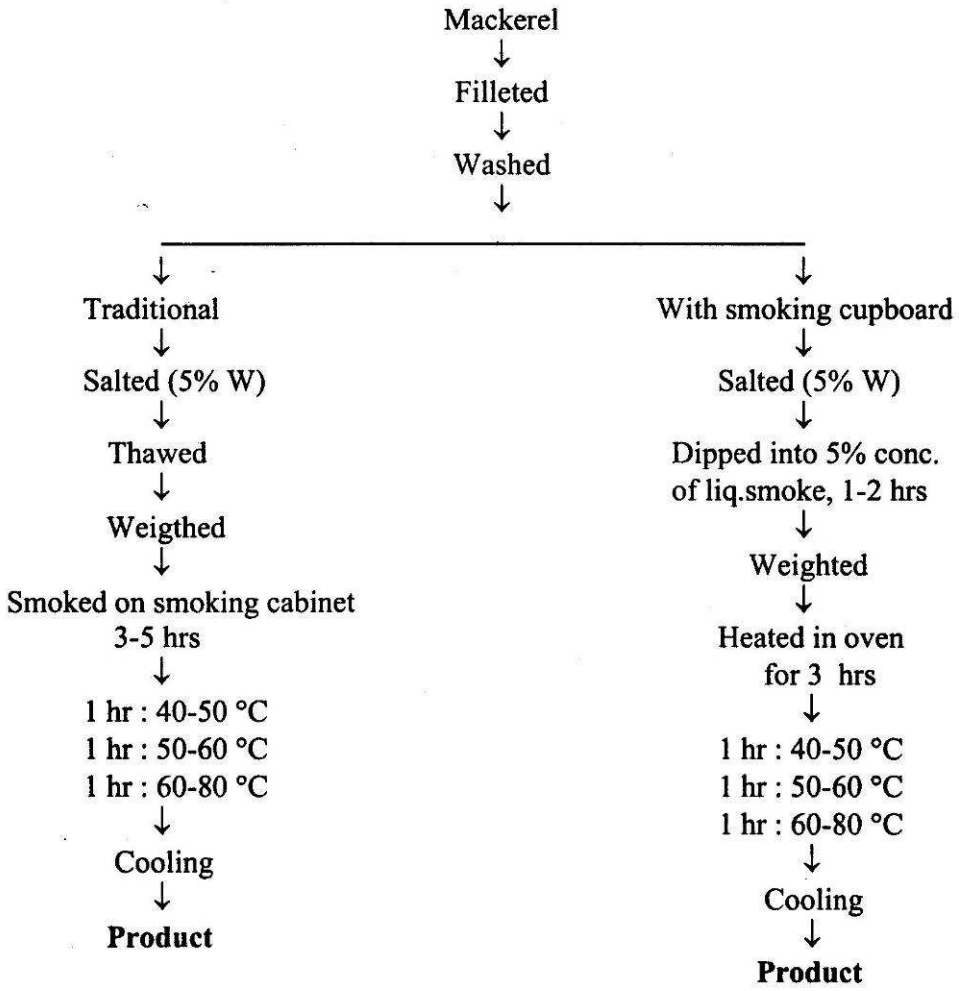

Figure : 1. Procedure of smoking fish.

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III. RESULT AND DISCUSSION

3.1. Smoke Characteristic

Approximately 1 kg sawdust was used every hour to give enough smoke production with low flame. This is done after several trial to provide a slight piquant flavour to the fish samples. The aim of using liquid smoke was to establish the smoked fish product which were similar to those produced by wood smoke. The liquid smoke was applied as recommended by the supplier i.e. 0.1-0.6 g TARISMOKE 10 per kg product or 0.1-0.3% added to brine.

3.2. Chemical Analysis

3.2.1. Raw Mackerel Fish

Table 1 shows the proximate analysis, water activity, and salt content of the raw material. The proximate composition of the raw material seems to be reasonable as reported by Borgstorm (1961) that mackerel has water content of 62.7-79.6 % and lipid content of 2.2-16.4 %.

Table 1. Proximate Composition, Water Activity, and Salt Content of Raw Mackerel Fish

Parameters	Composition (%)
1. Protein	18.88 (0.19)
2. Lipid	15.15 (0.57)
3. Moisture	63.00 (0.59)
4. Water Activity	0.99 (0.66)
5. Salt	0.60 (0.89)

All figures are means of triplicate. Figures in parenthesis are std. deviation.

3.2.2. Smoked mackerel using oak sawdust and liquid smoke

Table 2 shows the proximate composition, water activity and salt content of smoked fish using oak sawdust and liquid smoke.

Table 2. Proximate composition, water activity, and salt content of smoke fish treated by oak sawdust & liquid smoke

Parameters	Composition (%)				Probability (P)
Sample codes	TW	LW	TS	LS	
1. Protein	26.57 (± 0.31)	26.91 (± 0.41)	29.83 (± 0.07)	29.70 (± 0.26)	0.1988 (p>0.05)
2. Lipid	24.46 (± 0.36)	25.11 (± 0.35)	27.38 (± 0.28)	27.40 (± 0.20)	0.1151 (p>0.05)
3. Moisture	29.30 (± 0.33)	33.45 (± 0.36)	23.15 (± 0.32)	21.30 (± 0.37)	0.0008 (p<0.01)*
4. Aw	0.70 (± 0.02)	0.62 (± 0.04)	0.53 (± 0.02)	0.54 (± 0.01)	0.6276 (p>0.05)
5. Salt	1.50 (± 0.25)	1.52 (± 0.30)	2.86 (± 0.22)	3.14 (± 0.31)	0.4141 (p>0.05)

All figures are the means value of triplicate, figures in parenthsis are std. deviation.

All means at the same rows are not significantly different (p>0.05)

- Very significantly different (p<0.01)

ISSN: 1410-5217
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Note :
TW : Traditional Unbrined sample.
TS : Traditional Brined sample
LW : Liquid smoke Unbrined sample
LS : Liquid smoke Brined sample

Generally, there is no significant different of proximate composition between the product treated by oak sawdust smoke or liquid smoke ($p>0.05$). The protein and lipid content in this product both brined and unbrined sample treated by using liquid smoke were slightly higher than those of sample produced by oak sawdust smoke. Only the moisture content of the product were very significantly different ($p<0.01$), this is caused by the function of salt known as the phenomenon of osmosis. If a fish is placed in a brine, water will pass from the tissue into the brine until the strength of the two solution is equal (Clucas and Ward, 1996). Therefore, the moisture content of smoked brined fish were lower compared to the smoked unbrined fish.

In this work, the raw fish were dipped into liquid smoke to impart a smoke flavour and colour. It was difficult to exactly duplicate the colour of sawdust smoke to liquid smoke. This problem was also mentioned by Wheatson and Lawson (1985). Liquid smoke is rapid in achieving a uniform product and is much easier than sawdust smoke. Although it was difficult to duplicate in term of colour (liquid smoke tends to be darker), but generally liquid smoke is cheaper and quicker.

3.3. Sensory Analysis

3.3.1. Raw mackerel

Sensory assessment is the use of one or more of the five senses to judge, or form opinion on some aspect of quality (Burgess, 1965). The senses and question are including appearance, smell, taste, and touch. The raw fish sample was generally in grade A, as analised by panellists. The characteristics of its evaluation based on the EEC grades, the result is presented in table 3.

Table 3. A freshness grading scheme result, based on the EEC recommended

Attributes	Raw Fish		
Graded	I	II	III
Skin	A	B	A
Outer slime	A	A	A
Eyes	B	A	A
Internal odours	A	A	A
Gills	A	A	A

3.3.2. Smoked mackerel fish

Table 4 shows the means of result of the panellists scores.

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Table 4. Hedonic score result of smoked fish.

Sample codes	TW	TS	LW	LS
Appearance	4 (0.50)	4 (0.50)	4 (0.00)	4 (0.50)
Texture	4 (0.50)	4 (0.50)	3 (0.54)	4 (0.50)
Odour	4 (0.50)	4 (0.00)	4 (0.70)	4 (0.50)
Flavour	3 (0.00)	5 (0.57)	3 (0.57)	4 (0.00)
Preference	4 (0.50)	5 (0.57)	4 (0.50)	4 (0.50)
Total score	17.60 (23.50 %)	20.60 (27.50 %)	18.00 (24.00 %)	18.60 (25.00 %)
Ranking	IV	I	III	II

All figures are means of tends panellists scores. Figures in parenthesis are std. deviation.

Note :
TW : Unbrined fish smoked by using oak sawdust smoke
TS : Brined fish smoked by using oak sawdust smoke
LW : Unbrined fish smoked by using liquid smoke
LS : Brined fish smoked by using liquid smoke

Sensory test of the appearance, texture, odour, and flavour showed that there was no differences between the two products eventhough the hedonic score resulted the smoked fish using traditional method threated with salt was in the first rank, followed by liquid smoked fish added with salt, liquid smoked fish without salt and traditional smoked fish without salt in the second, third and fourth rank respectively.

3.4. Microbial Analysis

3.4.1. Enumeration

Bactericidal properties of the smoking process resulted from the combined effects of heating, drying, salting, and the chemical constitutions of the smoke (Wheatson and Lawson, 1985). Table 5 shows the number of colony of bacteria of raw fish and smoke fish after 2-3 days storages.

Table 5. Number of colony of bacteria in raw material and smoked fish samples after 2-3 days storage.

Sample	Storage	No. of colony / g		
		Diln. 10^{-1}	Diln. 10^{-2}	Diln. 10^{-3}
RM	1 day	Too numerous ammount	$7x10^3$	$1.7x10^4$
TW	2 days	$1x10^3$	$2.4x10^3$	0
TS	3days	0	0	0
LW	2 days	$1.5x10^3$	$9.5x10^3$	0
LS	3 days	0	0	0

All figures are the mean value of triplicate.

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As it can be seen in the table, in all of smoked mackerel sampels, no growth was detected after three days of storages. As mentioned by Clucas and Ward (1996), smoke produced from wood contains a large number of compounds, some of which, e.g. phenols, will kill bacteria. The present of salt has also inhibited the growth of some bacteria: halophilic (salt tolerant bacteria) may be killed by the combination effect of heat and smoke component. Many authors noted that they possibly grow after 5-6 days depending on the moisture contents and water activity.

3.4.2. Identification

This trial was done in order to identify a particular species of bacteria which is commonly found in the raw mackerel or smoked fish. No colony grew in brined smoked fish after storage for three days. This is suggested that the quality of the smoked fish were still good enough after three days storage and possibly due to the lower moisture content. There was only *Pseudomonas* species of bacteria identified in this study, but further study on this couldn't be carried out, as the time was very limited.

IV. CONCLUSION

Liquid smoke is considered as a substitute to traditional method, eventhough it was difficult to duplicate the colour of sawdust smoke as liquid smoke gives strong flavour and colour. But, in general there was no different proximate composition between liquid smoked and traditional smoked fish in this study.

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