

Quality characteristic of liquid smoked straw mushroom (*Volvariella volvacea*) ball during storage

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Abstract. Straw mushroom (*Volvariella volvacea*) ball was soaked for 15, 30, and 45 minutes with the concentration level 1%, 2%, and 3% (v/v) of the coconut shell liquid smoke. The chemical characteristics (water contains, total phenol, carbonil contains, total-N, TVB-N, and pH), microbiological characteristics (Total Plate Count), and sensory characteristics (color, flavor, taste, texture, and overalls) of the liquid smoked straw mushroom ball during 14 days storage at freezing temperature were investigated. The result showed that the water content and TVB-N were decreased after soaked and were increased after stored. On the other hand, the result of total phenol, carbonyl content, and Total-N were increased after soaked and were decreased after storage. The level of pH and Total Plate Count of the straw mushroom ball were decreased during storage. Due to the sensory characteristics of the straw mushroom ball, the panelists provide high values for the straw mushroom ball which was soaked in 3% concentration level with 30 minutes soaked time. The best-soaked treatment was by soaked at 30 minutes with 3% concentration level liquid smoke. The straw mushroom ball has $70.95 \pm 0.10\%$ water contains; $0.32 \pm 0.02\%$ total phenol; $1.08 \pm 0.22\%$ carbonyl contains; and $2.29 \pm 0.07\%$ total-N.

Keywords: quality characteristic, smoked straw mushroom ball

1. Introduction

Mushroom contained high protein, low fat, and around nine types of 20 essential amino acids. Mushroom also contained various types of vitamins, minerals, pure fiber, and very low calorie [1]. Straw mushroom is one of many popular consumption mushrooms in the world but has minimally processed food. The other food ingredient that could be used as materials mix in a meatball dough with not reduced the quality criteria of beef meatballs is a straw mushroom (*Volvariella volvaceae*). Straw Mushroom (*Volvariella volvaceae*) is one type of mushroom that has high fiber content and has good flavor and texture [2]. Straw mushroom (*Volvariella volvacea*) balls could be pleased for vegetarian and diet consumers.

The straw mushroom ball is perishable food which has a high water content and is easily damaged by oxidation or contaminated by microbiology. One of preservation method of the straw mushroom ball is using coconut shell liquid smoke as natural preservation. Liquid smoke is the product of the distillation or condensation of steam from the indirect or direct combustion of materials that contained lots of carbon and other compounds. Coconut shell liquid smoke has more than 400 components such as phenol and acid compounds that act as antibacterial and antioxidants [3]. Therefore, the utilization of liquid smoke in food product also could improve the sensory and physical characteristic, such as



taste, aroma, and textural properties. In this study, the soaked time and concentration level of coconut shell liquid smoke for the straw mushroom ball were investigated to investigate the effect preservative of coconut shell liquid smoke.

2. Materials and Methods

2.1. Materials

Straw mushroom (*Volvariella volvacea*) as obtained from gedong jati, Tulung, Klaten, Central Java (Indonesia). Tapioca "Rose Brand", pepper "Ladaku", egg, salt "Segitiga", garlic, and sodium triphosphate from Gede market (Surakarta, Indonesia). Coconut shell Liquid smoke from the Laboratory Processing Engineering of Agricultural Products, Faculty of Agricultural Technology, Gadjah Mada University.

2.2. Preparation of Coconut Shell Liquid Smoke Solution

Liquid smoke that would be used as a preservative diluted by using distilled water to be 1% v/v, 2% v/v, and 3% v/v concentration level.

2.3. Straw Mushroom Ball Production

The Straw mushroom ball production procedure was described by Ruri with simple modification [4]. The straw mushroom was sorted, washed, mashed with a blender, and drained with pressure. Then, 160 g of mashed mushrooms added with other ingredients (tapioca flour 40 g, 5 g salt, 0.6 g pepper, garlic, 4 g, STPP 1 g, White egg 30 g) and mixed. Then, the straw mushroom ball dough was formed like a ball with ± 2 cm diameter. Then, boiled in heat water for 10 minutes, and soaked in ice water for 10 minutes.

2.4. Liquid Smoked Straw Mushroom Ball Production

Straw mushroom balls were soaked with coconut shell liquid smoke with concentration level (1%, 2%, and 3%) with soak time (15 minutes, 30 minutes, and 45 minutes). Then, straw mushroom balls packed with vacuum plastic with size 14x19.5 cm, stored at freezing temperature (-19°C) for 14 days. All these experiments were performed in triplicate, and the water content, total phenol, carbonyl content, Total-N, TVB-N, pH, total plate count, and sensory characteristics (color, flavor, texture, overalls) of straw mushroom balls were determined after the storage time was 0, 7 and 14 days.

3. Results and Discussion

3.1. Chemical and Physical Properties of Straw Mushroom Balls

Liquid smoke contains more than 400 components and has a function as an inhibitor to the bacterial development and is quite safe as a natural preservative such as acids, phenolics, and carbonyls [5]. Liquid smoke that used in this experiment is liquid smoke from coconut shell with chemical characteristics such as total phenol 11.81%; carbonyl contains 18.31%; TVB-N 2.7676 mg/100g; and pH level 3.

Chemical properties of straw mushroom balls are shown in **Table 1**. **Table 1** showed the lowest levels of water contain was achieved by straw mushroom balls which were soaked in concentration level 3% liquid smoke and soaked 45 minutes which $70.84\pm 0.08\%$. SNI 01-3818-1995 reported that the water content level of meatball has maximal 70%. After soaked, the straw mushroom ball was decreased of water content. The decreased water content of the straw mushroom ball due to osmosis process. According to Purnamasari, phenol has a hypertonic characteristic; hypertonic is a high concentrated solution [6]. The hypertonic characteristic of phenol in liquid smoke caused osmosis activity on straw mushroom balls during soaking treatment. After storage, the water content of straw mushroom balls was increased. The increasing of the water content of the mushroom balls during storage might be caused by a microbial activity which can degrade protein and produce water. Microorganisms also generally produce water from respiration activity, and it can cause the increasing of the water content. According to Widyastuti, increasing the water content of the meatball also caused by syneresis process which can separate the water from the structure of starch gel and it occurred during storage at low temperature storage (cooling or freezing) [7].

Table 1 Chemical properties of straw mushroom balls

Soaked sample treatment	Water contains (%) [*]	Total phenol (%) [*]	Carbonyl contains (%) [*]	Total-N (%) [*]	TVB-N (mg N/100g) [*]
Untreated straw mushroom ball	72.91±0.88	0.03±0.01	0.57±0.13	2.18±0.05	4.079±3.32
1% 15 minutes	71.89±0.12	0.13±0.10	0.70±0.09	2.23±0.09	2.603±2.04
30 minutes	71.45±0.10	0.17±0.07	0.82±0.14	2.23±0.09	2.453±1.85
45 minutes	71.34±0.09	0.22±0.03	0.92±0.15	2.23±0.10	2.199±1.50
2% 15 minutes	71.55±0.10	0.26±0.04	0.83±0.18	2.25±0.09	1.862±1.03
30 minutes	71.25±0.09	0.27±0.04	0.99±0.22	2.27±0.08	1.680±0.78
45 minutes	71.14±0.08	0.28±0.03	1.01±0.21	2.28±0.07	1.146±0.03
3% 15 minutes	71.04±0.09	0.30±0.02	0.93±0.08	2.28±0.07	1.141±0.03
30 minutes	70.95±0.10	0.32±0.02	1.08±0.22	2.29±0.07	1.127±0.04
45 minutes	70.84±0.08	0.33±0.01	1.23±0.29	2.31±0.05	1.114±0.04

The highest total phenol was achieved by of the straw mushroom ball which was soaked in 3% concentration of liquid smoke and 45 minutes. The corresponding value was 0.33±0.01%. The presence of total phenolic compounds in untreated straw mushroom ball sample might be caused by the straw mushroom ball was contained antioxidant components from garlic and pepper as ingredients. During the storage, the decreasing of total phenol content of the straw mushroom ball was occurred. The decreasing of the total phenol caused by the increasing the water contain the mushroom ball. The phenol compound could be decomposed by hydrogen of water. In another hand, microorganism has the ability to degraded phenol compound. The degraded of phenol component by microbial was influenced by several factors such as microbial type, phenol concentration and environmental conditions [8].

The carbonyl content of the untreated straw mushroom ball was 0.57±0.13%. Carbonyl content on straw mushroom balls was from the organic compound, i.e., carbonyl groups and amino acid [9], aldehydes and ketones which contain in tapioca starch. During the storage, carbonyl content in the straw mushroom ball was decreased. The decreasing of the carbonyl content is due to the occurrence of protein denaturation that resulted in the breakdown of the bonds on carbonyl groups in amino acids and syneresis process. The highest carbonyl component was achieved by the straw mushroom ball which was soaked in 3% concentration of liquid smoke and 45 min soaking time.

Table 1 shows that the total-N of the straw mushroom ball was increased caused soaked in liquid smoke. According to Buckle, proteins are divided into two parts based on their solubility, was water-soluble proteins and insoluble water [10]. The partial discharge of water results in a total water soluble solid protein being left from the straw mushroom ball. The discharge of some water also reduced the mass of the material. Thus, the protein component in the straw mushroom ball was increased and also affects to the total-N of the straw mushroom ball. Total-N value of the straw mushroom balls was decreased during storage. The decomposition of the protein caused by microbial metabolism that was consumed the nitrogen in amino acid and resulted in the decreasing of the total-N in mushroom balls. The highest total-N was achieved by the straw mushroom ball which was soaked in 3% concentration of liquid smoke and 45 min soaking time.

According to Esminingsih, the TVB-N value is an index of damage or degradation due to protein [11]. The untreated straw mushroom ball has 4.079±3.32 (mg N/100g) and has the highest value of TVB-N. During storage, the TVB-N value was increased. The degradation process of protein will produce simple nitrogen compounds. The free amino acids and nitrogenous bases are evaporated being degradation process so the TVB-N was increased.

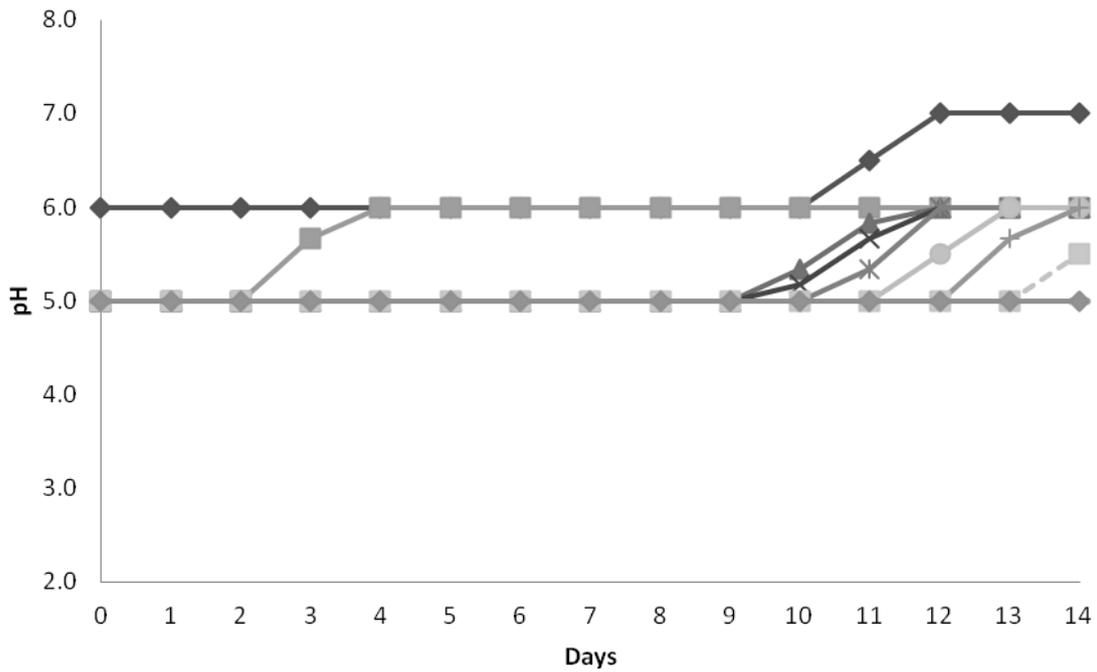


Figure 1. pH level of straw mushroom balls during storage from untreated straw mushroom ball (◆) 1%, 15 minute (■) 1%, 30 minute (▲) 1%, 45 minute (×) 2%, 15 minute (∗) 2%, 30 minute (●) 2%, 45 minute (+) 3%, 15 minute (–■–) 3%, 30 minute (–▲–) 3%, 45 minute(–◆–)

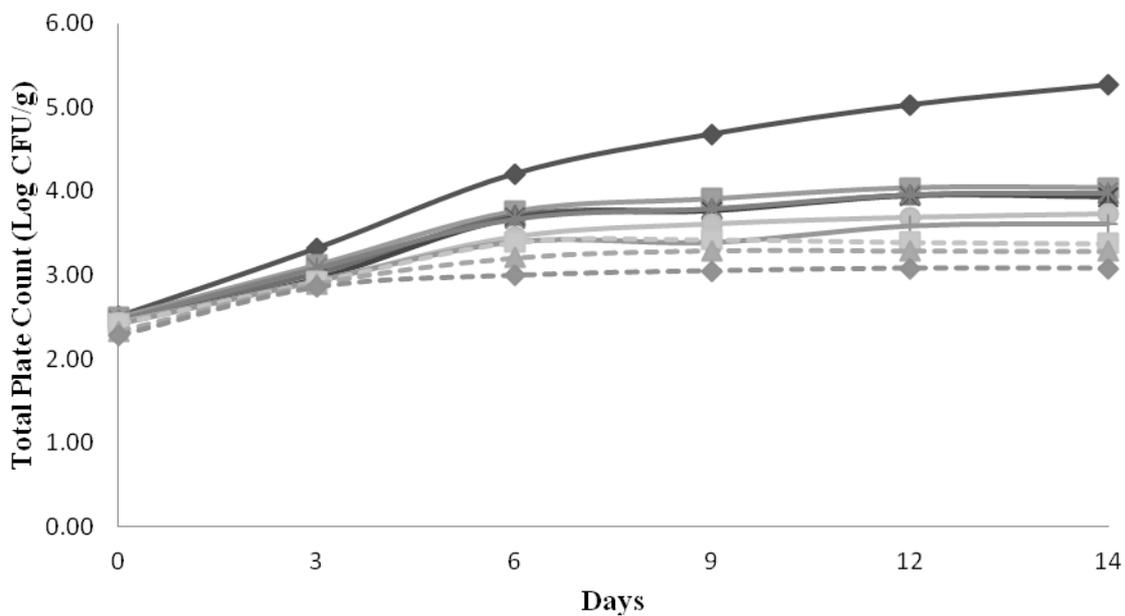


Figure 2. Total plate count of straw mushroom balls during storage from untreated straw mushroom ball (◆) 1%, 15 minute (■) 1%, 30 minute (▲) 1%, 45 minute (×) 2%, 15 minute (∗) 2%, 30 minute (●) 2%, 45 minute (+) 3%, 15 minute (–■–) 3%, 30 minute (–▲–) 3%, 45 minute (–◆–)

Straw mushroom ball has pH level 6, and it was decreased during soaked in liquid smoke. **Figure 1** shown the decreased pH level during storage. The decreasing of pH value of straw mushroom balls during storage caused by the acid component of liquid smoke. According to Zuraida, the decreasing of the pH values is due to the influence of acidity levels of coconut shell liquid smoke and the presence

of acidic compounds such as 2,3-dihydroxy-benzoic acid, 3-methoxybenzoic acid methyl ester, and 4-hydroxy-benzoic acid methyl esters based on GC-MS analysis [12]. During Storage, pH level was increased. According to Goulas and Kontominas, the increasing of pH is caused by the activity of bacterial that produced proteolytic enzymes [13]. This enzyme could breakdown proteins into ammonia, trimethylamine and other volatile components that have base characteristic so that the pH level would be raised. The highest pH level was achieved by the untreated straw mushroom ball. The corresponding value was 7. The lowest pH level was achieved by a straw mushroom ball which soaked in 3% concentration of liquid smoke and 45 minutes soaking time. The corresponding value was 5.

The microorganism activity could show in **Figure 2**. Before stored, the untreated straw mushroom ball has higher TPC value which was 2.53 (log CFU/g) and mushroom ball with 3% concentration level and 45 soaked times have the lowest TPC value which was 2.28 (log CFU/g). During storage, the presence of microorganism activity during storage at freezing temperatures can inhibit their growth. Bacteria that could slow growth at this freezing temperature are bacteria belonging to the psychrophilic group. Examples *Pseudomonas*, *Flavobacterium*, *Alcaligenes*, *Micrococcus*, *Enterobacter*, and *Anthrobacter* [10]. During storage, the higher concentration of the liquid smoke and the soaked time shown the lower the microorganism activity. According to Zuraida, liquid smoke combined with low temperatures can be either bactericidal or bactericidal depending on the concentration of liquid smoke, the temperature used, and the length of storage [12].

3.2. Sensory Properties of Straw mushroom balls

Straw mushroom balls were assessed for sensory attributes using an acceptance test after production (Table 2). The higher scores for straw mushroom balls flavor and taste value were found for straw mushroom balls that soaked on 1% concentration level with 15 min soaked time of liquid smoke. According to Yunus, carbonyl compounds in liquid smoke has a role to give the color and taste of the smoked product [5]. That compounds have a unique caramel-like scent. The types of carbonyl compounds present in liquid smoke include vanillin and aldehyde.

Table 2. Sensory properties of straw mushroom balls

Sample	Parameter					
	Color	Flavor	Taste	Texture	Overall	
Untreated straw mushroom ball	3.03 ^a	2.93 ^a	3.00 ^a	3.03 ^a	3.13 ^a	
1%	15 minutes	3.23 ^{abc}	3.93 ^d	3.97 ^d	3.13 ^a	3.33 ^{ab}
	30 minutes	3.40 ^{abc}	3.57 ^{bcd}	3.60 ^{bcd}	3.30 ^a	3.47 ^{ab}
	45 minutes	3.47 ^{abd}	3.90 ^{cd}	3.83 ^{cd}	3.40 ^{ab}	3.53 ^{abc}
2%	15 minutes	3.20 ^{ab}	3.53 ^{bcd}	3.50 ^{bc}	3.33 ^a	3.30 ^{abc}
	30 minutes	3.20 ^{ab}	3.23 ^{ab}	3.20 ^{ab}	3.23 ^a	3.40 ^{ab}
	45 minutes	3.67 ^{cde}	3.20 ^{ab}	3.23 ^{ab}	3.80 ^{bc}	3.73 ^{bc}
3%	15 minutes	3.50 ^{bcd}	3.47 ^b	3.37 ^{ab}	3.40 ^{ab}	3.57 ^{ab}
	30 minutes	4.03 ^e	3.50 ^{bc}	3.40 ^{ab}	3.97 ^c	3.87 ^c
	45 minutes	3.87 ^{de}	3.20 ^{ab}	3.27 ^{ab}	3.80 ^{bc}	3.83 ^{bc}

*Notation different letters in the same column indicate significant difference at a significance level of 5%

The higher scores for straw mushroom balls color, texture, and overall value were found on the straw mushroom balls that was soaked on 3% concentration of liquid smoke and soaked for 30 min. According to Darmadji, the colors in fumigation products especially meatballs are formed due to interactions between carbonyl compounds and amino groups [14]. Carbonyl compounds caused maillard reaction, so changed the color of meatballs to brown. According to Hadi, the protein content gave effect on the textural properties. The protein serves as a binding agent which encapsulates fat in the meatball hence the meatball emulsion become more stable, and the texture is denser [15]. The panelists of the acceptance test give a highest overall score on straw mushroom balls with 3% concentration level and 30 min soaked time of liquid smoke.

4. Conclusions

The water content and TVB-N were decreased after soaked and were increased after stored. On the other hand, the result of total phenol, carbonyl content, and Total-N were increased after soaked and were decreased after stored. The level of pH and Total Plate Count of the straw mushroom ball were decreased during storage. Due to the sensory characteristics of the straw mushroom ball, the panelists provide high values for the straw mushroom ball which was soaked in 3% concentration level with 30 min soaked time. The best-soaked treatment was by soaked at 30 minutes with 3% concentration level liquid smoke.

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