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Physical and Sensory Characteristics of Food Bar Based on Beneng Taro (*Xanthosoma undipes* K. Koch) and Soy Protein Isolate

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ABSTRACT

Beneng taro, a local food plant in Banten Province, has enormous potential to be developed as an effort to diversify food, one of which is used as a raw material in the manufacture of food bars. Ingredients formulation and roasting temperature can affect the characteristics of the resulting food bar. Therefore, researchers consider it necessary to conduct research related to the physical and sensory characteristics of food bars based on beneng taro, mocaf and soy protein isolate as one of food diversification, as well as the best formulation and roasting temperature of the food bar. This study used a completely randomized split plot design with two factors, namely roasting temperature and ingredients formulation. The L* value, a* value, and texture were all significantly impacted by the roasting temperature, according to the results. Meanwhile, the L*, a*, and b* values were significantly impacted by the addition of beneng taro flour and soy protein isolate. The a* value, b* value, as well as the panelists' evaluation of the color, texture, and overall parameters are significantly impacted by the interaction between the two factors. The formulas for the chosen food bars contained 30% taro flour and 70% soy protein isolate, and they were baked at 140 °C (S_2R_2) with the following characteristics: texture 26,59 N; L* value 46,75; a* 14,99; b* 32,17; and the value of preference for color, taste, aroma, texture and overall is 2,23; 2,10; 2,23; 2,15; and 2,25.
Keywords: Beneng taro, food bar, soy protein isolate

INTRODUCTION

Beneng taro is a local food plant of Banten Province which is spread in the area around Juhut Village, Karang Tanjung District, Pandeglang Regency. Ningsih & Hermita (2016) states that beneng taro can generally grow on the edge of forests, river banks, swamps, and cliffs with humus. This taro grows in the tropical lowlands at an altitude of 250-700 m above sea level (asl) with sufficient rainfall ranging from 175-250 cm/year. Suhaendah et al. (2021) mentioned that previously taro plants grew wild and were considered a nuisance plant because their growth was very easy and fast, but now they have started to be cultivated because they have enormous potential.

According to Yuliani (2013) beneng taro tubers have a length of 1,2-1,5 m and a weight of 35-40 kg at the age of 2 years. Bulb circumference can reach about 45-55 cm. Beneng taro tubers are produced from trees that have a height of about 2-2,5 m with a leaf width of 1 meter. Therefore, Budiarto & Yunia (2017) stated that taro beneng has unique characteristics where the tubers are large and yellow (koneng) with stems which are the largest part that can be consumed. Based on the data obtained in the research of Muttakin et al. (2015) beneng taro has a protein content of 8,77%; carbohydrates 84,88%; starch 6.97%; ash 8.53%; fat 0.46% and 84.65% water.

Beneng taro has been used by local residents to make chips and as a food ingredient that is processed by steaming, boiling or frying. Considering its enormous potential, further processing is one of the alternatives needed to reduce the decline in the quality of beneng taro and as an effort to diversify products made from beneng taro. After the harvesting process is carried out, beneng taro can be processed into flour which is a semi-finished product. Later this flour can be used as raw material in the manufacture of products such as brownies, macaroni, dry noodles, cookies and food bars.

Food bar is a food product in the form of a rod and solid. According to Aini et al. (2018) food bar is one of the processed food products in solid, square shape and has a low a_w (water activity) value. Purwanti (2019) adds that food bars generally have an water activity value in the range of 0,65–0,85 and a water content of around 15%-30%. There are several ingredients commonly used in making food bars such as margarine, milk, eggs, sugar and so on. Food bars can be made using local raw materials such as purple sweet potato flour (Nurhayati et al., 2018; Fadhlan et al., 2021; Elisabet, 2018), red bean flour (Anandito et al., 2016) and soybean flour (Fanzurna and Mohamad, 2020).

According to Elisabet (2018) the process of making a food bar begins with the manufacture of various flours that will be used, followed by the process of mixing all the ingredients that will be used until the dough becomes smooth, then molding and baking in the oven. In making a food bar, there are several things that can affect the characteristics of the resulting food bar, including the formulation of raw materials and the roasting temperature at the time of making the food bar.

The results of research by Nurhayati et al. (2018) using purple sweet potato flour and ripe banana (*Musa paradisiaca* Formatypica) showed that the food bar with the best characteristics was a food bar with 30% purple sweet potato flour added and 70% banana agung with a roasting temperature of 120℃ for 40 minutes and 5 minutes. The physical characteristics of the food bar are texture value of 75,22 g/mm, color of L, a*, and b* respectively of 43,47; 7,67; and 18,25. Based on the research by Fanzurna and Mohamad (2020) which utilizes kepok banana peel flour and soybean flour as the basic ingredients for making food bars, it shows that the best food bar formulation is the addition of 10% kepok banana peel flour and 90% soy flour. In this formulation, the favorite values for color, aroma, texture, taste and aftertaste are 5,10; 5,03; 4,43; 5,63; and 5,17.

Muchtadi & Sugiyono (2014) explain that the roasting temperature has a very large influence on the manufacture of food bars. The research results of Rahman et al. (2011) showed that the optimal roasting time and temperature in the process of making banana-based food bars is when the roasting temperature is 120℃ for 40 minutes and the temperature is 140℃ for 5 minutes. The characteristics of the resulting food bar are 18,02% water content; 2,75% ash content; fat content 4,86%, protein content 8,74%; and 63,27% carbohydrate content. Based on the research of Rahmawati et al. (2020) a temperature of 130℃ for 20 minutes is the best temperature and roasting time in making sorghum flour-based food bars. Based on the results of the formulation and the best roasting temperature, the sorghum flour-based food bar has a hardness value of 1597.56 g force.

The results of Budiarto and Yunia researchs (2017) show that beneng taro flour processed by local residents has a water content of 6,10%; 6,11% ash content; fat content 0,39%; protein content 6,70%; and 80,70% carbohydrate content. Based on these results in terms of protein content, the protein contained in beneng taro flour is almost equivalent to the protein found in low protein wheat flour, so that beneng taro flour can be used as raw material for making food bars.

This study aimed to determine the physical and sensory characteristics of a food bar made from taro beneng flour, soy protein isolate and mocaf as well as the best formulation and roasting temperature of the food bar.

MATERIALS AND METHODS

Tools and Materials

The tools used in the food bar manufacturing process are digital scales type PT-238 (Kova Fabio), containers, trays, brushes, basins, knives, cutting boards, analytical balance type H7K (excellent), electric cabinet dryer model AST105E, disk mill machine type AGR-MD24 (Maksindo), blender type HR2223/60 (Philips), sieve size 100 mesh, spoon, plastic spatula, mixer type HM-620 (Miyako), pan size 24 cm × 24 cm, electric oven type KBO-190LW (Kirin) and a ruler. Meanwhile, the tools used in the analysis process are texture analyzer type LLYOD TA1 (Ametek), chromameter model colorFlex EZ (Hunterlab), tasting booth for sensory assessment, stationery, label paper, HVS paper and camera.

The ingredients used in making the food bar are taro beneng from Juhut-Pandeglang Village, Banten, mocaf (Mocafine), margarine (Forvita), refined sugar (Rose Brand), egg yolks, skim milk (Indoprima), salt (Mama Suka), soy protein isolate (Para Agibusiness), NaCl solution and water. Procedures and formulations in making food bars refers to the research of Nurhayati et al. (2018).

Method

The design of this study used a quantitative method with a completely randomized split plot design consisting of two factors and three replications. The first factor is the roasting temperature (S) as the main plot consisting of three levels, namely:

S_1 = 120℃
S_2 = 140℃
S_3 = 160℃

The second factor is the ingredients formulation as subplot which consists of four levels, namely:

R_1 = Soy protein isolate : Beneng taro flour = 80%:20%
R_2 = Soy protein isolate : Beneng taro flour = 70%:30%
R_3 = Soy protein isolate : Beneng taro flour = 60%:40%
R_4 = Soy protein isolate : Beneng taro flour = 50%:50%

This research was carried out through three stages, namely the production of beneng taro flour, the production of food bars, as well as physical and sensory analysis. Physical analysis carried out is color and texture analysis. Meanwhile, the sensory analysis carried out was the level of panelists' acceptance of the parameters of color, texture, aroma, taste and overall.

Production of Beneng Taro Flour (Putri et al., 2021)

The making of beneng taro flour begins with the cleaning process of fresh taro beneng, then the process of peeling the skin using a knife is carried out. Then the washing process was carried out again in running water with a ratio of 2:1 (v/w). Beneng taro that has been cleaned and peeled is reduced in size, soaked in 10% NaCl solution for 2 hours. After the soaking process with NaCl solution, the taro beneng was then washed with water. After that, the drying process is carried out at a temperature of 50 - 60°C with a cabinet dryer for 6-12 hours. Beneng taro that has been dried is then milled using a disk mill machine until it becomes coarse flour. Furthermore, the flour is mashed using a blender and sieved manually using a 100 mesh sieve.

Production of Food Bars (Nurhayati et al., 2018)

The food bar production stage was completed by weighing and mixing the taro beneng flour and soy protein isolate according to the treatment ratio that had been set. The preparation of auxiliary components, which include 10% mocaf, 30% liquid margarine, 25% refined sugar, 10% egg yolk, 35% skim milk, and 0,25% salt of the total flour used, begins the process of producing a food bar. The egg yolks, liquid margarine, and powdered sugar are then combined with a mixer on low speed for 5 minutes. Furthermore, skim milk, salt, and composite flour containing mocaf were added at a rate of up to 10%, as were beneng taro flour and soy protein isolate, according to the treatment that was gradually determined. Then, gradually add water to make a smooth dough. Manually mix again with a spatula until the dough is uniformly spread. Then do the molding of the dough into the pan 24 cm × 24 cm. The molded dough is then cooked for 40 minutes at 120°C in a preheated oven. The resting or chilling phase is then carried out at room temperature for 10 minutes before cutting. The half-cooked dough was then cut with a size of 6 × 3 × 2 cm^3. The roasting procedure was then repeated in the oven for 5 minutes at the proper temperature for the stated treatment. After that, the roasting process was carried out again in the oven at the appropriate temperature for the specified treatment for 5 minutes. After baking, the food bar is cooled by allowing it to cool at room temperature for a few minutes after being taken from the oven.

Color Analysis (Fardiaz, 1984 <u>in</u> Lumba et al., 2017)

The color of the resulting food bar was measured using a chromameter brand Hunterlab colorFlex EZ spectrophotometer. The color notation system used is the hunter system where L* (brightness), a* (± red - green), b* (± yellow - blue). Before the measurement process, the chromameter is calibrated first with the white standard contained in the tool. The color measurement process is carried out by placing the sample in the cuvette that has been provided and then pressing the start button to start the measurement process. The light source is on and the reflectance is measured, so that the L*, a* and b* values will be obtained from the sample with a range of 0 (black) to ± 100 (white).

Texture Analysis (Kulthe et al., 2014)

Texture analysis of food bars in this study used a texture analyzer (LLOYD TA1). The analysis process begins by placing the sample in the sample storage area available in the tool, then the sample is pressed with a constant pressing speed of 50 mm/minute, the maximum load cell force is 1 kg and compression is 75%. The maximum force required to break a food bar is its hardness value (Newtons (N)).

Sensory Analysis (Garnida, 2020)

Sensory analysis in this study was conducted to measure the level of preference or the level of panelists' acceptance of food bar products. Sensory analysis in this study used a hedonic method (scoring test) which included color, texture, aroma, taste and overalls which were tested by 40 untrained panelists with 7 rating scales, namely 1 =

Very Disliked, 2 = Disliked, 3 = Somewhat Disliked Liked, 4 = Neutral, 5 = Slightly Liked, 6 = Liked and 7 = Very Liked. The results of the sensory data obtained are then processed in the form of a spider web.

Data analysis

The data obtained were analyzed by test of variance with a significance level of 5%. Then interpreted according to the observed parameters to see the tendency of each parameter. If the data obtained is significantly different, a DMRT (Duncan Multiple Range Test) further test will be carried out to determine the significant difference between treatments at a significance level of 5%. Data analysis using SPSS (Statistical Package for the Social Sciences) software.

RESULTS AND DISCUSSION

Physical Characteristics

Food Bar Color

The parameter used to indicate how light and dark a material is is called L* or brightness. The brightness level (L*) has a value range from 0 to 100. The absolute black material has a value of 0, while the white material has a value of 100. The brighter the material, the greater the L* value (Winarno, 2004).

The results of analysis of variance (Table 1) showed that the treatment of variations in roasting temperature had a significant effect ($P<0,05$) and the treatment of variations in ingredient formulations had a very significant effect ($P<0,01$), while the interaction between the two factors did not show a significant effect ($P>0,05$) to the value of L*. The L* value of the food bar as a result of this study ranged from 42,84 (sample S_3R_4) to 49,18 (sample S_1R_1). This result is higher than the research result of Nurhayati et al. (2018) which has an L* value ranging from 43 – 44. This shows that the food bar based on beneng taro, mocaf and soy protein isolate has a higher brightness value than the food bar made with purple sweet potato flour and ripe banana agung.

The more addition of beneng taro flour will decrease the brightness value (L*). This is presumably because the color of beneng taro flour is brownish yellow so that it makes the color of the food bar more brown and there is a degradation of carotenoid pigments contained in beneng taro flour. The higher the roasting temperature, the lower the brightness value (L*). This is thought to be due to the Maillard reaction during the food bar roasting process.

According to Tamanna and Mahmood, (2015) when a material contains protein components and reducing sugars that are processed at high temperatures, a Maillard reaction will form. Seftiono and Intan (2020) added that a change in the color of a product can occur due to a decrease in color stability, as well as the Maillard reaction which produces melanoidin pigments as a form of brown color during the roasting process. Proteins in skim milk and soy protein isolate were the source of amino groups, while reducing sugars were obtained from added refined sugar.

The parameter used to indicate the greenish-red color of a material is called the a* (redness) value. Meanwhile, the parameter used to indicate the bluish-yellow color of a material is called the b* (yellowness) value (Winarno, 2004). The results of analysis of variance (Table 1) showed that the treatment of variations in roasting temperature, formulation of ingredients, and the interaction between the two factors showed a very significant effect ($P<0,01$) on the a* value. The results of the analysis of variance (Table 1) showed that the variation of the roasting temperature did not show a significant effect ($P>0,05$), while the variation of the material formulation and the interaction between the two factors showed a very significant effect (P<0,01) on the value of b*.

The a* value of the food bar as a result of this study ranged from 11,80 (sample S_1R_1) to 16,80 (Sample S_3R_4). Meanwhile, the b* food bar value as a result of this study ranged from 28,73 (sample S_1R_3) to 32,77 (sample S_3R_1). This result is higher than the research result of Nurhayati et al. (2018) which has a* value ranging from 7 to 8 and b* from 16 to 18. This shows that the food bars based on beneng taro, mocaf and soy protein isolate have increased color and are similar to food bars made with purple sweet potato flour and ripe banana.

The more the addition of beneng taro flour and the higher the roasting temperature, the higher the a* and b* values produced. This can be caused by beneng taro containing carotenoid, namely a group of pigments that cause yellow, orange to red colors (Wahyuni et al., 2020). According to Budiarto and Yunia (2017), the carotenoid content in Taro Beneng flour is quite high, reaching 6,92 ppm or 0,692 mg/100 g.

Food Bar Texture

One of the factors that determine the quality of foodstuffs in the form of solid foods such as food bars is texture. The level of hardness of the food material determines how much pressure must be applied to crush it (Aulia, 2017). The results of analysis of variance (Table 2) showed that the treatment of variations in roasting temperature showed a very significant effect (P<0,01), while variations in the formulation of materials and interactions between the two factors did not show a significant effect (P>0,05) on the texture value. The texture of the food bar as a result of this study ranged from 25,96 (sample S_2R_4) – 33,06 (sample S_3R_2) N. Based on the results of the analysis, there was a decrease in the texture value in the ratio of 70:30 (R_2) and 50:50 (R_4) ingredient formulations.

This result is not in accordance with the literature described by Haliza et al. (2012) and Jariyah et al. (2017) which explains that the more taro flour is added, the food products produced tend to be harder. Haliza et al. (2012) added that the high content of dietary fiber in taro beneng flour is thought to be one of the components of the material that can affect the hardness value of the product. The hardness value of a food product increases along with the increase in the amount of dietary fiber contained in the material. According to Nurapriani (2010) the content of dietary fiber in beneng taro is high when compared to other taro cultivars such as taro butter which contains 6,08% dietary fiber. The result of Putri et al. (2018) research also revealed that the dietary fiber content of taro beneng was 9,52%.

Jariyah et al. (2017) explained that the presence of starch in taro flour will cause food products to be harder. This is because starch has a function to form texture, density, water binding and increase the volume of food products. According to Kusumasari et al. (2019) the starch content in taro beneng flour is 56,29%. Nindyarani et al. (2011) stated that the starch content in purple sweet potato flour was 74.57%, when compared to the starch content in beneng taro, the starch content in beneng taro was relatively low. Flour that has a high starch content will provide a strong and compact texture. This is in line with research conducted by Wulandari (2017) that the addition of more sweet potato flour compared to red bean flour has a higher texture value. Nindyarani et al. (2011) explained the main characteristics of starch as a determinant of texture, namely the nature of gelatinization and retrogradation.

In addition to the chemical content of the ingredients, the roasting temperature can also affect the hardness value of the food bar, an increase in the roasting temperature causes the texture of the food bar to get harder. This is supported by Muchtadi and Sugiyono

(2014) that the level of hardness of a food product is influenced by the roasting temperature. These results are in accordance with the research conducted by Azizaah et al. (2022) where a higher roasting temperature has a higher hardness value than a food bar with a lower roasting temperature. High roasting temperatures can cause the water content of the material to decrease due to evaporation of water in the heating process. The lower the water content in a food product, the harder the texture of the product will be.

Sensory Characteristics

Sensory analysis is a process of identifying, analyzing and interpreting product attributes through the five human senses such as the senses of sight, smell, taste, touch, and hearing. The purpose of sensory analysis is to determine the response or impression obtained by the human senses to a stimulus caused by a product. Based on the panelists' preference for color, taste, aroma, texture and overall parameters, a sensory assessment of the food bar was conducted (Figure 1). Color is a very important component in determining the quality and degree of acceptance of a material (Cicilia et al., 2021). Color is also the first impression obtained from a product to determine acceptance or rejection by consumers of a product.

Panelists' assessment of the color of the food bar has a real effect. The color of the food bar that was most favored by the panelists was the S_2R_3 sample (formulation 60:40; roasting temperature 140℃) while the S_2R_4 sample (formulation 50:50; roasting temperature 140°C) was the sample that the panelists did not like. This shows that on average the panelists evaluate that the food bar with more beneng taro flour added and baked at a higher temperature had a less favorable brown color than the addition of more soy protein isolate. Pradipta & Widya (2015) added that a change in the structure of starch granules will produce a brownish color when subjected to the heating or roasting process for a long time. This is in accordance with research conducted by Seftiono & Intan (2020) that the more addition of beneng taro flour will produce a darker color and are not favored by the panelists due to carotenoid degradation and the Maillard reaction.

Taste has an important role in determining how good a food product is. Consumers will not accept a food product even though it has a good and attractive color and aroma if it does not taste as good. The sense of taste is able to detect taste. A compound must be soluble in saliva so that the microvillus connection and the impulses that are formed are sent through the fibers to the condition center so that the compound can be recognized for its taste (Haliza et al., 2012).

Panelists' assessment of the taste of the food bar did not have a real effect. The taste of the food bar that was most favored by the panelists was sample S_2R_3 (formulation 60:40; roasting temperature 140°C), while sample S_2R_1 (formulation 80:20; roasting temperature 140°C) was a sample that the panelists did not like. This shows that on average the panelists assessed that the food bar with more beneng taro flour added and baked at a higher temperature had a more favorable taste than the addition of more soy protein isolate. This is presumably because the addition of soy protein isolate caused a Maillard reaction which caused an after taste that was not favored by the panelists. Fajri et al. (2013) explain that chemical compounds, temperature, consistency, interactions with other flavor components, the length of the cooking process, and many other factors can affect the taste of food products. Making food bars also uses skim milk, margarine and salt to add flavor. In addition, sugar is also added to give a sweet taste to the food bar.

Aroma is an odor caused by chemical stimuli detected by the olfactory nerves in the nasal cavity when a food product enters the mouth (Garnida, 2020). Consumer perceptions of the taste of food products are usually influenced by the aroma, so aroma is one of the important factors in organoleptic testing. Panelists' assessment of the aroma of the food bar did not give a real effect. The aroma of the food bar that was most favored by the panelists was sample S_2R_2 (formulation 70:30; roasting temperature 140℃), while sample S_2R_1 (formulation 80:20; roasting temperature 140℃) was a sample that the panelists did not like. This shows that on average the panelists assessed that the food bar added with beneng taro flour had a more favorable aroma than the addition of more soy protein isolate.

This is thought to be due to the unpleasant smell of soy protein isolate which is still felt from soybean raw materials. This is in accordance with research conducted by Juita et al. (2018) that red bean flour has a distinctive nutty aroma so that it is not liked by panelists because of the unpleasant aroma. The presence of an unpleasant odor in a food product is a consideration for consumers in accepting or rejecting the product. Based on the research of Cicilia et al. (2021) the presence of an unpleasant odor in modified jackfruit seed flour cookies caused the panelist's assessment to be low. This shows that unpleasant odors can reduce panelists' assessment of the aroma of a food product.

Pertiwi et al. (2017) explained that the presence of unpleasant odors was due to the presence of the lipoxygenase enzyme which naturally gives nuts a special aroma. Fanzurna & Mohamad (2020) added that a food product with a bad taste is caused by the presence of volatile components that make up the aroma, including aromatic compounds and esters. The volatile compounds in the material will evaporate when the roasting process occurs, resulting in a distinctive aroma in the material. Each ingredient used in the manufacture of food bars produces a different aroma. The addition of skim milk and vanilla can reduce the unpleasant odor found in food bars. According to Lestari (2015) taro flour has a savory aroma characteristic so that the amount of taro flour used will affect the aroma produced.

The sensation of pressure that can be observed with the mouth through biting or chewing, as well as touch with the fingers is called texture. The sensory attribute that is often used as a benchmark in texture assessment by consumers is hardness. The texture of a product is strongly influenced by the water content contained in a product (Ferdiansyah, 2015).

The texture that is not too hard and not too soft is preferred by the panelists. Panelists' assessment of the texture of the food bar has a real effect. The texture of the food bar that was most favored by the panelists was the S_3R_1 sample (80:20 formulation; 120℃ roasting temperature), while the S_2R_4 sample (50:50 formulation; 140℃ roasting temperature) was the sample that the panelists did not like the texture. This shows that on average the panelists evaluate that the food bar with more beneng taro flour added and baked at a higher temperature had an unfavorable texture compared to the addition of more soy protein isolate and a lower temperature.

This is presumably because the protein contained in soy protein isolate is higher than that of taro beng flour. This is in accordance with the research conducted by Cicilia et al. (2021) that the cookies density value of the research results is influenced by the higher protein content of modified jackfruit seed flour compared to wheat flour. Rauf (2015) explained that proteins will be easily denatured at high temperatures, causing the hydrogen bonds to break which will form a helical structure and proteins will interact with water. Water that is absorbed into the starch during gelatinization during baking can cause the water content of a material to decrease, causing the density of cookies to become harder.

The conclusion of the panelist's assessment of the food bar from several parameters carried out is the overall sensory parameter. Although there are several methods of objective analysis that can be used as a sign of a decrease in the quality of a food ingredient, the final determination is panelist satisfaction (Winarno, 2004). Overall, the most preferred food bar by the panelists was the S_2R_3 sample (formulation 60:40; roasting temperature 140°C), while the S_2R_1 sample (formulation 80:20; roasting temperature 140°C) was the least preferred sample by the panelists as a whole.

CONCLUSION

The selected food bar formulations were 30% beneng taro flour and 70% soy protein isolate with a roasting temperature of 140°C. The characteristics of the food bar formulation S_2R_2 are texture 26,59 N; value L* 46,75; value a* 14,99; value b* 32,17; and the value of color, taste, aroma, texture and overall preference respectively are 2,23; 2,10; 2,23; 2,15; and 2,25.

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Table 1. The response of L*, a* and b* food bar values to variations in roasting temperature and ingredient formulation

Variation of roasting temperature (S) (℃)	Variation of ingredient formulation (R) (%)				Average
	80:20 (R_1)	70:30 (R_2)	60:40 (R_3)	50:50 (R_4)	
L* value					
120℃ (S_1)	49,18±0,92 ^{tn}	46,74±0,39 ^{tn}	46,15±1,86 ^{tn}	45,47±1,54 ^{tn}	46,89^{B}
140℃ (S_2)	48,41±0,43 ^{tn}	46,75±0,38 ^{tn}	45,88±0,72 ^{tn}	45,40±0,06 ^{tn}	46,61^{B}
160℃ (S_3)	47,12±0,38 ^{tn}	46,80±1,34 ^{tn}	44,65±1,05 ^{tn}	42,84±0,65 ^{tn}	45,35^{A}
Average	48,24^{Z}	46,77^{Y}	45,56^{X}	44,57^{W}	
a* value					
120℃ (S_1)	11,80±0,49 ^{a}	14,36±0,21 ^{c}	13,04±0,83 ^{b}	15,56±0,43 ^{d}	13,69^{A}
140℃ (S_2)	12,20±0,95 ^{a}	14,99±0,05 ^{cd}	15,09±0,25 ^{cd}	15,53±0,18 ^{d}	14,45^{B}
160℃ (S_3)	14,67±0,34 ^{cd}	15,48±0,38 ^{d}	15,24±0,01 ^{d}	16,80±0,41 ^{e}	15,55^{C}
Average	12,90^{W}	14,95^{Y}	14,46^{X}	15,96^{Z}	
b* value					
120℃ (S_1)	28,77±0,38 ^{a}	32,27±0,39 ^{de}	28,73±0,16 ^{a}	31,73±0,92 ^{cde}	30,37 ^{tn}
140℃ (S_2)	29,23±1,24 ^{a}	32,17±0,61 ^{de}	29,62±0,64 ^{ab}	31,71±0,32 ^{cde}	30,68 ^{tn}
160℃ (S_3)	32,77±0,25 ^{e}	31,06±0,72 ^{cd}	29,12±0,82 ^{a}	30,71±1,10 ^{bc}	30,91 ^{tn}
Average	30,26^{X}	31,83^{Y}	29,16^{W}	31,38^{Y}	

Table 2. Texture response (N) of food bar to variations in baking temperature and ingredient formulation

Variation of roasting temperature (S) (℃)	Variation of ingredient formulation (R) (%)				Average
	80:20 (R_1)	70:30 (R_2)	60:40 (R_3)	50:50 (R_4)	
120℃ (S_1)	29,47±1,16 ^{tn}	26,46±2,18 ^{tn}	29,73±1,74 ^{tn}	29,50±1,86 ^{tn}	28,79^{A}
140℃ (S_2)	28,10±3,24 ^{tn}	26,59±1,91 ^{tn}	31,64±1,08 ^{tn}	25,96±1,72 ^{tn}	28,07^{A}
160℃ (S_3)	32,41±1,66 ^{tn}	33,06±3,24 ^{tn}	31,80±1,16 ^{tn}	29,68±2,10 ^{tn}	31,74^{B}
Average	30,00^{tn}	28,70^{tn}	31,06^{tn}	28,38^{tn}	

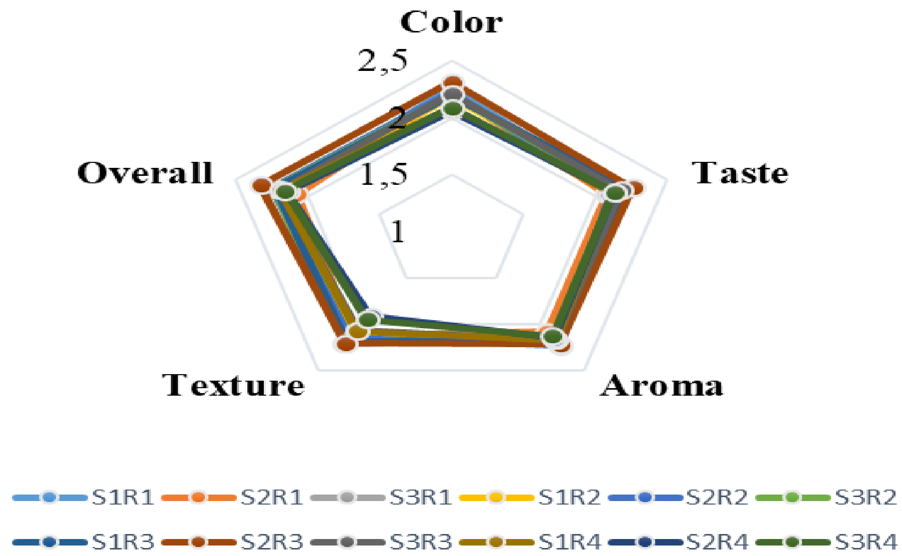

Figure 1. Sensory characteristics of food bars made of formulation S_1R_1, S_2R_1, S_3R_1, S_1R_2, S_2R_2, S_3R_2, S_1R_3, S_2R_3, S_3R_3, S_1R_4, S_2R_4 and S_3R_4


A. Sample S_1R_1


B. Sample S_2R_1


C. Sample S_3R_1


D. Sample S_1R_2


E. Sample S_2R_2


F. Sample S_3R_2


G. Sample S_1R_3


H. Sample S_2R_3


I. Sample S_3R_3


J. Sample S_1R_4


K. Sample S_2R_4


L. Sample S_3R_4

Figure 2. Food bar appearances