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# Yield, humidity, acceptance and preference of tilapia submitted to smoking process

## ABSTRACT

On account of being considered a species of great importance for the global aquaculture the *Oreochromis niloticus* (Nile tilapia) was selected to execute this experiment. The aim was to evaluate yield, humidity, acceptance and preference for individuals of this species submitted to the hot and liquid smoking processes. The flattened fish yields were 38.46 and 54.44% for the hot and liquid smoking processes, respectively. The humidity verified during the treatment was 81.01% for individuals submitted to the liquid treatment and 69.30% for the hot-smoked ones. The sensorial analysis reveals that both treatments exhibited good acceptance, however the hot-smoked ones were preferred. Thus, the smoking process, whatever the form, traditional or liquid, is an alternative to aggregate value to the fish.

**Key words:** Adding value, fish, *Oreochromis niloticus*

## Rendimento, umidade, aceitabilidade e preferência da tilápia submetida à defumação

## RESUMO

Por ser considerada uma espécie de grande importância para a aquicultura mundial, a *Oreochromis niloticus* (tilápia do Nilo) foi escolhida para a realização deste experimento. O objetivo foi avaliar o rendimento, umidade, aceitação e preferência de exemplares desta espécie submetidos à defumação quente e líquida. O rendimento foi de 38,46 e 54,44% para o pescado espalmado defumado a quente e na forma líquida respectivamente. A umidade observada nos tratamentos foi de 81,01% para os exemplares submetidos ao tratamento líquido e 69,30% para os tratados a quente. A análise sensorial revelou que ambos os tratamentos apresentaram boa aceitação, entretanto aqueles processados a quente foram preferidos. Portanto, a defumação, seja na forma tradicional ou líquida, é uma alternativa de agregação de valor a este pescado.

**Palavras-chave:** Agregação de valor, pescado, *Oreochromis niloticus*

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## INTRODUCTION

The World Health Organization (WHO) recommends the consumption of 12 kg inhabitant<sup>-1</sup> year<sup>-1</sup> of fish as ideal (Gonçalves, 2006). In Brazil, the exploration and utilization of the fishery resources do not hit the expected nutritional and economic benefits; a confirmation of this assertion is the average consumption of only 6 kg inhabitant<sup>-1</sup> year<sup>-1</sup> of fish (Gonçalves & Prentice-Hernández, 1998; Viegas et al., 2000). An alternative to improve the nutritional levels of the population is to promote the consumption of cured products, with lower cost when compared to other preservation forms (Gonçalves & Prentice-Hernández, 1999).

The flesh of fish, nowadays, exhibits a great market potential, on account of supplying the necessities of consumers considering the nutritional aspect, due to the elevated percentage of proteins and unsaturated fatty acids, besides the sensorial aspect regarding the delightful and bland flavour (Ferreira et al., 2002). Moreover, it is the most deteriorative animal product, reducing the required period for its distribution and trade. Currently, new technologies related to a better use are sought, on account of being a highly perishable food when fresh, being susceptible to microbiological contamination and decrease of the shelf life (Jesus et al., 2002).

Due to its great importance to the global aquaculture, the species *Oreochromis niloticus*, known as tilapia, is often indicated for intensive cultivation. It stands out as one of the most important species, because of its elevated growth rate and adaptability over adverse conditions, beyond exhibiting a good acceptance regarding the consumers (Souza et al., 2004).

Thereby, the treatments are alternatives for increasing the food life cycle, such as mechanisms to stimulate the different forms of fish presentation, since the consumer seeks foods of easy and fast preparation.

Nowadays, the smoking process has been used as a device to improve the quality of fishes (Sigurgisladottir et al., 2000), and the form of presentation to the consumer may interfere with its acceptance (Miler & Sikorski, 1994). Liquid smokes eliminated most of the problems associated to the traditional method, besides providing uniformity for the flavour and colour, avoiding the inconvenient utilization of sawdust and the cleaning of smoked products. The pollution affairs related to the use of firewood smoke are also eliminated, whereas on the stages of aging and filtration, tar, resin and 3,4-benzopyrine are eliminated on the natural liquid smoke (Pszczola, 1995).

The aim of this research was to evaluate the yield, humidity, acceptance and preference of the *O. niloticus* (Nile tilapia) between hot and liquid smoking, besides their effects over the eviscerated, beheaded and flattened product, determining the differences between both processes, seeking the viability of improving such the validity of the products as their aggregated value.

## MATERIAL AND METHODS

The experiment was executed at the Laboratory of Food Rodolpho Krutman, located in the Department of Rural Technology (DTR), in the Federal Rural University of Pernambuco (UFRPE). 20 Nile tilapias of the Aquiculture Station Professor Johei Koike (UFRPE) were used, with average length of 25.5 cm and average weight of 400 g.

The fishes were washed with chlorinated water (5ppm), desquamated, eviscerated, beheaded and flattened. They were put into a brine at 3% during 10 min, in the sense of facilitating the removal of impurities and blood (Machado, 1994). Lately, they were immersed for 45 min into a spicy brine (Table 1) in the proportion of 2:1, in other words, two litres of brine to 1 kg of fish, being further removed and submitted to drying at a lab oven for 45 min, at 55 °C, in the sense of reducing the humidity. Among all the stages, there was always a weighing process.

When they left the lab oven, the fishes were separated into two lots, each one with 10 fishes: Lot A, for hot smoking, with 1.940 kg; and Lot B, for liquid smoking, with 1.820 kg.

### Smoking Process

To execute the hot smoking, an industrial smoker, mark "DEFUMAX", was used; and as smoke fountain, *Hymenaea courbaril stilbocarpa* (jatobá) sawdust was used. The fishes were suspended on metal hooks and smoked for 120 min with the temperature ranging between 60 and 90 °C, being 60 °C throughout the first hour and 90 °C throughout the second one.

In the liquid smoking, smoke settles of the mark "Duas Rodas" were used, being 33 g of product for each litre of water over a proportion of two litres of solution for each kilogram of fish, following the manufacturer recommendations. The fish were kept immersed into the solution for 45 min and, after that, they were placed into the lab oven (55 °C) for 120 min, in the sense of reducing humidity percentage.

After the smoking process, the individuals were refrigerated, packed singly on styrofoam trays and covered in PVC film, being preserved under refrigeration (5 °C) for 48 h to execute the sensorial analysis.

**Table 1.** Ingredients and respective volumes by litre of salty brine at 20% throughout the *O. niloticus* smoking process

**Tabela 1.** Ingredientes e respectivos volumes por litro da salmoura condimentada a 20% utilizada na defumação de *O. niloticus*

Spicy Brine	Volume L <sup>-1</sup>
Ingredients	
Salt	200 g
Acetic acid	2 mL
Brown sugar	100 g
Hot pepper	2 g
Onion	20 g
Coriander	5 g

### Sensorial Analysis

Subsamples of hot-smoked and liquid-smoked tilapias ( $\pm 5$  g) were used. They were submitted to heating for 30 s into a microwave oven (Costa et al., 2008) and packed with aluminium sheet (Souza et al., 2004) for further analysis by a team of 30 untrained judges, being the visual characteristics analyzed through acceptance test by affective methods performed in laboratory. In this test, a hedonic scale ranging from 1 till 9 was used, in which 1 represented "I extremely disliked it", 2 "I disliked it very much", 3 "I moderately disliked it", 4 "I slightly disliked it", 5 "I did not like it nor disliked", 6 "I slightly liked it", 7 "I moderately liked it", 8 "I liked it very much", and 9 "I extremely liked it" (Minim, 2006). The data were submitted to the variance analysis (ANOVA) and the means were compared by the T test ( $p < 0.05$ ).

The preference was tested by paired comparison between both of the treatments, in which the samples were vacuum packaged in order to not affect the judges' evaluation (Minim, 2006).

### Microbiological Analysis and Humidity

The microbiological tests were executed in the Laboratory of Water Analysis and Alimentary Products (LAAPA), Located in Recife, State of Pernambuco, according to the procedures of the Sanitary Surveillance National Agency Resolution RDC n° 12/Anvisa (Brazil, 2001). The humidity was determined by the system of infrared drying at a temperature of 130 °C via the equipment GEHAKA.

## RESULTS AND DISCUSSION

### Yield

The yield of the eviscerated fish was 81.37% and, for the flattened one, it was 59.69%. As of the flattened weight, the liquid-smoked fish exhibited yield of 54.44%, being more elevated than the yield of the ones submitted to the hot smoking process which exhibited 38.46% (Table 2).

The yields found by Gonçalves & Cesarini (2008), on the smoking process of *Rhamdia quelen* fillets at traditional and liquid forms, were, respectively, 18.3 e 20.32%, while Souza et al. (2004) having the tilapia smoked for 5 h (hot smoking), found 63.33% for the entire eviscerated form and 27.11% for fillets, being the last value closer to the ones related to this research, due to a similar form of presentation (flattened), where the head weight reduces the yield. Feiden et al. (2009) found values of final yields ranging from 40.23 to 69.45% with individuals of *Astyanax* sp, however the chemical composition that varies according to the species and even within the same specie (Ogawa & Maia, 1999), causes differences on the yields.

### Percentage of Humidity

The humidity of fresh tilapia was 81.12%, after the brine 75.44% and, at the end of the drying process, 74.63%. Concerning the hot smoking process, its final percentage

**Table 2.** Yields of the Nile tilapia individuals submitted to the treatments and hot and liquid smoking processes

**Tabela 2.** Rendimentos dos exemplares da tilápia do Nilo submetidas aos tratamentos e à defumação a quente e líquido

Specifications	Pre-smoking Treatments	Humidity Smoking	Liquid Smoking
Number of individuals	20	10	10
Average length (cm)	25.5	-	-
Total weight (kg)	8.050	-	-
Average weight (kg)	0.402	-	-
Eviscerated weight (kg)	6.550	-	-
Split in half weight (kg)	3.910	-	-
Initial total weight (kg)	-	1.940	1.820
Smoked weight (kg)	-	1.250	1.660
Yield (%)	-	38.46	54.44

was 69.30%, while the liquid process exhibited a value of 80.01% (Table 3).

According to Ogawa & Maia (1999), the muscle of the fish contains from 60 to 85% of humidity. The value that was observed for the fresh tilapia at this research fit this zone; nevertheless, it differed from the research of Souza et al. (2005), who found 70.84 and 77.91% of humidity for the forms entire and fresh fillet, respectively. On the liquid smoking process of the *Pomatomus saltatrix* (anchovy), performed by Gonçalves & Prentice-Hernández (1999), it was verified a value of 59.79% for the humidity, being too inferior when compared to this research (80.01%), probably on account of the low temperature of the lab oven during the drying process. Gonçalves & Cesarini (2008), found no significant differences for the values of humidity on the *R. quelen* hot and liquid smoking processes.

### Sensorial Analysis

There was significant difference concerning the preference between the treatments ( $p = 0.00121$ ), in which the hot smoking process was the favourite one when compared to the liquid one. All the changes that characterize a smoked product (colouration, aroma, brightness) were observed for the hot-

**Table 3.** Final humidity and sample fluctuations during all stages of hot and liquid smoking process

**Tabela 3.** Umidade final e variação das amostras durante todas as etapas de defumação líquida e quente

Stages	Humidity (%)
Fresh	81.12
After the salting process (20%)	75.44
After the drying process	74.63
Hot smoking process	69.30
Liquid smoking process	80.01

## CONCLUSIONS

smoked product, perhaps this fact results on its major acceptance and preference in relation to the liquid treatment that exhibited little changes for these characteristics comparing to the fresh fish. The results do not corroborate with Gonçalves & Cesarini (2008) and Emerenciano et al. (2007), who found a higher acceptance for the liquid smoking process of the *Crassostrea gigas* (oyster) and the *R. quelen* (catfish), respectively, when compared to the hot process.

There was no significant difference for the acceptance test ( $p = 0,06831$ ). The hot smoking process obtained a mean of  $7.5 \pm 1.25$ , remaining between "I liked it very much" and "I moderately liked it", while the liquid smoking process, with mean of  $6.6 \pm 1.76$ , remained between "I moderately liked it" and "I slightly liked it", being both of them accepted by the tasters. These researches listing smoked fish, both on the hot-smoked form as on the liquid-smoked one, corroborate with the results that were obtained (Souza et al., 2004, 2005; Emerenciano et al., 2007; Gonçalves & Cesarini, 2008; Feiden et al., 2009).

### Microbiological Analysis

According to the Anvisa resolution RDC n° 12 (Brazil, 2001), only by the test for thermotolerant coliforms, the analyzed individuals remained out of the microbiological standards (Table 4).

Sales et al. (1988) found an elevated presence of coliforms ( $1.1 \times 10^5$ ) for the hot smoking process of this same species. On their case, the process was too rudimental, increasing the diverse forms of contamination. Throughout the treatments executed on this experiment, meticulous practices of hygiene were observed, notwithstanding, we verified an elevated percentage of thermotolerant coliforms (44.5 °C) for both treatments, what makes us questioning about the quality of fish that was obtained, however an analysis of the fresh fish, in order to make it possible to affirm with more confidence the causes for the alterations of the values that were observed, was not carried out. The contamination by coliforms was also observed on the work about mixed salting process of *Mugil curema* (mulletts) (Santana et al., 2009).

**Table 4.** Values of the parameters that are allowed by the RDC n° 12 and the ones found during the analysis of the hot and liquid smoking processes for the *Salmonella*, *Staphylococcus aureus* and thermotolerant coliforms at 45 °C

**Tabela 4.** Valores dos parâmetros permitidos pela RDC N°12 e os encontrados na análise da defumação quente e líquida para *Salmonella*, *Staphylococcus aureus* e coliformes termotolerantes a 45 °C

Test	RDC n° 12	Hot Smoking	Liquid Smoking
<i>Salmonella</i>	Absence	Absence	Absence
<i>S. aureus</i>	$5.0 \times 10^2$	$1.0 \times 10^1$	$1.0 \times 10^1$
Colliforms (44.5 °C)	$10^2$	$5.0 \times 10^2$	$8.3 \times 10^2$

The liquid-smoked fish presented a better yield, however, the hot-smoked fish presented higher preference by the judges. Thus, the smoking process, whatever the form (hot or liquid), is an alternative for aggregating value to the fish.

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