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Suboptimal land analysis of agricultural fishery resources (chitosan-liquid smoke *Cocos nucifera*) as natural food preservatives

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ABSTRACT

One of the suboptimal land resources is shrimp and coconut. Increasing productivity on suboptimal land is essential by utilizing typical land. A concern arises with the use of waste as a preservative. The necessity to replace preservatives made from chemical raw materials with natural alternatives is evident. The research aimed to determine and optimize the antioxidant properties of chitosan combined with liquid smoke from coconut shells (*Cocos nucifera*) as a natural food preservative. The study utilized a Completely Randomized Design (CRD) with 4 treatments repeated three times. The treatments consisted of different concentrations. The results indicated that varying concentrations of Cocos nucifera liquid smoke combined with sterilized glucose and chitosan had a significant effect on antioxidant analysis and the Maillard reaction. Higher concentrations of liquid smoke resulted in increased browning, likely due to the Maillard reaction occurring when glucose and chitosan were mixed with liquid smoke and then sterilized using an autoclave. This condition was expected to be favorable as it involves a reaction between free amino acids in chitosan and reducing sugar compounds from glucose. Additionally, aldehyde ketone compounds are found in Cocos nucifera coconut shell liquid smoke. Finally, the optimal concentration for antioxidant activity was treatment A2 (total concentration of 1% chitosan + 1% glucose + 3% coconut shell liquid smoke) with an IC_{50} value of 6.69% and a brown absorbance of 0.45%.

Keywords: antioxidant, chitosan, liquid smoke, maillard, preservatives

INTRODUCTION

Indonesia had about 126 million hectares of land which was suboptimal land. Suboptimal land means that it had a low fertility level, the land can be used as fishery and agricultural land. One of the suboptimal land resources is shrimp and coconut. The use of these resources tends to be more towards food raw materials and more towards production products rather than waste products. One of the suboptimal land increases is to increase productivity with typical land. Natural preservatives are needed to replace the use of chemicals that are widely circulated in the community. One of the natural preservatives that is often used and the result of suboptimal land is shrimp which is used as chitosan. Chitosan is fishery waste derived from shrimp shells. Chitosan has a natural polycation that can inhibit the growth of bacteria and molds (Tuesta et al., 2022) and has a mailard reaction as antioxidants (Kanya et al., 2023). Some studies use chitosan as an antibacterial combined with various other ingredients to produce better antioxidants (Sari et al., 2019a), one of the natural ingredients and suboptimal land yield is coconut. Coconut can be used as liquid smoke. Utilization of shells that are used as liquid smoke. These two resources

can be combined into a pickling mixture between chitosan-smoke liquid coconut shell.

Coconut shells as agricultural waste can be processed into liquid smoke which has antibacterial properties. The phenol content in liquid smoke provides antibacterial and antioxidant effects and can affect product quality so that it can be applied to all smoking products (Nugroho, 2018). Palm shell liquid smoke has a relatively strong activity and is able to reduce the number of DPPH free radicals with IC_{50} by 91.27 (Sumpono, 2018).

Modification of chitosan with various ingredients to antioxidant activity had been widely done, but no research has been done on chitosan combination of coconut shell liquid smoke (*Cocos nucifera*). The addition of glucose and sterilization in this study is a differentiator in existing research. Chitosan activity in combination with coconut shell liquid smoke with glucose addition and sterilization results in a Maillard reaction that serves to increase the effectiveness of antioxidants. In addition, shrimp and coconuts are the results of resources from suboptimal land for aquaculture and agricultural development. Therefore, developing waste innovations into more useful materials, it can increase suboptimal land towards agromaritim. In addition, the use of waste makes land management suboptimal. The purpose of the study was to determine the antioxidant activity of chitosan combination of liquid smoke from coconut shells (*Cocos nucifera*) as a natural food preservative.

MATERIALS AND METHODS

The materials used include a Bunsen burner, funnel, Erlenmeyer flask, beaker, measuring cup, measuring flask, dropper pipette, spatula, autoclave, spray bottle, Schott bottle, cuvette, spectrophotometer, hot plate with magnetic stirrer, analytical balance, test tube, micropipette, and vortex mixer. The main ingredients used in the study were chitosan from PT Monodon Group and coconut shell liquid smoke from Lubna Company. Additional ingredients include glucose and distilled water (aquades). The chemical used for analysis was acetic acid. The research method employed a Completely Randomized Design (CRD/RAL), and each treatment was repeated three times. The treatments used in this study were as followed:

A0 : 1% Chitosan + 1% Acetic Acid + 1% Glucose + 0% Liquid Smoke
A1 : 1% Chitosan + 1% Acetic Acid + 1% Glucose + 1% Liquid Smoke
A2 : 1% Chitosan + 1% Acetic Acid + 1% Glucose + 3% Liquid Smoke
A3 : 1% Chitosan + 1% Acetic Acid + 1% Glucose + 5% Liquid Smoke

RESULTS

Antioxidant Activity Analysis

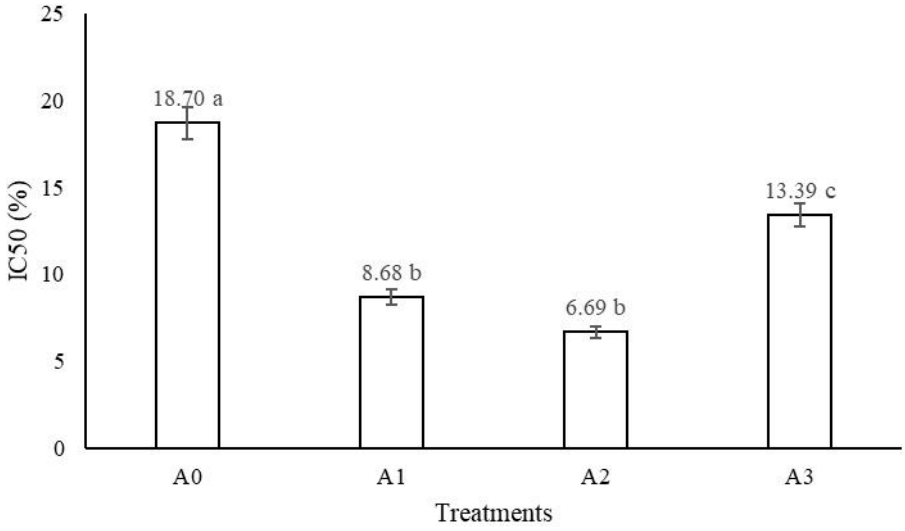
Antioxidants were compounds that inhibit or prevent cell damage due to free radical oxidation. Testing antioxidant activity in chitosan research combination of liquid smoke *Cocos nucifera* using DPPH method (2,2-diphenyl-lpicrylhydrazyl) dissolved in methanol. Antioxidants by the DPPH method were made with various dilution concentrations (0, 15, 10, 5, 1 mL) with the result of percent inhibition could be seen in Figure 1.

Based on Figure 1 above, the level of antioxidant activity of the chitosan-liquid smoke combination from Cocos nucifera could be determined by the value of the inhibitory concentration at 50% (IC50). IC50 represents the concentration of the sample capable of inhibiting radical activity by 50%. The lower the IC50 value, the stronger the antioxidant activity of the compound. A compound was considered a very strong antioxidant if its IC_{50} value was less than 50 ppm, active if it fell between 50-100 ppm, moderate if it ranges from 101-250 ppm, and weak if it's within 250-500 ppm. The antioxidant value indicates the highest antioxidant value. Research conducted by Sari et al. (2020a) demonstrates the value of the combination of solutions in producing the highest antioxidants.

Maillard Reaction Activity

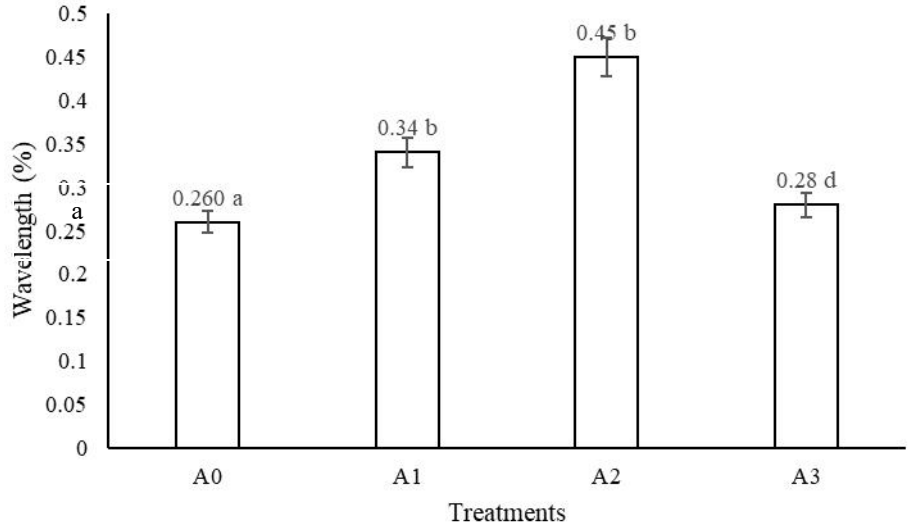
The Maillard reaction was formed from the interaction between free amino acid compounds contained in chitosan with carbonyl compounds contained in reducing sugars with the help of heating to produce a brown color. The average

absorbance value of brown color in chitosan research combination of Cocos nucifera liquid smoke with differences in concentration could be seen in Figure 2. Based on Figure 2 the highest absorbance value in treatment A2 was 0.42 and the lowest absorbance in treatment A0 was 0.21. The A1 treatment was markedly different from the A0 and A2 treatments. The results of the fingerprint analysis showed that the chitosan combination of Cocos nucifera liquid smoke with a difference in concentration had a significant effect on the average value of Maillard reaction absorbance at the level of 5%.



Information:
A0 : Chitosan + Acetic Acid + Glucose + 0% Liquid Smoke
A1 : Chitosan + Acetic Acid + Glucose + 1% Liquid Smoke
A2 : Chitosan + Acetic Acid + Glucose + 3% Liquid Smoke
A3 : Chitosan + Acetic Acid + Glucose + 5% Liquid Smoke

Figure 1. Percent inhibition with DPPH chitosan method combination liquid smoke *Cocos nucifera*



Information:
A0 : Chitosan + Acetic Acid + Glucose + 0% Liquid Smoke
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A2 : Chitosan + Acetic Acid + Glucose + 3% Liquid Smoke
A3 : Chitosan + Acetic Acid + Glucose + 5% Liquid Smoke

Figure 2. Chitosan brown absorbance combination liquid smoke *Cocos nucifera*

DISCUSSION

The lowest antioxidant yield was A2 treatment at 6.69% and the highest was A0 treatments at 18.70%. The lower the IC_{50} value, the more active the sample containing antioxidant compounds (Klomsakul et al., 2022). Treatment A1, A2, and A3 showed the lower the concentration the higher the percent of inhibition produced. The presence of percent inhibition indicates an antioxidant reaction in the chitosan liquid smoke combination *Cocos nucifera*. This was in accordance with research by Sari et al. (2020b) which states that the Maillard reaction resulting from heating chitosan and glucose in an autoclave for 15 minutes was higher than the use of chitosan and glucose.

In addition, the neutral fraction of liquid smoke contains phenols that can also act as antioxidants such as guaikol (2-methoxy phenol) and siringol (1,6-dimethoxy phenol) (Lingbeck et al., 2014). These phenolic compounds can act as hydrogen donors and were effective in very small amounts to inhibit fat autooxidation (Hutomo et al., 2015). The results show that antioxidants were due to chitosan elements heated with glucose (Sari et al., 2022a) (Sari et al., 2020a). In addition, the antioxidant content in liquid smoke, namely phenols, carbonyls, compounds and HPA is used in smoking products (Sari et al., 2022b).

Therefore, the use of a combination of liquid smoke with chitosan can strengthen its use as a food preservative because it can against bacterial (Suherman et al., 2018). Research by Desvita et al. (2023) on the use of liquid smoke from coconut shells as a preservative for meatballs. The use of liquid smoke can also control mites on dried ham (Shao et al., 2023), sausages (Takeda et al., 2021), beef (Rahmasari & Yemis, 2022), fish (Nithin et al., 2020), Cheese (Xin et al., 2022) as well as using a wide variety of ingredients. The materials used include brown bark (Handojo et al., 2022), eucalyptus oil twigs and rice husks (Mansur et al., 2021), the twigs (Huang et al., 2022) and treatments coconut shells (Rahmasari & Yemis, 2022). This study looked at the antioxidant and antibacterial activity contained in smoke so that it had the potential as a preservative. Based on the results, it is known that the difference in liquid smoke concentration affects the brown color. The higher the concentration of liquid smoke, the higher the absorbance value of the brown color produced. This is thought to be because chitosan glucose with a combination of liquid smoke sterilized with an autoclave forms a better Maillard reaction due to the presence of free amino acid compounds found in chitosan and reducing sugar compounds from glucose, as well as the presence of ketone aldehyde compounds found in the liquid smoke of coconut shells *Cocos nucifera*.

This is reinforced by research by Sari et al. (2023) which states that brown color and absorbance value influenced by chitosan glucose combination can affect antioxidant activity (Sari et al., 2023) potential as a functional natural preservative (Sari et al., 2024) and potential to smoke fish or other food (Sari et al., 2017) (Sari et al., 2019b) (Soares et al., 2016). This factor is due to the Maillard reaction formed by the formation of glycoamine substituted in the N group found in chitosan interacting with glucose (Saad et al., 2020). In addition, aldehyde and ketone compounds found in coconut shell liquid smoke *Cocos nucifera* affect the brown color. This is due to the heating process so that the Maillard reaction could take place. This is in line with Ina and Sirappa's research, (2021) that the color that occurs in smoked products is the result of a non-enzymatic reaction, through a condensation reaction between carbonyl and dicarbonyl in smoke with protein amino acids and free amino acids in food products.

CONCLUSION

Based on the conducted research, the combination of chitosan and liquid smoke from coconut shells (*Cocos nucifera*) exhibits antioxidant activity. The optimal concentration for this activity is observed in the A2 treatment, with an IC_{50} value of 6.69% and a brown absorbance of 0.45%

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