

The effect of commercial liquid smoke immersion on tofu storage period

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ABSTRACT

The study aimed to analyze the effect of commercial liquid smoke immersion on tofu production for 3 hours with chemical characteristics indicated such as water content, ash content, total microbes, and organoleptic test. The method used in this study is Completely Randomized Design with four treatments for 0, 3, 5, and 7-days storage using 0.5% of commercial liquid smoke. The ANOVA statistics indicates that three hours tofu immersion in liquid smoke significantly impacts on water content and ash content for 0, 3, 5, and 7-days storage. There was a significant increase of total microbes during storage period. The best treatment based on organoleptic test covering flavor, color, and texture was the treatment with 0 day tofu storage period.

Keywords:

Liquid smoke, Tofu, Total microbes, Organoleptic test

1. Introduction

Tofu is a food product produced by sediment of extracted soybean seeds through coagulation. Tofu is a daily food which is popularly known and commonly favored by people for its high digestibility [1]. The diversity of tofu processed product can be found in tofu meatball and tofu fries, favorite for people's consumption. Those tofu products consumed contain nutrition with rich nutrients, especially protein. Tofu's chemical composition (based on Min et al. [2]) consists of water content (88%), protein (6%), fat (3.5%), carbohydrate (1.9%), and ash content (0.6%).

Home industries in many regions within Gorontalo Province produce tempeh or tofu. Because of highly contained water (88%), tofu becomes a perishable food product. If stored in room temperature, tofu is able to stay longer for one day, and then rots. To maintain tofu's quality for a longer storing, sly merchants misuse formalin to gain extra benefits, for instance a case in Palembang in 2019, in which the National Agency of Food and Drug Control found 1.8 tons of tofu with formalin. Formalin is a carcinogenic chemical-compound causing cancers and mutagens which may bring about changes in liver cell and tissue function. In seeing that condition, there should be an alternative for changing formalin as food preservative [3]. Liquid smoke can be applied to food with various ways, such as mixing, immersion, injection, pouring into boiling water, and spraying [4].

Liquid smoke has the ability to preserve food, functions as a bacterial growth inhibitor, and is secure for its use of natural preservation by considering acid, phenol, and carbonyl compound contained in it. According to Darmadji [5], smoke components which influence on product taste are phenol, carbonyl, and organic acid with minor role to its taste. Phenol type which has a role in forming a flavor and aroma is a phenol with a low boiling point. This study aims to find out and analyze



the effects of commercial liquid smoke immersion on tofu's storing period through a test involving water content, ash content, total microbes, aroma, color, and texture.

2. Materials and Methods

2.1 Raw Material Preparation

This study was conducted in the Integrated Agricultural Laboratory, Faculty of Agriculture, Universitas Ichsan Gorontalo from February through April 2020. The materials used were tofu obtained from market, commercial liquid smoke grade food was ordered at online shopping, water, NaCl compound (0.89%), and PCA media. The tools used in this research are such as digital scale, oven, desiccator, drop pipette, volume pipette, furnace, petri dish, and incubator.

2.2 Research Procedures

Commercial liquid smoke was diluted with a concentrate of 0.5% or 5 ml soaked in 1 liter = 1000 ml water for three hours. It was then stored for 0, 3, 5, and 7-days in the incubator at 25 °C.

2.3 Product Analysis

The tofu was analyzed for parameters moisture content, ash content [6], total microbes [7], and organoleptic test used sensory apparatus [8].

2.4 Experimental Design

This study used a Randomized Complete Design (RAL) with 4 tofu storage treatments. Data obtained from the analysis results using Analysis of Variance (ANOVA) and advanced test using Duncan ($\alpha = 5$ percent), so known influence of each treatment. The experiment implemented Completely Randomized Design (CRD) with four treatments: tofu was diluted for 3 hours and stored for 0, 3, 5, and 7-days with 3 times retreatments. The mathematic model of CRD illustrated by Mattjik et al. [9] can be seen as follows:

$$Y_{ij} = \mu + \alpha_i + \varepsilon_{ijk} \quad (1)$$

Y_{ij} = Observed value from the treatment "i" and repetition "j"

μ = Mean value

α_i = Effect of storing treatment in phase "i"

ε = Effect of experimental error of the treatment "i" and repetition "j"

3. Results and Discussion

The result of water content, ash content, and total microbes of tofu product immersed in the liquid smoke for 3 hours stored during 0, 3, 5, and 7-days can be observed in Table 1.

3.1 Water Content

Water content is a vital component in a food product. It plays an important role in food security because of its determining factor of physical and chemical features, and microbial change. The water content in a food determines its acceptability, freshness, and endurance [10]. Based on the result, the water content in tofu immersed in a liquid smoke of 0 day as a controlled treatment, and stored for 3, 5,

and 7-days is approximately between 71,20% - 77,67%. Its lowest water content value is found in the 0-day storage. Meanwhile, its highest water content value is indicated by 7-days storage. During its storage, water content in tofu becomes higher as its hygroscopic nature or water absorption exists in the air around its storage.

Table 1. Tofu storage period immersed with liquid smoke for 3 hours in water content, ash content, and total microbes

Storage Period (day(s))	Water Content (%)	Ash Content (%)	Total Microbes (colony.gram ⁻¹)
0	71.20 ^a	2.00 ^a	7.0 × 10 ⁵
3	74.66 ^b	1.17 ^b	5.2 × 10 ⁸
5	75.80 ^b	1.00 ^b	8.3 × 10 ⁸
7	77.66 ^b	0.75 ^b	9.1 × 10 ⁸

Note: Various superscript characters in columns of water content and ash content share a significantly similar value of Duncan test (5%)

The Anova test indicates that liquid smoke has a significant effect on tofu during storage. Duncan test shows that storage treatment of 0 day is different from those of 3, 5, and 7-days storage period. By contrast, it's no difference shown in the treatments of 3, 5, and 7-days storage period. It indicates that the increased of water content has the ability to absorb water in the air during its storage as well as the immersed of liquid smoke has the role of antibacterial in the product when absorbing water in the tofu which leads to the increased of water content. Winarno [10] said that water content during storage is influenced by the humidity and the immersion duration. If the product has lower water content than the humidity, there occurs a water gas absorption in the air so that the product becomes humid, or the water content increases. The tofu's water content is classified as a product with higher water content, 88% as stated by Min et al. [2].

3.2 Ash Content

Ash content is an organic matter resulted from an organic material's burning. The ash content of a food product indicates the mineral content of an organic material's burning of it [11]. The ANOVA test shows that the ash content in the liquid smoke immersed tofu obviously has an effect during its storage. Meanwhile, Duncan test indicates that the immersion period of 0 day clearly differs from those of immersion storage periods of 3, 5, and 7-days. The other result signifies that the storage periods of 3, 5, and 7-days share the same (no difference).

The approximate value of ash content with storage periods of 3, 5, and 7-days ranging from the lowest through the highest is 0.75%-2.00%. The lowest ash content value is shown by that of 7-days storage period, and the highest is by 0-day storage period. During storage period, the tofu's ash content shows a decreased value. It shares the same research report done by Manurung et al. [12] which indicates that the ash content value decreases as a result of liquid smoke. Its decreased value has a strong relation to the tofu's salinity. In addition, the length of the storage period has an effect on the ash content.

3.3 Total Microbe

Total microbe is a count of microbial content in a substance. The method applied to finding out the total load of microbe in a sample, generally known as Total Plate Count (TPC). It illustrates the food contamination degree by general indicators. TPC is also defined as the total of Colony Forming Unit (CFU) of bacteria concentrating on the total bacteria existing in a food product (for instance, tofu). Based on the study, the gained total microbes of 3-hours immersion is 7×10^5 colony.gram⁻¹. The obtained total microbes of the 3, 5, and 7-days storage is 5.2×10^8 , 8.3×10^8 , and 9.1×10^8 colony.gram⁻¹ respectively. It shows that the total microbes increase during the storage periods because of existing bacteria's activity unraveling the protein.

The liquid smoke containing various compounds classified into phenol, acid, and carbonyl. The compound classification functions as antimicrobials, antioxidants, and flavor and color determinant. The liquid smoke is potentially functioned as antimicrobial and antioxidant, so it has an important part in any preservatives [13]. The microbial contamination threshold of tofu is leveled at 5×10^4 colony.mL⁻¹ based on the Indonesian National Standard, Number 7388 of 2009. If observed based on the microbial contamination of *S. aureus* and *E. coli*, the tofu is still fit for consumption under a condition that the tofu has not exceeded the microbial contamination threshold. It is because of the existing proteolysis microbe exploiting protein as nutrition source.

Ernawati [14] states that microorganism makes use of protein to help with the metabolism process. It agrees with Soeparno's [15] perspective who says that microorganism may lead to decay through proteolysis and texture reduction. The higher the slope value, the lower the ability of encapsulation product of liquid smoke in restraining the bacterial growth, and vice versa.

3.4 Aroma

Aroma is a smelling by nose as a reaction to the evaporation of solute in the air contained in the food, and it is assumed to be a specific smell. The aroma test in the food industry is very important since it provides a direct evaluation result to the consumers. It helps the panelist fondness towards the aroma. The test result indicates that the most favorite amongst the panelists is that the tofu preserved with 0.5% concentrate. The tofu produced has the smoke aroma. The smoke aroma of tofu is resulted from the liquid smoke permeated in the tofu layers. The phenol, carbonyl, and organic acid have influences on the aroma and taste. Darmadji [5] describes about it by indicating the components (phenol, carbonyl, and organic acids) with minor roles determining the taste of the smoked food product. A bad aroma can also be an indicator that a food product has led to a damaged state. It is caused by the production and storage processes unwell managed. The observation result based on the aroma attribute indicates that most of the panelists show a contentment response towards the 3-days immersed tofu. They do not give a good response to those with 3-days, 5-days, and 7-days storage periods. During the storage, the organoleptic value of the tofu aroma has decreased as the effect of the lengthier storage which leads to an increasingly microbial total.

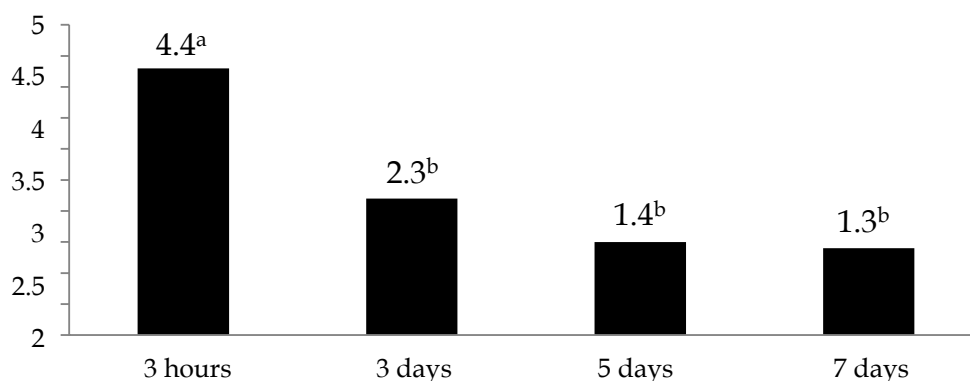


Figure 1. Average response of panelist on tofu aroma during storage period

3.5 Color

Color can be defined as an attribute to quality at a glance seen by consumers before the other attributes of product quality. A color may bring a guidance to know the chemical changes in a food product. It can be used as an important determinant of any taken food. The observation indicates that the immersed with liquid smoke at 0.5% concentrate has a clearly white color of tofu. Based on the questionnaire filled, 25 panelists crave that tofu with a clearly white color (not pale). It also indicates that there are 25 panelists confirm their liking towards clear and white tofu with 3-hours immersion of 0-day storage period. There are 5 panelists who like the yellowish-white tofu with 3-days storage period. There are 20 panelists interested with the brownish-yellow tofu of 5-days storage period. There are 10 panelists who concern with the brownish tofu of 7-days storage period. The 0-day storage period of liquid smoke immersion at 0.5% concentrate for 3 hours has not an effect on the color change of tofu because it has a liquid smoke concentrate level below 1.0%. Hardianto et al. [16] reported that the liquid smoke with 1% concentrate level does not influence on the color change. It means that the immersion periods of 1, 2, and 3 hours do not make any difference of tuna color (of his study). Based on the organoleptic test, it is indicated that the liquid smoke applied to tofu has no response towards the color of tofu. Under Indonesian National Standard 01- 3142-1998 and Indonesian Industry Standard Number 0270-1990, it is stated that the color criterion of quality tofu as conditioned is normal white or normal yellow. The picture of tofu 3, 5, and 7-days storage can be showed in figure 2.



Figure 2. Tofu color on 3, 5, and 7-days storage period

3.6 Texture

A texture test is conducted by using a spoon or hands touching. This kind of test has the purpose of sensing the texture of a food product. Based on the organoleptic

test, the use of various methods has a clearly significant influence on the tofu produced. The panelists have a tendency to be fond of that tofu with immersion method if compared with those of mixture method (which causes a soggy texture of tofu). The longer the storage in a room temperature, the more decreased the organoleptic test value of tofu texture. Its decreased value is affected by the water activity of the food product. It is suitable with Santoso's [17] report which said that the texture digression is also influenced by the microorganism activity degrading the protein. The protein becomes a simpler substance and leads a low ability of absorbing and holding water. Ginting et al. [18] reported that the water holding capacity of the protein brings about a soggy texture.

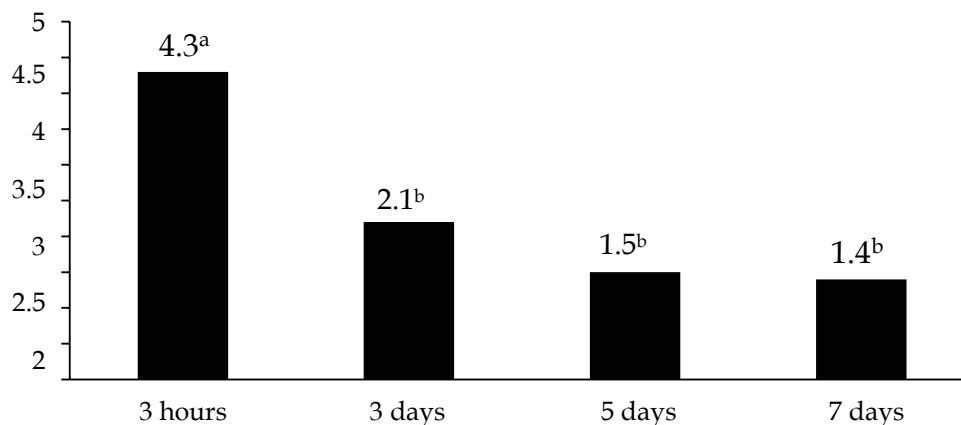


Figure 3. Average response of panelist on tofu texture during storage period

4. Conclusion

The commercial liquid smoke immersion in tofu product during 3-hours has a clearly significant effect on the 0, 3, 5, and 7-days storage periods measured by its water content (71.20–77.67%) and ash content (0.75–2.00%) parameters. During the 0, 3, 5, and 7-days storage, there is an increase of total microbes at about 7.0×10^5 through 9.1×10^8 colony.gram⁻¹. The best treatment of the liquid smoke immersed tofu is that of during 3 hours of 0-day storage period which is more favorable for the panelists based on three tests covering aroma, color, and texture.

References

1. Purwaningsih E. Cara pembuatan tahu dan manfaat kedelai. Jakarta: Ganeca Exact; 2007. 84 p.
2. Min S, Yu Y, Martin SS. 2005. Effect of soybean varieties and growing locations on the physical and chemical properties of soymilk and tofu. J. Food Sci. 2006;70(1):C8-C21.
3. Mustafa RM. Studi efektivitas bahan pengawet alami dalam pengawetan tahu [Undergraduate thesis]. Bogor: IPB; 2006.
4. Budijanto S, Hasbullah R, Prabawati S, Setyadjit, Sukarno, Zuraida I. Identifikasi dan uji keamanan asap cair tempurung kelapa untuk produk pangan. J. Pascapanen. 2008;5(1):32–40.

5. Darmadji P. Teknologi asap cair bermanfaat untuk pengolahan pangan pertanian [Pidato pengukuhan guru besar]. Yogyakarta: Universitas Gadjah Mada; 2009.
6. AOAC. Official Methods of Analysis of Association of Official Analytical Chemist. Virginia: AOAC International; 1995.
7. BPOM RI. Uji Escherichia coli dalam obat tradisional. Metode analisis PPOMN, MA PPOMN nomor 97/mik/00. Jakarta: BPOM; 2006. p. 112–4.
8. Standar Nasional Indonesia. Tahu. SNI 01- 3142-1998. Jakarta: Badan Standarisasi Nasional; 1998. 4 p.
9. Mattjik AA, Sumertajaya, IM. Perancangan percobaan dengan aplikasi SAS dan Minitab. Bogor: IPB Press; 2013. 350 p.
10. Winarno FG. Kimia pangan dan gizi. Bogor: M-Brio Press; 2008. 286 p.
11. Apriyantono A, Fardiaz D, Puspitasari NL, Yasni S, Budijanto S. Petunjuk laboratorium analisis pangan. Bogor: Pusat Antar Universitas Pangan dan Gizi, IPB; 1989.
12. Manurung HJ, Swastawati F, Wijayanti I. Pengaruh penambahan asap cair terhadap tingkat oksidasi ikan kembung (*Rastelliger sp*) asin dengan metode pengeringan yang berbeda. J. Peng. & Biotek. Hasil Pi. 2017;6(1):30-7.
13. Yuwanti S. Asap cair sebagai pengawetan alami pada bandeng presto. Jurnal Agritech. 2005;25(1):36-40.
14. Ernawati. Efek antioksidan asap cair terhadap sifat fisiko kimia ikan gabus (*Ophiocephalus striatus*) asap selama penyimpanan. Jurnal Teknologi Pangan. 2012;4(1):121–38.
15. Soeparno. Ilmu dan teknologi daging. 6th ed. Yogyakarta: Gadjah Mada University Press; 2015.
16. Hardianto L, Yunianta. Pengaruh asap cair terhadap sifat kimia dan organoleptik ikan tongkol (*Euthynnus affinis*). Jurnal Pangan dan Agroindustri. 2015;3(4):1356–66.
17. Santoso. Teknologi pengolahan kedelai (teori dan praktek). Malang: Laboratorium Kimia Pangan Fakultas Pertanian Universitas Widyagama; 2005. 37 p.
18. Ginting C, Ginting S, Suhaidi I. Pengaruh jumlah bubuk kunyit terhadap mutu tahu segar selama penyimpanan pada suhu ruang. J. Rekayasa Pangan dan Pert. 2014;2(4):52–60.