

The effect of drying temperature on chemical composition of chitosan powder from fishbone waste to hydroponic Deep Water Culture (DWC) application

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Abstract. The purpose of this study is to increase the added value of fishery waste, especially cork fish bones that have not been optimally utilized. The benefits of chitosan powder from cork fish bones can be used as a nutrient solution containing calcium in the DWC hydroponic system. The results of this study of cork chitosan bone powder obtained 22.65% Calcium Levels, 2.33% Moisture Content, 0.69% Ash Levels, Protein Levels 92.61%, 140 μm Particle Size, and 93.72% white degrees with microscopic properties obtained density $\rho = 0.1 \text{ Kg} / \text{m}^3$, Porosity $P = 61\%$, Strength of Pressure chitosan powder in water $\sigma = 0.13 \text{ Pa}$, Tensile strength of plant roots $\sigma = 100.63 \text{ N} / \text{m}^3$, Plant strain of $\epsilon = 6.14$, and Young's Modulus $E = 16.39 \text{ N} / \text{m}^3$. The hydrolysis process is carried out to obtain purer calcium chitosan powder with finer size fish so that it is easily absorbed by hydroponic plants.

1. Introduction

The community of South Sumatra Province uses cork fish as one of the main ingredients for making empek-empek and cracker business. As a result of the flourishing of the mushrooming culinary business in the city of Palembang, it will cause new problems from cork fish bone waste, the rest of the production from the Palembang culinary food maker. What is interesting here are many of our people who do not know the magnitude of the benefits of cork fish bones because of the calcium content in it. The main elements that makeup fish bones are Calcium, Carbonate, and Phosphate, while those in quantities small are Fluoride, Sodium, Magnesium, Strontium, Hydroxide, Citrate, and Sulphate. Cork fish has 70% protein, 21% other ingredients [1]. Cork fish is a type of freshwater fish native to Indonesian waters. Cork fishbone is the raw material for producing chitin and chitosan. The ability of chitosan applied in various fields of modern industry, for example, pharmaceuticals, biochemistry, cosmetics, food industry, and the textile industry has encouraged the development of various studies using chitosan, including modifying chitosan chemically or physically.

Hydroponics is a term used to describe several ways to grow crops without using land as a place to plant crops [4]. Hydroponics is a technique of planting with planting media without using soil, it can be in the form of gravel, coarse sand, or coconut fiber. One simple hydroponic system is the Deep Water Culture, which works to hang plants on a container so that the roots of the plant are submerged in water that has been mixed with nutrient solutions and given oxygen. In this study, nutrient solution was made from chitosan powder based on cork fish bone waste. The plants used in this study were lettuce.



Making chitosan is done by using the hydrolysis method consisting of three main steps, namely deproteination, demineralization, and deacetylation. The deproteination process aims to reduce protein content by using a dilute alkaline solution and sufficient heating. The demineralization process is intended to reduce mineral content (CaCO_3) by using low concentrations of acid to obtain chitin, while the deacetylation process aims to remove the acetyl group from chitin by heating it in strongly alkaline solution with high concentration [8]. Whereas the deacetylation process using alkali at high temperatures will cause the release of the acetyl group ($\text{CH}_3\text{CHO}-$) from the chitin molecule. The amide group in chitin will bind to a positively charged hydrogen group to form a free $-\text{NH}_2$ amine group [5].

This study will focus on the use of chitosan powder using hydrolysis method with temperature optimization to determine its effect on the chemical composition that has been made. Optimization was carried out at temperatures of 100°C , 125°C , and 150°C . Chitosan powder was then characterized by its chemical composition to determine calcium levels, water content, ash content, protein content, and white degrees.

2. Materials And Methods

2.1. Tools

The tools used are boiling pot, stove, filter paper, mortar, cup, furnace, 100 mesh size filter, distillation flask, micro Kjeldahl, aquabides, whiteness meter cup, balance sheet, pH meter, thermometer, test tube, stirrer, and glass measuring.

2.2. Material

The materials used were 0.1 N NaOH, 0.1 N HCl, cork fish bone waste obtained from the market in Palembang.

2.3. Research Procedure

This research was carried out by following the diagram below, to obtain chitosan powder for cork fish bone waste for DWC hydroponic systems:

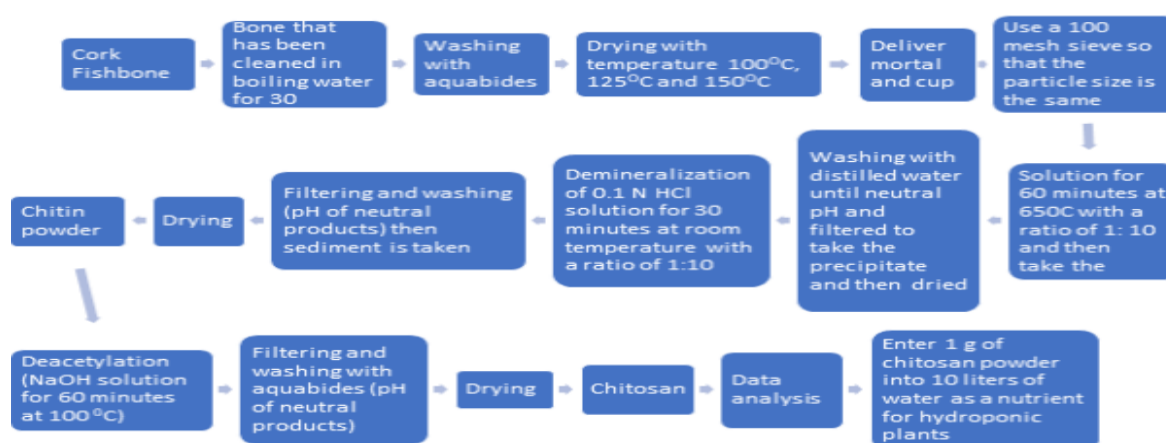


Figure 1. Flowchart of research to obtain chitosan waste fish cork bone waste for DWC hydroponic system

3. Results And Discussion

The research that has been carried out gets the results of the chemical composition of cork chitosan bone powder presented in the following table.

Table 1. Chemical Composition of Chitosan Fish Bone Powder

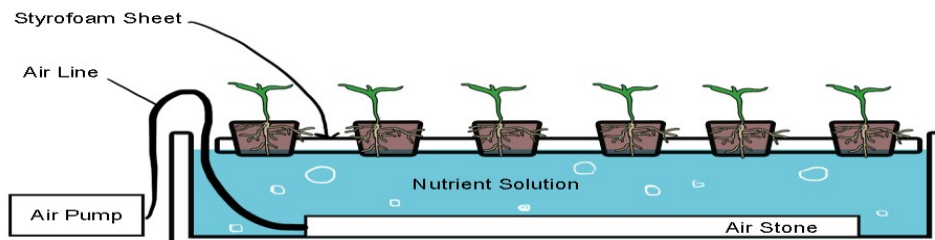
Parameter	Temperature Optimization Percentage		
	Sample 1 (100 ⁰ C)	Sample 2 (125 ⁰ C)	Sample 3 (150 ⁰ C)
Calcium Levels	21,78%	21,97%	22,6 %
Moisture Content	2,03%	2,16%	2,33 %
Ash content	0,79%	0,72%	0,69 %
Protein content	92,05%	92,34%	92,61 %
White Degrees	93,64%	93,69%	93,72 %

The results of the analysis of bone Tuna and Kakap [2], Patin [3] and Nila [6] can be seen in table 2.

Table 2. Fish Bone Chemical Composition

Parameter	Tuna	Kakap	Patin	Nila	Gabus	SNI (1995)
Calcium levels	-	-	-	20,67 %	22,61 %	-
Water content	6,54 %	6,73 %	9,26 %	8,76 %	2,33 %	Maksimum 16 %
Ash content	1,93 %	0,88 %	2,26 %	0,91 %	0,69 %	Maksimum 3,25 %
Protein Levels	91,01 %	86,61 %	85,91 %	-	92,61 %	-
Particle Size	-	-	-	-	140 μ m	-
White Degrees	-	-	-	78,40 %	93,72 %	-
Fat level	0,42 %	0,16 %	1,95 %	2,85 %	0,37 %	-

Based on table 2, we get information on the chemical composition of chitosan powder, cork fish bone. So that it can be used as a nutrient solution in the DWC hydroponic system by mixing 1 gram of chitosan powder with cork fish bone in 10 liters of water in a prepared container.

**Figure 2.** Illustration of the DWC image

Plant growth that has been given chitosan powder on lettuce plants with an initial plant length of 7 cm.

Table 3. Plant Growth given a chitosan bone fish cork powder

Time	Plant Length		
	Sample 1	Sample 2	Sample 3
5 Days	8 cm	8,3 cm	8,4 cm
10 Days	14 cm	15 cm	17 cm
15 Days	22 cm	24 cm	28 cm
20 Days	30 cm	31 cm	34 cm
25 Days	35 cm	37 cm	40 cm

DWC is very suitable for shortage plants, which is around 30-45 harvest days and is not appropriate for large plants and longevity. In this study researchers used lettuce. Based on table 3 by adding a solution of cork chitosan powder, this plant has a harvest time that is relatively faster than without surface treatment, which only takes 25 harvest days.

Based on table 1 and table 3 the best optimization temperature is at 150°C. The physical parameters of microscopic properties that can be used as an indicator of the nutritional content of cork chitosan powder obtained by the density of chitosan powder in water $\rho=0.1 \text{ Kg/m}^3$, Porosity $P = 61\%$, Pressure Strength of chitosan powder in water $\sigma = 0.13 \text{ Pa}$, Tensile Strength of plant roots $\sigma = 100.63 \text{ N/m}^3$, Plant strain of $\varepsilon = 6.14$, and Modulus Young $E = 16.39 \text{ N/m}^3$ which can be absorbed by the roots of lettuce plants.

The advantages of chitosan bone fish cork powder which is used as hydroponic plant nutrient solution is to reduce environmental problems by cork fish bone waste and calcium powder cork fish bone smaller than traditional fish meal because it uses the hydrolysis method, it is expected to be able to be absorbed with roots plants better in the nutritional formulations of the DWC hydroponic system.

Possible negative effects of chitosan powder of cork fishbone are used as a solution for hydroponic plant nutrition in the environment if it is equipped with a waste treatment plant because it uses chemicals in the process. So far the addition of NaOH and HCl is still relatively safe because it uses small normality.

4. Conclusion

This research obtained chitosan bone cork fish powder obtained 22.65% Calcium Content, 2.33% Moisture Content, 0.69% Ash Content, Protein Level 92.61%, Particle Size 140 μm , and white degree 93.72% with microscopic properties obtained density $\rho = 0.1 \text{ Kg/m}^3$, Porosity $P = 61\%$, Strength of Pressure chitosan powder in water $\sigma = 0.13 \text{ Pa}$, Tensile strength of plant roots $\sigma = 100.63 \text{ N/m}^3$, Plant strain of $\varepsilon = 6.14$, and Young's Modulus $E = 16.39 \text{ N/m}^3$.

Currently, researchers are conducting further research for the application of cork bone fish chitosan powder in the field of medical physics by making powder size into the size of nanoparticles.

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