Edible Film Characterization from Cassava Starch and Its Organoleptic Properties as Primary Packaging of Snake Fruit Lunkhead

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Abstract

Most of the food packaging material made from plastic, which is difilcult to be decomposed. We need food packaging materials environmentally friendly and edible directly with the product. The experiment was conducted in the laboratory of post-harvest, Yogyakarta AIAT in March to October 2012. The purpose of this study was to know the characteristics of edible film made from cassava starch and organoleptic value as primary packaging of snake fruit lunkhead. The experimental design used was completely randomized design with two factors, nine treatments and three replications. The first factor was the percentage of cassava starch used, the second factor was the type of plasticizer used. The results showed that: 1) The range of water content from the ninth edible film treatments were 10-32%. 2) The highest percentace of cassava starch addition, caused the increassing of edible film water vapor transmission rate. 3) The use of sorbitol plasticizers provides the highest water vapor transmission rate. 4) The range of peroxide content from ninth edible film treatment were 1,64 – 7,08 meq/kg. 5) As the primary packaging snake fruit lunkhead, the highest edible film panelist overall preferences was from sorbitol plasticizer and 4% use of cassava starch, ie. 80% of panelists like it, with an average value 3,8 which means they like it.

Keywords: *edible film, cassava starch, lunkhead, and packaging*

1. INTRODUCTION

Lunkhead fruit is a semi-wet traditional food with about 27% water content, it is made from fresh fruit, glutinous rice flour, sugar, coconut milk and other auxiliary materials (Rukhanah, 2005). Lunkhead can be made from various fruits, one of them is snake fruit. The processing of snake fruit into lunkhead aims to extend the shelf life, add to the economic value of the fruit at harvest time, at which time the availability abundant with the selling price relatively cheap.

In Indonesia, plastic is still the primary packaging materials used in everyday life and industry. Plastic packaging is not environmentally friendly. This is because the raw materials for making plastics are hazardous materials and takes along time to be decomposed (Setyowati *et al.*, 2013). To solve this problem, we need environmentally friendly and a renewable packaging material.

Edible film is a thin layer that serves as a food packaging material or coating, that can also be eaten along with products (Gulibert *et al.*, 1990). Edible films also serves to extend the shelf life of the packaged product, carrier nutritional components of food (vitamins, minerals, antioxidants, antimicrobial, preservatives, colors, and flavors), cost of manufacture is relatively inexpensive, and easy to be overhauled. Raw materials for making edible film is a compound of hydrocolloid and fats (Fama, 2005). Hydrocolloid compounds such as carbohydrates and protein, while the fatty compounds can be fatty acids. One of carbohydrate type is cassava starch. This starch is a cheap and abundant material, able to form a continuous polymer matrix. It has attracted particullar interest because it is able to form edible (Vicentini *et al.*,1999) and exible, tasteless, odourless, colourless, transparent, non toxic and biologically degradable (Chiumarelli *et al*., 2014 and Belibi *et al*., 2014).

Starch granules composed of amylose and amylopectin. Amylose content affects the properties of gelatinization, retrogradation, swelling energy, starch susceptibility to enzyme, and determine the quality of the product (Peroni *et al.*, 2006 in Hanum, 2010). Cassava starch have 0.20% protein content, 0.15% lipid, 0.21% ash and 19.8% amylose. Guilbert *et al*., (1990) stated that the stability of the edible film is influenced by amylopectin, whereas amylose effect on compactness. Starch with high amylose content produces flexible and powerful edible film (Thirathumthavorn *et al.*, 2007).

Edible film characteristics be affected by raw material, the type and concentration of plasticizer (Damat, 2008). Plasticizer from the polyhydric alcohols or polyols class ie. glycerin and sorbitol (Pagella *et al*., 2002). Without plasticizers exhibit poor mechanical strength and become fragile with low water content (Vicentini *et al*., 2005).Usually, increasing the concentration of plasticizer leads to reduction of mechanical resistance and rigidity and increasing deformability of film, but the behavior depends on the type of plasticizer used (Sobral *et al*,. 2001 and Gontard *et al*., 1993). The addition of sorbitol increase the value of elongation, fragility edible film decreases, and increased permeability (Prihatiningsih 2000).

This study aims to determine the characteristics of edible film made from cassava starch and organoleptic value as primary packaging from snake fruit lunkhead.

2. MATERIAL AND METHODS

The main raw material of edible film was cassava starch. Cassava starch extracted from cassava tubers. Additional materials used were some kind of plasticizers (sorbitol, beeswax, and glycerol) according to treatment, distilled water, stearic acid, and CMC. The addition of stearic acid serves to reduce the rate of water transmission. Stearic acid is long-chain fatty acids with a number of C atoms as much as 18 units, and hydrophobic (Rodhiquez, 2006).

Plasticizer used to raise the level of elasticity from the polymers produced, by reducing the degree of hydrogen bonding and increase the distance between the molecules of the polymer (Harris, 2000).

CMC serves as a stabilizer, produce edible film with a good textured and prevent retrogradation (Prihatiningsih, 2000).

The making process of cassava starch flow diagram of as follows:

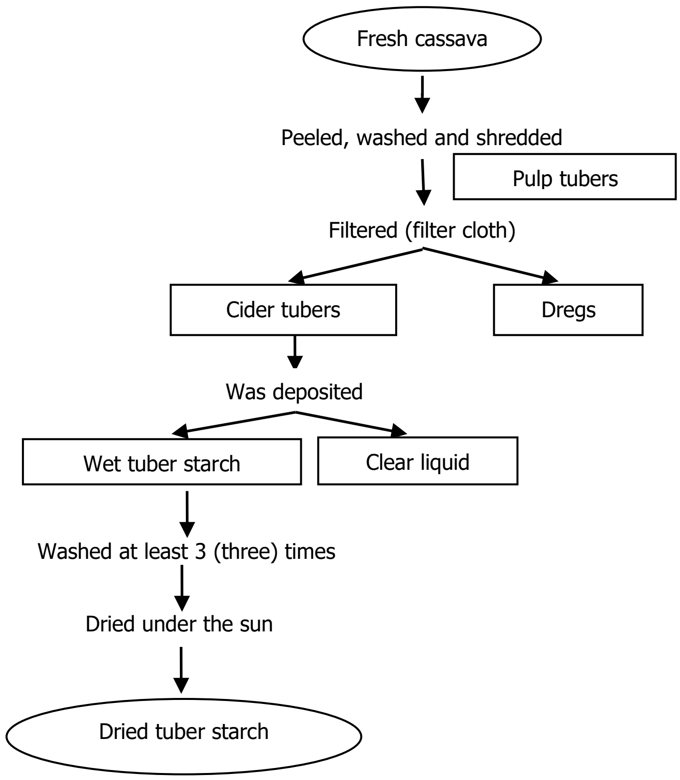

Figure 1. Process flow diagram for cassava starch

The manufacturing process of edible film flow diagram of as follows:

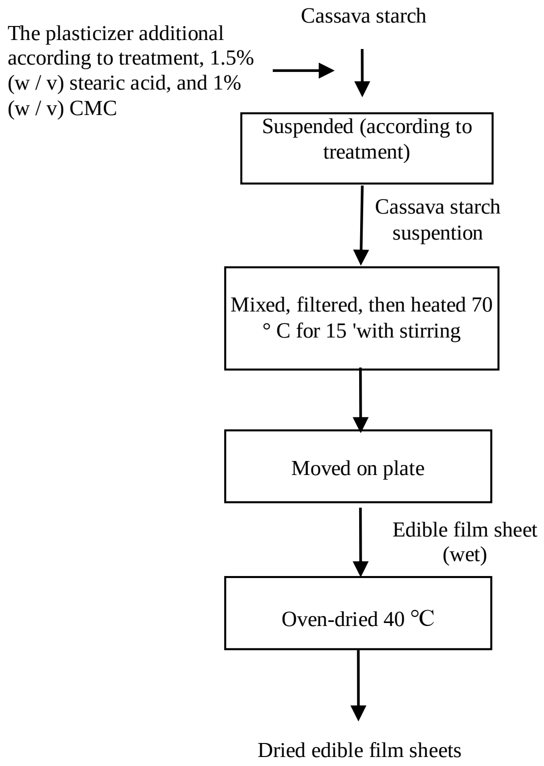

Figure 2. The making process of edible film flowchart according to the Ketser *et al.*, (1986) method which has been modified.

The equipment used were a stainless steel pot, mixer, magnetic stirrer, thermometer, oven, and auto-casting machine knives, basins, blender, filter cloth, winnowing, sifter, measuring cups and other equipment for physical and chemical analysis.

Research was conducted at the Laboratory of post-harvest, Yogyakarta IAIT and Chemix Pratama chemical laboratories. The experimental design used was complete randomized design with 2 (two) factors, 9 (nine) treatment and 3 (three) replications. The first factor was the cassava starch addition percentage, which were 3%, 4%, and 5%. The second factor was the type of plasticizer ie. glycerol, sorbitol, and beeswax. 9 (nine) treatments carried out were:

EF3G = edible film made from cassava starch 3% with 15% glycerol plasticizer.
EF3S = edible film made from cassava starch 3%, with 2% sorbitol plasticizer.
EF3L = edible film made from cassava starch 3%, with 0.3% beeswax plasticizer.
EF4G = edible film made from cassava starch 4%, with 15% glycerol plasticizer.
EF4S = edible film made from cassava starch 4%, with 2% sorbitol plasticizer.
EF4L = edible film made from cassava starch 4%, with 0.3% beeswax plasticizer.
EF5G = edible film made from cassava starch 5%, with 15% glycerol plasticizer.
EF5S = edible film made from cassava starch 5%, with 2% sorbitol plasticizer.
EF5L = edible film made from cassava starch 5%, with 0.3% beeswax plasticizer.

Edible films were then used as primary packaging snake fruit lunkhead. To determine consumer acceptance of snake fruit lunkhead that has been coated by edible film, the organoleptic test conducted with preferences method (hedonic scale). Hedonic scale was made with five levels of preferences (1-5), ie. 1 = strongly dislike, 2 = dislike, 3 = somewhat like, 4 = like, and 5 = very like. Test carried out on color, odor, texture, and overall preferences against nine treatments (Resurreccion, 1998). Test conducted on 25 random panelists.

The parameters observed and measured in this study were the water content (AOAC, 1990), the water vapor transmission rate, solubility, peroxide value, and organoleptic value.

The data were processed statistically with Duncan test (95% confidence level) (Steel *et al.*, 1995).

3. RESULT AND DISCUSSION

3.1 Water Contents

The processing of edible film made from starch basically uses the principle of gelatinization. Gelatinization process occurs due to the addition of water and cooking. This process led to amylose starch bonding close to each other due to hydrogen bond. The drying process results in shrinkage due to loss of water, so that the gel will form a stable film (Careda *et al.*, 2000). According to Sarmento (1997), starch gelatinization begins at 60.5°C. In the process of cooling to 50 ° C will increase the viscosity, there may be a small retrogradation, and the possibility of a small crystallization. The water content of edible film produced by treatment with the addition of cassava starch and plasticizer types was presented in Figure 3.

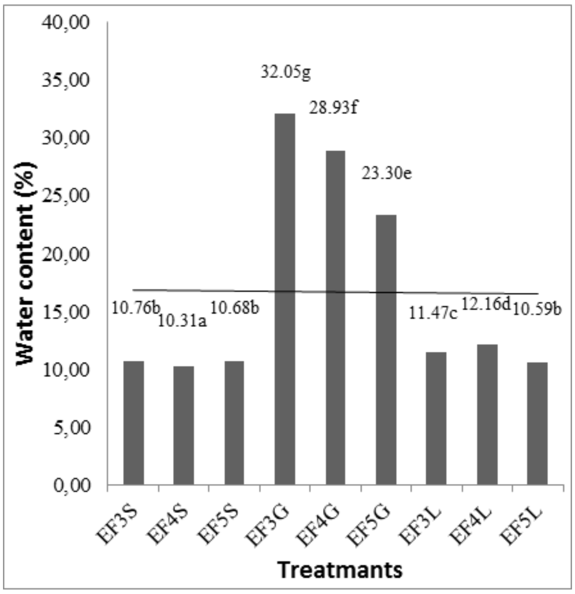

Figure 3. The water content of edible film produced from nine treatments

From Figure 3, it appears that: edible film from glyserol plasticizer provide the highest moisture content and elasticity, in comparison with sorbitol and beeswax. Edible film with the addition of sorbitol and beeswax, possess less elastic and rigid, if used as a wrapper will be broken easily.

3.2 Water vapor transmission rate

Water vapor transmission rate are amount of water vapor losted per unit time divided by the area of the film. Water vapor transmission rate are water vapor permeability through a unit area of the material flat surface with a certain thickness, as a result of a difference in vapor pressure unit between two surfaces at a certain temperature and humidity conditions. Therefore, it is one of the functions of edible film are to resist migration of water vapor; the water vapor permeability should be as low as possible (Gontard, 1993). Edible films with a basis of polysaccharides (starch cassava) have low water vapor permeability and permeability to oxygen. This is due a polymer having a large hydrogen bonds. According Careda *et al.,* (2000), 3% of cassava starch concentration of non-modified produce small pores, which may be caused by small bubbles of dissolved air when heating. Small pores resulting edible film of cassava starch has a low transmission rate to water vapor and gases (Santoso *et al.,* 2004). Water vapor transmission rate of edible film, with the addition of hydrocolloids, such as carbohydrates will produce a powerful film because it is a good barrier against the transfer of O2, CO2, and lipids.

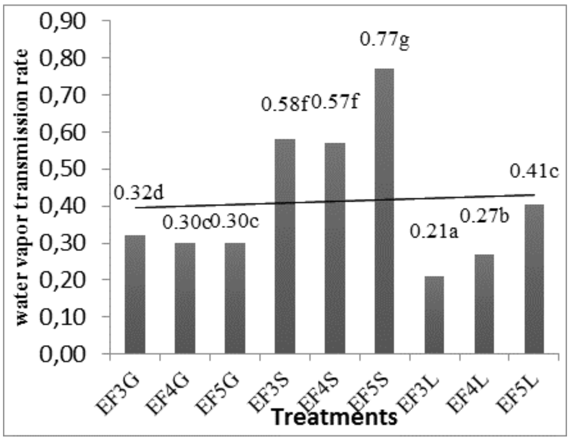

Figure 4. Transmission rate of nine treatments of edible film-making.

Figure 4. Shows that the more starch is added, the rate of transmission is also getting bigger, except the addition of glycerol. Edible films with sorbitol, has a water vapor permeability value hihger than glycerol and beeswax.

This is because the sorbitol has a particle size larger than glyserol and beeswax, cause enlargement of the free volume between the polymer chains, which facilitate the water molecules transfer (Donhowe *et al.*, 1993 and McHugh *et al.*, 1994). Glycerol and beeswax with a smaller molecular size would enter more into the film amourphous network, thus slowing down the transfer of water in the film.

3.3 Solubility

Solubility or percent solubility edible film are a dry weight percent of the film dissolved after immersion in water for 24 hours (Gontard, 1993). The solubility of the film is an important factor in determining biodegradibilitas when used as packaging films. There are films that the desired level of high solubility or vice versa depending on the type of product packaged (Nurjannah, 2004). This product requires edible film with low solubility. The lower solubility, result the melted more quickly.

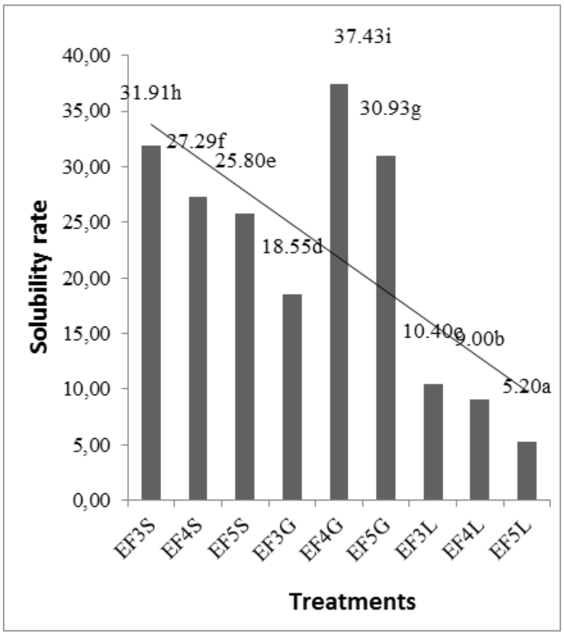

Figure 5. Solubility edible film produced by 9 treatments of edible film making

In Figure 5. Solubility values were influenced by the percentage of cassava starch used and the type of plasticizer

The smaller percentage starch used, the solubility values have higher tendencies, while the type of plasticizer, glycerol gives the average value highest solubility than others. This is similar with the Bourtoom (2007).

3.4 Peroxide

The use of fatty compounds in the produce of edible film, allowing these materials undergo rancidity process due to increased peroxide. The existence of the heating process causing fatty compounds exposed to air and water vapor, which causes the oxidized fatty compounds.

High peroxide number in food product causes rancid faster, because of the oxidation process. The maximum peroxide number on food product containing fat is 10 meq/kg (Anonim, 2014).

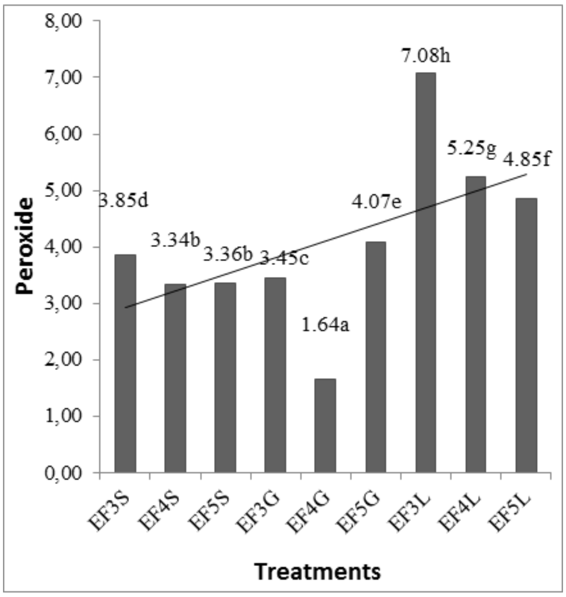

Figure 6. Numbers peroxide produced from edible film (meq/kg)

The ninth edible film has a peroxide number below 10 meq / kg, making it safe to consume. The highest peroxide number produced by beeswax plasticizer. While glycerol and sorbitol were relatively lower. This is because beeswax produces the most brittle edible film. Thus ability to inhibit the rate of gas and water vapor is smaller than edible film produced by glycerol and sorbitol. This leads to a higher peroxide numbers.

3.5 Organoleptic Test Result

Organoleptic test used to determine preferences and consumer acceptance of lunkhead that was wrapped with edible film. Observations conducted in sensory, stating liked or disliked, and accept or not on the physical properties of the product. Organoleptic test results presented in Table 1.

Table 1. Preferences value of organoleptic test results from snake fruit 'lunkhead' were wrapped with edible film

Treatments	Color	Texture	Odor	Overall preference
3% Cassave starch + gliserol	3,1a[1)]	2,4a	3,7a	3,1a
4% Cassave starch + gliserol	3,0a	2,5a	3,7a	3,1a
5% Cassave starch + gliserol	3,2a	2,6a	3,7a	3,2a
3% Cassave starch + sorbitol	3,8c	3,4b	3,4a	3,6ab

4% Cassave starch + sorbitol	3,9c	3,5b	3,5a	3,8b
5% Cassave starch + sorbitol	3,9c	3,6b	3,5a	3,6ab
3% Cassave starch + beeswax	3,2b	3,6b	3,5a	3,5ab
4% Cassave starch + beeswax	3,3b	3,6b	3,3a	3,4ab
5% Cassave starch + beeswax	3,3b	3,6b	3,3a	3,5ab

1) The same letters in the same column indicates no significant difference with Duncan test, with significance level of 95%

3.5.1 Color

Color plays an important role in food products, because if the color of a food is not exciting or unusual, although a complete nutritional content would reduce consumer acceptance (Winarno, 1991). Organoleptic test results snake fruit lunkhead color coated by edible film, shows that there are statistically significant differences between treatments addition of plasticizers such as glycerol, sorbitol and beeswax, but not significantly different with the starch treatment addition (the same type of plasticizer, ei. at type of plasticizer glycerol, starch addition of 3%, 4% and 5% yield different colors that are not real). Panelists preferred the snake fruit lunkhead color coated edible film with plasticizer sorbitol, with a value of 3.85 preferences. Snake fruit lunkhead coated with edible film from sorbitol plasticizer resembles wrapped in plastic PE, with glycerol as uncoated, and with beeswax resembles wrapped in paper.

3.5.2 Texture

Organoleptic test results snake fruit lunkhead texture coated by edible film with plasticizer glycerol, statistically significantly different from the texture of lunkhead snake fruit coated by edible film with sorbitol and beeswax plasticizer. Panelists preferred to the texture of snake fruit lunkhead coated by edible film with beeswax plasticizer, with 3.65 preferences value. The sorbitol plasticizer produces edible film which is elastic, resembling wrapping plastic. While glycerol produce edible film with a sticky surface texture. And beeswax produce edible film with brittle textures, broken easily.

3.5.3 Odor

Odor also one of the determinants of the quality of food products (Kartika *et al.,* 1988). Organoleptic test results of the scent / odor lunkhead snake fruit coated edible film statistically demonstrate that there is no real difference between odor lunkhead snake fruit edible film coated with a plasticizer glycerol, sorbitol and beeswax. All the edible odorless.

3.5.4 Overall preferences

To determine consumer acceptance as a whole, the assessment of overall satisfaction. The result was a noticeable difference between lunkhead wrapped in edible film from glycerol, sorbitol and beeswax plasticizer.

Table 2. Panelists percentage acceptance rate to snake fruit lunkhead coated by 9 types of edible film

Treatments	**Color (%)**	**Texture (%)**	**Odor (%)**	**Overall preferences (%)**
3% Cassave starch + gliserol	45	20	75	45
4% Cassave starch + gliserol	45	25	70	40
5% Cassave starch + gliserol	50	35	80	45
3% Cassave starch + sorbitol	80	70	50	65
4% Cassave starch + sorbitol	85	65	60	80
5% Cassave starch + sorbitol	85	65	60	85
3% Cassave starch + beeswax	55	75	60	55
4% Cassave starch + beeswax	55	70	70	50
5% Cassave starch + beeswax	50	65	55	55

The above table shows that the percentage of panelists acceptance rate in accordance with the value of panelist preferences

4. CONCLUSIONS

The average of edible film water content produced from the ninth treatments were 16.71%. The higher starch addition causes the water vapor transmission rate increases. The use of sorbitol plasticizer provides the highest water vapor transmission rate. Peroxide produced by ninth treatments edible film manufacture under safe levels for consumption (10 meq/kg). Edible films made from cassava starch with sorbitol, glycerol and beeswax plasticizer can be used as primary packaging lunkhead snake fruit. The highest panelist overall preferences at sorbitol plasticizer and 4% of cassava starch treatment ie. 80% of panelists liked and average value of preferences was 3.8 which means they like it.

5. REFERENCES

AOAC. 1990. *Official Methods of Analysis of The Association of Official Analytical Chemists*. Vol I, Published by AOAC International, Arlington, USA.

Anonim. 2014. *Kumpulan Praktikum Chemistry*.http://maulanaadiwibowo150595-praktikum.blogspot.co.id/2014/06/kimia-org-n-ik-percobaan-peroksida.html

Belibi, P. C., Daou, T. J., Ndjaka, J. M. B., Nsom, B., Michelin, L., & Durand, B. (2014). *A Comparative Study of Some Properties of Cassava And Tree Cassava Starch.* Physics Procedia, 55, 220{226.doi:10.1016/j.phpro.2014.07.032

Bourtoom,T. 2007. *Effect of Some Process Parameters on The Properties of Edible film Prepared Form Starch*. Department of Material Product Technology, Songkhala. (Online) available at http://vishnu.sut.ac.th./iat/food_inovation/up/rice/%20starch%20film.doc

Careda, M. P., C. M. Henrique, M. A. de Oliveira, M. V. Ferraz, N. M. Vincentini. 2000. Characterization of Edible Films of Cassava Starch by Electron Microscopy. Braz. *J. Food Technol* 3: 91-95 (on line). Avaliable at: http://www.ital.sp.gov.br/bj/artigos/bjft/2000/p0040.pdf

Chiumarelli, M. and Hubinger, M. D. 2014. *Evaluation of Edible And Coatings Formulated With Cassava Starch, Glycerol, Carnauba Wax And Stearic Acid.* Food Hydro-colloids, 38, 20{27.doi:10.1016/j.foodhyd.2013.11.013

Damat. 2008. Effects of Plasticizer Type and Concentration of The Edible Film Characteristics of Arrowroot Starch Butyrate. *AGRITEK* 16 (3): 333-339.

Donhowe. G and O. Fennema. 1993. Water Vapor And Oxygen Permeability of Wax Film. *Journal of The American Oil Chemists Society*. Volume 70. Issue 9. pp: 867 – 873.

Fama, L., Rojas, A.M., Goyanes, S. And Gerschenson, L. 2005. *Mechanical Properties of Tapioca-Starch Edible Films Containing Sorbates.* LWT 38: 631-639.

Gennadios, A., McHugh, T. H., Weller, C. L., and Krochta, J. M. 1994. Edible Coatings And Films Based On Proteins. In J. M. Krochta, E. A. Baldwin, & M. Nisperos-Carriedo (Eds.), *Edible Coatings And Films To Improve Food Quality* (pp. 210–278). Lancaster: Technomic Pub. Co., Inc.

Gontard, N., Guilbert, S., & Cuq, J.-L. (1993). Water And Glycerol as Plasticizer Affect Mechanical And Water Vapor Barrier Properties of An Edible Wheat Gluten Film. *Journal of Food Science*, 58, 206–211.

Guilbert, S. and B. Biquet. 1990. *Edible Films And Coating*s. *In*: G. Bureau and J.L. Multon (eds.). Food packaging, volume I. VCH Publishers, New York.

Hanum, F., 2010, Utilization Ginger Starch (*Zingiber officinale*) as Material Making Edible Film (Study of Ginger Starch and Glycerol Concentration), *Thesis*, FTP, Brawijaya University, Malang.

Harris, H. 2001. The Possible Use of Edible films from Tapioca Starch For Packaging Lempuk. *Journal of Agricultural Sciences Indonesia* 3 (2): 99-106

Kartika B., B. Hastuti and W. Supartono. 1988. *Pedoman Uji Inderawi Bahan Pangan. PAU Pangan dan Gizi*. Universitas Gadjah Mada. Yogyakarta.

Ketser, J.J., dan Fennema, O. 1986. *Edible film and Coating: A View, Food Technology*, 40 (12): 47-59.

Mchugh.T.J.. J.F. Aujard and J.M. Krochta. 1994. Plasticized Whey Protein Edible Film: Water Vapor Permeability Properties. *Journal of Food Science*. Volume 39. Issue 2 pp: 416 – 419.

Nurjannah.W. 2004. Isolasi dan Karakterisasi Alginat Dari Rumput Laut *Surgasum sp* Untuk Pembuatan Biogredable Film Komposit Alginat Tapioka. *Thesis*. Fakultas Teknologi Pertanian. Universitas Gadjah Mada. Yogyakarta.

Pagella, C., G. Spigno, and D.M. DeFaveri. 2002. *Characterization of starch based edible coatings*. Food and Bioproducts Processing 80:193-198.

Peroni, F.G.H., T.S. Rocha, and E.M.L. Franco. 2006. Some Structure And Physicochemical Charasteristics of Tuber And Root Starces. J. *Food Science Technology International.* Volume 12 Issue 6, pp. 550 – 523.

Prihatiningsih, N. 2000. The Effect of The Sorbitol Addition And Palmitic Acid to The Film Thickness And Mechanical Properties of Zein Edible Film. *Thesis*. Department of Agricultural Technology, Faculty of Agricultural Technology, Gadjah Mada University, Yogyakarta. *Thesis* (unpublished).

Resurreccion, A.V.A., 1998. *Consumer Sensory Testing for Product Development*. Aspen Publisher, Inc., Maryland.

Rodriguez, M, J. Oses, K. Ziani, and J.I. Mate. 2006. Combined Effect of Plasticizers And Surfactants on The Physical Properties of Starch Based Edible Films. *Food Res. Int*. 39: 840-846.

Rukhanah. 2005. Dodol Rumput Laut. *Thesis.* Fakultas Perikanan Universitas Brawijaya. Malang.

Santoso, B., D. Saputra, and R. Pambayun. 2004. Study of Edible Coating Technology From Starch And Its Application For Primary Packaging Lempok Durian. *Journal of Food Technology and Industries* Vol. XV No. 3 of 2004

Sarmento, A. L. S. C., Sobral, P. J. A., & Menegalli, F. C. (2000). Influence of Main Process Variables on Solubility And Mechanical Properties of Cross-linked Gelatin Biofilm. *Proceedings of 10th International Coating Science and Technology Symposium, Scottsdale*, USA (pp. 242–244).

Setyowati. R., Surahman, and Asti Mulasari. 2013. The Level of Housewife's Knowledge and Behavior in Managing Plastic Waste. *Public Health Journal* Vol. 7, No. 12 Juli 2013. P. 562-566.

Sobral, P. J. A., Menegalli, F. C., Hubinger, M. D., & Roques, M. A. (2001). Mechanical, Water Vapor Barrier And Thermal Properties of Gelatin Based Edible. *Food Hydrocolloids,* 15 (4-6), 423{432. doi:10. 1016/S0268-005X(01)00061-3

Steel, R.G.D. and J.H. Torrie, 1993. *Principples and Procedures of Statistics*. A Biomedical Approach, 3rd Ed. Mc Graw Hill, Kagasukha Ltd., Tokyo.

Thirathumthavorn, D. and S. Charoenrein. 2007. *Aging Effect on Sorbito And Non-crystallizing Sorbitol-Plasticized Tapioca Starch Films*. Starch 59:493-497.

Vicentini, N. M. & Cereda, M. P. (1999). Uso de _lmes de f_ecula de mandioca em p_oscolheita de pepino (cucumis sativus l.) *Brazilian Journal of Food Technology*, 2 (1- 2), 87{90

Winarno, F.G. 1991. *Food Chemistry and Nutrition, Technology and Consumer*. Jakarta: PT Gramedia.