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CHARACTERISTICS OF BEEF RENDANG WITH THE ADDITION OF RED GINGER (*Zingiber officinale var. Rubrum*) DURING STORAGE AT ROOM TEMPERATURE

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ABSTRACT

The addition of red ginger in the making of rendang was expected to increase antioxidants to prevent rancidity and increase the shelf life of rendang. This study aimed to analyze the physicochemical, organoleptic and antioxidant activity of beef rendang with the addition of red ginger at different levels based weight of meat (0%, 15%, and 30%). The tested rendang was stored in a tightly closed jar and left at room temperature. The results showed that the interaction of the addition of red ginger and storage period had a significant effect ($p<0.05$) on the pH value, water activity, moisture, protein content, TBARS value, and antioxidant activity, but has no significant effect on ash content, fat content, and tenderness. Ash and fat content as well as tenderness of beef rendang added red ginger were not different from beef rendang not added red ginger (control). Based on sensory test the addition of red ginger did not affect the preference of the panelists. The addition of red ginger to the manufacture of beef rendang has a positive effect on physicochemical characteristics and increases antioxidant activity. Generally, red ginger addition as much as 30% resulted the best result.

Key words*:* Antioxidan; organoleptic; red ginger; rendang

INTRODUCTION

Beef rendang is a processed meat product which is a traditional Minangkabau food made using meat, coconut milk, chilies, garlic, lime leaves or bay leaves, onion and salt. Making rendang takes 4-6 hours that cooked over medium heat until the rendang has a dark brown to blackish sauce. The problem that often occurs in dry or semi-wet processed meat products during storage is rancidity. Rancidity is damage or changes in the smell and flavor toward fat or fatty foods, this process is caused by the interaction of a number of oxygen with fats and oils (Azizah et al., 2016). Prevention of rancidity can be done by adding antioxidant ingredients such as red ginger.

Red ginger is a plant of the *Zingiberaceae* tribe that contains high essential oils so that it is effective as antibacterial (Cragg, 1997). Phenolic compounds have polar properties and function as free radical scavengers (Pebiningrum & Kusnadi, 2015). Red ginger rhizome (*Zingiber officinale Linn. Var Rubrum*) has several compounds that play a role in antioxidant activity. Bioactive compounds that act as antioxidants in red ginger include β-carotene, ascorbic acid, terpenoids, alkaloids, and polyphenols such as flavonoids, flavonoid glycosides, and rutin (Auroma et al., 1997). Red ginger was able to inhibit the development of *S. aureus* by 15.83 mm and *E. coli* by 15.33 mm (Sari et al., 2013). The addition of red ginger during the process of making rendang is expected to prevent rancidity and increase antioxidant activity. This study aims to examine the characteristics of beef rendang given the addition of red ginger.

MATERIALS AND METHODS

Procedure

The formulation of beef rendang ingredients followed Indriani et al., (2021) with the modification of the addition of red ginger (Table 1) and the manufacturing process based on information from the cooking chef at the rendang producer at Istana Rendang Jambak. Red ginger in the manufacture of beef rendang was used with concentrations of 0%, 15% and 30% based on the weight of the meat used. The prepared spices are mashed together with red ginger, then the spices are heated with coconut milk to a temperature of 60ºC then the diced meat was added. The meat is heated until the coconut milk dries up and was dark brown in color for about 3-5 hours. The beef rendang was stored at room temperature using glass jars for 0, 3 and 6 days to see the effectiveness of red ginger as a source of antioxidants and antimicrobials during storage.

Observed Variables

The sample used was only the meat part without using rendang seasoning. The variables observed in this study were pH value (used pH meter), aw value (used aw meter), moisture (the meat was weighed and dried using an oven for 2 hours at a temperature of 105ºC), protein (protein analysis was carried out by determining the crude protein content, the steps taken in protein analysis were destruction, distillation and titration), fat (sample was distilled until all the fat solvent has evaporated. At the time of distillation the solvent will be accommodated in the extractor chamber, the solvent is removed so

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that it does not return to the fat flask, then the fat flask is dried in an oven at 105°C, after which the flask is cooled in a desiccator until the weight is constant), ash (dried samples were put in tanur and heated at 600ºC for 7 hours), *Thiobarbituric Acid Reactive Substances* (the sample was distilled, the distillate was incubated in waterbath at 100ºC for 40 minutes. Distillate was then measured using a spectrophotometer with a wavelength of 532 mm), antioxidant activity (the sample was soaked in methanol for 2x24 hours, the methanol extract was reacted with DPPH and soaked in waterbath at 37°C for 30 minutes, then measured using a spectrophotometer with a wavelength of 532 mm) and sensory.

Table 1. Formulation of making beef rendang with the addition of red ginger

Ingredient	Formula*		
	P1	P2	P3
Beef	1.000 g	1.000 g	1.000 g
Red Ginger	**0 g**	**150 g**	**300 g**
Coconut milk	2.500 mL	2.500 mL	2.500 mL
Salt	10 g	10 g	10 g
Onion	200 g	200 g	200 g
Garlic	100 g	100 g	100 g
Chilies	200 g	200 g	200 g
Bay leaves	5 lembar	5 lembar	5 lembar

[a]Source: Formula P1 (Indriani et al., 2021), P2 and P3 (Indriani et al., 2021) modified with the addition of red ginger. *The composition of the formula is based on the weight of the meat used.

Design and Data Analysis

The experimental design used in this study was two-factorial completely randomized design (3x3) with 3 times making rendang. The first factor was the use of red ginger with a concentration of 0%, 15% and 30%. The second factor is storage period which consists of three levels (0, 3 and 6 days). The data were analyzed using analysis of variance (ANOVA) to determine the effect of the treatment and if it had a significant effect, the Tukey test was carried out (Steel & Torrie, 1991). Organoleptic assays were analyzed by Kruskal-Wallis non-parametric analysis.

RESULTS AND DISCUSSION

The results showed that meat of rendang with the addition of red ginger was almost the same as rendang without the addition of red ginger. Testing of physical properties is important to do because it will determine the physical quality in this study. The following presents the results of the physicochemical characteristics of beef rendang in Table 2.

The Value of pH

The pH value of beef rendang was significantly affected by the interaction of the addition of red ginger and the length of storage of beef rendang ($p<0.05$) based on the results of the ANOVA test and Tukey test (Table 2). The highest pH value was found in beef rendang with the addition of red ginger as much as 30% and storage period of 6 days, while the lowest pH value was found in beef rendang without the addition of red ginger and storage period of 0 days. The increase in the pH of beef rendang with the addition of red ginger was due to the pH content of red ginger ranging from 4.3 to 7.4 (Mulyono, 2002). During storage there was an increase in the pH value. The increase in pH value during storage can be caused by the activity of enzymes and bacteria that begin to take place (Wally et al., 2015), the increase in pH value during storage can also occur due to the process of protein changes by proteolytic enzymes in red ginger which is able to break down peptide bonds into simpler protein molecules (amino acids) so that it affects the pH value (Anas et al., 2019).

Table 2. Physicochemical characteristics of beef rendang

Variable	Addition of red ginger	Storage period (days) 0	3	6	Average
pH Value	0%	5.58 ± 0.06^{d}	5.76 ± 0.05^{bcd}	5.94 ± 0.07^{abc}	
	15%	5.73 ± 0.06^{cd}	5.93 ± 0.05^{abc}	5.96 ± 0.18^{ac}	-
	30%	5.92 ± 0.03^{abc}	5.98 ± 0.03^{ab}	6.04 ± 0.02^{a}	
Aw Value	0%	0.86 ± 0.003^{ab}	0.87 ± 0.002^{b}	0.88 ± 0.005^{c}	
	15%	0.88 ± 0,007^{ab}	0.89 ± 0.005^{ab}	0.89 ± 0.002^{a}	-
	30%	0.88 ± 0.006^{ab}	0.89 ± 0.002^{a}	0.89 ± 0.004^{a}	
Moisture	0%	40.15 ± 1.01^{bcd}	35.33 ± 0.91^{cd}	34.23 ± 0.94^{d}	
	15%	42.79 ± 2.29^{ab}	39.73 ± 0.47^{abcd}	38.64 ± 1.74^{bcd}	-
	30%	44.32 ± 5.82^{a}	41.59 ± 4.21^{abc}	39.14 ± 1.11^{bcd}	
Ash Content (%)	0%	2.70 ± 0.69	2.60 ± 0.22	2.50 ± 0.56	2.60 ± 0.10^{a}
	15%	2.58 ± 0.54	2.45 ± 0.62	2.42 ± 0.51	2.49 ± 0.08^{ab}
	30%	2.48 ± 0.56	2.33 ± 0.46	2.28 ± 0.45	2.36 ± 0.10^{b}
Average		2.59 ± 0.11	2.46 ± 0.14	2.40 ± 0.11	
Protein (%)	0%	34.04 ± 1.31^{ab}	33.34 ± 2.06^{ab}	31.57 ± 3.75^{b}	
	15%	39.14 ± 2.94^{ab}	36.50 ± 2.52^{ab}	34.67 ± 2.42^{ab}	-
	30%	40.14 ± 1.35^{a}	39.55 ± 3.31^{ab}	38.80 ± 2.91^{ab}	
Fat (%)	0%	18.64 ± 1.04	19.81 ± 2.50	20.68 ± 2.71	19.69 ± 1.00^{a}
	15%	14.48 ± 1.74	14.97 ± 3.73	17.06 ±0.16	15.51 ± 1.37^{b}
	30%	12.16 ± 3.78	14.24 ± 4.86	16.02 ± 0.67	14.47 ± 1.44^{b}
Average		15.43 ± 2.86	16.34 ± 3.02	17.91 ± 2.42	
Tenderness (g/mm^2)	0%	2322 ± 349	2149 ± 777	1988 ± 380	2153 ± 167
	15%	2207 ± 509	2007 ± 736	1820 ± 174	2011 ± 193
	30%	2158 ± 358	1914 ± 420	1837 ± 359	1970 ± 167
Average		2229 ± 84^{a}	2023 ± 118^{ab}	1882 ± 91^{b}	
TBARS (mg/kg)	0%	2.32 ± 0.56^{d}	10.43 ± 0.27^{b}	19.27 ± 1.09^{a}	
	15%	1.56 ± 1.26^{d}	5.47 ± 1.24^{c}	8.52 ± 1.28^{b}	-
	30%	1.10 ± 0.36^{d}	2.36 ± 0.21^{d}	3.15 ± 1.14^{cd}	

*Remarks: Numbers accompanied by different manuscript in the same column and row show a significant difference (P<0.05) based on the results of the ANOVA test and Tukey test

The Value of Aw

The results of the beef rendang test showed that the water activity (Aw) was significantly affected by the interaction of the addition of red ginger treatment and the storage period of beef rendang (p<0.05) based on the results of the ANOVA test and Tukey test (Table 2). The highest Aw value was found in rendang with the addition of red ginger as much as 30% with a storage period of 6 days, while the lowest Aw value was found in beef rendang without the addition of red ginger with a storage period of 0 days. Beef rendang with the addition of 30% red ginger has a higher moisture because the higher water content in the product will affect the high water activity as well (Sholehah et al., 2015). Although the results obtained are quite high, these results are still below the good aW limit for meat products, which is 0.90 (Arief et al., 2012).

Moisture

The moisture of beef rendang was significantly affected by the interaction of the addition of red ginger and the length of storage of beef rendang (p<0.05) based on the results of the ANOVA test and Tukey test (Table 2). The highest moisture was found in rendang with the addition of red ginger as much as 30% with a storage period of 0 days, while the lowest water content was found in beef rendang without the addition of red ginger with a storage period of 6 days. Beef rendang with the addition of red ginger has a higher moisture than rendang without the addition of red ginger. This was due to the moisture in fresh red

ginger which reaches 70.48% thereby increasing the moisture of the meat rendang (Pujilestari & Lestari, 2009). During storage there is a decrease in moisture. Changes in moisture that occur during storage can be caused by the environment such as the air temperature in the room, the relative humidity of the air around the material (Winarno & Jenie, 1983).

Ash Content

The ash content of beef rendang was significantly affected ($p<0.05$) by the addition of red ginger and there was no interaction in all treatments and storage period based on the results of the ANOVA test and Tukey test (Table 2). The test results showed the highest ash content was found in rendang without the addition of red ginger, while the lowest ash content was found in rendang with the addition of 30% red ginger. The low ash content in rendang with the addition of red ginger can be caused by the low moisture, the lower the moisture, the higher the ash content of a food (Farrel et al., 2020). The ash content of beef rendang without the addition of red ginger or with the addition of red ginger shows a value that is below the maximum limit of SNI 7474:2009 regarding beef rendang, which is 5%. The ash content in a food is due to the mineral content found in the raw materials used (Arlinda et al., 2021).

Protein Content

The protein content of beef rendang was significantly affected by the interaction of the addition of red ginger and the storage period of beef rendang ($p<0.05$) based on the results of the ANOVA test and Tukey test (Table 2). The highest protein content was found in beef rendang with the addition of red ginger as much as 30% and storage period of 0 days, while the lowest protein content was found in beef rendang without the addition of red ginger and storage period of 6 days. Beef rendang with the addition of red ginger has a higher protein value than rendang without the addition of red ginger due to the protein content of red ginger which reaches 10-20% (Putri, 2019). The protein content of beef rendang made has a higher value than SNI, which is at least 20%, this shows that the rendang made has a higher protein content than SNI.

Fat Content

The fat content of beef rendang was significantly affected ($p<0.05$) by the addition of red ginger and there was no interaction between the addition of red ginger and storage period based on the results of the ANOVA test and Tukey test (Table 2). Storage period also has no effect on the fat content of beef rendang. The highest fat content was found in beef rendang without the addition of red ginger, while the lowest fat content was found in beef rendang with the addition of red ginger as much as 30%. The results of this study indicate that the more addition of red ginger the lower the fat content in beef rendang. This is because the use of ginger in food can increase the activity of the lipase enzyme which will hydrolyze fat into glycerol and fatty acids so that it will reduce fat levels (Irawan & Septiana, 2012). The fat content in beef rendang has a number that is below the limit of SNI 7474:2009 concerning beef rendang, which is a maximum of 30%. The low fat content in beef rendang is directly proportional to the moisture and high protein content.

Tenderness

The tenderness (g/mm^2) of beef rendang was significantly affected ($p<0.05$) by the storage period factor based on the results of the ANOVA test and Tukey test (Table 2). Tenderness was not affected by the addition of red ginger and was not affected by the interaction of the addition of red ginger and storage period. Even though beef rendang was added with red ginger in a fairly high amount, there was no significant difference between beef rendang added with red ginger and without red ginger. This can be due to the moisture of the beef rendang. According to Zahro et al., (2019) the moisture can affect the tenderness of the

meat, the lower the moisture it will increase the tenderness of the meat. The low moisture of rendang without the addition of red ginger causes the tenderness of rendang without the addition of red ginger was no significantly different compared to beef rendang with the addition of red ginger, although red ginger contains protease enzymes that can tenderize meat (Soeparno, 2005). Along with the length of storage of meat tenderness gradually increases, this was because the flavonoid content in spices will inhibit bacteria from degrading meat protein, so as to maintain meat tenderness (Cita et al., 2018).

Malondialdehyde Content as *Thiobarbituric Acid Reactive Substances* (TBARS)

The value of thiobarbituric acid reactive substances (TBARS) for beef rendang was significantly influenced by the interaction of the addition of red ginger and storage period of beef rendang ($p<0.05$) based on the results of the ANOVA test and Tukey test (Table 2). The lowest TBARS value was found in beef rendang with the addition of red ginger as much as 30% with a storage period of 0 days, while the highest TBARS value was found in beef rendang without the addition of red ginger with a storage period of 6 days. The low value of TBARS in beef rendang with the addition of red ginger is due to the phenolic compounds in red ginger such as gingerol and shogaol which function as antioxidants, especially the higher gingerol content and able to inhibit the breakdown of fats and oils that cause rancidity (Nakamnanu et al., 2019). During storage there was an increase in the TBARS value which was quite high in beef rendang without the addition of red ginger, in contrast to beef rendang with the addition of 30% red ginger with a not too high increase in TBARS. The increase in TBARS value during storage can be caused by lipid damage in foodstuffs due to peroxidation reactions triggered by free radical compounds.

Antioxidant Activity

The test results of antioxidant capacity and inhibitory activity on DPPH of beef rendang were significantly affected by the interaction of the addition of red ginger and storage period of beef rendang ($p<0.05$) based on the results of the ANOVA test and Tukey test which can be seen in Table 3.

Table 3. Antioxidant activity of beef rendang

Variable	Addition of red ginger	Storage period (day)		
		0	3	6
Antioxidant Capacity (mgVCE/g)	0%	115.13 ± 5.78^{c}	87.52 ± 10.71^{d}	71.62 ± 11.45^{d}
	15%	138.53 ± 2.23^{ab}	124.32 ± 4.58^{bc}	110.03 ± 1.32^{c}
	30%	144.43 ± 3.54^{a}	137.96 ± 6.61^{ab}	133.79 ± 2.53^{ab}
Inhibition of DPPH (%)	0%	74.04 ± 3.66^{c}	56.57 ± 6.78^{d}	46.51 ± 7.25^{d}
	15%	88.84 ± 1.41^{ab}	79.85 ± 2.89^{bc}	70.81 ± 0.84^{c}
	30%	92.58 ± 2.24^{a}	88.48 ± 4.18^{ab}	85.84 ± 1.60^{ab}

*Remarks: Numbers accompanied by different letters in the same column and row show a significant difference ($P<0.05$) based on the results of the ANOVA test and Tukey test

Antioxidant capacity and activity DPPH inhibition increased significantly ($p<0.05$) as the concentration of red ginger was added. The highest antioxidant capacity and inhibitory activity against DPPH was found in rendang with the addition of red ginger as much as 30% on day 0 storage, while the lowest antioxidant capacity and inhibitory activity against DPPH was found in rendang without the addition of red ginger on day 6. This was because red ginger contains bioactive components as antioxidants which causes a higher value of antioxidant capacity and inhibition of DPPH.

During storage there was a decrease in antioxidant capacity and inhibition of DPPH. However, rendang with the addition

of red ginger experienced a very slight decrease in capacity and on the 3rd and 6th days, rendang with the addition of red ginger as much as 30% had no significant difference. This was because red ginger contains flavonoid compounds that are able to capture superoxidation directly and derivatives of flavonoids can capture highly reactive radical derivatives (Arifin & Ibrahim, 2018).

Organoleptic

The color, taste, aroma, texture and general appearance of rendang were hedonic showing values that were not significantly different. The results of testing the hedonic quality of beef rendang with the addition of red ginger had a significant effect ($p<0.05$) on the color, taste and aroma parameters. The table of organoleptic test results for beef rendang can be seen in Table 4.

Table 4. Organoleptic of rendang daging

Sensory	Variable	Addition of red ginger		
		0%	15%	30%
Hedonic Test	Color	4.13 ± 0.68	4.20 ± 0.55	4.00 ± 0.62
	Taste	3.83 ± 0.59	3.93 ± 0.74	3.83 ± 0.75
	Aroma	4.17 ± 0.65	3.97 ± 0.76	3.97 ± 0.72
	Texture	4.23 ± 0.63	4.17 ± 0.75	4.10 ± 0.71
	General appearance	4.23 ± 0.50	4.19 ± 0.40	4.00 ± 0.59
Quality Test	Color	3.69 ±1.12^{a}	3.45 ± 1.06^{ab}	3.09 ± 0.96^{b}
	Taste	2.25 ± 0.84^{a}	2.97 ± 1.12^{b}	3.41 ± 1.07^{c}
	Aroma	2.24 ± 0.57^{a}	2.56 ± 0.98^{ab}	2.75 ± 1.02^{b}
	Texture	3.73 ± 0.83	3.77 ± 0.82	4.03 ± 0.72

Hedonic test 1 = dislike very much, 2 = dislike, 3 = a little like, 4 = like, 5 = very much like

Quality Test; Color: 1=yellowish brown, 2=light brown, 3=reddish brown, 4=dark brown, 5=very dark brown. Taste: 1=very no red ginger taste (just rendang taste without ginger taste), 2=no red ginger taste (ginger taste but no red ginger), 3=slight red ginger taste, 4=red ginger taste, 5=very red ginger taste. Aroma: 1=very unscented red ginger (just rendang taste without ginger taste), 2=no red ginger scent (ginger taste but no red ginger), 3=slightly red ginger scent, 4=red ginger scent, 5=very red ginger scent. Texture: 1=very not tender (very hard), 2=not tender, 3=a little tender, 4=tender, 5=very tender

The hedonic test of beef rendang with all treatments on all parameters did not have a difference in the level of preference of the panelists, namely the average panelist liked the color, taste, aroma, texture and overall beef rendang either with the addition of red ginger or without the addition of red ginger. The color parameter has an average of 4.00-4.20 (likes), taste has an average of 3.83-3.93 (likes), aroma has an average of 3.97-4.17 (likes), texture has an average of 4.10 - 4.23 (likes), and general appearance has an average of 4.00-4.23 (likes). Overall, the panelists liked rendang either with or without the addition of red ginger.

The results of this study showed that the color of beef rendang showed significantly different results ($p<0.05$) with an average of 3.09-3.69. Rendang with the addition of red ginger as much as 30% and 15% give a reddish brown color, while rendang without the addition of red ginger give a dark brown color. The color of beef rendang with the addition of red ginger which is reddish brown is due to the high moisture so that the red color of the meat has not changed myoglobin pigment to brown (Akbar & Gusnita, 2020). The taste of rendang produced in this study showed significantly different results ($p<0.05$) with an average of 2.25-3.41. Rendang with the addition of 30% and 15% red ginger give a slightly red ginger taste, while without the addition of red ginger it does not taste red ginger. This was because the use of other spices during the cooking process causes the red ginger taste to not stand out too much (Akbar & Gusnita, 2020). However, the addition of red ginger up to 30% was still

acceptable to the panelists based on the hedonic test.

The aroma of rendang produced showed significantly different results ($p<0.05$) with an average of 2.24-2.75. The addition of 30% and 15% red ginger to the rendang give a slight red ginger aroma. The red ginger aroma that does not stand out is due to the use of other spices during the cooking process (Akbar & Gusnita, 2020). The addition of red ginger during the manufacture of rendang did not significantly affect the texture of the resulting rendang, which had an average of 3.73-4.03 (tender). The value obtained shows that the tenderness between rendang without the addition of red ginger and rendang with the addition of red ginger was not much different, this was in accordance with the tenderness test which is not significantly different in the tenderness test.

CONCLUSIONS

The addition of red ginger to beef rendang increased the pH value, moisture, aw value, protein content, and antioxidant activity and was able to reduce the increase in TBARS during storage. The ash content, fat content and tenderness of beef rendang given the addition of red ginger with beef rendang without the addition of red ginger did not show any difference. The addition of red ginger up to 30% did not reduce the panelists' preference for the rendang meat produced.

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