



Physicochemical Properties of Retort Pouch Packaged Rembiga Satay with Various Sterilization Time

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Abstract. Rembiga Satay is a culinary specialty originating from Lombok Island, characterized by the use of beef as the main ingredient and a unique blend of spices that impart a distinctively spicy and sweet flavor profile. Rembiga satay is a popular choice among tourists. Nevertheless, it is not a great option for a souvenir due to its limited shelf life. The utilization of retort pouch packaging for canning presents a potential alternative for prolonging the shelf life of rembiga satay. However, the application of sterilization on this method can have an impact on the physicochemical characteristics of the food product. The objective of this study is to investigate the effect of sterilization time on the physicochemical properties of rembiga satay when packaged using retort pouches. The research was conducted using a one-factor randomized group design, which encompassed six sterilization times: 3, 6, 9, 12, 15, and 18 minutes. The empirical findings indicate that the sterilization time had a significant impact on the acidity (pH), color, and texture but did not have a significant impact on the water activity (A_w) of rembiga satay that was packaged in retort pouches. As a result, the total microbial count for all treatments remained consistent at 1×10^4 . The retort pouch-packaged rembiga satay achieved optimal physicochemical characteristics when subjected to a sterilization length of 9 minutes. These physicochemical properties include a pH value of 6.00, an A_w (water activity) of 0.76, a texture of 4.32 N, and a color value of 50.96.

Keywords: canning, physicochemical properties, rembiga satay, retort pouch, sterilization time

1 Introduction

Lombok Island is recognized as a prominent tourism destination within the country of Indonesia. The development of supplementary industries is important in order to provide support for the island. One of the essential components that must be present is the presence of food and beverage establishments or culinary enterprises. One crucial factor in addressing the requirements of tourists has been highlighted by [1]. Diversifying local culinary potentials can serve as viable alternatives for meeting the gastronomic

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preferences of tourists [2]. The culinary potential found within the local community is a manifestation of the indigenous knowledge and traditions of the Sasak people, who possess a wealth of gastronomic diversity.

Satay Rembiga is a traditional gastronomic delicacy originating from Lombok Island. It is prepared with beef that is marinated with distinctive Lombok spices, resulting in a delectable combination of spicy and sweet flavors [1]. Sate Rembiga is highly regarded not just by the local population of Lombok but also by tourists, who often consider it a distinctive culinary memento. One limitation of Rembiga satay as a keepsake is its very short shelf life due to its classification as a semi-wet food. This characteristic can potentially promote the proliferation of bacteria, leading to spoilage and a subsequent decline in the overall quality of the satay [3]. In order to extend the duration of product viability, it is important to employ contemporary technological advancements, such as canning technology [4]. Food canning is a method of preserving food using hermetically closed packaging and using a heating process (sterilization) to kill pathogenic microbes, kill microbes that cause spoilage and their spores, and to inactivate enzymes that can damage food quality [5].

Canning encompasses a broader range of packaging methods beyond the traditional usage of canned packaging. These alternative methods include the use of non-canned packaging materials such as tetra pack, glass jars, plastic packaging, and retort pouches [6]. A retort pouch refers to a pliable packaging in the form of a pouch that is utilized for the purpose of containing pre-cooked food [7]. Retort pouches composed of aluminum foil laminated with polymer exhibit resistance to sterilization procedures and possess the ability to be stored for extended durations at room temperatures [8]. The application of retort pouches in conjunction with the vacuum process has been found to be suitable for food products that do not contain liquid components, such as satay rembiga.

Similar to traditional canning methods, the utilization of retort pouches for canning purposes involves the implementation of a sterilization process. The canning process requires the usage of an ideal temperature of 121°C for sterilization. However, the duration of sterilization may vary depending on the specific type and qualities of the food being processed [9]. Foods having a pH level exceeding 4.6, such as sate rembiga, a type of processed beef, typically necessitate a prolonged exposure to elevated temperatures during the cooking process. Nevertheless, thermal sterilization gives rise to numerous unregulated physicochemical impacts on the quality of food. The utilization of the general retort heating method is associated with a decline in the quality of sterilized food [10]. This decline can be attributed to the method's poor heat transfer rate and extended sterilization time, which fail to satisfy customers' expectations for food that is both high in quality and nutritionally rich. The impact of various sterilization methods on the texture and color of meat products varies [11]. The objective of this study was to investigate the impact of varying sterilization durations on the physicochemical properties of retort pouch packaged rembiga satay.

2 Materials and methods

2.1 Methodology

The research employed an experimental method conducted in a laboratory. Randomized Block Design (RBD) was utilized with six sterilization time, including 3, 6, 9, 12, 15, and 18 minutes. The experiment was replicate three times for each treatment.

2.2 The Manufacture of Rembiga Satay

The primary ingredient in rembiga satay is sirloin beef. The beef utilized contains no fat or connective tissue. The beef undergoes a process of rinsing with a continuous flow of water. The meat that has been cleaned is subsequently diced into cubes measuring approximately 2 cm in length, 0.5 cm in width, and 1 cm in thickness. The ingredients utilized in the preparation of rembiga satay consist of cayenne pepper (6.11%), huge chili (4.07%), dried chili (17.18%), garlic (4.07%), granulated sugar (30.54%), salt (2.04%), flavoring (1.18%), candlenut (2.04%), cooking oil (10.18%), brown sugar (20.34%), and lime (2.23%). The grinding procedure is conducted on cayenne pepper, huge chili, dried chili, garlic, and candlenut. Once the spices have been thoroughly blended, supplementary components including granulated sugar, brown sugar, salt, flavoring, and lime are incorporated.

Subsequently, the meat is combined with a seasoning. The meat portions that have been combined with the seasonings are threaded onto bamboo skewers. Following the process of skewering, the marination stage involves allowing the food to rest at room temperature for a duration of 30 minutes. After marination process, the satay is manually grilled using charcoal fuel derived from coconut shells for a duration of 2-3 minutes until it reaches a cooked state, indicated by the characteristic red-brown coloration of the satay. The rembiga satay, which has undergone the cooling process, is afterwards packaged in a retort bag of 16 cm x 22.5 cm. Each package has 10 skewers, with a weight of 100 g per package. The rembiga satay, which has been placed within the packaging, is afterwards subjected to vacuum sealing using a vacuum sealer.

2.3 sterilization

The sterilization procedure is conducted immediately following the closure of the retort bag. The sterilization process involves subjecting the materials to a temperature of 121°C for varying durations, including 3 minutes, 6 minutes, 9 minutes, 12 minutes, 15 minutes, and 18 minutes. Following the sterilization procedure, the retort pouch was next subjected to a cooling process at at -4°C in a cool box for 15 minutes. This cooling step aims to prevent the regrowth of thermophilic bacteria and prevent over-cooking.

2.4 Determination of the physicochemical parameters of retort pouch-packaged products

The physicochemical characteristics of the Rembiga satay packed in retort pouches were assessed following a 14-day incubation period at room temperature. The pH was determined using a Schott pH meter in accordance with the modification Indonesian

National Standard (SNI) 06-6989.11-2019. Water activity was evaluated using a portable. Colour measurements were conducted using a colorimeter, following the methodology outlined in the MSEZ User Manual [12]. The data collected from the observation were subjected to analysis of variance (ANOVA) at a significance level of 5% using the Costat software. When there was a significant difference, a subsequent examination was conducted with the Honest Real Difference Test (HSD) at the same level of significance.

3 Results and discussion

3.1 Acidity (pH)

The effect of the length of sterilization on the pH of rembiga satay in pouch packaging can be seen in Table 1.

Table 1. Acidity (pH), Water activity (Aw), Color and Texture of Retort Pouch Packaged Rembiga Satay

Sterilization duration (minutes)	pH	Aw	Color (°Hue)	Texture (N)
3	6,17 ^a	0,76	58,87 ^a	7,70 ^a
6	6,10 ^a	0,76	52.42 ^{ab}	5.70 ^{ab}
9	6.00 ^{ab}	0,76	50.96 ^{bc}	4.32 ^{abc}
12	6.00 ^{ab}	0,76	51.79 ^{bc}	3.60 ^{bc}
15	5.81 ^{ab}	0,79	46.78 ^{bc}	1,57 ^c
18	5,58 ^b	0,77	45,50 ^c	1,43 ^c
HSD	0,517	-	6,66	3,507

Different letters in the same column indicate data is significantly different at 5% alpha.

The data presented in Table 1 demonstrates the influence of sterilization duration on the pH levels of retort packaged-rembiga satay. The pH of rembiga satay exhibited a reduction in correlation with the increase in sterilization time. The decline in pH of retort packaged-rembiga satay can be attributed to the rise in thermal energy within the material, leading to increased dissolution of acidic chili components and subsequent addition of H⁺ ions to the solution [13]. Consequently, the elevated concentration of H⁺ ions result in the solution becoming acidic and the pH decreasing. The decline in pH levels is associated with the decomposition of organic acids included in food items, resulting in the formation of many components that contribute to the reduction of pH levels [14]. It has been stressed that the observed decline in pH can be attributed to the process of protein denaturation, which leads to the liberation of amino groups and the subsequent formation of amino acids [15]. The pH of rembiga satay in pouch packing is impacted by the elevated temperature it is subjected to during the sterilization

process. The application of elevated sterilization temperatures may lead to a reduction in the pH of the satay rembiga pouch. There is an inverse relationship between the temperature applied to the product and the rate of increase in pH, whereby greater temperatures result in lesser rates of pH increase [16]. This aligns with the viewpoint suggesting that elevated temperatures will expedite the decline in pH [17]. An extended duration of sterilization has the potential to decrease the pH level [18]. It found that variations in pH values result from varying sterilization times [19].

3.2 Water Activity (A_w)

Water activity (A_w) is one of the factors that can affect food spoilage because water activity can describe the bacteria's need for water. The effect of sterilization time on A_w of rembiga satay in pouch packaging can be seen in Table 1. Judging from Table 1, the treatment of sterilization duration does not affect the A_w value of pouch-packaged rembiga satay. This is because the packaging is closed so that the water contained in the material does not evaporate during the sterilization process and is trapped in the closed packaging used, so it does not affect the A_w value of the satay rembiga pouch. The high temperatures result in protein denaturation causing a decrease in the ability to bind liquids, so the liquid will come out as a drip, so the A_w value tends to be high even though it has been given a sterilization treatment [20]. The A_w value of retort packaged-rembiga satay ranged from 0.77-0.79 for all samples. As a result, the total microbial count for all treatments remained consistent at 1×10^4 Total Plate Count (TPC) assay.

3.3 Color ($^{\circ}$ Hue)

Color is one part of the product appearance and is an important sensory assessment parameter because it is the first sensory assessment trait seen by consumers. Under normal conditions, rembiga satay usually has a brownish red color. The effect of sterilization time on the value of $^{\circ}$ Hue of retort pouch packaged-satay rembiga can be seen in Table 1. The duration of the sterilization process had a significant impact on the color of the retort pouch packaged-rembiga satay. Capsanthin from large red chilies, cayenne pepper, and curly chilies is the primary pigment responsible for the sample's red hue [21]. The decrease in $^{\circ}$ Hue value is presumably due to the decomposition of the pigment capsanthin [22]. All products produce color with $^{\circ}$ Hue within the range of 45,5 to 58,8, indicating that they are red in color.

The level of the retort pouch packaged-rembiga satay color has a negative correlation with the duration of sterilization. Sterilization at high temperatures and for an extended period of time alters the physical properties, specifically the color [23][24]. The red color in the rembiga satay seasoning originates from red chili, the content in red chili is capsanthin, so it can cause color components due to heating. Carotenoid compounds are sensitive to high temperatures and can be affected by heating [25]. When

the temperature is too high, the chili's color becomes darker. This is consistent with the findings that sterilization of kalio meat tends to diminish the resulting color [26].

3.4 Texture

Texture is one of the most essential characteristics of meat's product quality and of food ingredients because it contributes to the product's "bite" sensation [27]. Table 1 displays the impact of sterilization time on the texture of retort pouch-packaged rembiga satay. In Table 1, the texture of the satay rembiga pouch is substantially affected by the length of sterilization. The retort pouch packaged-rembiga satay texture degraded as the sterilization time increased. This is consistent with another research which indicates that cooking temperature and duration can influence the tenderness of meat [28]. The tenderness of the meat was caused by proteins denaturation at an internal temperature of 80°C [21]. This can lead to an increase in the distance between meat fibres. Changes in meat texture mainly occur due to protein denaturation caused by heat treatment, which triggers contraction of myofibril proteins such as protein aggregation and coagulation [29]. Protein in meat is generally composed of myofibril protein, thus changes in myofibril protein will have a direct impact on meat quality [30]. Moreover, several changes in meat as a result of the thermal process, including denaturation, muscle cell rupture, sarcomere contraction, enlargement of the extracellular distance and intracellular cavity, and the presence of aggregated protein granules in the extracellular space [21]. The meat muscle can become softer as a result of protracted heating, which breaks protein bonds in connective tissue [31]. The extended sterilization time will reduce the level of hardness caused by muscle cell damage and gelatinization of muscle collagen during the heating process [32].

4 Conclusions

Sterilization time had a significant effect on the pH, color, and texture of the retort pouch packaged-rembiga satay. Sterilization duration did not significantly affect the A_w of retort pouch packaged-rembiga satay, so that the total microbes of all treatments were the same, namely $<1 \times 10^4$. The duration of sterilization for 9 minutes produced retort pouch packaged rembiga satay with the best physicochemical characteristics based on the criteria of pH value 6.00, A_w 0.76, texture 4.32 N, and color 50.96, which are in the red criteria.

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