



Edible Coating Starch Making for Preserving Fruit as an Alternative for Junior High School Science Practicum on Additives Substance Material

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Article history	Abstract
Submission : 2022-01-17	This research aimed to study the edible coating starch making for preserving fruit as an alternative for junior high school science practicum on additives substance material. The edible coating is a thin layer that can be consumed, inhibits microbial growth, and provides physical protection to the coated fruit. The steps to make edible coating starch carried out by the researchers are as follows: producing an eatable coating solution from cassava starch, making citronella extract fragrant, and application on fruit. Based on the results of research, edible coating starch with the addition of 30% citronella grass extract was the best treatment. Grapes could last up to 14 days of storage and showed a decrease in water content and fruit sugar by 72.22% and 4.80%, respectively. Based on the questionnaire of the teacher's responses to the manufacture of edible coating starch as an alternative to the science practicum, the results on the material aspects were in the marvelous category (90.62%), practical aspects were in a good category (79.01%), the cost and safety aspects were in the good category (85.11%). Therefore, it was possible to apply edible coating practice in schools.
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Keyword	
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1. INTRODUCTION

Science is one of the subjects that students must take in junior high school. Science is inseparable from everyday life and has an important role in life because the process of life depends on nature, substances that depend on nature, and symptoms that exist in nature (Wisudawati & Sulistyowati, 2017). In science learning, students must be involved physically and mentally. Providing hands-on experience to students in science learning is pivotal to developing students' competencies. Based on Ramadhan & Suyanto (2020), the implementation of the learning process cannot be separated from good planning. It is hoped that the role of teachers in paying attention to practicum learning planning can provide opportunities for students to understand the learning process in and outside the laboratories.

The objective of science learning in accordance with the 2013 Curriculum is inseparable from the role of the teachers to facilitate students in the learning science process. Teachers need to help students to develop a number of skills to be able to explore and understand the surrounding environment (Amin,

2010). The ideal condition for science learning is a balance of concepts, processes, and applications. Science practical has a crucial role in learning science (Prajoko et al., 2017). Based on Collete & Chiappetta (1994), science practical is a series of activities that enable the application of various process skills, foster learning motivation, and develop scientific attitudes to support material understanding and obtain scientific products.

One of the contents of the science learning material in 8th grade of junior high school is preservatives in chapter 5 entitled additives and addictive substances. These additives and addictive substances are in accordance with KD (Basic Competence) 3.6, which describes various additives in food and beverages, addictive substances, and their impacts on health. Preservatives are additives that are closely related to daily life. If students can understand the material of additives, one of which is food preservatives, they can provide information on the characteristics of natural preservatives and the impacts of their use on health. The importance of food preservative material requires the appropriate learning method so the students can understand the material.

An alternative idea for science learning activities is to teach food preservation material, one of which is through a practicum. Through the practicum, students will be more active in participating in activities, simulating experiences, and doing a visible thing, so the tendency to understand a concept reaches 70-80% (Falahudin et al., 2016). Based on the analysis of several grade VIII science text lessons in the first semester, in the chapter on additives and addictive substances, there is no practicum for food preservative material, especially in fruit preservation. Concerns in the community with the issue of the use of preservatives that are harmful to health in some food products require studies and solutions so that the problems and their various impacts can be resolved.

According to research conducted by Susiyawati & Qusyairi (2013), students' knowledge of various types of preservatives and foods containing preservatives is relatively lower than their knowledge of the meaning of preservatives. This is understandable because information about numerous preservative types is not generally known and not easily understood by common people, especially junior high school students. The use of natural food preservatives needs to be introduced to students about the contents, process, and use to increase students' knowledge.

One of the natural preservatives that are harmless and can be consumed is edible coating. The edible coating is one of the preservation technology innovations aiming to improve food quality and maintain food freshness (Wan et al., 2007). The edible coating is a thin layer that can reduce the transmission of water vapor or oxygen, inhibits microbial growth from external sources, maintains moisture and provide physical protection for packaged food/fruit (Raghav et al., 2016). Besides being applied to fruits and vegetables, the edible coating is also commonly applied to processed food products, such as cheese, meat, sausages, and bakery (Galus & Kadzińska, 2015). Furthermore, researchers provide alternative solutions for food preservative practicum, one of which is making edible coatings.

There are various types of materials can be used as edible coatings. The materials used for edible coating consist of polysaccharides (starch, pectin, cellulose, chitosan, and alginate), proteins (soy protein, whey protein, casein, cornstarch, albumen eggs, collagen, and wheat), and lipids (beeswax, mineral oil, vegetable oil, and surfactants) (Paul et al., 2018). These ingredients are easy to find in everyday life as starch. Starch can be made from cassava starch, cassava, sago, and other materials. Thus, students can easily find them.

Research conducted by (Winarti et al., 2012) regarding edible coatings made from sago starch by adding antimicrobial citronella grass oil on paprika shows that the combination of coating treatment with the addition of citronella oil is effective in extending the shelf life of peppers up to 7 days compared to the control. In addition, research conducted by Pokatong et al. (2014) shows that an edible coating of Gembili starch (*Dioscorea esculenta* L.) by adding plasticizers can extend strawberry shelf life 2.4-2.8 times longer than the control. Coating strawberries with different starch-plasticizer can be accepted by consumers, both hedonic and scoring.

The application of the edible coating method can be conducted in several ways, namely by means of dipping, dripping, foaming, panning, spraying, and so on (Hu et al., 2020). The selection of the appropriate application method for edible coatings depends on the characteristics of the food, the coating material, the desired coating effect, and the cost.

The results of this study are expected to be useful for science teachers in junior high schools in introducing materials, making edible coatings as a natural food preservative and its benefits in practicum, especially on additive materials, and providing meaningful learning experiences for middle school

students. This study aims to determine the teacher's response to the idea of making edible coatings as an alternative for science practicums in junior high school, especially on additives materials.

2. METHOD

This type of research is an experimental research type. The research design used was RAL (Completely Randomized Design) with three treatments, namely edible coating starch with the addition of citronella extract fragrant concentration (10%, 20%, and 30%) and control as a comparison with six replications.

The material used in this study was grapes as a sample of preserved food. The ingredients for making starch edible coating were cassava starch, CMC, pure coconut oil, citronella grass extract, and aquadests. The materials for measuring sample reduction sugar levels were standard glucose solutions, nelson A reagent, nelson B reagent, and arsenomolybdate reagent.

The tools used in this study were mortar and pestle, analytical scales, blenders, spectrophotometers, desiccators, cuvettes, test tubes, measuring cups, magnetic stirrers, fine filters, glass alarms, drop pipettes, measuring pipettes, measuring flasks, and oven. The stages of research carried out were:

2.1 Making of cassava starch

One kilogram cassava tubers were washed and then drained. Then, they were peeled and cut into small pieces. Cassava tubers were grated and squeezed with a filter cloth to take the filtrate. The filtrate obtained was left for more or less 24 h to form starch deposits from the cassava.

2.2 Making of citronella grass extracts

Citronella grass at sufficiently were washed using running water and cut with a sterile knife (sprayed with alcohol). The citronella grass cuts were then blended. After blending, the citronella grass was squeezed and filtered using a filter cloth to obtain the liquid. The liquid from the filter was used as fragrant citronella grass extract.

2.3 The process of making starch edible coating and its application

The process of making edible coating from cassava starch referred to the modified method developed by Winarti et al. (2012) as follows: one part cassava starch was mixed with ten parts aquadest and stirred with a scale mixer 1 until homogeneous for 10 min, then filtered using a filter cloth. The starch suspension was put into a 1000 mL measuring cup and heated on a hot plate while stirring with a scale 1 magnetic stirrer until it reached a temperature of approximately 65°C, then carboxymethylcellulose (CMC 1.0%) was gradually added while continuing to be heated and stirred with a magnetic stirrer until homogeneous. Pure coconut oil (10%) was then added as a plasticizer gradually while continuing to be heated and stirred until the starch suspension thickened. The solution was then cooled to 30°C, then the addition of fragrant citronella grass extract was treated (10%, 20%, and 30%).

The application of the edible coating on fruit was conducted by dyeing for 15 min. Then, the sloping process was carried out by air drying for 60 min. After the coating material dries, grapes were placed in a small container with a closed condition at room temperature (25-26°C) to continue the observation process during storage.

2.4 Observation phase

The observation phase was conducted by observing the water content and reducing the sugar content of grapes. Observation of water content was carried out by oven method (Thermogravimetry) (Winarno, 2002). Determination of Reducing Sugar Levels was carried out using the Nelson-Somogyi Method (Yazid & Lisda, 2006). Data on water content and reducing sugar content obtained in this study were analyzed using MANOVA (Multivariate Analysis of Variance).

From a simpler manufacturing process of edible coating that may be carried out in schools, the researcher asked for responses from 15 junior high school science teachers by distributing questionnaires. Questionnaires are used to determine the teacher's response to the possibility of making edible coatings as an alternative practicum, especially on additives material. The questionnaire was in the form of teacher responses consisting of three aspects, namely material, practicality, cost,

and safety. The teacher's response consists of 11 statements in which each statement consists of 4 answer options namely SS = Sangat Setuju/Strongly Agree, S = Setuju/Agree, TS = Tidak Setuju/Disagree, and STS = Sangat Tidak Setuju/Strongly Disagree. After the teacher provided a response the conversion value was in the form of SS = 4, S = 3, TS = 2, and STS = 1. The grid of questionnaires for teacher responses can be seen in Table 1.

Table 1. Grid of questionnaires for teacher responses

Aspects	Indicators
Material	a. Practicum edible coating in accordance with KD
	b. Edible coating practicum activities in accordance with the material being studied
	c. Edible coating practicum activities can provide real experiences for students
	d. Edible coating practicum activities can increase students' insight
Practical	a. Practicum for making edible coating is quite easy to make
	b. Edible coating practicum will make it easier to teach additive material concepts
	c. The time needed for lab work is not too long
	d. Tools and materials for edible coating practicum are easy to obtain
Cost and Safety	a. Edible coating lab tools and materials do not require expensive fees
	b. All edible coating practicums are cost-effective so they can be applied in schools
	c. All edible coating practicum activities are harmless for students so that it is possible to apply them at school

Initial data in the form of scores was then converted into five-scale qualitative data (data intervals). The conversion in score to a scale of five referred to Riduwan (2014) which can be seen in Figure 1. The results of the questionnaire were then analyzed descriptively.

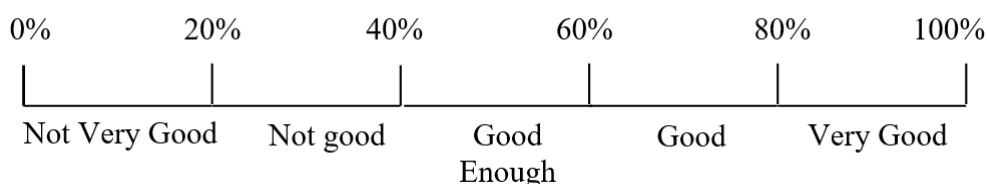


Figure 1. Reference conversion percentages into five categories

3. RESULT AND DISCUSSION

One of the parameters to see the freshness and durability of the fruit is to measure the water content and reduce the sugar content during storage. The data from the measurement of water content and reducing sugar levels can be seen in Table 2.

Table 2. Result of measurement water content and reducing sugar content

Treatment	Average (%)	
	Water Content	Reducing Sugar Content
Control	43.03	8.96
Starch	50.33	7.12
Starch + citronella grass extract 10%	55.93	6.57
Starch + citronella grass extract 20%	65.28	6.11
Starch + citronella grass extract 30%	72.22	4.80

Data from the measurements of water content and reducing sugar content were then analyzed using MANOVA. Prior to the MANOVA test, the prerequisite tests were carried out, namely the normality test and homogeneity test. The normality test was performed using the Kolmogorov-Smirnov and Shapiro Wilks tests at a significance level of 0.05. Based on the results of the normality test, it showed that the water content and reducing sugar content for the control and all treatments were normally distributed. This is because the Kolmogorov-Smirnov and Shapiro-Wilk significance values are greater

than 0.05 (5% significance level). The next prerequisites test was the homogeneity test. The homogeneity test was carried out to determine the similarity of the variable variant-covariance matrix simultaneously. Data is said to have covariant-variants if the significance value of Box's M test is greater than 0.05. The Box's M test results showed that the significance value was 0.890 ($p > 0.050$). Thus, it can be concluded that the variance-covariance matrix of the population is homogeneous, so the MANOVA test can be continued.

The MANOVA test was used to test whether there were differences in several bound variables between different groups. The hypothesis tested were:

Ho: There was no difference in water content and reducing sugar content between control and treatment (starch edible coating, starch edible coating + citronella grass extract 10%, 20%, 30%).

Ha: There were differences in water content and reduced sugar content between control and treatment (starch edible coating, edible coating starch + citronella grass extract 10%, 20%, 30%).

Decisions were taken using analysis of Hotteling's Trace. If the significance value obtained is less than 0.05, then Ho is rejected and Ha is accepted. The results of the MANOVA test can be seen in Table 3.

Table 3. The Result of the MANOVA

Effect	Sig.	Conclusion
<i>Hotteling's Trace</i>	0.000	Ho rejected

The results of the MANOVA test in Table 2 show that the significance value was less than 0.05. Thus, it can be concluded that there are differences in water content and reduced sugar content between control and treatment (starch edible coating, edible coating starch + citronella grass extract 10%, 20%, 30%).

Based on the research results, the starch edible coating, with the addition of 30% citronella grass extract, was the best treatment. Grapes could last up to 14 days of storage and showed the results of water content and reduced sugars in fruits of 72.22% and 4.80%, respectively. Untreated grapes (control) experienced the greatest water loss with a final average of 43.03% and reduced sugars fruits of 8.96%. This is because grapes are still carrying out life processes, namely the processes of respiration and transpiration after harvesting. The higher the respiration rate, the shorter the shelf life. Increased respiration rate will cause changes in compounds such as carbohydrates in fruit and produce CO₂, energy, and water that evaporates through the surface of the fruit skin which causes weight loss. Water coming from respiration activity will evaporate and cause water in the fruit to decrease. This is supported by Sharma et al. (2019) that fat can reduce air transmission, polysaccharides can control oxygen and other gas transmission, while protein films provide the mechanism.

The highest reduced sugar content in this study, was reducing sugar content without edible coating (control), while for starch with the addition of citronella grass extract of 10%, 20%, and 30% had reduced sugar content below the control value. Starch, as an edible coating material, can maintain reduced sugar content. This is because the coating of starch edible coating will reduce contact with oxygen so that respiration is inhibited and sugar use will be delayed (Santosa & Wirawan, 2014). According to Abdi & Kadir (2017), the increase in reduced sugar without coated with the edible coating is due to the hydrolysis process of starch into simple sugars (glucose and fructose) with the help of enzymes contained in the fruit.

The smaller the water content obtained indicates that the freshness of the grapes decreases. The decreasing water content causes the grapes to shrink further, where this weight loss is caused by high transpiration. Transpiration is water evaporation from agricultural commodity networks (Gardjito et al., 2015). Furthermore, the longer the storage, the lower the sugar level. This is because, during the ripening process, there is a change of starch into sugar.

Cassava starch is an example of a potential polysaccharide as an edible coating. Furthermore, polysaccharides are the base material of edible coatings, that can act as selectively permeable membranes for CO₂, and H₂O gases exchange, where their properties can extend the shelf life of grapes due to the respiration of grapes can be reduced (Gardjito et al., 2015). However, starch-based edible coatings have a weakness, namely low water resistance and low water vapor barrier properties, because the hydrophilic nature of starch can affect its stability and mechanical properties (García et al., 2011). Low film stability will shorten storage capacity so that it is less than optimal due to water vapor and microbes that enter

through the film will damage the material food. To improve the physical and functional properties of the starch film, it is necessary to add biopolymers or other materials, including materials that are hydrophobic and/or have antimicrobial properties (Winarti et al., 2013). One of the antimicrobials is citronella grass extract.

The natural preservatives of citronella grass can inhibit microbial growth in grapes, resulting in the decrease in sucrose can be inhibited. This is because fragrant citronella extract has bioactive components, such as saponins, tannins, flavonoids, alkaloids, and polyphenols that can function as antimicrobials (Syamsuhidayat & Hutapea, 1991). Based on research of Moniharapon et al. (2016), citronella grass extract can suppress microbial growth in tofu and maintain shelf life of tofu.

Based on the questionnaire distributed to 15 junior high school science teachers and the average value of teacher responses to the manufacture of edible coating as a practical alternative which can be seen in Table 4, there are three aspects of teacher's responses, namely: (1) material; (2) practicality; (3) costs and safety.

Table 4. Percentage average of every aspect from teacher's response

Aspects	Average (%)	Category
Material	90.62	Very Good
Practical	79.01	Good
Cost and Safety	85.11	Very Good

Based on Table 4, it is known that the material aspect category is in the very good category with an average value of 90.62%. This means that the practicum of making edible coatings is in accordance with KD 3.6, namely explaining various additives in food and beverages, addictive substances, and their impact on health. Furthermore, this edible coating practicum is in accordance with the material studied and can provide the real experiences for students. Thus, the students' knowledge also increases.

The practical aspects as displayed in Table 4, were in the good category with an average value of 79.01%. This shows that the practicum of making edible coatings is easy to make because the tools and materials are easy to obtain. Furthermore, it does not require a long time. The practical edible coating can make it easier for teachers to teach material concepts of additives. Based on Table 4, it can be seen that the cost and safety aspects had an average value of 85.11% in the very good category. This means that all practical activities for making edible coatings do not require expensive costs and are harmless for students, so it is possible to be applied in schools. According to Amin (2010), research-based learning will stimulate students to be always updated on the development of science and can be done contextually because it is based on concrete data from research results. Contextual learning is a learning system that links learning material with real world so that students can connect their knowledge and their application in daily life (Khusniati, 2012). Contextual learning activities can not only be conducted in the classroom but also in the laboratory. Teachers must be good at designing learning environments that can be easily related to real life. In this type of environment, students can find a connection between ideas that are not realistic in real-world contexts (Sahin, 2019). In addition, according to Nurmiyati (2009), utilizing relevant research results to the subject matter can make learning more active.

The initial learning that the teachers can perform starts from real problems in learning process, for example, the negative impact of preserving food/fruit ingredients for health. The next is an introduction to the solution using non-hazardous natural preservatives, such as edible coatings. Students are invited to perform practical work to make edible coatings and apply them to food /fruit. To observe the freshness parameters in food/fruit other than water content and reducing sugar content, a simple way that students can do is to directly observe the organoleptic properties of the fruit, such as color, aroma, taste, and texture. This is consistent with the research conducted by Anggarini et al. (2016) that canna edulis edible coatings can maintain the organoleptic properties of Anna apples. In addition, according to Baldwin et al. (2011), the application or use of a barrier layer (coating) can maintain the aroma of food, however the coating can also be used as a flavoring on the product surface.

This research is only limited to the teacher's response that the idea of making edible coatings carried out in this study can be used as an alternative practice for students in additive material, so further development is needed. One of them is developing practicum guidelines for food/fruit preservatives based on edible coating, which is expected to facilitate students in practicing edible coatings. In accordance with

the 2013 curriculum, science learning is demanded through a scientific approach so that students are more active and obtain real experience in learning activities (Sutanto & Qurniani, 2015).

4. CONCLUSION

Based on the results of the study, it can be concluded that there was a difference in the effect of edible coating with the addition of citronella grass extract (*Cymbopogon nardus* L.) at different concentrations of water content and reduced sugar content. The best water content was edible coating starch with the addition of 30% citronella grass extract with an average of 72.22%. The best reducing sugar content was edible coating starch with the addition of 30% citronella extract with an average of 4.80%. Based on the results of the teacher's questionnaire response to the manufacture of starch edible coating as an alternative to the science practicum, the material aspects were in the very good category (90.62%), practical aspects in a good category (79.01%), and cost and safety aspects in a very good category (85.11%). Thus, it is possible to apply edible coating practices in schools.

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