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Chemical and Microbiological Characteristics of Canned Rendang Seasoning (Temperature and Sterilization Time Study)

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A B S T R A C T

This study aimed to evaluate the effects of sterilization temperature and time on the chemical and microbiological characteristics of canned rendang seasoning. A Completely Randomized Design (CRD) with two factors was employed, using sterilization treatments at 121°C and 126°C for 10 and 15 minutes. Observed parameters included F0 value , moisture content, protein, fat, ash, and the prevalence of Clostridium botulinum. The highest F0 value was recorded at 126°C for 10 minutes (28.70 minutes); however, the treatment of 121°C for 15 minutes (F0 = 5.98 minutes) was selected as optimal, as it meets food safety standards without compromising chemical quality. Microbiological analysis yielded negative results for C. botulinum across all treatments up to day 30 of storage. Chemical characteristics remained relatively stable, with moisture content ranging from 58.55% to 58.94%, ash content from 4.119% to 4.339%, protein content from 28.486% to 28.731%, and fat content from 17.697% to 18.111%, with no significant differences among treatments. Sterilization at 121°C for 15 minutes is recommended as the optimal condition for producing safe and high-quality canned rendang seasoning suitable for both domestic and export markets.

Contribution to Sustainable Development Goals (SDGs):
SDG 2: Zero Hunger
SDG 3: Good Health and Well-Being
SDG 12: Responsible Consumption and Production
SDG 9: Industry, Innovation and Infrastructure

1. INTRODUCTION

Indonesia is an agricultural country, where the majority of the population is involved in agriculture. Rendang seasoning is one of Indonesia's culinary heritages that holds great potential to be developed into a ready-to-eat food product with high commercial value. Over time, many micro, small, and medium enterprises (MSMEs) have begun producing instant rendang seasoning in the form of wet paste to meet the demands of both domestic and export markets. However, rendang paste products face serious challenges related to food safety and shelf-life stability during storage. Rendang paste generally contains high levels of moisture and fat, resulting in a relatively short shelf life.

According to Ref. [1] spice pastes with high moisture content are susceptible to chemical deterioration, such as rancidity, and serve as a medium for the growth of pathogenic microorganisms during storage. This issue is further exacerbated by the tendency of small-scale producers to determine expiration dates based

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solely on estimation, without scientific testing of shelf life. This uncertainty poses a significant risk to food safety, particularly due to the potential growth of pathogenic bacteria, such as Clostridium botulinum. *C. botulinum* is an extremely dangerous microorganism because it can produce botulinum toxin, which is lethal and resistant to high temperatures.

Therefore, a preservation method capable of ensuring the microbiological safety of rendang seasoning products is necessary. Thermal sterilisation using an autoclave is an effective method for eliminating microorganisms and their spores by applying high temperatures for a specified duration. In the context of canning low-acid foods, such as rendang seasoning, international food safety standards require a minimum F_0 value of 3.0 minutes, calculated based on the inactivation of C. botulinum spores, to achieve commercial sterility.

Several previous studies have evaluated canning technology on Indonesian processed food products, such as sambal roa [2], vegetable wax [3], and beef rendang [4]. However, specific studies focusing on the characteristics of non-meat rendang seasoning in canned form are still very limited. In fact, rendang seasoning without animal-based components has greater export potential because it is not subject to strict regulations concerning animal products.

Determining optimal sterilisation parameters through the evaluation of F_0 values and microbiological characteristics is crucial in the development of safe canned food products. Additionally, thermal sterilisation can also alter the chemical properties of the product, including moisture, ash, protein, and fat content, which are key indicators of the nutritional quality of rendang seasoning.

Based on the large market potential, the importance of food safety, and the limited research on canned rendang seasoning, this study aims to evaluate the effects of varying sterilization temperatures and durations on the microbiological and chemical characteristics of canned rendang seasoning. The results of this study are expected to contribute to the development of safe and high-quality preservation technology for rendang seasoning and to support the growth of Indonesia's food industry.

2. MATERIALS AND METHODS

2.1. Research Materials

The primary material used in this study is rendang paste seasoning produced by the MSME Taragak Randang in Yogyakarta. For chemical analysis, the materials used include sulphuric acid, 10% NaOH, 32% NaOH, HCl, oxalic acid, phenolphthalein (PP) indicator, 4% boric acid (H_2BO_4), Kjeldahl tablets, and petroleum benzene. Additionally, the microbiological media and reagents used include Plate Count Agar (PCA) and Buffered Peptone Water (BPW). Additional solutions required include distilled water (aquadest) and alcohol. All materials were used according to standard procedures to support the analysis.

2.2. Research Equipment

The equipment required for the canning of rendang seasoning includes two-piece cans with dimensions of 72.38 mm × 55 mm × 59.36 mm, a can washer (Can Washer MH-8600), an exhaust box, an automatic double seamer, an autoclave (Tomy SX-700), a can cooling shaker, and a heat penetration test data logger (ELLAB CTF 9004 Channel) equipped with a thermocouple to measure heat penetration into the can. Analysis equipment includes a Quebec Colony Counter, a pH meter, a C3 Texture Analyzer (Brookfield), an analytical balance (Kern ABC), a laminar air flow (LAF) JSCB-1200 SB, micropipettes (100–1000 µl) with blue tips (Brand), an incubator (Binder), Kjeldahl Digester K-446, Kjeldahl Master K-375 (Büchi), a muffle furnace, desiccators, spoons, knives, trays, aluminum foil, magnetic stirrers, latex gloves, an oven (Memmert), volumetric flasks, measuring cylinders, beakers, petri dishes, dropper pipettes, Soxhlet apparatus, filter paper, Erlenmeyer flasks, funnels, crucibles, stir rods, silica gel, fume hoods, vortex mixers, plastic wrapping, and other analytical tools.

2.3. Experimental Design

This study employed a Completely Randomized Design (CRD) with a two-factor factorial pattern and two replications. The data obtained were analyzed using Analysis of Variance (ANOVA) at the 5% significance level. To determine differences among treatments, a post hoc test was conducted using Duncan's Multiple Range Test (DMRT) at the 5% significance level. This research employed two treatment factors as independent variables: sterilisation temperature and sterilisation time. The first factor is sterilization temperature with two levels: 121°C (A1) and 126°C (A2). The second factor is sterilisation time, which has two levels: 15 minutes (B1) and 20 minutes (B2). The combination of these two factors resulted in four different treatment groups, as follows:

A1B1: sterilization at 121°C for 15 minutes
A1B2: sterilization at 121°C for 20 minutes
A2B1: sterilization at 126°C for 15 minutes
A2B2: sterilization at 126°C for 20 minutes

2.4. Research Implementation

The sterilization process was carried out in two stages at different times. First, sterilization was performed at 121°C for 10 minutes and 15 minutes. Second, sterilization was conducted at 126°C for 10 minutes and 15 minutes. The study was conducted in four main stages: (1) Sample preparation, (2) Measurement of F value using a thermocouple connected to a Heat Penetration Test device, (3) Proximate analysis including moisture, ash, fat, and protein content, and (4) Microbiological testing using Total Plate Count (TPC).

The F_0 value testing in this study was conducted to determine the effectiveness of the thermal sterilization process in ensuring the microbiological safety of canned rendang seasoning. The F_0 value represents the equivalent time at 121.1°C required to achieve commercial sterility, particularly to inactivate Clostridium botulinum spores, which are highly resistant to heat [5]. Samples of rendang seasoning were packed in tinplate cans and sterilized using an autoclave at two temperature variations (121°C and 126°C) and two time durations (10 and 15 minutes). During sterilization, the core temperature of the product was recorded using a thermocouple, which was then used to calculate the F_0 value based on thermal lethality. The calculation was performed using an integral approach that accounts for the deviation of the actual temperature from the reference temperature, with a z-value of 10°C [6].

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2.5. *Observed Parameters*

The parameters observed in this study included chemical and microbiological analyses of rendang seasoning after the sterilization process. Chemical analysis involved the measurement of moisture and ash content using the oven method, protein content using the Kjeldahl method, and fat content using the Soxhlet method, all based on AOAC (2005) standards. Meanwhile, microbiological analysis was conducted using the Total Plate Count (TPC) method, as described by Fardiaz (2000), to determine the total number of microorganisms in the sample. These observations aimed to assess the impact of sterilization treatments on the quality and safety of the rendang seasoning.

2.6. *Data Analysis*

The data obtained were analyzed using Analysis of Variance (ANOVA) at the 5% significance level. To determine significant differences among treatments, a post-hoc test was conducted using Duncan's Multiple Range Test (DMRT) at the 5% level [7].

3. RESULT AND DISCUSSION

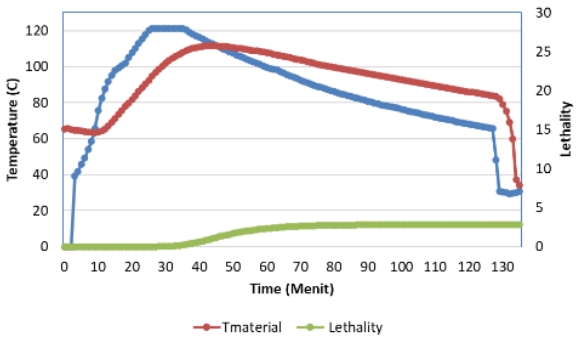
3.1. *Preparation of Rendang Seasoning*

The canned rendang seasoning was made from a blend of spices following a conventional rendang seasoning formula without the addition of coconut milk. The preparation process began with the selection of high-quality spices, followed by washing and peeling, weighing according to the specified formulation, and final rinsing. The spices were then ground to achieve a smooth texture and cooked for approximately 2.5 hours in a pan with added cooking oil.

3.2. *F_0 Testing*

In this study, sterilization of canned rendang products was carried out using three treatment variations: 121°C for 10 minutes, 121°C for 15 minutes, and 126°C for 10 minutes. Each treatment produced different heating curves and lethality values, which were then calculated to determine the F_0 value. Ideally, there should have been four treatments; however, during the final treatment at 126°C for 15 minutes, a technical error occurred with the data detection instrument, preventing data collection during the sterilisation testing process. Below is a detailed description and analysis of the three completed treatments.

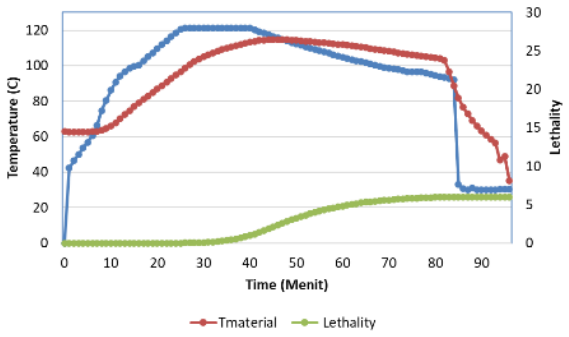
In the first treatment, which was carried out at 121°C for 10 minutes as shown in Figure 1, the data indicated that the initial product temperature was around 65°C, then gradually increased to reach approximately 121°C. The initial F_0 area value was very small, ranging from 2.6×10^{-6} and increasing to a maximum value of approximately 0.12 at a temperature of 102°C. The accumulated F_0 value from all this data yielded a total of 2.83 minutes. This value is still below the recommended minimum F_0 threshold for the microbiological safety of low-acid products, which is 3 minutes. This indicates that although the sterilization temperature was appropriate, the 10-minute heating duration was insufficient to achieve adequate thermal lethality throughout all parts of the product, particularly at the cold spot.



Picture 1. F_0 Value of Taragak Randang Rendang Seasoning Based on Lethality Sterilized at 121°C (A1) for 10 Minutes (B1)

In the first treatment, namely sterilisation at 121°C for 10 minutes, as shown in Figure 19, the data indicated that the initial temperature of the material was approximately 65°C, which then gradually increased until it reached around 121°C. The F_0 area value was initially very small, ranging from 2.6×10^{-6} and increasing to a maximum value of approximately 0.12 at 102°C. The accumulated F_0 value from all data resulted in a total of 2.83 minutes. This value is still below the minimum recommended F_0 threshold for the microbiological safety of low-acid foods, which is 3 minutes. This indicates that although the sterilization temperature was appropriate, the 10-minute heating duration was insufficient to achieve adequate thermal lethality throughout the entire product, especially at the coldest point (cold spot). These results are consistent with the study by [8], which indicated that a minimum F_0 value of 3 minutes is required to achieve a commercially safe level of sterility for low-acid food products. The study emphasized that insufficient heating duration may lead to the survival of pathogenic microorganisms, particularly *Clostridium botulinum* spores. Research conducted by [9] also supports this finding, where they found that at 121°C, a minimum of 12–15 minutes is required to reach an adequate F_0 value for products with similar packaging sizes. This explains why the resulting F_0 value of 2.83 minutes still does not meet food safety standards.

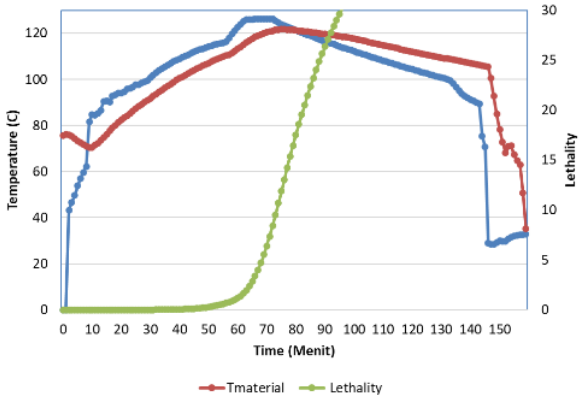
The second treatment involved heating at 121°C for 15 minutes. The data showed an increase in product temperature from approximately 62°C until it reached and maintained around 121°C. The F_0 area values also increased significantly compared to the first treatment. At temperatures approaching the retort temperature, F_0 area values ranged from 0.1 to more than 0.2, resulting in a total accumulated value of 6.64 minutes. This value far exceeds the minimum threshold of 3 minutes, indicating that adding just 5 minutes of heating duration increases the achieved thermal lethality by more than double. This provides strong evidence that sterilisation time has a significant influence on the accumulation of lethality, especially once the product temperature reaches the sterilisation temperature.



Picture 2. F_0 Value of Taragak Randang Rendang Seasoning Based on Lethality Sterilized at 121°C (A1), for 15 Minutes (B2)

The second treatment involved heating at 121°C for 15 minutes. The data showed an increase in the product temperature from approximately 62°C until it reached and maintained a level around 121°C. The F_0 area value increased significantly compared to the first treatment. At temperatures approaching the retort temperature, the F_0 area value ranged from 0.1 to over 0.2, resulting in a total accumulation of 5.98 minutes. This value far exceeds the minimum threshold of 3 minutes, indicating that by extending the heating duration by 5 minutes, the thermal lethality achieved increased by more than twofold. This serves as strong evidence that sterilization time has a significant impact on increasing lethality accumulation, especially once the product temperature has reached the sterilization level.

This finding is consistent with the study by [10], which demonstrated that extending the sterilisation time at a constant temperature results in a logarithmic increase in the F_0 value. They found that every 5-minute extension at 121°C can increase the F_0 value by 2 to 3 times, depending on the product's and packaging's characteristics. A kinetic study conducted by [5] also supports these results, reporting that the thermal death rate constant at 121°C ranges from 0.045 to 0.158 min^{-1}, which explains why increasing the exposure time from 10 to 15 minutes has a significant impact on lethality accumulation.



Picture 3. F Value of Taragak Randang Seasoning Based on Lethality Sterilized at 126°C (A2), for 10 Minutes (B1)

The third treatment applied a sterilization temperature of 126°C for 10 minutes, resulting in a rapid increase in product temperature and a sustained period at sterilization levels. The F_0 value increased exponentially after the material temperature exceeded 110°C, reaching a peak of over 1.0/min between 121 °C and 126°C, yielding a total F_0 of 12.72 minutes, the highest among all treatments. This indicates that higher temperatures substantially accelerate microbial lethality, even without extending the processing time.

The third treatment used a higher temperature, namely 126°C as mentioned, but with the heating duration remaining at 10 minutes. The results showed that the temperature of the material quickly reached the sterilization temperature and remained long enough at that temperature. The F0 value area increased exponentially, especially after the material temperature exceeded 110°C, with a peak F0 value reaching more than 1.0 at around 121–126°C. The accumulation of these values resulted in a total F0 of 28.70 minutes. This is the highest value among the three treatments and indicates that increasing the sterilization temperature has a significant impact on accelerating thermal lethality. Although the heating time was not extended, the higher temperature accelerated the achievement of lethal conditions for microorganisms. These results are following the principles of Arrhenius kinetics as explained in the study by Ref. [11] where an increase in sterilization temperature of 10°C can increase the microorganism death rate by up to 10 times. In this case, the 5°C increase from 121°C to 126°C resulted in a substantial increase in the F0 value, from 2.83 to 12.72 minutes. Research conducted by [12] demonstrated that sterilisation at high temperatures with short times (High Temperature Short Time - HTST) can yield high F0 values while maintaining the nutritional quality of the product. They found that at temperatures of 125–130°C, F0 values could be reduced from 10–15 minutes to 8–12 minutes, which is consistent with the findings in this study. A comparative study by [13] also supports the HTST approach, as they reported that sterilisation at 126°C provides better energy efficiency compared to conventional sterilisation at 121°C with longer durations.

3.3. *Effect of Temperature and Sterilization Time on the Prevalence of Clostridium botulinum in Canned Rendang*

The test on the prevalence of *C. botulinum* aims to ensure whether the sterilization process is capable of killing both vegetative cells and spores of this bacterium. Observations were made on three sterilisation temperature and time treatments: 121°C for 10 and 15 minutes, and 126°C for 10 and 15 minutes. The test results on the presence of *C. botulinum* in each treatment are presented in Table 1.

Table 1. Total *C. botulinum* bumbu rendang steril

Sample Code	Total *C. Botulinum* (CFu/g)	
	Day-0	Day-30
A1B1	Negative/g	Negatif/g
A1B2	Negative/g	Negative/g
A2B1	Negative/g	Negative/g
A2B2	Negative/g	Negative/g

Based on the research results in Table 1, all samples of canned rendang seasoning (A1B1, A1B2, A2B1, and A2B2) yielded negative results for the presence of C. botulinum on both day 0

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and day 30. This indicates that the applied autoclave sterilisation process has effectively inactivated C. botulinum and its spores.

Based on the research results in Table 10, all samples of canned rendang seasoning (A1B1, A1B2, A2B1, and A2B2) yielded negative results for the presence of C. botulinum on both day 0 and day 30. These results can be explained through the thermal resistance characteristics of *C. botulinum* and the effectiveness of the applied autoclave sterilization process. *C. botulinum* spores are among the most heat-resistant spores among pathogenic organisms; therefore, their inactivation is considered the standard for commercial sterilization (Physical Treatments to Control Clostridium botulinum Hazards in Food, PMC, 2023). This principle underlies the concept of "botulinum cook" in the canned food industry, where sterilization parameters are specifically designed to inactivate the most resistant *C. botulinum* spores.

3.4. Protein Content

The analysis of variance results showed that there was no significant interaction ($p \geq 0.05$) between the sterilisation temperature treatment and the sterilisation time treatment on the protein content of rendang seasoning. The sterilization temperature treatment and sterilization time duration each did not have a significant effect on the protein content of rendang seasoning. The average protein content values of rendang seasoning with sterilization temperature and time duration treatments can be seen in Table 2.

Table 2. Average value of protein content of rendang seasoning with temperature treatment and sterilization time

Treatment Fat Content (%)		Treatment Fat Content (%)	
Temperature	Time	Mean ±	DMRT (5%)
121°C	10 minutes	28.486a ± 1.45	3.926
	15 minutes	28.638a ± 0.21	4.013
126°C	10 minutes	28.655a ± 1.36	4.033
	15 minutes	28.731a ± 0.28	4.033

The protein content of rendang seasoning ranges from 28.486% to 28.731%. A 121°C sterilisation temperature treatment for 10 minutes resulted in the lowest protein content (28.486%), while a sterilisation temperature treatment of 126°C for 15 minutes resulted in the highest ash content (28.731%). This is due to the complexity of the interaction between sterilization temperature and exposure time to protein stability in rendang seasoning systems that contain various bioactive components. The relatively small difference in protein content suggests that the sterilisation treatment at the temperature and time range used does not have a significant protein degradation effect, but rather a tendency to increase measured protein levels with the increase in heat treatment intensity.

From the aspect of product quality, the analysis results showed that all sterilisation treatments produced good and relatively stable protein levels. The protein content, which ranges from 28.486% to 28.731%, indicates that rendang seasoning has a fairly high protein content and does not undergo significant degradation during the sterilisation process. This indicates that the sterilization process applied is effective in achieving the preservation goal without significantly sacrificing the nutritional quality of the protein. Research by Comprehensive Reviews in Food Science and Food Safety (2021) confirms that a proper sterilization process can maintain the nutritional value of proteins while ensuring the microbiological safety of products.

3.5. Fat Content

The results of the variety analysis showed that there was no significant interaction ($p \geq 0.05$) between the sterilisation temperature treatment and the length of sterilisation time on the fat content of rendang seasoning. The sterilisation temperature treatment and the length of sterilisation time each did not have a noticeable effect on the fat content of the rendang seasoning. The average fat content of rendang seasoning with sterilisation temperature treatment and varying sterilisation times is presented in Table 3.

Table 3. Average value of rendang seasoning fat content by temperature treatment and sterilization time

Treatment		Fat Content (%)	
Temperature	Time	Mean±	DMRT (5%)
121°C	10 minutes	17.697a ± 0.52	3.926
	15 minutes	18.097a ± 0.46	4.013
126°C	10 minutes	18.012a ± 0.71	4.033
	15 minutes	18.111a ± 0.76	4.033

The fat content of rendang seasoning ranges from 17.697% to 18.111%. A 121°C sterilisation temperature treatment for 10 minutes resulted in the lowest fat content (17.697%), while a sterilisation temperature treatment of 126°C for 15 minutes resulted in the highest fat content (18.111%). This suggests that increased temperature and sterilisation time tend to maintain or slightly increase the measured fat content in rendang seasoning, although statistically significant differences are not observed. This phenomenon can be explained by the complexity of physicochemical changes that occur in lipid components during the thermal sterilisation process, where a balance exists between the oxidative degradation process and changes in fat extractability due to modifications in the spice matrix structure.

The relatively good stability of the fat during the sterilisation process can also be attributed to the protective properties of the bioactive components contained in the spices that comprise rendang seasoning. The phenolic compounds, tocopherols, and other antioxidant compounds found in turmeric, ginger, onion, garlic, and other spices can act as natural antioxidants, protecting fats from excessive oxidation during heat treatment. Research conducted by Frontiers in Nutrition confirms that antioxidant compounds in spices can provide a protective effect against lipid oxidation during thermal processes, thus helping to maintain the stability of fats in the final product.

3.6. Up Air

The results of the variance analysis showed that there was no significant interaction ($p \geq 0.05$) between the sterilisation treatment temperature and the sterilisation time on the moisture content of rendang seasoning. The sterilisation temperature treatment and the sterilisation time each did not have a significant effect on the moisture content of rendang seasoning. The average value of rendang seasoning water content, as affected by sterilisation treatment temperature and sterilisation time, can be seen in Table 4.

Table 4. Average value of rendang seasoning water content with Treatment Temperature and Sterilization Time

Treatment		Moisture Content (%)	
Temperature	Time	Mean±	DMRT (5%)
121°C	10 minutes	28.486a ± 1.45	3.926
	15 minutes	28.638a ± 0.21	4.013
126°C	10 minutes	28.655a ± 1.36	4.033
	15 minutes	28.731a ± 0.28	4.033

The moisture content of rendang seasoning ranges from 28.486% to 28.731%. Treatment Temperature sterilization of 126°C for 10 minutes resulted in the lowest ash content (28.486%) and Treatment Temperature sterilization of 126°C for 15 minutes resulted in the highest ash content (28.731%). This indicates that the higher the sterilisation temperature used, the higher the moisture content in the rendang seasoning, and the longer the sterilisation time, the higher the moisture content. The results of the variety analysis showed that there was no significant interaction ($p \geq 0.05$) between the sterilisation treatment temperature and the sterilisation time on the moisture content of rendang seasoning. The sterilization temperature treatment and the length of sterilization time each also have an unreal effect on the moisture content of rendang seasoning. The moisture content of rendang seasoning ranges from 28.486% to 28.731%, with a very narrow range of only 0.245%.

The absence of a significant effect of Treatment Temperature and Sterilisation Time on the moisture content of rendang seasoning indicates that the sterilisation parameters used in this study have not reached conditions that can cause substantial changes in moisture content. This is different from the research of [14] reported that sterilization at a temperature of 130°C for 20 minutes can reduce the moisture content of food products by up to 15-20%. This difference shows that the Temperature and Time parameters used in this study are still in a relatively moderate range.

3.7. Ash Content

The results of the variety analysis showed that there was no real interaction ($p \geq 0.05$) between the sterilization treatment temperature and the sterilization time on the ash content of rendang seasoning. The sterilisation temperature treatment and the sterilisation time each did not have a significant effect on the ash content of rendang seasoning. The average value of the ash content of rendang seasoning with the sterilization Treatment Temperature and the length of sterilization time can be seen in Table 5.

Table 5. Average value of ash content of rendang seasoning with Treatment Temperature and Sterilization time

Treatment		Ash Content (%)	
Temperature	Time	Mean±	DMRT (5%)
121°C	10 minutes	4.339a ± 0.38	3.926
	15 minutes	4.232a ± 0.11	4.013
126°C	10 minutes	4.305a ± 0.11	4.033
	15 minutes	4.119a ± 0.11	4.033

The ash content of rendang seasoning ranges from 4.119% to 4.339%. Treatment Temperature sterilization of 126°C for 15 minutes resulted in the lowest ash content (4.119%) and Treatment Temperature sterilization of 121°C for 10 minutes resulted in the highest ash content (4.339%). This indicates that the high-temperature sterilisation process in canned rendang seasoning affects the mineral content, although the difference is not statistically significant. The decrease in ash content at a treatment temperature of 126°C for 15 minutes (4.119%) compared to a treatment temperature of 121°C for 10 minutes (4.339%) can be explained by several factors related to the characteristics of the canned rendang seasoning product and the sterilisation process applied.

The absence of a statistically significant difference ($p \geq 0.05$) indicates that the sterilisation process under the tested conditions (121-126°C for 10-15 minutes) retains the mineral content well. This aligns with the principles of commercial sterilisation, which aim to maintain nutritional quality while ensuring the microbiological safety of the product. Thus, canned rendang seasoning products still have adequate nutritional value for consumption with a long shelf life

4. CONCLUSION

Based on the study results, the highest F0 value was recorded at a 126°C temperature treatment for 10 minutes, which was 28.70 minutes. However, a temperature treatment of 121°C for 15 minutes, with an F0 value of 5.98 minutes, is considered the most optimal condition because it meets food safety standards without compromising the product's chemical quality. All treatments carried out showed negative results on Total Plate Count (TPC) on both day 0 and day 30 of storage. This demonstrates that the applied sterilisation process has been microbiologically effective. In terms of chemistry, the moisture content, ash, protein, and fat in the product did not show significant differences between treatments, indicating that the chemical stability of canned rendang seasoning is maintained even after it has undergone the sterilisation process. Therefore, treatment at a temperature of 121°C for 15 minutes is recommended as the safest and most optimal combination in maintaining the quality and safety of canned rendang seasoning products.

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