Chitosan for Preservative

by Rina Sugiarti Dw

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The Effectiveness of Chitosan from Shrimp Skin as a Natural Preservative for Meatball

Rina Sugiarti Dwi Gita[1,3], Joko Waluyo[1], Dafik[2], Indrawati[1]
[1]Department of Postgraduate of Science Education, University of Jember, Indonesia
[2]Department of Postgraduate of Math Education, University of Jember, Indonesia
[3]Department of PAUD, IKIP PGRI Jember, Indonesia
Email: Gitarina16@gmail.com

Abstract. Meatball is one of the most favorite processed food in Indonesia, it has delicious taste, tasty gravy, and affordable price. It is also easy to find a meatball stall in Indonesia, including Jember. Preservatives are usually used to keep the meatballs stay longer. Some preservatives, however, contain harmful substances, like formalin and borax. Both formalin and borax are not allowable for consumption since it may harm human's health. The present study aimed to investigate a main ingredient for natural food preservative, to be further recommended as a preservative for meatball. The food preservative to be investigated in this study is *chitosan* made from shrimps shell wastes. To answer the research objective, a method used was an experiment of making *chitosan* solution. The concentration of *chitosan* created in the study is 1,5%. To test preservative efficacy of using *chitosan*, three treatments were given, namely (1) meatballs are coated with 1,5% of *chitosan*; (2) meatballs are mixed with 1,5% *chitosan* solution; and (3) meatballs without *chitosan*. These three treatments were observed and tested using organoleptic testing based on the length of storage, on day 1, 2, 3, and 4 in a room with a certain temperature. The parameters used for testing the preservatives include taste, color, odor, and texture. The study indicated that the 1,5% of *chitosan* solution was found effective for preserving meatballs naturally when used as coating

1. Introduction

Meatball is a popular food in Indonesia. It can be found in almost every part of the country. Meatball is usually served with noodle, gravy, added with ketchup, soy sauce, chili sauce, and seasonings. It is favorite due to its delicious and mouthwatering taste, even best when served hot. It also becomes people's favorite because of its affordable price. Eatig meatball is recommended when it is still in good shape and not stale.

When stored in a long period, meatball's quality may be reduced, affecting its taste, odor, color, and texture. In order to avoid quality loss when stored, meatballs are usually added with preservatives. The preservatives should not contain non-food safe materials, like formalin and borax which are harmful for health. Therefore, it calls for a need for natural preservatives for meatballs which are unlikely to cause side effects on health.

One of natural preservatives which are food safe is *chitosan*. It is produced from processing chitin contained in shrimps shell. Shrimps shells contain protein, calcium, and chitin, thus have advantages for health. Shrimp belongs to Crustaceans whose shells contain 25-40% protein, 45-50% calcium carbonate, and 15-30% chitin. *Chitosan* is derived from chitin polysaccharides, which makes it a natural product [1].

Chitosan is biodegradable and non-toxic [2], thus recommended for preserving food. The reactive amino and hydroxyl groups contained in *chitosan* are powerful substance for preservative and color stabilizer. Moreover, *chitosan* can be used as preservative because of its ability to inhibit the growth of putrefactive microorganisms. *Chitosan* can also function as coating on preserved products, thus reduce contacts with the environment [3]. Furthermore, it also works as an anti-bacterial material for food products [4]. With its anti-microbial characteristic, *chitosan* is capable of preventing the pathogen bacterials ad putrefactive microorganisms, which includes fungi [5].

There are a number of advantages from using *chitosan* as natural preservative, one of which is it has a structure looking like cellulose-tissue as found in fruit and vegetables. Several hypotheses regarding the working mechanism of *chitosan* as an anti-bacterial states are within the notion that its affinity attribute is very powerful when working with microbe DNA thus they can be bonded and distract mRNA and protein synthesis [4]. Therefore, it is important to conduct a deeper study regarding the use of *chitosan* as natural food preservatives. The study aimed to investigate the process of creating *chitosan* from shrimps shell wastes and its effectiveness as natural preservatives for meatballs.

2. Research method

This is an experimental research conducted by producing *chitosan* from chitin contained in shrimps shell wastes. The procedure of the experiment starts from washing the shrimps shell wastes in flowing water. After washed, the clean shrimps shell is drained by drying it under the sun or microwaved until totally dry. Then, the dry shrimps shell is ground using a blender into powder. The shell powder is further processed to demineralize. Demineralization is done to separate the mineral content of the shell, like $CaCO_3$. This process is done by heating HCl 1 M solution for an hour at 90º C. Once ths process is complete, the procedure continues to deproteinization process by deluting NaOH 3,5% for an hour at 90º C. The next process is deacetylation, the process to remove an acetyl group, using NaOH solution by 50% for an hour at 120 – 140ºC. This process will produce *chitosan* [6], [7], [8].

The effectivity testing of chitosan as preservatives for meatballs is done at the 1,5% concentration of chitosan solution [9]. Technically, this particular testing was done in three treatments: first, meatballs are mixed with 1,5% of chitosan solution; second, meatballs are coated by 1,5% chitosan; and third, meatballs are not added with chitosan. Furthermore, obsevation was done to all treatments for four consecutive days. The data obtained from this observation was documented, and organoleptic test was conducted. The documentation was done by observing and capturing every treatment during testing. Then, the organoleptic test was done to get the data if there were any change to taste, color, odor, and texture of meatballs under the three treatments. The whole procedure of producing chitosan can be seen in Figure 1, while the procedure of chitosan testing on meatballs can be observed by Table 1.

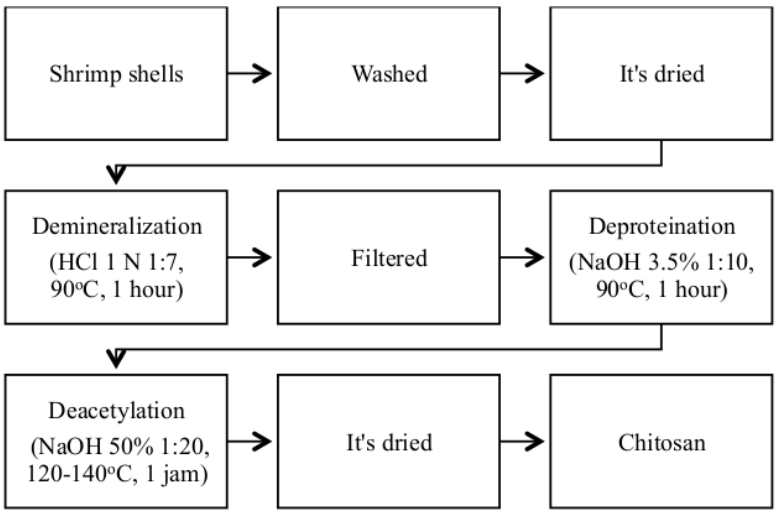

Figure 1. The process of making chitosan from shrimp shells

Table 1. Procedure of *chitosan* testing on meatballs

Treatment	Description	Observation (Days)	Parameter	Score/Criteria
1	Before cooking the meatball dough is mixed with 20 ml of 1.5% chitosan solution, then cooked, drained, and stored at room temperature.	D1,D2,D3,D4	Taste, color, aroma, texture	5 (Very good); 4 (Good); 3 (Not good); 2 (Bad); 1 (Very bad)
2	Meatballs are cooked, drained, dipped in a 1.5% chitosan solution for 20 minutes, drained, and stored at room temperature.	D1,D2,D3,D4	Taste, color, aroma, texture	5 (Very good); 4 (Good); 3 (Not good); 2 (Bad); 1 (Very bad)
3	Meatballs are cooked, drained, and stored at room temperature, without being given chitosan.	D1,D2,D3,D4	Taste, color, aroma, texture	5 (Very good); 4 (Good); 3 (Not good); 2 (Bad); 1 (Very bad)

3. Result

In this section, we will describe our result findings of the effectiveness of the use 1.5% *chitosan solution*. The study was carried out by doing three threatments. Firstly, the meatball with no citosan, secondly the citosans solution is mixed with methball, and the last the citosan solution is coated to the meatball surface. The meatballs were stored in a place with room temperature, and we analyse the the change of four indicators, namely taste, color, odor and texture. For detail description of result findings of chitosan preservative on meatballs are presented below.

3.1 First treatment: without chitosan

The first treatment is to observe meatballs without adding chitosan into the dough. The result of the four-day observation can be seen in Table 2, Figure 2, and Figure 3.

Table 2.Result of organoleptic test on meatballs without chitosan

Days	Meatballs	Taste					Color					Odor					Texture				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
D-1	M1					✓					✓					✓					✓
	M2					✓					✓					✓					✓
	M3					✓					✓					✓					✓
	M4					✓					✓					✓					✓
	M5					✓					✓					✓					✓
D-2	M1				✓				✓						✓					✓	
	M2				✓				✓						✓					✓	
	M3				✓				✓						✓					✓	
	M4				✓				✓						✓					✓	
	M5				✓				✓						✓					✓	
D-3	M1			✓				✓					✓						✓		
	M2			✓				✓					✓						✓		
	M3			✓				✓					✓						✓		
	M4			✓				✓					✓						✓		
	M5			✓				✓					✓						✓		
D-4	M1	✓					✓					✓					✓				
	M2	✓					✓					✓					✓				
	M3	✓					✓					✓					✓				
	M4	✓					✓					✓					✓				
	M5	✓					✓					✓					✓				

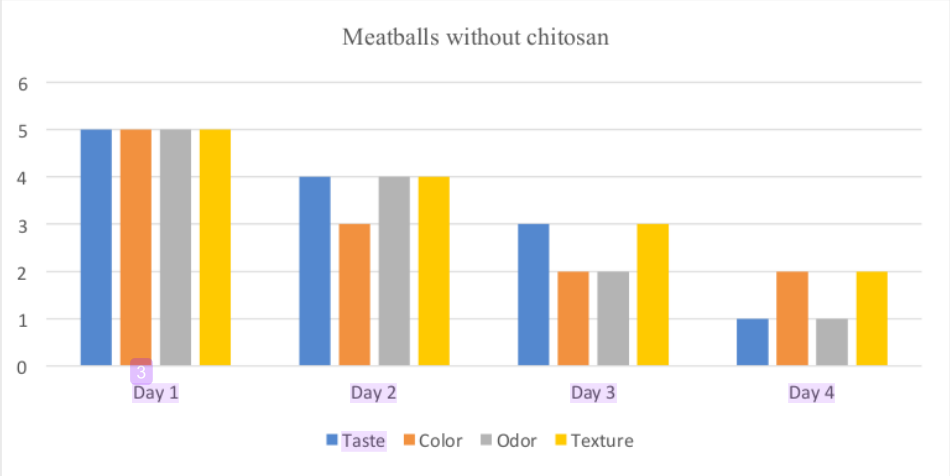

Figure 2. Bar chart showing organoleptic test result on meatballs without chitosan

Figure 3. Observation documentation of meatballs without chitosan

3.2 Second treatment: mixed with 1,5% chitosan solution

The second treatment is to test the effectiveness of chitosan on meatballs by mixing 20 ml chitosan solution at 1,5% concentration into meatballs dough. After four consecutive days of observation, the data were obtained, as presented in Table 3, Figure 4, and Figure 5 in the following.

Table 3.Result of organoleptic test on meatballs mixed with 1,5% chitosan solution

Days	Meatballs	Taste					Color					Odor					Texture				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
D-1	M1					✓					✓					✓					✓
	M2					✓					✓					✓					✓
	M3					✓					✓					✓					✓
	M4					✓					✓					✓					✓
	M5					✓					✓					✓					✓
D-2	M1					✓					✓					✓					✓
	M2					✓					✓					✓					✓
	M3					✓					✓					✓					✓
	M4					✓					✓					✓					✓
	M5					✓					✓					✓					✓
D-3	M1				✓				✓					✓					✓		
	M2				✓				✓					✓					✓		
	M3				✓				✓					✓					✓		
	M4				✓				✓					✓					✓		
	M5				✓				✓					✓					✓		
D-4	M1		✓					✓					✓					✓			
	M2		✓					✓					✓					✓			
	M3		✓					✓					✓					✓			
	M4		✓					✓					✓					✓			
	M5		✓					✓					✓					✓			

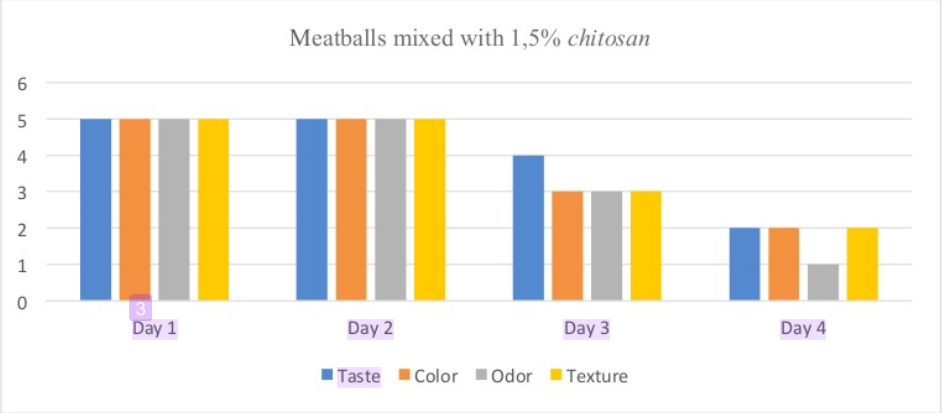

Figure 4.Bar chart showing organoleptic test result on meatballs mixed with 1,5% chitosan

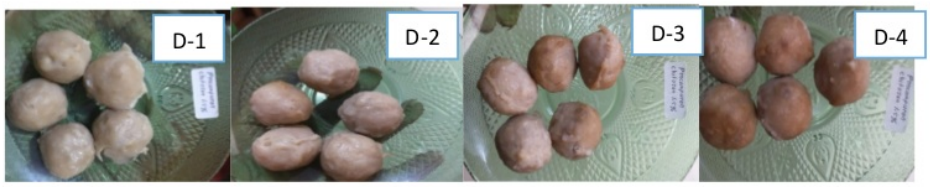

Figure 5. Observation documentation of meatballs mixed with 1,5% chitosan

3.3 Third treatment: coated with 1,5% chitosan solution

The third treatment is to test chitosan effectiveness on meatballs coated chitosan solution with 1,5% concentration into meatballs dough. The result of four consecutive days observation can be seen in Table 4, Figure 6 and Figure 7.

Table 4.The result of organoleptic test on meatballs coated with 1,5% chitosan solution

Days	Meatballs	Taste					Color					Odor					Texture				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
D-1	M1					✓					✓					✓					✓
	M2					✓					✓					✓					✓
	M3					✓					✓					✓					✓
	M4					✓					✓					✓					✓
	M5					✓					✓					✓					✓
D-2	M1					✓					✓					✓					✓
	M2					✓					✓					✓					✓
	M3					✓					✓					✓					✓
	M4					✓					✓					✓					✓
	M5					✓					✓					✓					✓
D-3	M1				✓					✓					✓					✓	
	M2				✓					✓					✓					✓	
	M3				✓					✓					✓					✓	

	M4	✓	✓	✓	✓
	M5	✓	✓	✓	✓
D-4	M1	✓	✓	✓	✓
	M2	✓	✓	✓	✓
	M3	✓	✓	✓	✓
	M4	✓	✓	✓	✓
	M5	✓	✓	✓	✓

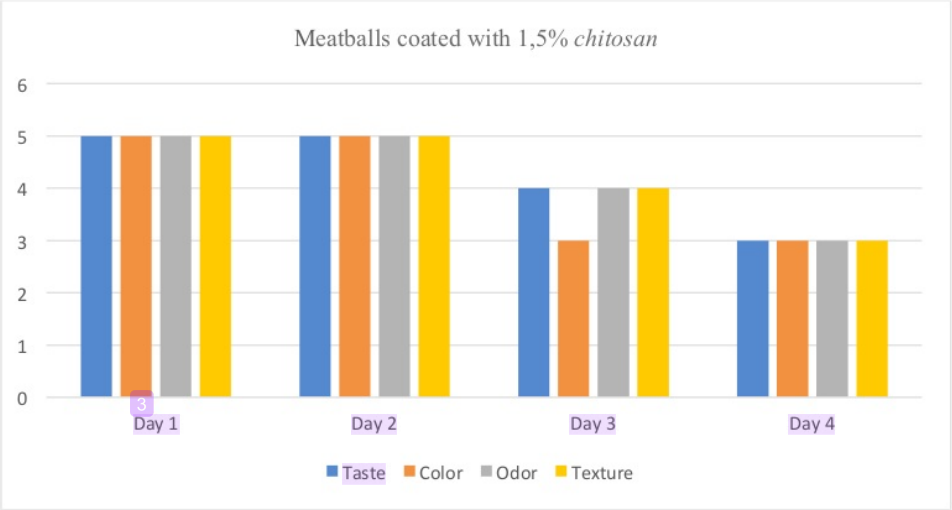

Figure 6.Bar chart showing organoleptic test result on meatballs coated with 1,5% chitosan

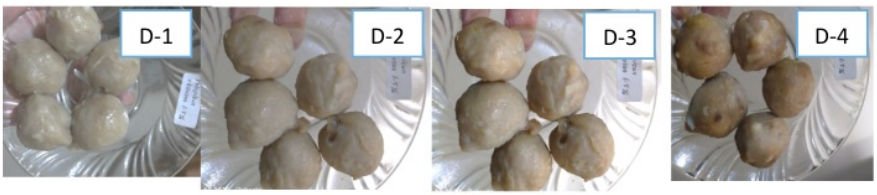

Figure 7. Observation documentation of meatballs coated with 1,5 chitosan

4. Discussion

Now, we will show the analysis of the effectiveness of the use 1.5% chitosan solution on meatball respected to our result findings. The results show that third threatment of citosan solution is significantly effective for being preservative for meatballs, namely when we coat the citosan solution on the meatball surface. The followings are the details of discussion.

4.1 First treatment: without chitosan

Based on the observation, meatballs without chitosan started to change in color on day 2, from lighter color on day 1 to darker on day 2. This implies that meatballs started to lose its quality due to change in color, indicating that they got oxidized and probably contaminated by damaging microbes. Afterwards, on day 3, changes were more significant in taste, color, odor,

and texture.Finally, on day 4 changes became more obvious. The meatballs did not taste good, the color turned dark, while their odor smelled like rotted, and the texture became a little stiff. These happened because chitosan as preservatives became ineffective on day 4, therefore more microbes contaminated the meatballs [9].

4.2 Second treatment: mixed with 1,5% chitosan solution

The result of observation on day 1 and 2 indicates no significant change in taste, color, odor, or textureof meatballs. This finding implies that meatballs had not been contaminated by microbes. Further, it implies that the 1,5% chitosan solution added to meatball dough works well [9]. On day 3, changes were identified in color and texture; its light color turned , and its chewy texture turned tender on the third day. This change indicates the process of meatballs being oxydized. Finally on day 4, changes were observed in all parameters, taste, color, odor, and textureof the meatballs. The meatballs tasted less delicious and a little sour, looked darker, smelled bad, and the texture became mushy. These changes implied that chitosan as preservatives became even less effective, therefore more putrefactive microbes came and contaminated the meatballs.

4.3 Third treatment: coated with 1,5% chitosan solution

Based on the result identified on day 1, 2, and 3, there were no significant changes in taste, color, odor, and textureof meatballs coated with 1,5% chitosan solution. This result indicates that meatballs remained in the same quality as no damaging microbes contaminated them. Furthermore, the meatballs remained good until three days because the 1,5% chitosan solution used as coating worked well. Such chitosan coating on meatballs were found more effective in preventing microbes' contamination [7]. Then, on day 4, the quality started to decrease, like there were changes in taste, color, odor, and texture. The tasteof the meatballs became less delicious and a little sour. Their color turned darker, the meatballs started to smell bad, and the texture became tender even mushy. These changes emerged due to the ineffective preservatives on day 4, thus damaging microbes started to contaminate the meatballs.

5. Conclusion

The study is briefly concluded in three points, as follows: 1) Chitosancan be produced by processing shrimps shell through demineralization, deproteinization, and deacetylation. 2) Chitosan can be made as natural preservatives for meatballs. It has been proven through the study that meatballs when added with chitosan with 1,5% concentration can maintain the quality longer than when not added with it. 3) Chitosan is more effective as natural preservatives for meatballs when it is as a coating.

6. Acknowledgments

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