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PHYSICAL CHEMICAL CHARACTERISTICS OF JELLY CANDY HYDROXYAPATITE FROM YELLOWFIN TUNA FISH BONE WASTE (Thunnus albacares)

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ABSTRACT

Introduction : jelly candy is a soft-textured candy that is generally given to children with the aim of optimal growth and development with calcium. Hydroxyapatite content in the preparation of jelly candy can be achieved by using the addition of ingredients containing calcium that come from nature, one of which is by using yellowfin tuna fish bone meal as the main ingredient to increase the calcium content in jelly candy. The aim of the research was to find out that hydroxyapatite from yellowfin tuna bones (Thunnus albacares) can be formulated in the form of jelly candy to determine the hydroxyapatite of yellowfin tuna bones (Thunnus albacares) contains calcium. The research method uses laboratory experimental research. The treatment in this research is a dosage formulation of jelly candy from the bones of yellowfin tuna (Thunnus albacares). The results showed that the higher the concentration of yellowfin tuna bone meal (Thunnus albacares) the higher the calcium levels. The conclusion of this research is that hydroxyapatite of yellowfin tuna bones (Thunnus albacares) can be formulated into dosage forms jelly candy. Yellowfin tuna bone hydroxyapatite (Thunnus albacares) contains calcium and the highest calcium content is in F3 (7%) with a value of 39.3%..

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INTRODUCTION

Indonesia is known to have enormous natural resource potential, one of which lies in the marine and fisheries sector. This is because two-thirds of Indonesia's territory is ocean, has more than 17,000 islands and a coastline of 81,000 km. The fisheries sector in

Indonesia has a very important role because it is able to survive in situations of economic crisis, financial crisis and monetary crisis. The fisheries sector also has a large contribution to economic growth in several developed countries such as the United States, Japan, China and countries in Europe (1). Tuna fish (I remember sp.) is a type of fish with high economic value and is the type of fish most sought after in Indonesian seas. Tuna, tuna and skipjack tuna are found in many areas in Eastern Indonesia, including in the North Sumatra region, which is a tuna production center which must be developed to support the production of these fish. Tuna fish (I remember sp.) has a high protein content and has a delicious taste (2). Fisheries waste is waste obtained from fisheries processing which can cause environmental pollution. Pollution cannot be avoided if waste disposal is carried out without prior waste processing or waste utilization. Tuna fish is a type of fish that contains quite high levels of calcium. Based on previous research conducted by Pangestika in 2021 entitled research on the use of catfish bone meal and tuna bone meal, the results of this research show that tuna fish bones have a calcium content of 39.24% higher than the calcium content in tuna fish bones in the study, namely amounting to 14.01% (3).

Fish bones are a by-product of fish processing that can be reused in the form of products and food ingredients. Tuna fish bones can be used as an ingredient in making flour which is rich in calcium. The processing of fish bone meal goes through several stages so that the fish bone meal has a long shelf life (4).

Fish bones contain a lot of calcium in the form of calcium phosphate as much as 14% of the total bone structure. This complex form of calcium phosphate is found in bones and can be absorbed by the body well, around 60-70%. Fish bones are solid waste that contain bone-building elements in the form of calcium, phosphorus and materials containing nitrogen such as amino acids that form collagen. (5) Jelly candy as a semi-wet food has a shelf life of 6-8 months if placed in a jar and 1 year if the packaging has not been opened. Jelly candy has a tendency to become sticky due to the hygroscopic nature of the reducing sugars that make up the candy, so coating agents need to be added. Jelly candy generally requires a coating ingredient in the form of a mixture of tapioca flour and sugar flour. This coating is useful for preventing the candy from sticking to each other and also for adding sweetness (6). Hydroxyapatite is a natural inorganic element calcium derived from bones which can be used for bone regeneration, repair, filling, expanding and reconstructing bone tissue. This is because hydroxyapatite has perfect biocompatibility properties when implanted in bone. Apart from that, hydroxyapatite can also be used as an adsorbent to overcome environmental pollution of heavy metals. Hydroxyapatite for industrial applications is generally obtained by synthetic methods (7).

Based on the results of previous research conducted by Untailawam et al, it is known that fish bones have not been used properly until now. Fish bones are only left as

waste. In this research, fish bone meal was made from fish bone waste and studies were carried out regarding the calcium content contained in fish bone waste. (8)

Referring to research conducted by Lia Anggresani et al, it was found that hydroxyapatite from mackerel fish bone meal can be processed into jelly candy. Currently, jelly candy is widely used in the pharmaceutical sector as a medicine for patients who have lost primary teeth, especially children. (9)

Based on the background above, researchers are interested in using hydroxyapatite from yellowfin tuna bones (Thunnus albacares) as an additional ingredient in preparations jelly candy, The method used to observe the calcium content in jelly candy is the SEM method (Scanning Magnetic Electrons), FTIR (Fourier Transform Infrared), XRD (X-Ray Fluorescence), Complexometry.

METHODS

The type of research used is laboratory experimental research. The treatment in this research is a dosage formulation Jelly candy from the bones of yellowfin tuna (Thunnus albacares). And also use descriptive methods to analyze the calcium content. The time of this research will be carried out from June to August in 2023. Experimental research on making yellowfin tuna bone hydroxyapatite (Thunnus albacares) was carried out at the Helvetia Medan Health Institute Laboratory. Research for fish bone hydroxyapatite test parameters was carried out at the Laboratory of the University of North Sumatra and the Laboratory of the State University of Medan. The sample used in this research was yellowfin tuna.

(Thunnus albacares).

Research Tools

The equipment used is knives, scales, stirrers, spoons, pans, gas stoves, baking sheets, ovens, beakers, spatulas, and refrigerators, SEM, IFTR, XRD instruments,

Research Materials

Ingredients for making jelly candy include: Gelatin, Konjac Glucomannan, Carrageenan, Yellowfin tuna fish bone meal, Granulated Sugar, Sodium Benzoate, Water

RESULT AND DISSCUSION

Complexometric Analysis Results

The results of complexometric analysis showed that the bones of yellowfin tuna (Thunnus albacares) can be seen in the table below:

Table 1. Complexometric Test Results

Analysis Method	Results	Condition
Complexometry	(+)	Purple Color Formed

Based on the results of complexometric analysis tests, it shows that hydroxyapatite of yellowfin tuna bones (Thunnus albacares) is positive for calcium as indicated by the formation of a purple color in the solution resulting from complexometric titration.

Table 2. Na vaccination2 EDTA 0.01M CaCo molarity3

Repetition	Volume Titran (ml)	Molarity (M)	Average Molarity (M)
1	3,2	0,03	
2	3,2	0,03	0,03
3	3,1	0,03	

Based on the results of standardization of Na2 EDTA 0.01M CaCo molarity3 showed that the standardization of Na2 EDTA has an average Molarity of 0.03 M.

Table 3. Determination of Sample Calcium Rate

Sample	Average Titrant Volume (ml)	Average Calcium Level (%)	Average Calcium Content (gr)
F1	7,2	28,9	0,289
F2	8,1	50,5	0,505
F3	9,8	58,2	0,582

Based on the results of determining calcium levels, there are results in (%) and (gr).

Characteristic Evaluation Results Jelly Candy

Organoleptic Test Results

Organoleptic test results of preparations jelly candy can be seen in the table below:

Table 4. Organoleptic Test Results

Formula	Organoleptic	Observation result
F0	Color	Transparent pink
	Aroma	The distinctive aroma of *dried fruit flavor*.
	Tasting	sweet
	Texture	Chewy, a bit sticky
F1	Color	Dull red
	Aroma	The distinctive aroma of *dried fruit flavor*.
	Tasting	sweet
	Texture	Chewy, not sticky
F2	Color	Cloudy yellow
	Aroma	The distinctive aroma of *dried fruit flavor*.
	Tasting	Not too sweet
	Texture	Not too chewy, not sticky
F3	Color	Cloudy green
	Aroma	The distinctive aroma of *dried fruit flavor*.
	Tasting	Not too sweet
	Texture	Solid, not sticky

Test Results Hedonic

Test results hedonic preparation jelly candy can be seen in the table below:

Table 4. Test Results Hedonic

Formula	Number of Panelists' Favorite Levels		
	TS	**S**	**SS**
F0	-	11	4
F1	-	6	9
F2	4	9	2
F3	12	3	-

Based on the results of the liking level test, it was found that the most liked formula was F1 with a tuna bone meal concentration of 3% with a very high liking level with 9 panelists.

Elasticity Test Results

Elastic test results preparation jelly candy can be seen in the table below:

Table 5. Elastic Test Results

Formula	Elastic Test Results (mm)			Values
	Repetition I	**Repetition II**	**Repetition III**	
F0	1,5	1,5	1,5	1,5
F1	1,2	1,2	1,2	1,2
F2	1,2	1,2	1,2	1,2
F3	1,3	1,3	1,3	1,3

Based on the results of the elasticity test, this shows that the concentration of yellowfin tuna bone meal is higher (Thunnus albacares) does not affect the level of elasticity of the jelly candy produced.

Water Level Test Results

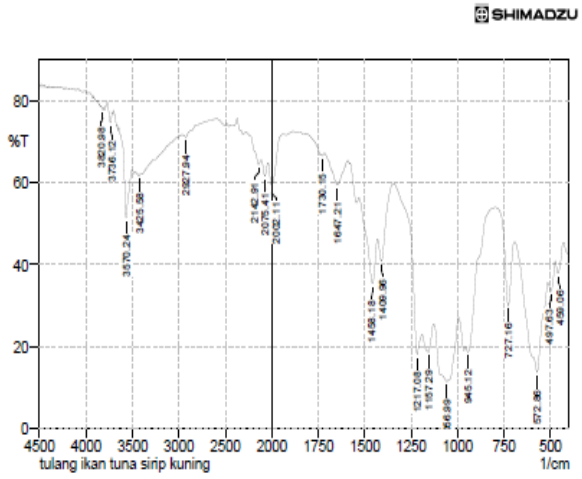
Water level test results preparation jelly candy can be seen in the table below

Table 4.6. Water Level Test Results

Formula	ME	II	I, I, I	Values
F0	18,5%	6,5%	10%	11,66%
F1	4,5%	13%	17,5%	11,66%
F2	19,5%	16%	11,5%	15,66%
F3	8,5%	18,5%	9,5%	12,16%

Based on research results, the water content test shows that the water content of the candy they went in formula 2 and formula 3 meet the water content requirements according to SNI, namely no more than 20%

FTIR Analysis



	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	459.06	37.95	4.443	474.40	428.2	17.991	1.069
2	497.63	33.451	4.469	514.00	474.40	18.124	1.196
3	572.86	13.702	25.125	692.44	514.00	103.902	33.917
4	727.16	30.073	18.261	796.6	692.44	37.671	5.935
5	945.12	18.715	3.694	956.69	796.6	67.423	-10.052
6	1058.99	11.573	5.745	1083.99	995.27	73.074	8.672
7	1157.29	18.729	1.769	1165	1130.29	29.487	0.66
8	1217.08	18.209	10.878	1344.38	1192.01	59.05	-8.53
9	1409.96	40.811	8.781	1431.18	1344.38	28.151	1.947
10	1458.18	35.406	13.641	1527.82	1431.18	33.949	5.733
11	1647.21	59.487	0.61	1674.21	1643.35	6.694	0.129
12	1730.15	66.542	0.442	1735.93	1716.65	3.38	0.032
13	2002.11	59.481	8.075	2040.69	1942.32	18.748	2.405
14	2075.41	61.557	3.589	2117.84	2040.69	15.191	0.849
15	2142.91	64.454	2.987	2229.71	2117.84	19.327	0.875
16	2927.94	71.076	0.805	2945.3	2877.70	9.725	0.151
17	3425.58	61.894	0.212	3433.29	3414	4.011	0.015
18	3570.24	51.452	16.033	3647.39	3510.45	28.28	5.296
19	3756.12	74.573	3.281	3774.69	3716.83	6.651	0.488
20	3820.98	77.864	0.35	3826.77	3813.27	1.455	0.015

Figure 1. FTIR Analysis

Based on the results of the FTIR analysis test, it shows that hydroxyapatite from yellowfin tuna bone waste contains 20 types of functional groups contained in yellowfin tuna bones, however, there are 4 functional groups that have strong vibrations recorded on the FTIR instrument. Based on the FTIR graph to determine the functional groups contained in the sample it is divided into 4 regions, in region 1 with a wavelength range of 4000-2500 cm-1, The strongest peak is at a wavelength of 3570.24 cm-1, This shows that this wavelength is an O-H functional group with varying peak intensity. Where the

O-H functional group based on the IR spectrum functional group table is at a wavelength of 3200 - 3600 cm-1. In region 2 with a wavelength range of 2500 - 2000, the strongest peak is at a wavelength of 2142.91 cm-1, This shows that this wavelength is a C≡C functional group with changing peak intensity, where the C≡C functional group based on the IR spectrum functional group table is at a wavelength of 2100 - 2260 cm-1. In region 3 with a wavelength range of 2000 - 1500 cm-1, The strongest peak is at a wavelength of 1647.21 cm-1, This shows that this wavelength is a C=C functional group with an alkene compound type, where the C=C functional group based on the IR spectrum functional group table is at a wavelength of 1610-1680 cm-1. Then in region 4 with a wavelength range of 1500-400 cm-1, The strongest peak is at a wavelength of 1056.99 cm-1, This shows that this wavelength is a C-O functional group with strong intensity, where the C-O functional group based on the IR spectrum functional group table is at a wavelength of 1050-1300 cm-1.

Complexometric Analysis

Based on the results of complexometric analysis tests, it shows that hydroxyapatite of yellowfin tuna bones (Thunnus albacares) is positive for calcium as indicated by the formation of a purple color in the solution resulting from complexometric titration. The complexometric method was chosen because calcium levels are a metal mineral that binds Na2EDTA and becomes a complex ion. Calcium compounds form unstable complexes with Na2EDTA at low pH, Therefore titrate these metals with Na2EDTA is carried out in ammonia buffer solution pH 10. To determine the end point of the titration, a metal indicator is used, namely an indicator that can form complex compounds with metal ions, namely Eriochrome Black T (EBT).

SEM analysis

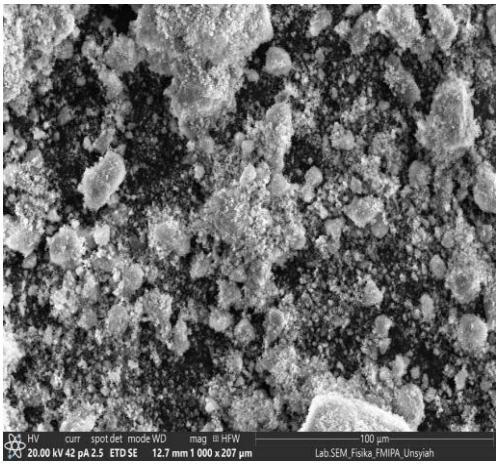


Figure 3. SEM Analysis

Based on the results of SEM analysis in this study, it shows that calcium crystals contained in yellowfin tuna bone hydroxyapatite (Thunnus albacares) in granular form. The shape of the granules is the result of nucleation maturation and growth of calcium phosphate crystals, which are generally larger crystals that will integrate the smaller crystals around them. Then the distribution of the crystals is uneven and lumpy because the stirring process during synthesis is not perfect, causing the crystals in the solution to not be distributed evenly

CONCLUSION

Hydroxyapatite from yellowfin tuna bone waste (Thunnus albacares) can be formulated into dosage forms jelly candy. Physical chemical properties jElly candy meets the requirements and hydroxyapatite of yellowfin tuna bones (Thunnus albacares) contains calcium.

SUGGESTION

It is recommended that future researchers determine the levels of other minerals in tuna bones

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