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The effect of coating of edible film from bovine split hide gelatin on beef meatballs properties

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh proses pelapisan atau *coating edible film* yang berasal dari gelatin kulit sapi *split* pada bakso daging sapi dalam menghambat kerusakan mikrobiologis beserta karakteristik bakso daging sapi dengan konsentrasi pelapisan yang berbeda. Materi yang digunakan adalah gelatin tipe A (telah diproses menggunakan agen *soaking* asam) dari kulit sapi *split* serta bakso daging sapi. Penelitian menggunakan Rancangan Acak Lengkap pola faktorial 3 x 3 dengan 3 level *coating* (0, 5, dan 10%) dan lama penyimpanan pada suhu 10^{o}C (3, 6, dan 9 hari). Jika terdapat perbedaan yang signifikan, maka dilanjutkan dengan uji Duncan's Mutiple Range Test (DMRT). Hasil penelitian menunjukkan bahwa konsentrasi *coating* dan lama penyimpanan berpengaruh nyata terhadap protein terlarut, nilai pH, daya ikat air, dan jumlah mikrobia pada bakso daging sapi. Gelatin kulit sapi *split* dapat digunakan sebagai *edible coating* pada bakso sapi dan memperpanjang masa simpan bakso sapi.

Kata kunci: edible coating, gelatin, kulit sapi split, bakso daging sapi

ABSTRACT

The aim of research was to determine the effect of the coating of edible film derived from bovine split hide gelatin on inhibiting microbiological damages and properties of the beef meatballs with different coating concentrations. The material used was gelatin types A (processed with acid curing agent) from the bovine split hide and glycerol. The completed randomize design (CRD) with a factorial pattern of 3 x 3 was used in this study. The first factor was 3 levels of coating concentration (0, 5, and 10%) and the second factor was 3 levels of storage time at 10^{o}C (3, 6, and 9 days). It was continued to Duncan's Multiple Range Test (DMRT) if the treatment indicated significant effect at a probability level of 5%. The results showed that the storage time and coating concentration affected the soluble protein, pH value, water holding capacity (WHC), and total plate count (TPC) in beef meatballs. Bovine split hide gelatin can be used as an edible coating on beef meatballs and extend the shelf time of beef meatballs.

Keywords: edible coating, gelatin, bovine split hide, beef meatballs

INTRODUCTION

During recent years, food packaging has strongly improved and developed, primarily due to increased demands on product safety, extended shelf life, durability, water resistance properties, environmental friendliness, consumer convenience, and cost efficiency (Farhan and Hani, 2017). The plastic as a packaging has been inseparable from daily life because a plastic is food packaging material which is inexpensive, readily available and durable. However, if contaminated with food, it can cause negative effects for human. Several of these are hazardous to human health and the environment, for instance carcinogenic, mutagenic, toxic for reproduction, sensitizing and hazardous to the aquatic environment with long lasting effects (Lithner, 2011).

It was necessary to find other packaging materials such as plastics in which at the same time can be reformed natural (biodegradable) and can be used for human consumption (edible). One method of packaging is by using edible films (McHugh and Krochta, 1994). Furthermore, an edible film is one hydrocolloid such as proteins, polysaccharides (pectin, gums, and starches) and fats and their mixtures (composite).

In the recent research, raw material of edible film commonly used was from gelatin (Weng *et al.*, 2014; Alexandre *et al.*, 2016; Tulamandia *et al.*, 2016). Edible film raw material often used is bovine hide gelatin, but bovine leather is more profitable for tanned. Gelatin is produced from the connective tissue collagen fibers which were hydrolyzed with acids or bases (Junianto *et al.,* 2012). Gelatin was derived from various animal skin have been studied such as chicken skin (Sarbon *et al*., 2013), pig skin (Duconseille *et al*., 2017), bovine hide (Gómez-Estaca *et al*., 2009), goatskin (Said, 2011), fish skin (Junianto *et al.,* 2012) and bovine split hide (Wulandari *et al.*, 2016).

Bovine split hide is one of the by products of the leather tanning industry. The split hide still contains protein, when it is hydrolyzed to produce gelatin. The edible film can be formed from gelatin protein. Edible coating of biodegradable packaging is a new technology introduced in the world of food processing (Kenawi *et al*., 2011). Edible film is a thin layer that can be consumed and is often used as a food coating (Bourtoom, 2008). One of the advantages of edible film as a packaging material is edible and better than the synthetic wrapping. Edible packaging is generally used to improve the mechanical properties of the food, minimize respiration in fruits and vegetables, limit the movement of moisture and other gases, provide antimicrobial or antioxidant capabilities to the product, enhance the sensory properties, and extend the shelf life of the product (Pascall and Lin, 2013). Because gelatin is the raw material for making edible film, so bovine split hide can be used as the raw material of the edible film. Bovine split hide has advantages as deversification the utilization of tannery waste, increase the added value of tannery waste and lower production cost of edible film production.

Krochta *et al.* (2002) stated that an edible film serves as a barrier to mass transfer (moisture. oxygen, solutes, and fat). Edible film can be applied in food products such as sausages, meatballs, fruits, and medicines.

Meatballs are a food product that is round, made of a mixture of animal meat and starch. The meatballs are perishable foodstuffs and have a relatively short shelf life. According to Jridi (2015), an attempt to make the shelf life of meatballs longer than expected has been done, but these efforts often do not pay attention to the safety and the feasibility of consumption. Efforts to extend the shelf life of meatballs paying more attention to food safety and feasibility of consumption are needed. One way is by applying an edible coating on the meatballs. The hydrocolloid-shaped edible coating can coat the meatballs that can inhibit microbial contamination directly. One method of edible coating production is that it can be made from gelatin with addition gelatin and plasticizers such as glycerol, sorbitol, sucrose, and polyethilene glycol.

The aim of this research is to apply edible film from bovine split hide gelatin as edible coating on meatballs and to know the effect of edible film in inhibiting microbiological damage along with physical properties of meatballs with different coating concentration and storage time.

MATERIALS AND-METHODS

Experimental Design

The study used completely randomized design with a factorial pattern of 3 x 3. The first factor was 3 levels of coating concentration (0, 5, and 10%) and the second factor was 3 levels of storage time at 10^{o}C (3, 6, and 9 days) and it was repeated 3 times.. It was continued to Duncan's

Multiple Range Test (Steel and Torrie, 1993) if the treatment indicated significant effect at a probability level of 5%. The SPSS Statistics v.15.0 (Chicago, IL, USA) software was used for the statistical processing of data.

Preparation of Edible Coating

Preparation of edible coating was conducted based on Antoniewski (2007) methods. The diagram of of edible film solution preparation is shown in Figure 1.

Preparation of Beef Meatballs

The beef meatballs preparation was based on Akcan *et al.* (2017) methods with slightly modified.

Determination of Soluble Protein

Soluble protein was analyzed by using Lowry method at the wavelength of 750 nm (Owusu-Apenten, 2002), Protein concentration was obtained by comparing the absorbance of sample and the absorbance of bovine serum albumin (BSA).

Weight Loss

Weight loss assay was based on Odiase *et al.* (2013) method. The weight of beef meatballs was taken and weight loss (%) was calculated as follows:

Weight loss (g) = [beef meatballs mix (g) - dried beef meatballs (g)]

Weight loss (%) = [Weight loss (g)/ Beef meatballs (g)] x 100%

Water Holding Capacity

Water holding capacity was calculated by using the method of Swatland (1984) as follows: 0.3 g of meatball put on filter papers placed between two glass plates which are 5 mm thick, the samples are burdened with a load weighing 35 kg for 5 minutes. The Extensive wet area was obtained by reducing the total area covered by the sample using graph paper. The value of water holding capacity is obtained by the formula:

$$mgH_2O = \frac{\text{The square of wet area } (cm^2)}{0.0948} - 8$$

$$WHC\ (\%) = \text{Water level}\ (\%) - \frac{mgH_20}{\text{weight sample}\ (g)}\ x\ 100\%$$

Total Bacteria

The bacterial test with total plate count method. Nutrient Agar medium sterilized was poured into petri dishes in warm condition. One gram of meatball is poured into the test tube containing 9 mL of sterile distilled water as a dilution of 10^{-1}. Then 1 mL were taken and put in a test tube into two as a dilution of 10^{-2} and so on until dilution of 10^{-4}. Then 1 mL was taken to be grown in a petri dish in dilution of 10^{-3} and 10^{-4}. The medium was put in an incubator at 37ºC for 2 x 24 hours. The number of colonies was

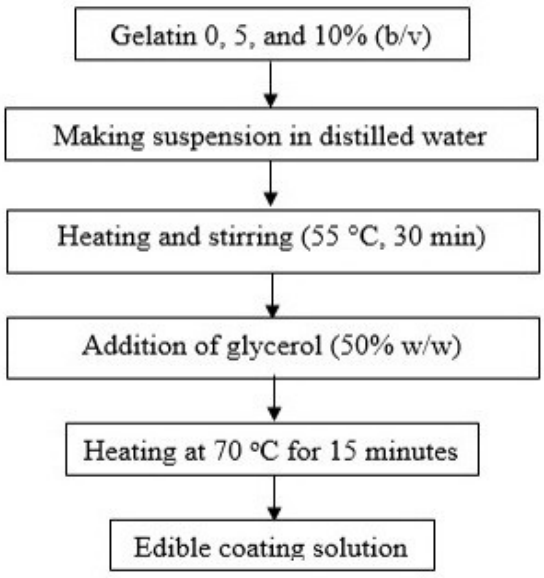

Figure 1. Flow chart of preparation of edible coating derived from gelatin bovine split hide (Antoniewski *et al.,* 2007).

calculated by Colony counter. Colonies that count is a petri dish with a number of 30-300 colonies (AOAC, 2005).

RESULTS AND DISCUSSION

Soluble protein

The result showed that the interaction between the coating concentration factor and storage time factor at the level ($P<0.05$) affected the levels of soluble protein in beef meatballs. The beef meatballs soaked in a solution of 10% at 3 days storage may slow the rate of decline in protein content of beef meatballs under cold storage conditions. The result of soluble protein measurement was shown in Table 1.

The high concentration of coating in beef meatballs at short storage will inhibit the decreasing of soluble protein. The edible film serves as a coating that coated the surface of the beef meatballs which were able to reduce the level of damages created by microbes. This was consistent with the statement in Mc.Hugh and Krochta (1994), that edible film can function as a food protector.

The results showed coating concentration has significantly different ($P<0.05$) of soluble protein. It is highly associated with the bgrowth of proteolytic bacteria that went in through the surface of beef meatballs that can damage the proteins inside. Yuliatmo *et al.* (2017) also stated that proteolytic bacteria could produce protease enzymes that could breakdown the complex structured protein to be simpler structured protein. High edible coating concentrations and longer storage times cause the chance of bacteria to metabolize bovine meatballs into smaller ones causing smaller numbers of proteins that bacteria can break down into simpler units.

pH Value

The differences of coating concentration and storage time as well as an interaction showed the significant effect on ($P<0.05$) the pH value of beef meatballs. The average pH value of beef meatballs is presented in Table 1. The higher the concentration of gelatin, the lower the pH value.

The storage time and coating concentration had a significant effect on the pH value of beef meatballs. The longer storage time, the lower pH value of beef meatballs. This result was in agreement of Shon *et al.* (2011), which resulted a decrease in pH value after the products stored more than 2 days. Erwanto (1998) stated that in general, the pH value value is closely related to the microbes contaminating meat. If the content of microbes is low, then the microbial activity will be slowly, and the ability to change the meat nutrient material into lactic acid will also get slowly.

Weight Loss

The results of analysis of variance showed that the storage time and the interaction were not significant. whereas the coating concentration has a significant effect ($P<0.05$) toward weight loss value. The average weight loss of the beef meatballs is presented in Table 1.

The Duncan test results for the treatment of bovine split hide coating concentration showed that the value of the weight losses of meatballs has the real effect. The measurement results showed that the higher the coating concentration, the smaller the percentage of weight losses of meatballs. It was caused the gel formed during the heating blanketed the beef meatballs on the outside so that the fluid lost due to evaporating during the heating can be suppressed. Cooking losses of beef meatballs as the result of this research was affected by water loss during storage. The storage of meatballs in this study used the temperature of 10°C, so it does not evaporate too much. It was influenced by a protein that can bind water. The more water the protein retained, the less water there is to come out so the value of weight losses reduced (Ockerman and Hansen, 2000).

Water Holding Capacity

The concentration factor in the gelatin of split cow hide and storage time as well as an interaction has a significant effect ($P<0.05$) on water holding capasity. The data of water holding capacity measurement is presented in Table 1.

The highest water holding capacity of beef meatballs is obtained at treatment with the concentration of 10% coating and storage time of 3 days reached 56.73%. The bovine split hide gelatin as an edible coating with a concentration of 10% can form a better thin layer of protein films than 5% concentration and beef meatballs without coating.

A thin layer of protein films provided effective protection against the surface of water evaporation and oxidation of other dietary components. In addition, to prevent the loss of moisture, a thin layer of protein films is less permeable to oxygen. The decrease of oxygen

Table 1. Average Values of Soluble Protein, pH Value, Weight Loss, Water Holding Capacity and the Number of Bacteria on Beef Meatballs with Different Coating Concentrations and Storage Time

Parameter	Coating Concentration (%)	Storage time (days)			Average
		3	6	9	
Soluble Protein (mg/mL)	0	0.191±0.002^{ab}	0.179±0.007^{a}	0.164±0.016^{a}	0.178±0.008^{a}
	5	0.273±0.027^{c}	0.270±0.023^{c}	0.232±0.073^{bc}	0.258±0.041^{b}
	10	0.389±0.008^{e}	0.326±0.003^{d}	0.324±0.024^{d}	0.346±0.012^{c}
Average		0.464±0.012^{b}	0.259±0.011^{a}	0.240±0.038^{a}	
pH Value	0	6.10±0.021^{e}	5.95±0.01^{c}	5.46±0.006^{a}	5.84±0.012^{b}
	5	6.03±0.006^{d}	5.94±0.011^{c}	5.46±0.026^{a}	5.81±0.014^{a}
	10	6.02±0.015^{d}	5.95±0.021^{c}	5.67±0.015^{b}	5.88±0.017^{c}
Average		6.05±0.014^{c}	5.95±0.014^{b}	5.53±0.016^{a}	
Weight Loss (%)	0	1.13±0.70^{bc}	1.28±0.62^{cd}	1.35±0.57^{d}	1.25±0.63^{b}
	5	0.35±0.03^{ab}	0.44±0.27^{ab}	1.03±0.74^{ab}	0.61±0.09^{a}
	10	0.18±0.03^{a}	0.18±0.12^{a}	0.25±0.13^{a}	0.20±0.09^{a}
Average^{ns}		0.55±0.25	0.63±0.34	0.88±0.68	
Water Holding Capacity (%)	0	52.85±1.56^{bc}	48.09±3.40^{ab}	44.32±4.08^{a}	48.42±3.01^{a}
	5	53.41±1.51^{c}	55.99±5.16^{c}	52.97±2.08^{bc}	54.12±2.92^{b}
	10	56.73±1.44^{c}	56.45±1.59^{c}	56.29±1.36^{c}	56.49±1.46^{b}
Average		54.33±1.50^{b}	53.51±3.38^{a}	51.19±2.51^{a}	
Amount of Bacteria (x 10^4)	0	10.00±2.00^{ab}	12.00±2.00^{b}	45.33±1.53^{e}	22.44±1.84^{c}
	5	9.00±1.00^{ab}	11.00±1.00^{b}	36.33±1.53^{d}	18.78±1.84^{b}
	10	7.00±2.65^{a}	9.00±1.00^{ab}	25.00±2.00^{c}	13.67±1.88^{a}
Average		8.67±1.88^{a}	10.67±1.33^{b}	35.55±1.69^{c}	

Different superscript in the same row and columns showed significant differences (P< 0.05)

permeability can keep food fresh. Thus. the higher the water holding capacity the more reduced the weight losses.

Jridi *et al.*. (2015) stated that a thin layer of polysaccharide provides effective protection against surface browning and fat oxidation and component oxidation other food. In addition to preventing the loss of moisture, a thin layer polysaccharides are less permeable to oxygen. decrease permeability oxygen can keep food.

Total Bacteria of Beef Meatballs

The interaction between coating concentration and storage time showed significantly different ($P<0.05$) on the total colony of beef meatballs. This is because of the ability of gelatin to coat the surface of beef meatballs highly dependent on the concentration of coating and storage. The properties of gelatin expected as a coating on the beef meatballs to be perfect with the higher concentration of gelatin. Low increasing bacteria was caused by shorter storage time.

Gelatin is a protector or film former of coating the surface of beef meatballs. Therefore, the evaporation and damage caused by microbes during storage can be reduced. The gelatin will cover surface of beef meatballs and reduce the chance of bacteria to get into beef meatballs. Decreasing the number of bacteria also occurred by edible coating which has function to inhibit migration of moisture from the environment to the protected medium. In this case the storage time of meatballs becomes longer (Said, 2011).

In general, the mechanism of action is to damage the main structures of microbial cells. The positive charge of the $NH3^{+}$ group on edible coating can interact with the negative charge on the surface of the bacterial cell (Helander, 2001). The damage to the bacterial cell wall results in attenuation of cell wall strength, wall shape of the cells become abnormal, and the cells pore enlarged.

CONCLUSION

Gelatin from bovine split hide can be made as the edible coating and can be used to maintain meatballs properties in soluble protein content, pH value and water holding capacity and inhibit microbial growth. Edible film from bovine split hide can be applied as the edible coating for beef meatball.

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