



# **Effect of Red Ginger Essential Oil (*Zingiber officinale* Var. *Rubrum*) Addition on Chitosan Based Edible Coating towards Organoleptic Characteristics Pempek**

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## **ABSTRACT**

This study aims to determine the best concentration of red ginger essential oil addition (*Zingiber officinale* var. *Rubrum*) edible coating to chitosan on the organoleptic quality of pempek. The research method was experimental which consisted of 5 treatments, namely control, addition of red ginger essential oil with concentrations of 0%, 0.5%, 1%, and 1.5% with 20 panelists as replicates. Parameters observed included organoleptic characteristics (appearance, texture, aroma, taste, tooth test, and folding test) based on the panelists' preference level using hedonic tests and chemical analysis (moisture content and fat content) and the shelf life of pempek. The data from the water content and fat content tests were analyzed descriptively, while the organoleptic test results were analyzed using non-parametric statistics with the test Friedman, if the test Friedman gave a rejection, multiple comparisons were performed and test was performed Bayes for decision making. The results showed that the best treatment in extending the shelf life of pempek was treatment D with the addition of 1% red ginger essential oil with a moisture content of 55.30% on the first day and 55.31% on the fourth day. While the fat content on the first day was 1.42% and on the fourth day it rose to 2.72% with the characteristics of appearance, texture, aroma, and taste still favored by the panelists.

**Keywords:** Edible coating; essential oil; mackerel; pempek; red ginger.

## 1. INTRODUCTION

Pempek is a traditional food from Palembang, South Sumatra, which is made from ground fish meat and tapioca flour as its raw materials. Pempek also contains 82.36% carbohydrates, 13.95% protein, and 0.31% fat. Pempek derived from fish has a fairly high water content of 61.46% which can accelerate quality degradation. Pempek lenjer with the composition of 39.7% came from the fish and kept on at room temperature (25°C) have a shelf life for a day [1]. Pempek preservation needs to be done so that the quality of pempek can be maintained so that it can extend the shelf life of pempek by applying *active edible coating* using chitosan.

Chitosan has a strong positively charged amino group that can bind the negative charge of other compounds that can inhibit bacterial growth, and is easily degraded biologically and irregularly [2]. will bind to the cell membrane protein glutamate which is a component of cell membranes. Because of these properties, chitosan can be used as an *edible coating* with the aim of extending the shelf life of a food product.

*Edible coating* is a method of applying a thin layer to the surface of a food product by *dipping, spraying, casting, and brushing* on the food surface. *Edible coating* can protect products from microorganisms, oxygen, fungi, and can bind water. To maximize the durability of pempek, additional antimicrobial compounds can be used in *edible coatings* chitosan called *active edible coatings*. *Active edible coating* is the application of *edible coating* chitosan with the addition of certain ingredients such as essential oils that can be used to inhibit microbial growth. antimicrobial activity of essential oils from spices such as ginger have antimicrobial compounds as inhibitors for the growth of microorganisms. According to the research the antibacterial activity of both essential oils can inhibit gram-negative bacteria [2].

Red ginger is a spice plant that contains a lot of essential oils (3.90%) higher than other types of ginger plants such as elephant ginger and emprit ginger. Red ginger essential oil contained 64.6% compounds *monoterpenoid* from 19 identified compounds, with major components being *geranial* (28.4%), *neral* (14.2%), and *B-sesquiphellandrene* (9.9%) [4]. Essential oils are lipophilic which can penetrate bacterial walls

because they have polysaccharides, phospholipids, and fatty acids that can damage cell walls so that they can kill bacteria and can remove cytoplasmic material.

Product shelf life is a sensory change in a product that can be considered whether the product is still feasible or not accepted by consumers. Pempek with a composition of 39.7% derived from fish and stored at room temperature can only be last for one day [1]. So that the level of acceptance needs to be checked on the quality of the product that can be measured physically, chemically, and sensory.

Based on the explanation above, a research was conducted on *edible coating* of chitosan with the addition of antibacterial compounds from red ginger (*Zingiber officinale roxb. var rubrum*) containing essential oils to maximize the shelf life of pempek and improve its organoleptic quality.

## 2. MATERIALS AND METHODS

### 2.1 Time and Place

This research will be carried out in November 2020 - January 2021 at the Fishery Product Processing Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University. , Sumedang Regency, West Java, Indonesia.

### 2.2 Materials and Tools

Materials zused in the study included 500 g of mackerel meat, 100 ml of distilled water, 500 g of tapioca flour, 13 g of salt, 150 ml of ice water, 14 g of garlic, red ginger essential oil obtained from CV. M & H farm bogor, chitosan obtained from CV. *Bio Chitosan* Indonesia. The tools used are knives, cutting boards, basins, *food processors*, blenders, frying pans, strainers, analytical scales, pots, stoves, ziplock plastic, measuring cups, beakers.

## 3. RESEARCH PROCEDURE

### 3.1 Procedure of Making Chitosan Active Edible Coating

Weighed 1.5 grams of chitosan powder in a glass beaker then added 9 ml of 1% glacial acetic acid diluted with distilled water until the volume reached 100 ml at 40°C until a

suspended solution was formed. Furthermore, red ginger essential oil was added according to the concentration. Then the active edible coating is filtered and ready to use.

### 3.2 Procedure for Making Pempek

Mackerel fillet in to 2 parts until it reaches 500gr then washed and cleaned. Then the filet is mashed using a *food processor* with 150 ml of cold water added. After the mackerel is smooth, put into the basin and add 500 grams of tapioca flour, 7 grams of flavoring, 14 grams of ground garlic, and 13 grams of salt. The ingredients are stirred until a dough forms, then small lenjerans are formed with a diameter of 2 cm and a length of 6 cm. then the pempek is boiled at a temperature of  $\pm 100^{\circ}\text{C}$  until the pempek floats. The ripe pempek is drained.

### 3.3 The Application of Active Edible Coating Chitosan Pempek

Pempek which has been boiled is immersed in the solution *chitosan edible coating* for 5 minutes. After that, organoleptic observations were carried out (taste, aroma, appearance, texture, bite test, and folding test), water content test and fat content test. The rest of the pempek was stored in a plastic *clip lock* that had been perforated at room temperature ( $25^{\circ}\text{C}$  -  $30^{\circ}\text{C}$ ). Pempek is observed until there is a decrease in quality.

### 3.4 Research Methods

Method used in this research is an experimental method consisting of 5 treatments, namely pempek without treatment, 0%, 0.5% 1% and 1.5% with 20 semi-trained panelists as replicates with a concentration of 1.5% chitosan. in each treatment the addition of red ginger essential oil based on the volume of *edible coating*. The

parameters observed in this study were organoleptic characteristics (appearance, texture, aroma, taste, tooth test, and folding test) based on the panelists' preference level and chemical analysis (water content and fat content) in pempek for each treatment.

### 3.5 Data Analysis

The results of chemical tests, bite tests and folding tests were analyzed descriptively. Meanwhile, the results of the organoleptic test were analyzed using non-parametric methods, namely using the test *Friedman* to determine the panelists' preference for the organoleptic characteristics of pempek. If the test *Friedman* shows significant results, a further test is carried out, namely (*multiple comparisons multiple comparison*) to determine the difference between each treatment carried out using the method *Bayes* by considering the weight of the criteria and the median value [5].

## 4. RESULTS

### 4.1 Organoleptic Characteristics of Pempek

Test observations were carried out using a hedonic (liking) scale with observation parameters in the form of appearance, aroma, texture, and taste as well as folding tests and tooth tests to determine the panelists' preference level.

### 4.2 Appearance

Appearance is one of the organoleptic parameters that has an important role for panelists to assess the quality of a product. The average value of the hedonic test on the appearance of Pempek is presented in Table 1.

**Table 1. Value of the appearance of pempek tenggiri on storage day 4**

Red Ginger Essential Concentration (%)	Median	Average
Control	3	3.7 <sup>a</sup>
0	3	3.8 <sup>a</sup>
0.5	5	4.7 <sup>ab</sup>
1	6	5.8 <sup>ab</sup>
1.5	5	4.9 <sup>b</sup>

*Note: The numbers followed by different letters on the average treatment indicate a significant difference according to the multiple comparison test with a significance level of 5%*

The Friedman test value at the 5% test level showed that the appearance of the *edible coating* chitosan did not have a significant effect on the appearance characteristics of pempek. The addition of different concentrations of red ginger essential oil showed an average value of 5.8 in pempek, the addition of 1% red ginger essential oil concentration with a median value of 6 which means that the appearance is favored by the panelists. The use of coatings using gelatin on barramundi fish fillets containing lemongrass oil is able to maintain the brightness level [6]. coating using *edible coating* made from polysaccharides is able to improve flavor, texture, color and increase stability during storage, as well as improve appearance and reduce the level of spoilage of a product [7].

### 4.3 Aroma

Aroma in a food product has an important role in the food industry as a producer of flavorings that can be used to enhance taste, which can increase the attractiveness of a food product [8]. The average value of the hedonic test on the texture of Pempek is presented in Table 2.

The value of the Friedman test results at the 5% test level showed that the aroma of the addition of 1% red ginger essential oil had a significant effect on the characteristics of the pempek aroma with a median value of 7 with an average value of 6.0, which means that the aroma was

favored by the panelists. Red ginger essential oil contains *zingiberene* (component of ginger essential oil aroma) ranging from 19.61%-21.38% [9]. Thereaction *Maillard* occurs during the frying process which will give the food a distinctive aroma and taste [10].

### 4.4 Taste

Taste is a biological perception produced by material entering the mouth that is perceived by taste receptors in the mouth and aroma receptors in the nose. The average value of the hedonic test on the taste of pempek is presented in Table 3.

The value of Friedman's test results at the 5% test level shows the taste of *edible coating* Pempek chitosan with the addition of red ginger essential oil, 1% the average value is 5.9 with a median value of 7 which means that the panelists like it. Chitosan in *edible coatings* has a function as a coating on food products and has barrier properties (*Barrier*) is good, because the polysaccharide coating can form a strong and compact matrix so that the transfer of taste and aroma from the product is hindered by the layer [11]. Essential oils and *oleoresin* ginger cause more dominant characteristics, such as ginger pungent aroma due to the essential oils and *oleoresin* which give *after taste* a spicy taste on the food [12].

**Table 2. Value of the aroma of pempek tenggiri on storage day 4**

Red Ginger Essential Concentration (%)	Median	Average
Control	4	4.2 <sup>a</sup>
0	4	4.2 <sup>a</sup>
0.5	5	5.4 <sup>ab</sup>
1	7	6.0 <sup>b</sup>
1.5	3	4.1 <sup>a</sup>

Note : The numbers followed by different letters on the average treatment indicate a significant difference according to the multiple comparison test with a significance level of 5%

**Table 3. Value of the taste of pempek tenggiri on storage day 4**

Red Ginger Essential Concentration (%)	Median	Average
Control	6	6.2 <sup>b</sup>
0	7	6.3 <sup>b</sup>
0.5	6	6.1 <sup>b</sup>
1	7	5.9 <sup>b</sup>
1.5	5	4.1 <sup>a</sup>

Note : The numbers followed by different letters on the average treatment indicate a significant difference according to the multiple comparison test with a significance level of 5%

#### 4.5 Texture

Texture is one of the organoleptic parameters that has an important role for panelists to assess the chewy quality of a product. The average value of the hedonic test on the texture of Pempek is presented in Table 4.

The Friedman test value at the 5% test level shows that the texture of the *edible coating* of chitosan has a significant effect on the texture characteristics of pempek. The addition of different red ginger essential oil shows the highest textural characteristic value is found in pempek with the addition of 1% red ginger essential oil with an average value of 6.0 and a median value of 6 which means the texture is favored by the panelists. The addition of chitosan to pempek can improve the texture of pempek to be more elastic because chitosan is hydrophobic. Solvent molecules will be trapped between them and are mobilized, so that an upright and rigid structure is formed that is resistant to certain pressures and significantly affects the texture of pempek-pempek [13].

#### 4.6 Dental

The bite test is another test method used to measure the gel strength of a product. The bite test is used to measure the level of elasticity sensorily, this elasticity is related to the strength of the gel [14]. The average value of the bite test of Pempek *edible coating* of chitosan with the

addition of red ginger essential oil concentration is presented in Table 5.

The median value of the bite test on control pempek with pempek without the addition of red ginger essential oil (0%) shows the number 5 with an average value of 5.2 and 5.35, which means the level of elasticity of pempek is normal. The median value of the bite test on pempek with the addition of red ginger essential oil 0.5%, 1%, and 1.5% showed a median value of 5 with an average value of 5.65-6.0 which means the level of elasticity of pempek is rather strong. The use of *edible coating* chitosan with the addition of red ginger essential oil is proven able to provide a better level of elasticity pempek compared to the control treatment and the treatment without red ginger essential oil (0%). The addition of essential oils to *edible coatings* during storage on meatballs has a better elasticity value than the treatment of meatballs without antimicrobial packaging [15].

#### 4.7 Fold the folding

Testtest is one of the tests used to determine the level of elasticity in a product. The folding test was carried out by slicing the sample with a thickness of 5 mm and then tested by folding it into a half circle and a quarter circle [16]. The average value of folding test of pempek *edible coating* of chitosan with the addition of different concentrations of red ginger essential oil is presented in Table 6.

**Table 4. Value of the texture of pempek tenggiri on storage day 4**

Red Ginger Essential Concentration (%)	Median	Average
Control	3	3.5 <sup>a</sup>
0	5	4.7 <sup>ab</sup>
0.5	5	4.9 <sup>ab</sup>
1	6	6.0 <sup>b</sup>
1.5	5	5.6 <sup>b</sup>

Note : The numbers followed by different letters on the average treatment indicate a significant difference according to the multiple comparison test with a significance level of 5%

**Table 5. Value of biting test of red ginger essential oil pempek**

Concentration (%)	Median	Average
Control	5	5.2 <sup>a</sup>
0	5	5.4 <sup>a</sup>
0.5	6	5.7 <sup>a</sup>
1	6	6.0 <sup>a</sup>
1.5	6	5.9 <sup>a</sup>

Note : The numbers followed by different letters on the average treatment indicate a significant difference according to the multiple comparison test with a significance level of 5%

**Table 6. Value of folding test of red ginger essential oil pempek**

Ginger Essential Oil Concentration of Red Ginger Essential Oil (%)	Median	Average	Rating	Elasticity Level
Control	5	4.1 <sup>a</sup>	AA	Very Squishy
0	5	5 <sup>a</sup>	AA	Very Squishy
0.5	5	5 <sup>a</sup>	AA	Very Squishy
1	5	5 <sup>a</sup>	AA	Very Squishy
1.5	5	5 <sup>a</sup>	AA	Very Squishy

Note : The numbers followed by different letters on the average treatment indicate a significant difference according to the multiple comparison test with a significance level of 5%

The application of *edible coating* chitosan with the addition of different concentrations of red ginger essential oil, namely 0%, 0.5%, 1%, and 1.5% did not give a significant difference to the control treatment. The use of *edible coating* chitosan with the addition of red ginger essential oil was able to provide a better level of elasticity for pempek when compared to the control treatment. This is because the chitosan used as an ingredient for making *edible coatings* has high chemical reactivity which is able to bind water and oil so as to produce better elasticity [17].

#### 4.8 Decision Making Method Using Bayes

Method *Bayes* is one tool for measuring a chance of any decision taken by changing the ratio paired with a set of numbers that can present the priority value relative weights of the criteria and alternatives. Decision making using the method *Bayes* requires information in the form of *probabilities* for each alternative which will produce an expected value as the basis for decision making [18]. The average value of the test for *Bayes* pempek *edible coating* of chitosan with the addition of different concentrations of red ginger essential oil is presented in Table 7.

Based on the test table *Bayes* above, it can be concluded that taste is the most important criterion compared to appearance, aroma and texture. The use of *edible coating* chitosan on pempek with the addition of 1% red ginger essential oil obtained the highest alternative value of 6.64. Based on the preference test parameters that have been carried out, pempek *edible coating* chitosan with the addition of 1% red ginger essential oil concentration is the best treatment and is still preferred by panelists.

#### 4.9 Shelf Life of Pempek at Room Temperature

During the storage of pempek *edible coating* of chitosan with the addition of different

concentrations of red ginger essential oil at room temperature, observations were made on the shelf life of pempek with organoleptic parameters (appearance, aroma, and texture). Damage to the quality of pempek is marked by changes in the texture of pempek such as the presence of mucus on the surface of pempek, changes in brownish yellow color in pempek, and a foul odor arises [19]. Observations of daily organoleptic tests are presented in Table 8.

Based on the shelf life table above, during the storage of pempek *edible coating* of chitosan with the addition of different concentrations of red ginger essential oil at room temperature, observations were made on the treatment of pempek with organoleptic parameters including appearance, aroma, taste and texture. Pempek made through the boiling process is a semi-wet food that is prone to damage and has a short shelf life [20]. *edible coating* of chitosan with the addition of red ginger essential oil for four days. Pempek on the fourth day was still favored by panelists with a brilliant appearance, the aroma of red ginger essential oil began to decrease but still the faint smell of ginger and acetic acid, and had a chewy texture, so pempek was still suitable to enter the frying process.

#### 4.10 Water Content

Content is a factor that has a big influence on the durability of a processed material. This is because water can affect the quality of a product, especially on the appearance, texture, and taste of the product [21]. The results of the water content test of Pempek *edible coating* of chitosan with the addition of different concentrations of red ginger essential oil on day 1 and day 4 are presented in Table 9.

Based on the table above, the water content of control pempek then increased on the 4th day, which was 61.40%. However, the water content of pempek *edible coating* chitosan with the

addition of red ginger essential oil 0%, 0.5%, 1%, and 1.5% on the first day obtained water content of 58.85%, 55.65%, 55.31 %, and 53.23% during the storage period of pempek, the water content decreased on the fourth day, namely 56.81%, 55.31%, 55.30% and 53.06%. This is because the greater the concentration of essential oils fed, the lower the water content. Essential oils are hydrophobic so that the addition of essential oils to the product can increase the barrier properties against moisture and have resistance to gases, vapors, or liquids, and sensory properties in *coated products* [7].

#### 4.11 Fat content

Is one of the important elements in foodstuffs, because it has a function to improve the physical

form and structure of foodstuffs, add nutritional and caloric value, and provide a savory taste to foodstuffs [22]. The data from the research on the fat content of pempek *edible coating of chitosan* with the addition of different concentrations of red ginger essential oil on day 1 and day 4 are presented in Table 10.

Based on the table above, the fat content of control pempek on the first day was 2,68% and then decreased on the fourth day, which was 1,79%. In the 0% treatment without the addition of red ginger essential oil, the fat content of pempek using *edible coating chitosan* also decreased. On the first day of 0% treatment the fat content was 2.32%, on the fourth day it decreased to 1.85%. However, in pempek *edible coating of chitosan* with the addition of red ginger

**Table 7. Matrix of decisions for assessment of pempek active edible coating**

Concentration of Red ginger essential oil (%)	Criteria for				Alternative	Value
	Appearance	Aroma	Texture	Taste		
Control	3	4	3	6	4.68	0.17
0	3	4	5	7	5.38	0.20
0.5	5	5	5	6	5.52	0.21
1	6	7	6	7	6.64	0.25
1.5	5	3	3	5	4.57	0.17
Criteria Weight	0.27	0.12	0.09	0.52		

**Table 8. Average value of organoleptic characteristics of pempek mackerel during storage**

Day to	Storage																			
	Appearance					Aroma					Taste					Texture				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
1.	7, 2	7, 2	8, 0	8, 3	7, 6	7, 5	7, 3	6, 4	6, 3	4, 0	7, 3	7, 1	6, 5	6, 4	4, 7	6, 8	7, 3	7, 6	7, 8	6, 3
2.	6, 7	6, 9	7, 3	7, 2	7, 1	7, 5	6, 4	5, 4	6, 0	4, 1	6, 9	6, 1	6, 0	6, 5	3, 9	7, 2	7, 0	6, 8	6, 8	5, 6
3.	5, 7	5, 9	5, 7	4, 9	6, 1	7, 1	6, 6	5, 8	5, 8	6, 4	6, 3	6, 0	6, 1	6, 9	4, 9	6, 2	6, 2	6, 1	5, 9	5, 5
4.	3, 7	3, 8	4, 7	5, 8	4, 9	4, 2	4, 2	5, 4	6, 0	4, 1	6, 2	6, 3	6, 1	6, 9	4, 1	3, 5	4, 7	4, 9	6, 0	3, 8
5.	3, 0	3, 2	3, 6	4, 3	4, 4	2, 9	2, 9	3, 5	4, 2	4, 0	3, 3	3, 5	5, 2	5, 5	3, 6	3, 0	3, 3	3, 8	4, 0	3, 3

**Table 9. Test results of water content of pempek active edible coating**

Concentration of Red ginger essential oil (%)	Water content (%)	
	1 <sup>st</sup> Day (%)	4 <sup>th</sup> Day (%)
Control	55,95	61,40
0	58,85	56,81
0,5	55,65	55,31
1	55,31	55,30
1,5	53,23	53,06

**Table 10. Test results of fat content of pempek active edible coating**

Concentration of Red Ginger Essential Oil (%)	Fat Content (%)	
	1 <sup>st</sup> Day (%)	4 <sup>th</sup> Day (%)
control	2.68	1.79
0	2.32	1.85
0.5	1.85	1.96
1	1.42	2.22
1.5	1,05	2,35

essential oil with different concentrations of 0.5%, 1%, and 1.5%, the fat content test on the first day was 1.85%, 1.42%, and 1.05% during the storage period of pempek increased on the fourth day with fat content of 1.96%, 2.22% and 2.35%. Essential oil compounds with high concentrations will diffuse and their hydrophilic components will bind to oil molecules which will cause the lysis of the entire membrane *lipoprotein* which will result in cell wall damage, causing microbial cells to die [23].

## 5. CONCLUSION

Based on the research that has been carried out, it can be concluded that adding 1% essential oil to *edible coating* chitosan is the best treatment for organoleptic tests (appearance, texture, aroma, taste, bite test, folding test) and chemical tests (moisture content, content of water). fat) and able to inhibit microbial growth and extend the shelf life of pempek up to four days at room temperature.

## DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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