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Liquid smoke application in latex as an environment-friendly natural coagulant

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Abstract: Liquid smoke has many benefits, especially in the food, fishery, timber, and plantation industries. It is used as a preservative or durability increased and aroma and taste addition in the food and fishery industry. In the wood industry, liquid smoke can resist termite attacks, while in the plantation industry, it functions as a latex coagulant containing antifungal, antibacterial, and antioxidants that can improve rubber product's quality. Most of the rubber farmers in Bangka Belitung still use alum as a coagulant to coagulate their latex. However, alum coagulant can reduce the quality of the processed rubber material (bokar). The reason farmers use alum is that raw materials are cheap, therefore getting coagulant raw materials at low prices and not pollute the environment with a less moderate aroma/odor caused by non-recommended coagulant materials (alum) are avoided. This study aims to apply liquid smoke as a natural coagulant in latex freezing. The research method used a Completely Randomized Design, with liquid smoke concentration replicated three times. Parameters observed were clotting time speed and organoleptic test for odor during 14 days of storage. The results showed that the best concentration of liquid smoke was 15% no odor and a clotting time of 8.23 minutes.

1. Introduction

Coconut (Cocos nucifera) is an agricultural product with high economic value and is widely grown in coastal areas [1,2]. The utilization of coconut is besides fruit all parts of the coconut plant also can be used to meet economic, social, and cultural needs [1,3]. Among them are various handicrafts from sticks, furniture, and building materials (laminated beams) from coconut trees, and the leaves used as food wrappers such as ketupat and lepet. In addition, coconut leaves used for traditional events [4,5,6,7].

The use of coconut in the Bangka Belitung Islands is limited only to the fruit. Both consumed fresh (young coconut water and young fruit flesh), or processed as food (grated coconut and coconut milk), while the coconut shell and coir have not been utilized optimally. Efforts to optimize coconut shells,

which are waste from coconut grating and coconut milk extraction, are used as raw materials of liquid smoke manufactured.

Liquid smoke is from condensation or condensation of steam resulting from direct or indirect combustion of materials that contain lots of lignin, cellulose, hemicellulose, and other carbon compounds [8]. Liquid smoke has many benefits, especially in the food, fisheries, timber, and plantation industries. In the food and fishery industry, the basic principle of using liquid smoke is used as a preservative or increasing durability and adding aroma and taste [8]. It is because liquid smoke contains antimicrobial and antioxidant compounds. In the wood industry, Liquid smoke functions to resist termite attacks [9], yet in the plantation industry, Liquid smoke functions as a latex coagulant with functions properties of liquid smoke such as antifungal, bactericide, and antioxidant that can improve the quality of rubber products produced [10,11,12].

Most of the rubber farmers in Indonesia still use coagulants damaging the quality of rubber-like para vinegar, TSP fertilizer, alum. The coagulant is acidic but does not have bactericide and antioxidant properties and stimulates the development of natural antioxidants destroying bacteria in the bokar. The growth of spoilage bacteria biodegrades the protein in the bokar into ammonia and sulfide induced smells bad, causing air pollution around it [13]. Therefore, the quality of bokar produced by farmers meets the requirements of SNI 06-2047-2002 and reduces air pollution. It is necessary to look for a latex coagulant which not only acidic but also bactericide and antioxidant.

The coagulants recommended by the government as a coagulant of latex are antacid or formic acid and natural coagulation, including liquid smoke [14,15]. Liquid smoke used as a latex coagulant in bokar with odorless is more environmentally friendly, reducing air pollution [16]. The advantages of liquid smoke coagulants from other coagulants, such as Deorub liquid smoke made from palm fruit shells are that the freezing process is expediter, the resulting bokar is cleaner and has elasticity and high dry rubber content, thereby increasing the quality and selling price of bokar [13,17,18]. This study aims to determine the concentration of liquid smoke as a natural coagulant in latex.

2. Research Method

This research was conducted at the integrated coconut laboratory, Faculty of Agriculture, Fisheries and Biology, University of Bangka Belitung, in August 2021. The liquid smoke used in this study came from coconut shells which were made by themselves using a pyrolysis device (Grant from the Ministry of Research and Technology). Dikti in 2009) in the Faculty of Agriculture, Fisheries, and Biology. The latex used comes from farmers in Balunijuk Village.

Furthermore, liquid smoke was applied to fresh latex (pure without a mixture of water) with 5, 10, and 15% of Liquid smoke concentrations according to the treatment. Treatment control using formic acid with a concentration of 2% [14,13,17], and alum with a concentration of 2% alum (generally done by farmers in Bangka Island). The latex that has been mixed with the coagulant is stirred and allowed to clot to form sheets.

Each treatment was replicated three times. The parameters observed on the slab were the speed of clotting time measured using a stopwatch, while the odor organoleptic test parameters were carried out for two weeks of storage and observed eight times. The off-odor intensity score determined in the organoleptic test by the panelists scored 1 to 5. Scores of 1 (very bad odor), 2 (odor), 3 (slightly odor), 4 (no odor) and 5 (absolutely no odor) [17].

3. Result and Discussion

In this study, the raw material of rubber latex (latex) used was pure garden rubber sap without mixing water. Furthermore, the rubber sap is mixed with liquid smoke, alum, and rubber vinegar (formic acid) according to the treatment and stored for 14 days. The parameters observed were the speed of latex clumping and the aroma or off the odor of the latex produced.

3.1. Speed of Clumping of Latex

Latex is a product of rubber plantations obtained by tapping the bark of rubber trees [19], while clumping is the transform sol phase to a gel phase with the help of a coagulant material commonly called a coagulant. Latex will coagulate if the electrical charge lessens (dehydration), the pH of the latex

decreases (addition of acid H+), and the addition of electrolytes. The decreasing in latex pH can occur either naturally or intentionally or by special treatment on latex-like coagulation agent additions [20].

The speed of clotting time was measured using a stopwatch. The data on the momentum of latex clumping time are in table 1.

Table 1. The speed of latex clumping time

Observation	Treatment				
	Liquid smoke 5%	Liquid smoke 10%	Liquid smoke 15%	Alum 2%	Formic Acid 2%
Clumping time (minutes)	8.42	8.34	8.23	13.25	26.09

Based on Table 1, it can be seen that the fastest latex clumping time is in the 15% liquid smoke treatment, with a time of 8.23 seconds. This is because the more doses of liquid smoke used, the more organic acids contained in the liquid smoke, so that the resulting pH value decreases so that it will accelerate the clotting process [20]. Furthermore, if the latex coagulation uses a low concentration, the pH of the agglomeration is above the iso-electric point, so the latex takes a longer time to agglomerate, and the clotting that occurs is also imperfect [21]. Completed agglomeration can occur at the iso-electric point at pH 3.7 – 5 [22].

In addition, the speed of latex clumping time influenced by the type of coagulant used. Coagulants that can coagulate rubber using chemicals and natural ingredients. The chemical recommended by the government as a latex coagulant is antacid or formic acid, while natural agglomerates, including liquid smoke [13]. Liquid smoke used as a latex coagulant in a bokar that does not smell bad, is more environmentally friendly, reducing air pollution around it [16].

3.2. Aroma or off odor of latex

The results of organoleptic test observations on the aroma or off the odor of frozen latex are in Figure 1. The organoleptic test in this study was carried out on the clumping of latex using liquid smoke, alum, and vinegar. Organoleptic tests carried out on five treatments of liquid smoke at 5%, 10%, and 15%, respectively, alum 2%, and vinegar or formic acid 2%. Observations were made for 14 days with a total of 8 observances, which carried out every two days.

Latex storage is carried out for 14 days because the KKK (Dry Rubber Content) of bokar will increase after being stored for 14 days, and then the increase in KKK will be tiny and tend to be stable, so it is recommended that farmers sell the bokar after being stored for two weeks [23].

Linked to organoleptic test showed that the overall treatment of latex clumping with a dose of 15% liquid smoke showed the best results, ie 88% showed very odorless results. The use of liquid smoke at a 15% dose caused coagulated latex very odorless since the observation day 0 to 12 which the odor level of the latex changed slightly on the 14th day.

The use of liquid smoke with larger doses can overcome the problem of foul odor. On the 14th day of observation, in the three treatments of liquid smoke, either 5%, 10%, and 15%, respectively, produced a very odor latex (12%), odor (12%), and very odorless (88%). The results of organoleptic tests using

alum and formic acid with a 2% dose gave more than 50% of latex products odor to very odor. The use of alum caused a change in odor from the 6th to 14th day of observation became very odor.

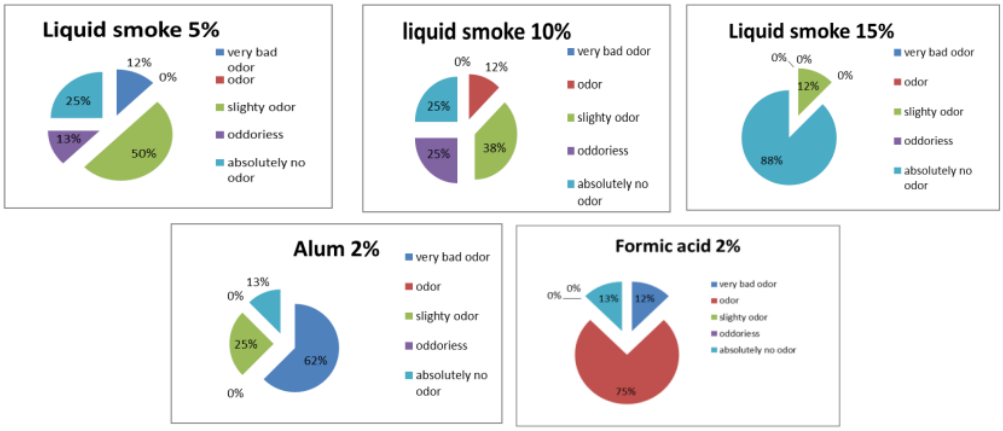

Figure 1. The results of processed data based on organoleptic tests on the aroma or off the odor of latex produced

Natural rubber contains 98% unsaturated bonds (double bonds), thus causing easy deterioration when exposed to ozone, oxygen, and sunlight [24]. The presence of a double bond –C = C- in the rubber molecule, allows oxidation reactions to occur. Oxidation of rubber by air (O_2) occurs in the double bond of the molecule, so the length of the polymer chain will be shorter. The termination of the polymer chain causes the viscosity of the rubber to decrease. Oxidation of rubber by air will occur more slowly when the levels of natural antioxidants (proteins and lipids) are high and rubber-metal ions are low [24]. Efforts that can prevent the oxidation process in latex are to use liquid smoke as a coagulant. In addition, Coagulation using citric acid and acetic acid requires much water, is not environmentally friendly [25], and is dangerous for workers and the community [26].

Liquid smoke contains acetic acid, phenolic compounds, and carbonyl compounds. The acetic acid contained in the Liquid smoke functions as a latex coagulant, while the phenolic compounds are proven to be bactericide, anti-oxidant, and anti-fungal so that rubber plasticity value is maintained. The carbonyl compound itself will give the coagulum a brown color [8]. Antibacterial from acid and phenol compounds in liquid smoke will kill bacteria in latex, hence no smell because there is no decomposition of protein into ammonia and sulfide. Meanwhile, anti-oxidant from phenol will protect rubber molecules from the oxidation process so that the PRI (Plasticity Retention Index) value remains high [17,27,28]. It has been reported that liquid smoke prevents the growth of micro-organisms, and insects [29].

The advantages of liquid smoke coagulants over other coagulants, such as Deorub liquid smoke made from palm fruit shells, are that the freezing process is fast, the resulting bokar is cleaner and has elasticity and high dry rubber content, thereby increasing the quality and selling price of bokar [13]. In addition, hence the quality of bokar produced by farmers meets the requirements of SNI 06-2047-2002, so it is safe for export.

The potential and optimization of the utilization of coconut shells into liquid smoke in the Bangka Belitung a[illegible] have the potential to be further developed. In addition to providing added value to coconut shells, the liquid smoke produced can be used as a natural coagulant because it reduces environmental pollution caused during the processing.

4. Conclusion

The concentration of liquid smoke to use is 15% because it can agglomerate latex in 8.23 minutes. Furthermore, based on organoleptic tests on aroma, as many as 88% stated that the odor was very

odorless, so it was highly recommended to be applied by farmers as an environmentally friendly coagulant.

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