Therefore, meatballs require the use of natural packaging to help maintain the quality and shelf life of beef meatballs during room temperature storage. Efforts have been made to safely extend the shelf life of beef meatballs including the use of natural packaging. The concept of natural packaging originates from environmental pollution issues. Therefore, the materials are edible and naturally biodegradable. Edible packaging is a thin product coating that has biodegradable properties (decomposed) and is made from edible materials that can be applied to food products [2]. Edible packaging has an effective effect on controlling the decline in the quality of meat products, especially by inhibiting microbial growth, and antioxidant activity, and maintaining sensory properties [3]. Edible packaging can be applied to food products. One of which is by implementing a coating technique. With the existence of many processed meat foods that are healthy and can have a long shelf life, it is necessary to explore natural raw materials to make edible biodegradable coatings.

Taro starch is a type of polysaccharide that is biodegradable, easy to obtain, and has a fairly high starch content of 80% consisting of 5.55% amylose and 74.45% amylopectin [4]. Taro starch is a type of tuber that has the potential to be used as a raw material for biodegradable coatings and generally has stiff and brittle properties. The addition of natural plasticizers is needed to increase the flexibility of the packaging film. Furthermore, a natural ingredient that can improve the lack of taro starch properties is gelatin. When combined with starch, gelatin can provide flexible and elastic properties to packaging films [5]. Gelatin can be used widely in the food industry because it is good at binding water, forming gels, blocking water vapor, emulsification tendency [6], good film formation [7] and has a high digestibility [8]. Gelatin coming from cow bones, cow skin, and pork skin, is a by-product of animal husbandry and can be used as a profitable and beneficial alternative for society [9]. It also comes from poultry including chickens, birds, and ducks [10]. One source of gelatin that has the potential to be used as raw material for making biodegradable coatings, is duck bone waste. In general, duck bone waste cannot pollute the environment, but can be used as a raw material for making gelatin [11].

The implementation of coating for meatballs is by using the dipping method [12]. The dipping method is often used on fruit and meat which has a greater thickness of the coating material and makes it easier to adjust the viscosity of the solution [13]. [14] conducted research concerning film characterization of taro starch and duck bone gelatin and obtained the best gelatin concentration of 5%. However, in the research, it had not been applied to processed meat products such as beef meatballs. The application of biodegradable coatings as primary packaging for meatball products is an interesting matter to study. Therefore, it is necessary to study the effect of using biodegradable coatings from taro starch *(Xanthosoma sagittifolium)* and duck bone gelatin on the quality of beef meatballs during storage at room temperature.

2 Method

2.1 Material

In this study, the raw materials were taro tubers obtained from the Rogojampi Market in the Banyuwangi Regency. The duck bones were obtained from local restaurants that sell processed duck menus and beef as the basic ingredient for making meatballs obtained from the Rogojampi Market in Banyuwangi Regency. The chemicals used were sodium hydroxide (NaOH, analytical grade, Merck KGaA, Darmstadt, Germany), aqHydrochloric Acid (HCl, analytical grade produced by PT. Smart Lab Indonesia), distilled water (produced by CV. Makmur Sejati, Malang, Indonesia), and glycerol (produced by CV. Sahabat Lab, Indonesia).

2.2 Process of applying the biodegradable coating to beef meatballs

The implementation of a biodegradable coating for beef meatballs began by preparing the main ingredient, namely beef meatballs [15]. Materials used for making biodegradable coatings such as duck bone gelatin and taro starch *(Xanthosoma sagittifolium)* had to be prepared before conducting a mixing process. Taro starch is obtained from the separation of suspension and water from the sedimentation of taro tubers and has been ground. Meanwhile, duck bone gelatin is obtained from gelatin extraction using the acid and base method. The mixing process was done with 5% of duck bone gelatin and 95% of taro starch with the addition of distilled water. Furthermore, the process of stirring the biodegradable coating materials using a magnetic stirrer and heating on a hot plate for 30 minutes at 80°C. The solution was added to 1% glycerol until it became homogeneous. The biodegradable coating was applied to beef meatballs by dipping method for one minute. The application was done by flattening the biodegradable coating layer on the surface of the beef meatballs and then the drying process was carried out. The beef meatball dipping process was done with the same repetition, while the dyeing was done two times. The biodegradable coating of beef meatballs was stored at a room temperature of 27-29°C. Then, it was analyzed for chemical and organoleptic quality every 0, 6, 12, 18, and 24 hours. Tests were carried out by comparing biodegradable beef meatball products with those without biodegradable coatings [16].

2.3 Water-holding capacity test

The water-holding capacity of meat protein can be determined by Clunies et al. (1986) method [17]. As much as 5 grams of meatball samples were mashed, put into a centrifuge tube, and centrifuged at 3000 rpm for 30 minutes. The liquid was separated from the sample mixture and then weighed [18]. The percentage of water holding capacity can be calculated using Equation 1:

$$WHC = \frac{BS}{BA!} x100\% \quad (1)$$

Where
BS = volume of absorbed water (mL)
BA = weight of sample (g)

2.4 Water content te st

Water content was determined directly using an oven at 105°C [19]. The empty cup was put in the oven for at least 2 hours. Then, the empty cup was transferred to a desiccator for 30 minutes until it reached room temperature, and the empty cup was weighed. The sample of

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5-15 grams was weighed into the cup. The cup containing the sample was put in the oven at 105°C for 16-24 hours. After drying, the sample cup were closed and kept in a desiccator (about 30 min) for cooling to ambient temperature. For moisture content calculations, sample weights before and after experiments were recorded using a digital balance of 0.0001 (g) accuracy. The calculation of water content can be calculated by Equation 2:

$$\mathrm{M} = \frac{Mo-Mt}{Mo}\ x\ 100\% \qquad (2)$$

where:
M = water content (%)
Mo = sample weight before experiment (g)
Mt = sample weight after experiments (g)

2.5 Tests of pH, protein, and fat content

The AOAC method was implemented to test pH, protein content, and fat content [20]. A sample of 2 grams of beef meatballs was mashed and then homogenized using distilled water for one minute at room temperature using a vortex. After that, the pH was measured using a digital pH meter. Furthermore, protein content was determined by calculating the nitrogen content in beef meatballs using the Kjedahl method. Crude protein was calculated as the nitrogen content multiplied by 6.25. Crude fat content was calculated by the Soxhlet method. Crude fat was obtained by extracting 5 g of sample in a Soxhlet apparatus using petroleum ether as the solvent.

2.6 Organoleptic test

The organoleptic test was carried out using the hedonic quality method, namely with a general assessment. This organoleptic test used 30 untrained panelists using a rating scale of 1 to 5 (5 highly desirable and 1 highly undesirable) [13]. The organoleptic assessment of beef meatballs was texture, aroma, and color. The rating scale color: 1 (dark brown and gray), 2 (brown and gray), 3 (grey), 4 (light gray), 5 (pale gray). Texture: 1 (mushy), 2 (moderately mushy), 3 (moderately chewy), 4 (chewy), 5 (very chewy). Aroma: 1 (very dominant rotten aroma), 2 (dominant rotten aroma), 3 (moderately meat aroma), 4 (predominant meat aroma), 5 (very dominant meat aroma).

2.7 Statistical analysis

Each variable was repeated three times and the mean standard deviation value was calculated. The study used a factorial Randomized Block Design with factor A, namely beef meatballs without biodegradable coating, and beef meatballs with biodegradable coating. Factor B was beef meatball storage time with 0, 6, 12, 18, and 24 hours at a room temperature of 27-29°C. Data were analyzed using one-way analysis of variance (ANOVA). When there was a significant difference between the treatments, the process was continued with the test using Duncan's Multiple Range Test (DMRT) with a significance level of P<0.05 using the IBM-SPSS program.

3 Results and discussion

3.1 Water Holding Capacity (WHC)

The results of the water-holding capacity showed that there was an interaction between the use of biodegradable coatings on beef meatballs and storage time. The results of the analysis of variance (ANOVA) on the use of biodegradable coatings and storage time had significantly different effect (P<0.05) on the water-holding capacity. The results of the water-holding capacity and data analysis carried out are presented in Table 1. The lowest water-holding capacity value was in meatballs without the use of biodegradable coatings with a storage time of 24 hours was 4.03% due to damage. The results showed that the water-holding capacity had an average value of 4.03% - 18.81%. The water-holding capacity of beef meatballs packaged with biodegradable coating was higher than beef meatballs without biodegradable coating. This happened because the biodegradable coating of beef meatballs contained a layer containing taro starch and duck bone gelatin.

Table 1. Chemical quality of beef meatballs during storage.

Parameter	Beef Meatballs	Storage Time (h)				
		0	6	12	18	24
pH	Non coating	7.06±0.10^{a}	6.69±0.02^{b}	6.50±0.07^{c}	6.52±0.01^{c}	6.39±0.03^{d}
	Coating	6.81±0.56^{a}	6.56±0.01^{b}	6.45±0.55^{c}	6.47±0.22^{c}	6.45±0.31^{c}
	Average	6.94±0.14^{a}	6.62±0.07^{b}	6.48±0.07^{c}	6.49±0.03^{c}	6.42±0.04^{d}
WHC	Non coating	17.68±1.74^{a}	13.15±1.95^{b}	9.81±2.67^{c}	7.18±1.99^{d}	4.03±0.92^{e}
	Coating	18.81±2.62^{a}	14.05±2.30^{b}	9.03±1.70^{c}	6.11±0.65^{d}	4.65±1.42^{d}
	Average	19.40±2.23^{a}	14.75±2.12^{b}	10.50±2.22^{c}	7.80±1.54^{d}	5.46±1.21^{e}
Water Content	Non coating	64.09±0.43^{e}	65.46±0.41^{d}	66.18±0.88^{c}	68.24±0.53^{b}	70.87±0.73^{a}
	Coating	62.40±0.64^{c}	63.30±0.78^{b}	63.78±0.18^{b}	65.19±0.69^{a}	65.83±0.63^{a}
	Average	61.24±1.01^{d}	61.62±0.63^{d}	62.74±0.76^{c}	65.06±1.35^{b}	66.50±2.58^{a}
Protein Content	Non coating	18.47±0.42^{a}	18.04±0.16^{ab}	17.4±0.71^{b}	16.41±0.38^{c}	15.82±0.21^{c}
	Coating	17.34±0.17^{a}	17.13±0.36^{ab}	16.66±0.33^{b}	16.65±0.40^{b}	15.84±0.19^{c}
	Average	17.90±0.68^{a}	17.58±0.56^{a}	17.03±0.63^{b}	16.53±0.37^{c}	15.83±0.18^{d}
Fat Content	Non coating	9.75±0.05^{a}	8.08±0.33^{b}	6.97±0.22^{c}	6.06±0.12^{d}	5.61±0.05^{e}
	Coating	9.02±0.43^{a}	8.62±0.37^{a}	8.03±0.16^{b}	6.933±0.16^{c}	6.28±0.49^{d}
	Average	9.38±0.40^{a}	8.35±0.43^{b}	7.50±0.61^{c}	6.50±0.49^{d}	5.94±0.48^{e}

Notation $^{a.\ b}$ on line and notation $^{a.\ b.\ c.\ d.\ e}$ in different columns shows significantly different effects (P<0.05)

The higher the taro starch content in the coating, the higher the water-holding capacity of the coating beef meatballs. Research conducted by [21] showed that high amylose and amylopectin in starch were able to bind water and retain it during the processing coating. In addition, gelatin also had chemical properties that were good at binding water and oil during the coating process. The average water-holding capacity of uncoated beef meatballs was 403 % with a storage time of 24 hours. Which resulted in a low value because there was no coating and preservatives added so that it would damage the structure of muscle protein more quickly to bind water. This was supported by the opinion of [22] who stated that the low water holding capacity was caused by denaturation and depolymerization processes. At storage times of 12 and 18 hours, the WHC of uncoated meatballs was higher than coated meatballs, because the biodegradable coating ability at that time was less able to protect the product from moisture.

The results of the analysis of variance (ANOVA) of the average storage time were significantly different (P<0.05) to water-holding capacity. The average value of water-holding capacity from storage time ranged from 19.54 to 46%5. The value of water-holding capacity decreased with the length of storage time due to the starch retrogradation process, this causes the biodegradable coating to also experience a decrease in water holding capacity. The starch contained in the tapioca flour in beef meatballs expanded before it re-crystallized and released some of the water so that the water-holding capacity of the meatballs decreased. Coating materials can protect products from environmental damage, such as water, oxygen, dust, humidity, light which can damage the water binding ability of products, especially proteins in products. So with the coating, the product is better able to water holding capacity. According to [23] that the water-holding capacity of meatballs was influenced by the nature of starch gelatinization. On the first day, the starch experienced optimal gelatinization so that the water binding capacity was high. In addition, the factor of beef meatballs that affected the decrease in water-holding capacity during storage time was the increase in protein denaturation in meat which was weakly bound between the water molecules in the meatballs. Long storage time will cause protein denaturation because storage time affects the length of time it reacts with light rays which will increase the temperature and also air which causes an increase in water content, where the water content will be a catalyst for enzymes to denature protein. The longer the storage time, the lower the ability of beef meatballs to bind water due to actin and myosin damage in beef meatballs. The damage to actin and myosin caused a decrease in the ability of muscle proteins to bind water [24], so the longer the water-holding capacity of meatballs without biodegradable coatings decreased, the faster they were stored. According to [25] the average water-holding capacity of beef meatballs was 18.21%. The water-binding capacity of beef meatballs was depends on proteins and structures that bound water, especially myofibril proteins [26].

3.2 Water content

The results of analysis of variance (ANOVA) using biodegradable coating on beef meatballs and storage time had a significantly different effect (P<0.05) on the moisture content. The results of the water content value and data analysis carried out are presented in Table 1. The lowest water content value was beef meatballs packaged with biodegradable coating with a storage time of 0 hours of 62.40% and the highest water content value was beef meatballs without biodegradable coating with a long 24-hour storage of 70.87%. The results showed that the water content had an average value of 62.40% - 70.87%. The water content value of beef meatballs without biodegradable coating was higher than the biodegradable coating beef meatballs. The high value of water content in beef meatballs without biodegradable coating occurred because there were no preservatives and a coating that protected beef meatballs. This happened because of the activity of the water around the place, especially moisture or water vapor that was at room temperature easily entered. The water content of biodegradable coating beef meatballs was lower because biodegradable coating beef meatballs had a coating that was able to maintain water vapor permeability with duck bone gelatin and taro starch coating ingredients. The low water vapor permeability was due to the compact structure of the packaging [27]. The increase in water content during storage is because the stored beef meatballs will absorb water vapor from the air until the water vapor pressure in the beef meatballs is the same as the water vapor pressure in the air in the storage room.

When beef meatballs were stored at room temperature, there was a transfer of environmental moisture into the beef meatballs, thereby increasing the water content of the meatballs. The use of room temperature in the storage process could also result in chemical reaction rates, enzymatic reactions, and texture changes causing product damage. Rusli et al. (2018)[28], stated that the higher the water content in the meatballs, the shorter the shelf life. The water content in food products, especially beef meatballs, was a maximum of 70%. In addition, high water content also resulted in textural instability in meatballs [29].

3.3 pH

The pH value indicated that there was an interaction between the use of biodegradable coating on beef meatballs and storage time. The results of the analysis of variance (ANOVA) using biodegradable coatings and storage time had a significantly different effect ($P<0.05$) on pH values. The results of the pH value and data analysis carried out are presented in Table 1. The lowest pH value was meatballs without biodegradable coating with a storage time of 24 hours (6.39), while the highest pH value was beef meatballs without biodegradable coating with a storage time of 0 hours (7.06). This was in line with the opinion of Newton and Gill (1980) [30] stating that the average pH value at 0-hour storage tended to be higher because microbial activity to convert glycogen into lactic acid had not occurred when compared to the subsequent storage time. The results showed that the pH value had an average value of 6.55 - 6.63. The pH value of beef meatballs with biodegradable coating was higher than beef meatballs without biodegradable coating. This happened because the biodegradable coating of beef meatballs had a layer that protected the beef meatball damage so that the beef meatballs were more durable. The biodegradable coating of duck bone gelatin taro starch could protect beef meatballs from contamination and also from the transfer of environmental moisture into food ingredients. The biodegradable coating of beef meatballs was able to maintain the pH product.

The average pH value of beef meatballs decreased the longer they were stored. This proved that an increase in acidity indicated by a decrease in pH value occurred due to the decomposition of beef meatball protein. This was in line with the research result of [31] showing that the longer the storage, the lower the pH of the meatballs. This was caused by organic acids formed from the breakdown of carbohydrates by lactic acid bacteria. In addition, it was also in line with the research of [32] showing that the pH of meatballs stored for 3 days at room temperature decreased.

3.4 Protein content

The results of analysis of variance (ANOVA) using biodegradable coatings and storage time had a significantly different effect ($P<0.05$) on protein content. The results of the protein content and data analysis carried out are presented in Table 1. The lowest protein content was in meatballs without biodegradable coating with a 24-hour storage time (15.82%), while the highest protein content was in beef meatballs without biodegradable coating with a storage time of 0 hours. The results showed that the protein content of beef meatballs had an average value of 16.72% - 17.23%. the protein content of beef meatballs without biodegradable coating (18.47±0.42a) or 17.23% was higher than beef meatballs biodegradable coating (17.34±0.17a) or 16.72%. This happened because the biodegradable coating of beef meatballs had a layer that protected the beef meatball damage so that the nutritional content of the product could be maintained.

The average protein of beef meatballs decreased the longer they were stored. This was due to the activity of microorganisms and enzymatic activity that affected the protein content in beef meatballs. The growing microorganisms generally damaged proteins and converted them into amino acids [33]. The growth of microorganisms in beef meatballs was followed by an increase in water content and a decrease in water-holding capacity during storage. According to [34], protein content was closely related to water content and total microbes in food. The use of biodegradable coating on beef meatballs was able to inhibit the increase in water content and total microbes. Coating is a thin layer made of consumable materials and formed to coat food to impede the transfer of masses such as moisture, oxygen, light, lipids, and solutes [35].

3.5 Fat Content

The results of the analysis of variance (ANOVA) on the use of biodegradable coatings and storage time had a significantly different effect ($P<0.05$) on fat content. The results of the fat content and data analysis carried out are presented in Table 1. The lowest fat content was in meatballs without biodegradable coating with a storage time of 24 hours (5.61%), while the highest fat content was in beef meatballs without a biodegradable coating with a storage time of 0 hour (9.75%). The results showed that the fat content of beef meatballs had an average value of 7.29% - 7.78%. The fat content of beef meatballs with biodegradable coating was higher than beef meatballs without biodegradable coating. This was because the biodegradable coating of beef meatballs had a layer that protected the beef meatball damage. The use of a biodegradable coating for beef meatballs during storage could reduce the contact of beef meatballs with air thereby inhibiting oxidation reactions. In addition, a biodegradable coating made from duck bone gelatin was a good oxygen barrier. Therefore, it inhibited oxidation reactions [36]. Oxidation reactions in beef meatballs were indicated by the presence of rancidity in the product.

The average fat content of beef meatballs was lower the longer they were stored. The decrease in fat content was due to the muscle fibers in beef meatballs underwent structural changes during storage so that cavities were formed in the muscle fibers so that water and fat came out. The longer the storage, the faster it underwent a hydrolysis reaction which reduced the fat content of beef meatballs. According to Temkov and Muresan (2021) [37] that the presence of water in foodstuffs caused fats to be hydrolyzed into glycerol and fatty acids. The product of hydrolysis produced a rancid taste and smell in the oil or fat. Furthermore, fat reduction or damage occurred due to chemical changes in meatballs such as hydrolysis and rancidity. Fat damage began with the formation of free radicals caused by factors that accelerated reactions such as light, heat, and fat peroxide [38].

3.6 Organoleptic

3.6.1 Color

The results of the color organoleptic values indicated that there was an interaction between the use of biodegradable coatings on beef meatballs and storage time. The results of analysis of variance (ANOVA) using biodegradable coating on beef meatballs and storage time had a significantly different effect (P<0.05) on color organoleptic values. The results of the color organoleptic values and the data analysis carried out are presented in Table 2 The lowest color organoleptic value was from beef meatballs without biodegradable coating with a 24-hour storage time of 1.37 in the dark brown and gray category. During the 24-hour storage time, beef meatballs were damaged. This was due to an oxidation or browning reaction on the surface of the meatballs so that the color became brownish gray over time of storage. The highest color organoleptic value was in biodegradable coating beef meatballs with 0 hour storage time of 4.90 in the pale gray color category. The pale gray color on the surface was due to the coating of duck bone gelatin and taro starch. This was in line with the result of research conducted by [13] showing that the change in the color of biodegradable coating beef meatballs to a brighter color was due to a thin layer of polysaccharides providing effective protection against browning of the surface of beef meatballs.

Table 2. Organoleptic quality of beef meatballs during storage.

Parameter	Beef Meatballs	Storage Time (h)				
		0	6	12	18	24
Color	Non coating	4.57±0.50 a	3.77±0.62 b	2.97±0.66 c	1.97±0.66 d	1.37±0.49 e
	Coating	4.90±0.30 a	4.37±0.55 b	3.93±0.58 c	3.50±0.57 d	3.17±0.83 e
	Average	4.73±0.44 a	4.07±0.66 b	3.46±0.79 c	2.73±0.98 d	2.27±1.13 e
Aroma	Non coating	5.00±0.00 a	4.00±0.58 b	2.73±0.86 c	1.90±0.66 d	1.50±0.57 e
	Coating	4.43±0.50 a	4.00±0.37 b	3.40±0.56 c	3.07±0.78 d	2.80±0.76 d
	Average	4.72±0.45 a	4.00±0.48 b	3.07±0.80 c	2.48±0.93 d	2.15±0.93 e
Teksture	Non coating	4.13±0.73 a	3.73±0.58 b	2.93±0.74 c	2.50±0.77 d	1.90±0.88 e
	Coating	4.33±0.47 a	4.03±0.49 a	3.33±0.60 b	2.77±0.77 c	2.40±0.77 d
	Average	4.23±0.62 a	3.88±0.55 b	3.13±0.70 c	2.63±0.78 d	2.15±0.86 e

Notation [a. b] on line and notation [a. b. c. d. e] in different columns shows significantly different effects (P<0.05)

The results showed that the color organoleptic had an average value of 2.93 - 3.97. The organoleptic value of the color of beef meatballs with biodegradable coating was higher than beef meatballs without biodegradable coating packaging with an average of 3.97 in the light gray category. This was due to the addition of duck bone gelatin and taro starch as a coating material for beef meatballs, including the type of polysaccharide which was a good barrier, so that the color coating layer on beef meatballs became more protected. This means that the application of biodegradable coatings from taro starch (Xanthosoma sagittifolium) and duck bone gelatin to beef meatballs had a positive effect on color, especially when stored at room temperature for 24 hours. The average organoleptic value of beef meatball color without biodegradable coating was 2.92 in the gray category. Degradation of color change was affected by temperature and water activity due to the absence of coating material on beef meatballs without a biodegradable coating.

The use of biodegradable coatings on beef meatballs decreased over time of storage. This component then underwent polymerization to form a dark-colored component, namely melanoidin, which caused discoloration in products made from meat, namely meatballs [39]. In addition, the decrease in the color of the meatballs was affected by the main meat ingredients used so the color quality changed. Besides, the longer the storage time, the more unwanted color appeared. The color of meatball products was also influenced by the myoglobin content of the meat. The higher the myoglobin, the redder the color of the meat. The red color of the meat changed to brownish gray due to the oxidation process [18]. The brownish-gray color in the oxidation process occurred when the reaction of hemoglobin (red) became oxyhemoglobin (purple and red). This reaction underwent denaturation and formed heme. Then the heme underwent oxidation to become hemin so that the brownish-gray color in this reaction occurred.

3.6.2 Aroma

The results of the organoleptic value of aroma indicated that there was an interaction between the use of biodegradable coatings on beef meatballs and storage time. The results of analysis of variance (ANOVA) using biodegradable coating on beef meatballs and storage time had a significantly different effect ($P<0.05$) on the organoleptic value of aroma. The results of the aroma organoleptic values and the data analysis carried out are presented in Table 2. The lowest aroma organoleptic value was from beef meatballs without biodegradable coating with a 24-hour storage time of 1.50 for the rotten meat aroma category. The highest aroma organoleptic value was from uncoated beef meatballs with a storage time of 0 hours of 5.00, a very flavorful category of beef. This was because beef meatballs without coating were not damaged at the beginning of storage.

The results showed that the organoleptic aroma had an average value of 3.03 - 3.55. The organoleptic mean value of biodegradable coating beef meatball aroma was 3.54 in the dominant meat aroma category. Biodegradable coating beef meatballs had a protective layer on the surface of duck bone gelatin and taro starch. This was because the coating layer had gelatin protein which exhibited barrier properties with CO_2 and several aromatic compounds as well as good barrier properties [40]. The coating on beef meatballs at room temperature for 24 hours turned out to have a positive effect on the aroma because the damage to beef meatball products could be minimized by a coating layer to slow down the growth or activity of microorganisms that caused sour or rotten aroma in beef meatball products. The average organoleptic value of beef meatball aroma without biodegradable coating was 3.03 in the moderate meat aroma category due to the absence of a coating that protected the meatballs from microorganisms. Beef meatballs without a biodegradable coating did not emit a distinctive beef aroma due to the formation of ammonia hydrogen sulfide and methyl sulfide compounds. Therefore, the distinctive aroma of beef disappeared, became odorless, and turned into a slightly rotten aroma.

The average organoleptic value of aroma from storage time ranged from 4.60 to 2.42 with the dominant rotten aroma category. The longer the storage time for beef meatballs without a biodegradable coating, the more biodegradable beef meatballs produced a rotten aroma. The stench was caused by the activity of lipase and protease enzymes. Apart from the presence of enzyme activity, oxidation and contraction processes also affected the aroma with the surrounding air causing evaporation so that the aroma was reduced. Even, the longer it was stored, it created a more rotten aroma [41].

3.6.3 Texture

The results of the texture organoleptic values indicated that there was an interaction between the use of biodegradable coatings on beef meatballs and storage time. The results of analysis of variance (ANOVA) using biodegradable coating on beef meatballs and storage time had a significantly different effect (P<0.05) on texture organoleptic values. The results of the texture organoleptic values and data analysis carried out are presented in Table 2. The lowest textured organoleptic values were beef meatballs without biodegradable coating with a storage time of 24 hours of 1.90. The outer part of the beef meatball texture became slightly harder, but the inner part became slightly softer. This was because during 24-hour storage a lot of water vapor entered from the surrounding environment due to the absence of a coating that protected beef meatballs from environmental damage.

The results showed that the texture organoleptic had an average value of 4.31 3.04. The organoleptic average value of biodegradable coating beef meatball texture was 3.37 in the chewy category. This was due to the biodegradable coating resisted the entry and exit of water from the sample so that the water content in the sample was successfully maintained and the texture became dry. According to [12], a combination of polysaccharides such as starch and their derivatives as a constituent of biodegradable coatings had the function of providing a smooth surface and preventing loss of water vapor. The average organoleptic value of beef meatball texture without coating was 3.04 in the moderately chewy category. Beef meatballs without a biodegradable coating did not have a coating that protected the product and there were no added preservatives, so the water content in the product was easy to absorb and the texture was not chewy, slightly hard on the outside, slightly soft on the inside. In addition, the decrease in the water-holding capacity of the protein also caused the texture to become soft. According to [42], the activity of microorganisms which degraded proteins into simpler compounds caused the ability of proteins to bind water to decrease. Factors affecting the texture value are color, marbling, and water-holding capacity. Texture was also closely related to connective tissue proteins, myofibrils, and sarcoplasm [43]. The decreased texture of the two treatments the longer the storage time was probably due to the marbling fat content in the meat, especially beef. The longer the storage time of the meatballs, the faster the texture changed.

4 Conclusion

The use of biodegradable coatings of taro starch (Xanthosoma sagittifolium) and duck bone gelatin can affect the quality of beef meatballs at room temperature storage for 24 hours. There is an interaction between the use of biodegradable coating on beef meatballs and storage time. Biodegradable coating of taro starch and duck bone gelatin can form a protective layer on the surface of beef meatballs, which can help maintain the quality of beef meatballs including changes in water-holding capacity, water content, pH, protein content, fat content, and organoleptic. The use of biodegradable coatings of taro starch (Xanthosoma sagittifolium) and duck bone gelatin on beef meatballs can slow down the deterioration of beef meatballs, namely slowing down the increase in water content during storage, slowing down the decrease in pH, and protein content and fat content and slowing down the change in color, aroma, and texture of beef meatballs at room temperature for 24 hours. Taro starch and duck bone gelatin can be used as biodegradable coating packaging materials because they are capable of blocking the transmission rate of water vapor, and oxygen barrier, and can form a compact film structure to protect beef meatball products from damage.

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