



The Effect of Adding Citronella Oil (*Cymbopogon nardus*) on Edible Coating from Chitosan towards Organoleptic Characteristics of Pempek

Ratu Keyla Kamal^{1*}, Iis Rostini¹, Mega Laksmi Syamsudin¹ and Rusky Intan Pratama¹

¹*Department of Fisheries, Faculty of Fisheries and Marine Science, Padjadjaran University, Sumedang Regency, West Java, Indonesia.*

Authors' contributions

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

Article Information

DOI: 10.9734/AJFAR/2021/v11i330202

Editor(s):

(1) Dr. Luis Enrique Ibarra Morales, University of Sonora, Mexico.

Reviewers:

(1) Mohebat Abd El Karem Abd El Aziz, Animal Health Research Institute, Egypt.

(2) Wafai Z. A. Mikhail, Cairo University, Egypt.

(3) Dr. Jayappa Mahalappa Koli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, India.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/65337>

Received 20 November 2020

Accepted 27 January 2021

Published 12 February 2021

Original Research Article

ABSTRACT

The purpose of this research was to determine the best concentration of citronella oil on the edible coating from chitosan towards the organoleptic quality of pempek. This research used an experimental method consisting of 5 treatments: without edible coating (control one), addition of citronella oil with a concentration of 0%, 1.5%, 2.5%, and 3.5% using 20 panelists as replications. The parameters observed in this research were organoleptic characteristics (appearance, texture, aroma, taste, teeth cutting test, and folding test) based on the panelists' preference level using a hedonic test and chemical analysis (water content and fat content) and shelf life of pempek for each treatment. Chemical test data were analyzed descriptively while the organoleptic test results were analyzed using the Friedman test. Based on the Friedman test, it was found that pempek edible coating chitosan with the addition of citronella oil up to 2.5% is still preferred by panelists with a water content on 1st day was 53.08% and on 4th day was 53.05% while the fat content on 1st day was 1.46% and on 4th day was 2.72%. Based on the Bayes test, taste is the most important criterion compared to appearance, texture and aroma. Pempek edible coating chitosan with the addition of citronella oil has a shelf life of up to 4 days.

*Corresponding author: Email: ratukeyla10@gmail.com;

Keywords: Citronella oil; chitosan; edible coating; organoleptic; pempek.

1. INTRODUCTION

Pempek is a traditional food from South Sumatra which uses fish as raw material. Pempek is prone to damage because it has high water content. This is the reason sellers take a shortcut to preserve pempek by adding borax as a preservative because borax can be obtained easily and the price is quite affordable.

To solve this problem, chitosan can be used as a substitute for borax. Chitosan is a derivative product of chitin polymer which is produced from fishery processing industrial waste, one of which is shrimp head and shell waste. Chitosan can be used as a natural preservative in making edible coatings because it contains antibacterial compounds that can inhibit the bacterial growth by damaging cell membranes [1].

Edible coating is a group of edible packaging materials that can protect food products, the original appearance of the product can be maintained and can be eaten immediately and is safe for the environment [2]. Edible coating is made of edible materials by dipping, spraying, casting, brushing onto the surface of food products to protect and increase the added value of the product (Miskiyah 2010). To maximize the durability of pempek, additional antimicrobial compounds can be used in the edible coating which is commonly called the active edible coating. Active edible coating is the application of an edible coating with the addition of certain materials so that it can inhibit damage by microorganisms [3].

Citronella oil has a function to inhibit bacterial growth so that it can be used as a food preservative. The chemical composition of citronella oil contains 32-45% citronellal compounds, 12-18% geraniol, 12-15% citronellol, 3-8% geraniol acetate, 2-4% citronellal acetate [4]. Citronella oils have lipophilic properties that can pass through bacterial walls because the bacterial walls are composed of polysaccharides, fatty acids, and phospholipids, which can cause damage to cell walls so they can kill bacteria. In addition, essential oils can also inhibit the stability of bacterial cell membranes and cause loss of cytoplasmic material [5].

The shelf life of a product can be determined based on sensory changes in the product that consumers can consider whether the product is still suitable or not acceptable. Changes in the

quality of a product can be measured from changes in physical, chemical, and sensory acceptance levels [6].

Based on this explanation, it is necessary to conduct research on the addition of additional antibacterial compounds such as citronella oil (*Cymbopogon nardus*) to chitosan edible coating to maximize the durability of pempek and improve its organoleptic quality.

2. MATERIALS AND METHODS

2.1 Time and Place

This research was conducted during July-October 2020. The study was conducted in the Fishery Product Processing Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Sumedang Regency, West Java, Indonesia.

2.2 Materials and Tools

The materials used are water soluble chitosan powder food grade 100 g from CV. Bio Chitosan Indonesia, citronella oil food grade 60 ml from PT. Aroma Atsiri Indonesia, mackerel fish meat 500 g, distilled water 100 ml, tapioca flour 500 g, salt 13 g, ice water 150 ml, garlic 14 g. The tools used are knives, cutting boards, basins, meat grinders, blenders, pans, filters, analytical scales, ziplock plastic, measuring cups, beaker glass.

2.3 Research Procedure

2.3.1 Procedure of making chitosan active edible coating

Water soluble chitosan powder is weighed as much as 1.5 grams and put into a beaker glass then 100 ml of distilled water is added, then the solution is stirred until it is homogeneous. Furthermore, citronella oil is added according to the concentration determined then the active edible coating is filtered and ready for use.

2.3.2 Procedure of making pempek

Mackerel fish meat is mashed using a meat grinder, then put into a basin then added with ice water and stir until evenly distributed. Then the necessary ingredients are weighed and put in the basin and then stirred until a dough forms. The dough is formed by a small lenjer, then the

pempek is boiled at a temperature of $\pm 90^{\circ}\text{C}$ until the pempek floats. The cooked Pempek is drained.

2.3.3 The application of active edible coating chitosan

Pempek is immersed in chitosan edible coating solution for 5 minutes. Then the organoleptic test was carried out, and the other pempek were stored in ziplock plastic which had been given a hole at room temperature (25°C - 30°C). Organoleptic quality observations were carried out once a day.

2.4 Research Methods

This research used an experimental method consisting of 5 treatments: without edible coating control one, addition of citronella oil with a concentration of 0%, 1.5%, 2.5%, and 3.5% using 20 panelists as replications. In each treatment using a chitosan concentration of 1.5%. The parameters observed in this research were organoleptic characteristics (appearance, texture, aroma, taste, teeth cutting test, and folding test) based on the panelists' preference level using a hedonic test and chemical analysis (water content and fat content) on pempek for each treatment.

2.5 Data Analysis

Chemical test data were analyzed descriptively. The results of the organoleptic test were analyzed using non-parametric, namely the Friedman test to determine the level of preference for the panelists to the organoleptic characteristics of pempek. If the Friedman test shows significant results, a further multiple comparison test is carried out to determine the difference in each treatment [7].

The hedonic test usually produces many of the same numbers so it is necessary to carry out an analysis that can provide differences between treatments. The best decision making from several treatments can use the Bayes method by considering the criterion weight and median value.

3. RESULTS

3.1 Organoleptic Characteristics of Pempek

Observation of the organoleptic characteristics was carried out using a hedonic scale to determine the level of preference for the panelists. The criteria observed were appearance, texture, aroma, and taste. Folding test and teeth cutting test were also carried out.

3.1.1 Appearance

Appearance will give rise to a good impression or not according to the panelist's level of preference for the product [8]. The hedonic average value of pempek appearance is presented in Table 1.

The results of the Friedman test showed that the application of chitosan edible coating with the addition of citronella oil to a concentration of 3.5% did not have an effect on the appearance characteristics of pempek with a median value ranging from 7 to 9, which means that pempek is still favored by panelists. Edible coating made from polysaccharides can improve flavor, texture, color and increase stability during storage, improve appearance and reduce the level of spoilage of a product [9]. The addition of lemongrass oil to gelatin edible film can increase the brightness of the color of the barramundi fish fillets [10].

Table 1. Value of Pempek Appearance Based on Concentration of Citronella Oil

Concentration of citronella oil (%)	Median	Average
Control	7	7.1 ^a
0	7	7.1 ^a
1.5	9	8.1 ^a
2.5	9	8.3 ^a
3.5	7	7.5 ^a

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%

3.1.2 Texture

Texture is an organoleptic assessment parameter that affects consumer acceptance of a product. The hedonic average value of the pempek texture is presented in Table 2.

The results of the Friedman test showed that the median value of the highest texture characteristics was found in the addition of 2.5% citronella oil with a value of 8, which means that the panelists preferred it. The lowest median value for texture characteristics is in the control treatment with a value of 5 which means normal or neutral. The addition of citronella oil to pempek can improve the texture of pempek to become more elastic because the essential oil is hydrophobic. Hydrophobic group will tend to produce a strong gel system because it can hold water into the product so that it can affect the elasticity of the pempek [11].

3.1.3 Aroma

Aroma can determine the delicacy of food and affect the level of acceptance [12]. The hedonic average value of the pempek aroma is presented in Table 3.

The results of the Friedman test showed that the highest median value of aroma characteristics was found in the control treatment, the addition of 0%, 1.5% and 2.5% citronella oil with a value of 7, which means that the panelists preferred it. The lowest median value for aroma characteristics is in the treatment of 3.5%

citronella oil with a value of 5 which means normal or neutral. Essential oils are formed from volatile compounds, these compounds easily reach the olfactory system at the top of the nose. Citronella contains essential oils of 0.4% [13].

3.1.4 Taste

Taste is a parameter that determines the final decision of consumers to accept or reject a food product [14]. The hedonic average value of the pempek taste is presented in Table 4.

The results of the Friedman test showed that the median value of the highest taste characteristics was in the control treatment, the addition of 0%, 1.5% and 2.5% citronella oil with a value of 7, which means that the panelists preferred it. While the median value of the lowest taste characteristics was found in the addition of 3.5% citronella oil with a value of 4 which means that it is less favorable. Pempek with a concentration of 3.5% citronella oil has a spicy and slightly bitter taste. The more citronella oil is added, the spicy sensation will increase, this is because the volatile compounds in citronella oil can give a bitter and spicy taste [15].

3.1.5 Folding test

The folding test is a test to see the elasticity of a product. The average value of the chitosan edible coating pempek fold test with the addition of different concentrations of citronella oil is presented in Table 5.

Table 2. Value of pempek texture based on concentration of citronella oil

Concentration of citronella oil (%)	Median	Average
Control	5	5.6 ^a
0	7	7 ^{ab}
1.5	7	7.1 ^{ab}
2.5	8	7.9 ^b
3.5	6	6 ^a

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 pempek aroma based on concentration of citronella oil

Concentration of citronella oil (%)	Median	Average
Control	7	7.2 ^b
0	7	7.3 ^b
1.5	7	6.4 ^{ab}
2.5	7	6.3 ^{ab}
3.5	5	4.9 ^a

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 chitosan edible coating with the addition of different concentrations of citronella oil, namely 0%, 1.5%, 2.5%, and 3.5% did not give a significant difference to the control treatment. However, the use of chitosan edible coating with the addition of citronella oil was able to provide a better elasticity level of pempek compared to the control treatment. Chitosan which is used as an edible coating material has high chemical reactivity properties that can bind water and oil to produce better elasticity [16].

3.1.6 Teeth Cutting Test

The teeth cutting test is used to measure the level of sensory elasticity, this elasticity is related to the strength of the gel [17]. The average value of the chitosan edible coating pempek teeth cutting test with the addition of different concentrations of citronella oil is presented in Table 6.

The median value of the control treatment shows the lowest value is 6, which means that the pempek has a rather strong elasticity level. The

highest median value of the teeth cutting test was found in the addition of 0%, 1.5%, 2.5%, and 3.5% citronella oil with a value of 7 which means that pempek has a fairly strong elasticity level. The use of chitosan edible coating with the addition of citronella oil was able to provide a better elasticity level of pempek compared to the control treatment. The use of chitosan edible coating with the addition of citronella oil was able to provide a better elasticity level of pempek compared to the control treatment. Chitosan has high chemical reactivity properties which can bind water. the reduced water content in a product will cause the product to be more compact and tougher in texture [18].

3.2 Decision Making Using the Bayes Method

The results of calculations to determine the best treatment were carried out by considering the appearance, aroma, texture, and taste criteria of chitosan edible coating with the addition of different concentrations of citronella oil are presented in Table 7.

Table 4. Value of pempek taste based on concentration of citronella oil

Concentration of citronella oil (%)	Median	Average
Control	7	7.3 ^b
0	7	7.2 ^b
1.5	7	6.5 ^b
2.5	7	6.2 ^b
3.5	4	3.8 ^a

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 pempek folding test based on concentration of citronella oil

Concentration of citronella oil (%)	Median	Average	Ranking	Elasticity
Control	5	4.7 ^a	AA	Very Elastic
0	5	5 ^a	AA	Very Elastic
1.5	5	5 ^a	AA	Very Elastic
2.5	5	5 ^a	AA	Very Elastic
3.5	5	5 ^a	AA	Very Elastic

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 pempek teeth cutting test based on concentration of citronella oil

Concentration of citronella oil (%)	Median	Average
Control	6	6.1 ^a
0	7	6.5 ^a
1.5	7	6.5 ^a
2.5	7	6.6 ^a
3.5	7	6.3 ^a

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%

Based on the Bayes test, taste is the most important criterion compared to appearance, texture and aroma. The use of chitosan edible coating on pempek with the addition of 2.5% citronella oil obtained the highest alternative value of 9.98. The lowest alternative value is found in the addition of 3.5% citronella oil treatment of 6.85. Based on the preference test parameters that have been carried out, pempek edible coating chitosan with the addition of 2.5% citronella oil concentration is the best treatment and is still preferred by panelists.

3.3 Shelf Life of Pempek at Room Temperature

The characteristics of organoleptic quality degradation in pempek are the appearance of mucus on the surface, the color changes to dullness, has an unpleasant taste, and has a bad smell [19]. Pempek was stored at room temperature and its organoleptic parameters were observed, such as appearance, aroma, and texture. Based on observations up to day-5 carried out by panelists, it was found that the shelf life up to the acceptance limit for chitosan edible coating pempek with the addition of citronella oil was 4 days. Pempek on day-4 is still preferred by the panelists with the appearance of the pempek is still bright, there is no foul smell yet, and the texture is still elastic, so that the pempek is still feasible to get into the frying process.

3.4 Water Content

The results of the water content test of pempek using chitosan edible coating with the addition of different concentrations of citronella oil on day-1 and day-4 are presented in Table 8.

Water content of control pempek or without active edible coating chitosan increased from 55.95% on day-1 to 61.40% on day-4. However, the water content of chitosan edible coating pempek with the addition of citronella oil was 0%, 1.5%, 2.5%, and 3.5% decreased on day-4. Essential oils are hydrophobic which can increase the barrier properties against moisture and have resistance to gases, vapors or liquids, and sensory properties in products that use edible coatings [9].

3.5 Fat Content

The results of the pempek edible coating chitosan fat content test with the addition of different concentrations of citronella oil on day-1 and day-4 are presented in Table 9.

The value of the control pempek fat content or without active edible coating decreased from 2.68% on day-1 to 1.85% on day-4. The fat content value of pempek using chitosan edible coating with the addition of 0% citronella oil also decreased from 2.32% on day-1 to 2.22% on day-4. However, the fat content of chitosan edible coating pempek with the addition

Table 7. Matrix of pempek active edible coating assessment decisions

Concentration of citronella oil (%)	Criteria				Alternative value	Value of priority
	Appearance	Aroma	Texture	Taste		
Control	7	7	5	7	8.36	0.19
0	7	7	7	7	9.30	0.21
1.5	9	7	7	7	9.51	0.22
2.5	9	7	8	7	9.98	0.23
3.5	7	5	6	4	6.85	0.16
Weight Criteria	0.11	0.28	0.14	0.47		

Table 8. The results of the S Day-1 and Day-4

Concentration of citronella oil (%)	water content	
	1 st Day (%)	4 th Day (%)
Control	55.95	61.40
0	58.85	56.81
1.5	53.23	53.06
2.5	53.08	53.05
3.5	52.53	52.08

Table 9.The results of the pempek active edible coating fat content test on Day-1 and Day-4

Concentration of citronella oil (%)	Fat content	
	1 st Day (%)	4 th Day (%)
Control	2.68	1.85
0	2.32	2.22
1.5	1.85	2.35
2.5	1.46	2.72
3.5	1.07	3.52

of citronella oil was 1.5%, 2.5%, and 3.5% increased on day-4. Essential oil compounds with high concentrations will diffuse and their hydrophilic components will bind to oil molecules which will eventually cause lysis of the entire lipoprotein membrane which results in damage to the cell walls causing the death of microbial cells [20].

4. CONCLUSION

Based on the research, it can be concluded that pempek with the addition of 2.5% citronella oil to the chitosan edible coating is the best treatment with the criteria of appearance, texture, aroma, and taste that are still favored by panelists. The addition of citronella oil to pempek effectively increases the shelf life of pempek up to 4 days.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Hui Liu, Yumin Du, Xiaohui Wang, Liping Sun. Chitosan kills bacteria through cell membrane damage. *International Journal of Food Microbiology*. 2004;95(2):147–155.
- Kinzel, B. Protein-rich edible coatings for foods. *Journal Agricultural Research*. 1992;40(5): 20-21.
- Mulyani S. The development of carrageenan-based active edible coating with natural active ingredients to extend the shelf life of catfish meatballs at room temperature. Thesis to Faculty of Agriculture. University of Lampung; 2019.
- Ketaren S. Introduction to essential oil technology. Balai Pustaka Jakarta; 1985.
- Dewi DNS. Antibacterial activity of lemongrass essential oil (*Cymbopogon Citratus*) against propionibacterium acnes in vitro. Essay. Medical School. University of Jember; 2015.
- Asiah N, Cempaka L, David W. Estimated shelf life of food products. Bakrie University Publishing; 2018.
- Daniel WW. Statistika Nonparametrik Terapan. PT. Gramedia. Jakarta; 1989.
- Rochima E, Pratama RI, Suhara O. Chemical and organoleptic characterization of pempek with the addition of goldfish bone flour from cirata reservoir. *Journal Akuatika*. 2015;(4)1:79-86.
- Winarti C, Miskiyah, Widaningrum. Production technology and application of starch-based antimicrobial edible packaging. *Journal Litbang Pertanian*. 2012;31(2):85- 93.
- Ahmad M, Benjakul S, Sumpavapol P, Nirmal NP. Quality changes of sea bass slices wrapped with gelatin film incorporated with lemongrass essential oil. *International Journal of Food Microbiology*. 2012;155(3):171-178.
- Sudrajat BN, Diniyah N, Fauziah RR. Characterization of physical and functional properties of koro benguk (*Mucuna pruriens*) protein isolate. National Seminar Proceedings APTA. Department of Agricultural Product Technology. University of Jembe;2016.
- Tribaditia R. Determination of optimization value from organoleptic characteristics of aroma and taste of corn hair tea products with the addition of lime and honey. *Journal Agroscience*. 2016; 6(1): 20-29.
- Kristiani B. Quality of serai (*Cymbopogon nardus* (L.) Rendle) effervescent powder Drink with variation in concentrations of citric acid and na bicarbonate. Essay. Faculty of Biotechnology. Atma Jaya University Yogyakarta. Yogyakarta;2013.
- Nirmala D, Masithah ED, Purwanto DA. Chitosan as an alternative preservative for Kamaboko Kurisi fish (*Nemipterus nematophorus*) in cold storage. *Fisheries*

- and Marine Scientific Journal. 2016;(8)2:109-125.
15. Ariyani F, Laurentia EF, Felycia ES. Extraction of essential oils from lemongrass plants using methanol, acetone, and n hexane solvents. Widya Teknik Journal. 2008;7(2): 124-133.
 16. Nurilmala M, Suptijah P, Nurfianti D. The use of chitosan as a gel forming in kurisi fish ball (*Nemipterus nematophorus*). Journal of Fisheries Product Technology. 2007;10(1):35-46.
 17. Edam M. Fortification of fish bone flour against the physical chemical characteristics of fish ball. Journal of Industrial Technology Research. 2016;8(2):83-90.
 18. Niamnuy C, Devahastin S, Soponronnarit S. Some Recent Advances in Microstructural Modification and Monitoring of Foods During Drying: A Review. Elsevier Ltd; 2013.
 19. Pratama M, Warsiki E, Haditjaroko L. Label performance to predict pempek shelf life under various storage conditions. Journal of Agricultural Technology. 2016; 26(3): 321-332.
 20. Agustini, Desi. Efforts to suppress the growth of fusarium oxysporum f.sp. cubense in banana plants with application of biopesticide in citronella leaves (*Cymbopogon Nardus L. Randel*). Journal Agrosience. 2017;7 (1):203-213.

© 2021 Kamal et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/65337>