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THE USE OF VACUUM IMPREGNATION TECHNOLOGY TO IMPROVE SMOKING PROCESS

Rodiah Nurbaya Sari[1*)], Diah L. Ayudiarti[1)], Gunawan[3)]

[1)]Center for Research and Development of Product Processing and Biotechnology of Marine and Fisheries
[2)]Indonesian Research Institute for Fisheries Post-harvest Mechanization

*e-mail: rodiah_ns@yahoo.com/rodiah_ns@kkp.go.id

ABSTRACT

One of the new technologies contributing to preserve of the original properties of food (as fruit or vegetables or fish) is vacuum impregnation. Vacuum impregnation is one method to preserve foods using vacuum and pressure to fill the porous with osmotic solution. The application of vacuum impregnation had been conducted on smoked processing using liquid smoke for catfish fillet (*Pangasius sp*) and tilapia fillet (*Oreochomis sp*). Vacuum impregnation tool was used having 5 kg capacity of fillet product, vacuum pressure at 0.71 kg/cm^2 and range of 0-6 kg/cm^2 impregnation pressure. The research had done using osmotic solution with liquid smoke 1.5% and 17.4 g of salt/liter of water and the tool was set at condition of 0.71 kg/cm^2 vacuum pressure and variations treatment such of vacuum process time (5 and 10 min), impregnation pressure (1 and 2 kg/cm^2), and impregnation process time (5, 15, and 25 min). Each treatment was done in two replications. Analysis of these fillets before smoking process such of water content, protein content, fat content, color measurement, and hardness (cutting force). After smoking process these fillets are also analyzed for phenols content. Results showed that based on several parameters of the treatment, smoked fillet of catfish needed 35 minutes with phenol content 0.34 mg/kg and tilapia 25 minutes with 16.40 mg/kg phenol content. Thus by using vacuum impregnation tool could be shortening the smoking process for both of fillet.

Keywords: fillet, liquid smoke, original properties, vacuum impregnation

INTRODUCTION

Smoking is the oldest known method used for preserving fish. At present, the effects of brining and smoking on colour and sensory perception are at least as important as the preservative effect. There are three different steps of the total smoking process; brining, heating, and smoking (Aminullah *et al*. 1986). Several studies have been reported on the effect of different smoking processes on fish quality (Cuppet *et al*. 1989; Espe *et al*. 2002; Jittinandana *et al*. 2002).

The modern smoking process is done by using liquid smoke. Liquid smoke has advantages such as easy to apply, smoke concentration can be adjusted according to consumer tastes, the product has a uniform appearance and environmentally friendly (Swastawati, 2011). Furthermore, the important thing is liquid smoke not only instrumental in shaping sensory characteristics but also in terms of food security (Guilén and Cabo 2004; Suñen *et al*. 2001; de Roos 2003; Darmadji 2006; Bortolomeazzi *et al*. 2007; Martinez *et al*. 2011).

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Smoked fish is a traditional food products (exotic indigenous food) are very well known by the people of Indonesia. Various processed products of smoked fish products in Indonesia has become typical of the region, among others, are fish sale (West Sumatra, North Sumatra, and South Kalimantan), pe and iwak grilled fish (Central Java and East Java), fish fufu (North Sulawesi and Gorontalo), wooden fish (Southeast Sulawesi and West Papua) and fish asr (Maluku). Attention to the location of products in the various provinces, then from the other side shows the huge market potential of smoked fish in the country. Even the fish processed had export markets, namely: wood fish (semi-dried skipjack stick) and smoke dried sea cucumbers (dried-smoked sea cucumber) (Sumaryanto *et al.* 2010).

Common problems being faced by the smoked traditional fish processors are they don't concern for the quality and food safety level also fish processing techniques are still done manually without regard to sanitation and hygiene so the quality is low (Anisah 2007). And generally in Indonesia the curing process is still done in traditional so the process requiresd a longer time.

Technology that can reduce food preservation (fruits, vegetables, and fish) process time (including the smoking) is a technology with a vacuum impregnation technique (VI) and osmotic dehydration (OD) involving hydrodynamic mechanism (HDM). Vacuum impregnation of a porous product consists of exchanging the internal gas or liquid occluded in open pores for an external liquid phase, due to the action of hydrodynamic mechanisms promoted by pressure changes (Fito 1994; Fito and Pastor 1994). The operation is carried out in two steps after the product immersion in the tank containing the liquid phase. In the first step, vacuum pressure (p_1~50-100 mbar) is imposed on the system for a short time (t_1) in the close tank, thus promoting the expansion and outflow of the product internal gas. The releasing of the gas take the product pore native liquid with it. In the second step the atmospheric pressure (p_2) is restored in the tank for a time (t_2), and compression leads to a great volume reduction of the remaining gas in the pores and so to the subsequent inflow of the external liquid in the porous structure. Compression can also reduce the pore size depending on the mechanical resistance of the solid matrix (Fito *et al.* 2001).

This research applying vacuum impregnation technology in smoking catfish and tilapia filet using a vacuum impregnation tool that designed by Research Center for Marine and Fisheries Product Processing and Biotechnology. And the research purposes was using vacuum impregnation technology could improve smoking process in the quality of smoked fish and the process can be more easily, hygienic, and effective also with a short time.

MATERIALS AND METHODS

1. Materials

Preparation. The fresh catfish (*Pangasius sp*) and tilapia (*Oreochomis sp*) were manually filleted without skin. The fillet weight of each sample average 160-200 g and 105-150 g. The fresh fillet were anlyzed of proximate, such as: salt content (SNI method 01-2354.2-2006), fat

content (SNI method 01-2354.2-2006), and protein content (IKU method A.5.4-01-04/Kjeldahl); and texture determination (cutting force).

Osmotic Solution. Osmotic solution consisting of salt 17.4 g/ liter (1.74%) and 1.5% liquid smoke (Bugueno *et al*. 2001).

The other material such as liquid smoke, salt, and chemicals to anlyze of proximate and phenol. The main tool that used in this reasearch was vacuum impregnation tool (Figure 1). The other for anlyze such as *Texture Analyser* (TA XT Plus) and *Spectrofotometer*.

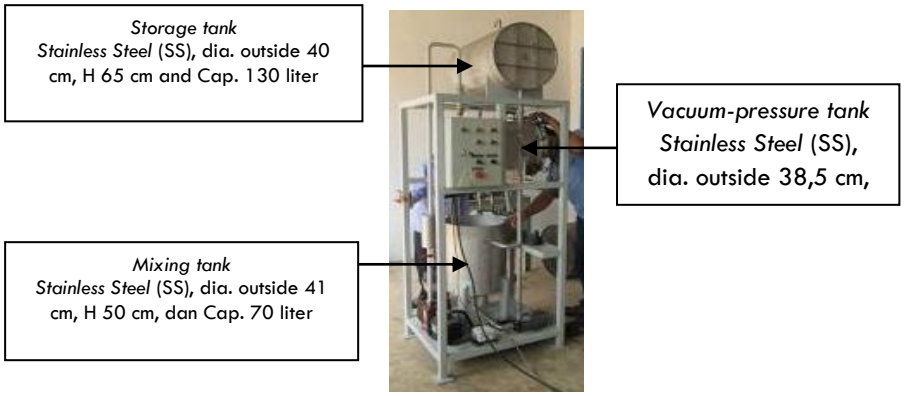


Figure 1. Vacuum impregnation tool (P800 mm X L650 mm X T2390 mm)

2. Methods

Vacuum impregnation tool was turned on first. Then preparing the osmotic solution in the mixing tank (mixing tank), mixing them until evenly, and transferred to a storage tank (storage tank). The fillet in vacuum-pressure tank and the vacuum process was begun. Vacuum pressure was set at 0.71 kg/cm^2. Then performed with the variation of pressure impregnation process, 1 and 2 kg/cm^2 (Bugueno *et al*. 2001). Vacuum impregnation process was carried out at room temperature.

The other treatment variation was during of vacuum process (5 and 10 minutes) (Bugueno *et al*. 2003; Bugueno *et al*. 2001) and during of impregnation proces (5, 15, and 25 minutes) (Bugueno *et al*. 2001). The replication of experiment was done twice repeats. The smoked fillets were also anlyzed proximate (same as fresh fillets) and phenol content (SMEWW 21th (2005): 5530-Phenols. B. D).

RESULTS AND DISCUSSION

Proximate analysis of smoked fillet (salt content, protein content, and fat content). Proximate analysis can be seen in Table 1 whereas the appearance of smoked fillets with vacuum impregnation tool is presented in Figure 2.

Table 1. Salt content, protein content, and fat content of smoked fillet

No.	Sample	Test parameters		
		Salt Content (%)	Protein Content (%)	Fat Content (%)
1.	**FP fresh**	**0,06**	**15,33**	**8,88**
2.	FPV5T1-5	1,55	15,82	3,26
3.	FPV5T1-15	1,49	15,87	0,15
4.	FPV5T1-25	0,58	15,46	3,26
5.	FPV10T1-5	0,42	16,65	1,17
6.	FPV10T1-15	0,85	16,24	1,01
7.	FPV10T1-25	0,77	15,89	1,14
8.	FPV5T2-5	0,84	16,65	0,54
9.	FPV5T2-15	1,59	16,03	1,00
10.	FPV5T2-25	0,55	15,94	1,20
11.	FPV10T2-5	0,69	17,00	1,39
12.	FPV10T2-15	1,04	15,38	0,85
13.	FPV10T2-25	0,76	16,04	1,01
14.	**FN fresh**	**0,04**	**17,94**	**0,55**
15.	FNV5T1-5	0,70	18,56	0,58
16.	FNV5T1-15	1,45	18,98	1,44
17.	FNV5T1-25	0,71	18,09	1,26
18.	FNV10T1-5	1,74	18,36	1,52
19.	FNV10T1-15	1,75	19,41	1,50
20.	FNV10T1-25	1,37	18,45	1,11
21.	FNV5T2-5	0,71	18,88	0,58
22.	FNV5T2-15	1,57	18,84	1,31
23.	FNV5T2-25	1,24	18,23	1,38
24.	FNV10T2-5	1,17	18,37	1,45
25.	FNV10T2-15	1,58	18,27	1,49
26.	FNV10T2-25	0,71	17,88	1,02

* Note: FP: catfish fillet, FPV5T1-5: fillet, vacuum process for 5 minutes, impregnation pressure 1 kg/cm^2 during 5 minutes, FN: tilapia fillet, FNV5T1-5: tilapia fillet, vacuum process for 5 minutes, impregnation pressure 1 kg/cm^2 during 5 minutes

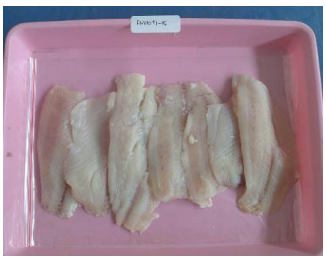
Salt content of these fillets were still below the maximum limit specified by SNI 2725.1: 2009 of 4% mass fraction (smoked fish) and SNI 2721.1-2009 is 20% mass fraction (dried salted fish). The using of salt in the smoking process because salt can attract water molecules around it (hydrated ions). The higher of salinity, the more water was withdrawn by the ion hydrate (Desrosier and Muljohardjo 1988).

FPV5T1-5

FPV5T1-15

FPV5T1-25

FPV10T1-5



FPV10T1-15

FPV10T1-25

FNV5T0-5

Figure 2. The appearance smoked fillets with vacuum impregnation tool

Hardness (Cutting force). Result of smoked fillet of cutting force can be seen in Table 2.

Almost all treatments had a higher cutting force values than the fresh filet conditions. Barat *et al*. (1999) conducted that the sample had progressive relaxation volume after compression-induced time pressure impregnation maintained. Changes in sample volume would show the effect of suction on the external solution in accordance with the pressure gradient and hydrodynamic flow paired with salt diffusional capture.

Table 2. *Cutting force of smoked fillet*

No.	Sample	*Cutting force* (gf/cm²)
1.	**FP fresh**	**3878,35**
2.	FPV5T1-5	9038,08
3.	FPV5T1-15	10164,51
4.	FPV5T1-25	3688,53
5.	FPV10T1-5	13632,60
6.	FPV10T1-15	13913,34
7.	FPV10T1-25	7291,75
8.	FPV5T2-5	1635,79
9.	FPV5T2-15	2476,34
10.	FPV5T2-25	6634,37
11.	FPV10T2-5	7997,62
12.	FPV10T2-15	6634,59
13.	FPV10T2-25	10556,55
14.	**FN fresh**	**2144,19**
15.	FNV5T1-5	2512,00
16.	FNV5T1-15	2852,63
17.	FNV5T1-25	3818,57
18.	FNV10T1-5	4696,49
19.	FNV10T1-15	3874,88
20.	FNV10T1-25	4223,23
21.	FNV5T2-5	2422,72
22.	FNV5T2-15	1843,60
23.	FNV5T2-25	3299,49
24.	FNV10T2-5	5052,59
25.	FNV10T2-15	3897,11
26.	FNV10T2-25	4266,32

* Note: FP: catfish fillet, FPV5T1-5: fillet, vacuum process for 5 minutes, impregnation pressure 1 kg/cm² during 5 minutes, FN: tilapia fillet, FNV5T1-5: tilapia fillet, vacuum process for 5 minutes, impregnation pressure 1 kg/cm² during 5 minutes

Phenol Content. Result of smoked fillet of phenol content could be seen at Table 4 below.

The resulting phenol content lower than resulted of Rama *et al*. (2013) which stated phenol for catfish filet smoke using liquid smoke with 7% concentration for 60 minutes was 10.63 mg/kg. This case was assumed due to the relative availability of water on fat content and the smoking process affected the solubility diffusion and preventing water interstitial and

fatty compounds from taking smoke component also influenced by the thickness of the filet (Clifford 1980).

Tabel 4. Phenol content of smoked fillet

No.	Sample	Phenol Content (mg/kg)
1.	FP fresh	-
2.	FPV5T1-5	0,01
3.	FPV5T1-15	0,01
4.	FPV5T1-25	0,01
5.	FPV10T1-5	0,23
6.	FPV10T1-15	0,01
7.	FPV10T1-25	0,01
8.	FPV5T2-5	0,04
9.	FPV5T2-15	0,27
10.	FPV5T2-25	0,23
11.	FPV10T2-5	0,14
12.	FPV10T2-15	0,34
13.	FPV10T2-25	0,28
14.	**FN segar**	-
15.	FNV5T1-5	17,30
16.	FNV5T1-15	11,97
17.	FNV5T1-25	15,11
18.	FNV10T1-5	7,76
19.	FNV10T1-15	16,40
20.	FNV10T1-25	17,35
21.	FNV5T2-5	16,91
22.	FNV5T2-15	15,55
23.	FNV5T2-25	10,53
24.	FNV10T2-5	11,60
25.	FNV10T2-15	17,11
26.	FNV10T2-25	14,73

* Note: FP: catfish fillet, FPV5T1-5: fillet, vacuum process for 5 minutes, impregnation pressure 1 kg/cm^2 during 5 minutes, FN: tilapia fillet

CONCLUSIONS

The best treatment that produced the best smoked fillet based on these analysis parameters for catfish was vacuum processed for 10 minutes and impregnated with 2 Kg/cm^2 pressure for 25 minutes while for tilapia was vacuum processed for 10 minutes and impregnated with 1 Kg/cm^2 pressure for 15 minutes.

The use of vacuum impregnation on the fillet smoking process with liquid smoke could accelerate the time, for catfish was 35 minutes (time total) with phenol content reached a maximum of 0.34 mg/kg and tilapia was 25 minutes with phenol content reached a maximum of 16.40 mg/kg.

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