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Evaluation of physical, nutritional and sensorial properties cookie supplied with *Hibiscus sabdariffa* L. seed powder (without shell)

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Abstract

Roselle (*Hibiscus sabdariffa* L.) seed is a valuable food resource owning to its high amount of nutrition such as protein, edible oil and fiber. Hence, this study researched on the application of roselle seed in a cookie product. Roselle seed was pre-treated turning into roselle seed powder without shell (RSP). To enhance the yield and soluble capacity of RSP, maltodextrin was used as supplement in RSP. Study was estimated the content of RSP was replaced to wheat flour in cookie's recipe, the physical quality of dough and cookie was carried out. Nutrition value and sensory quality of cookie were also examined. Result was compared to control cookie (without RSP replaced), which was result of the supplement of maltodextrin value in RSP was 20% (RSP20) and 30% of RSP20 was replaced of wheat flour in cookie's recipe. Compared to the dough and the cookie control, the dough with 30% of RSP20 replaced was significantly stickier and low in the hardness, adhesiveness and springiness. In overall acceptance, the cookie with 30% RSP20 scored the highest (7.01) among other formulations. The quality of cookie also showed a higher content of protein (9.51g/ 100g), lipid (23.8g/ 100g), total dietary fiber (1.25g/ 100 g) and improved its antioxidant activity with a higher total phenolic content (1.91 mgGAE/g cookie) and stronger radical scavenging capacity (73.98%).

Introduction

Health and nutritious foods continue to be global concerns. For many different reasons, safe and nutritious foods are inadequate for one billion people to eat in undeveloped and developing countries (Mercycorps, 2015). Demand is rising while food resources are diminishing. It is necessary to find out about new food resources to exploit and apply them in the food industry. *Hibiscus sabdariffa* L., known as roselle, is an annual plant that belongs to the family Malvacease, is grown up in tropical and sub-tropical countries such as Vietnam, India and Malaysia (El-Adawy and Khalil, 1994). Roselle has been widely cultivated for its calyces used as vegetable, herbs and mostly applied for making wine, jelly, tea, syrup and other desserts. In the food industry, roselle seeds are discarded as waste or a by-product after harvesting crops. Nevertheless, its seeds were reported as a valuable and nutritious food source due to the high amount of protein (30.94%), lipid (23.26%) and carbohydrate (38.05%) (Liu *et al.*, 2005). Additionally, the roselle seed oil is edible and supposed to be a rich source of γ–tocopherol (Mohamed *et al*., 2007). Recently, researchers found that roselle seed showed potential hypocholesterolemic effects in rats and has high amount of lysine in roselle seed protein, that would properly be a valuable source of functional ingredients (Hainida *et al*., 2008a).

Cookie is known as a convenient and worldwide food. To exploit this valuably nutritious food resource and enhance the economy of developing countries as Vietnam, this study was aimed to research roselle seed applied into cookie and study the effect of the roselle seeds on cookies in terms of physical and chemical characteristics.

Materials and Methods

Pre-treatment

Roselle seeds were obtained from Binh Thuan province, Vietnam. Since many antinutrients are water-soluble, they simply dissolve when foods are soaked. In legumes, soaking has been found to decrease antinutrient (Bishnoi *et al*., 1994). The seeds were rinsed and soaked in distilled water for 8 hours at 35^{0}C. The mixture was blended for 5 min and screened successively using 60 and 200 mesh sieves to remove the seed shell. The filtrate obtained was marked as the solution of roselle seed without shell (RSS). Amount of maltodextrin was added into the RSS following several levels: 0, 20 and 40% of dried weight. Consequently, the RSS was applied to vacuum evaporator to concentrate then

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it was homogenized before going to spray-dry at inlet temperature 160^{0}C and the roselle seed powder (RSP) was obtained which was marked as RSP0; RSP20 and RSP40. In process of pre-treatment, the spray drying with temperature of 160^{0}C might reduce anti-nutritional factors, based on report of Halimatul e*t al.* (2007), heat treatment can reduce antinutrient or inactive or enzyme inhibitors. The RSP was stored in dark and dry place for future use.

Proximate analysis of roselle seeds and roselle seed powder

Moisture, crude protein, crude oil, total carbohydrate and ash content were determined by following the procedure of AOCS (1997).

Cookie preparation

The formulation of cookie control was made from wheat flour and the other ingredients based on the weight of wheat flour: sugar (40%), unsalted butter (30%), egg (25%), baking powder (1.5%), salt (0.5%) and vanilla essence (0.5%). To this formula, each RSP was added following different amount to replace wheat flour by 15, 40, 45 and 60%. By this way, a total of 12 types of cookies were produced and named as 0m-15, 0m-30, 0m-45, 0m-60, 20m-15, 20m-30, 20m-45, 20m-60, 40m-15, 40m-30, 40m-45 and 40m-60. The doughs were formed after mixing all of the ingredients. The dough were taken to physical analysis right away after making. The dough was then sheeted to a thickness of 2 mm with the help of rolling pin and aluminum frame of standard height. Twelve different cookies respectively were done after baking in an oven at 150^{o}C for 10 minutes. The cookies were packed and stored at room temperature for its physical, chemical analysis and sensory evaluation.

Physical analysis of cookie dough

The texture profile analysis (TPA) of cookie dough was carried out with Brookfield Texture Analyser. A 12.7 mm cylindrical acrylic probe was used in two compression cycles: the trigger and test speed, which were 4.5 g and 0.5 mm/s, respectively. The textural characteristics were determined value of the hardness, cohesiveness, adhesiveness, springiness.

Physical analysis of cookie

Physical characteristics of cookies such as diameter, thickness and spread factor were measured according to the AACC methods (2000). Six cookies were placed edge to edge to determine the diameter. The total diameter of the six cookies was measured in millimeters. The cookies were rotated at an angle of 900 for duplicate reading. This was repeated once more and the average diameter was reported.

Six cookies were placed on top of one another to determine the thickness. The total height of the six cookies was measured in millimeters. This was duplicated and average diameter was reported.

The spread factor (SF) was calculated from diameter (D) and thickness (T) of the cookie as above by using the following equation.

$$SF=D/T\times CF\times 10$$

Where correction factor (CF) at constant atmospheric pressure was 1.0 in this case.

The textural characteristics of cookie were measured by the compression method using the Texture Analyser Brookfield. The cookie samples were compressed with a 2 mm diameter stain steel rod probe at 0.5 mm/s test speed. The recorded parameter was cookie hardness.

Sensory evaluation of cookie

The sensory evaluation was carried out due to two aims. The first sensory evaluation was conducted with 9 trained assessors, who evaluated the sensory acceptability of appearance, texture, aroma and flavor of the cookie that had different levels of RSP0; RSP20 and RSP40. The second sensory evaluation was conducted with 60 untrained assessors, who evaluated the sensory acceptability of finalized cookies added roselle seed powder based on appearance, texture, aroma and flavor.

Proximate chemical composition analysis of cookie

The control cookie and the most preferred cookie was ground into powder form in order to carry out chemical analyses such as moisture, crude protein, crude lipid, anti-oxidant activities and dietary fiber following the procedure of AOAC 985.29 (2000)

Total phenolic content

The samples were extracted with 80% (v/v) methanol for 2 hours at room temperature, using an orbital shaker. The ratio of sample to extraction medium was 1:100. The mixture was filtered through a filter paper. The filtrate was used for the antioxidant assays. The total phenolic content of cookies was determined with Folin-Cioalteu reagent by the method of Kahkonen *et al.* (1991). Briefly, 0.2ml of each sample extract was mixed with 1ml of a 10-fold dilution of Folin-Ciocateu reagent and 0.8ml of 7.5% (w/v) bicarbonate solution, and allowed to stand at room temperature for 1 hour. The absorbance was measured at 765 nm. The total phenolic content was expressed as gallic acid equivalents (GAE) in milligrams per gram of dry material.

DPPH radical-scavenging activity

Free radical-scavenging was evaluated using the 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical according to the method of Shimada *et al.* (1992) . Briefly, 5ml of teach sample extract was added 1ml of 1nM DPPH in methanol. A control was prepared by adding 1ml of DPPH solution to 5 ml of 80% methanol. Following storage in the dark for 1 hour, the absorbance was read at 517 nm. The percentage of free radical-scavenging activity was calculated, based on the following equation.

Free radical-scavenging activity (%)

$$= \left[1 - \frac{\textit{absorbance of sample at 517 nm}}{\textit{absorbance of control at 517 nm}}\right] \times 100$$

Statistical analysis

All experiments were repeated three times. All of the results were analyzed by using Statgraphics Software for One-way Analysis of Variance (ANOVA) with the significant differences between the means at the 5% level. Differences are considered statistically significant at $p<0.05$

Results and Discussion

Proximate chemical composition analysis of roselle seeds and RSP

The processing roselle seeds by soaking, sprouting and cooking significantly decreased the anti-nutritional factors (Yagoub *et al.*, 2008). Besides that, the roselle seed gives the bitter taste and dark color owing to its seed shell. Therefore, pre-treatment of the roselle seed was carried out to remove the seed shell for the diminishment of anti-nutritional elements and the improvement in the sensory of the cookie product. According to Abu-Tarboush *et al*. (1996), heat treatment may lead to the reduction of anti-nutritional factors or inactivation of enzyme inhibitors. During spray-drying being a microencapsulation process, maltodextrin had played a role as a carrier supporting spray-drying technique. Lipid in RSS was capsuled by a combination of maltodextrin and protein. According to Young et al. (1993), combinations of proteins and carbohydrates were effective and functional microencapsulating agents.

Table 1 shows the results of the proximate analyses of roselle seed and all RSP with various amount of maltodextrin. Generally, the results of crude protein (24.91%), crude lipid (20.02%) and total carbohydrate (41.16%) content of roselle seed were approximately same in the report of Abu-Tarboush (1996). In comparison with RSP0, RSP20 (content of 20% of maltodextrin) and RSP40 (content of 40% of maltodextrin) have a substantial change in physicochemical characteristics after spray drying. The water soluble index value of RSP20 (60.51%) was higher than RSP0 (59.51%) and RSP40 (58.85%). While increasing amount of maltodextrin was added, the amount of lipid and protein declined. In contrast, the amount of carbohydrate, total sugar and reducing sugar grew dramatically due to the maltodextrin increasing. Roselle seed powder had a low content of insoluble fiber ranging from 0.14 to 0.18%. Compared with the publication of Hainida *et al.* (2008b), this result is much more lower than the insoluble fiber content of dried roselle seed and boiled roselle seed, which were 13.42% and 10.49%, respectively. It may due to the removal of seed shell which mainly contains insoluble fiber and this also showed that the method of shell removal was effective and efficient.

Physical analysis of cookie dough

The effect of RSP0, RSP20 and RSP40 in the cookie's formulation to dough texture is shown in Table 2. Dough containing RSP had significantly lower hardness, cohesive, springiness and higher adhesiveness. Among formulations containing the same levels of those RSP, dough's hardness were slightly declining following the supplement of RSP0, RSP20and RSP40. Among formulations containing RSP with the same levels of maltodextrin, dough's hardness were sharply falling following the amount of RSP rising from 0% to 60%. The drop in hardness was probably caused due to the higher RSP which prevented albumin, globulin and lipid from forming a gluten structure in dough. Maltodextrin is a hydrophilic compound that competed glutenin of wheat flour to absorb water, which had brought to dough less cohesive and less hard. This also explains a reason for a steady decline in springiness which known as the capability of recovery into its original length when stretched. The weaker the gluten structure was formed, the lower the springiness in dough was. On the other hand, there was a rise in the adhesiveness of dough throughout the addition RSP from 0% to 60%. The amount of RSP and maltodextrin caused the cross-links of the dough to become weaker and easily separate and stick onto the probe, this may also be a disadvantage of the dough forming process.

Table 1. Proximate chemical composition of roselle seed and RSP0, RSP20, RSP40 (% w/w)

Components	RS	RSP0	RSP20	RSP40
WSI		59.51 ± 1.12^{ab}	60.51 ± 0.75^{b}	58.85 ± 0.53^{a}
Ash	4.87 ± 0.15	7.82 ± 0.14^{c}	6.71 ± 0.01^{b}	5.85 ± 0.02^{a}
Crude protein	24.91 ± 0.19	39.40 ± 1.06^{c}	32.54 ± 0.88^{b}	28.05 ± 0.73^{a}
Crude lipid	20.02 ± 0.15	30.82 ± 0.60^{c}	27.65 ± 0.34^{b}	23.36 ± 0.43^{a}
Total carbohydrate	41.16	21.96	33.1	42.74
Total sugar	6.02 ± 0.26	8.59 ± 0.16^{a}	23.79 ± 0.83^{b}	25.84 ± 1.07^{c}
Reducing sugar	1.36 ± 0.051	4.01 ± 0.19^{a}	15.18 ± 0.57^{b}	17.09 ± 0.44^{c}
Soluble fiber		5.87 ± 0.34^{a}	6.82 ± 0.22^{b}	7.74 ± 0.78^{c}
Insoluble fiber		0.16	0.14	0.18

Mean with different letters within in the same column represent significant differences at $p<0.05$

Table 2. Effects of roselle seed powder on dough characteristics

Formulations	Hardness (g)	Cohesiveness	Springiness (mm)	Adhesiveness (gs)
Control (0m-0)	275.73 ± 13.03^{a}	0.313 ± 0.02^{a}	1.82 ± 0.03^{a}	-7.05 ± 0.19^{a}
0m – 15	250.97 ± 1.39^{b}	0.303 ± 0.01^{b}	1.80 ± 0.06^{b}	-7.12 ± 0.58^{a}
20m-15	237.4 ± 18.12^{c}	0.299 ± 0.01^{b}	1.80 ± 0.06^{b}	-8.45 ± 3.81^{b}
40m-15	200.8 ± 17.33^{d}	0.293 ± 0.01^{c}	1.76 ± 0.03^{c}	-10.30 ± 0.65^{c}
0m – 30	143.67 ± 15.21^{e}	0.297 ± 0.02^{b}	1.79 ± 0.18^{b}	-9.32 ± 0.47^{c}
20m-30	142.13 ± 7.99^{e}	0.291 ± 0.04^{c}	1.75 ± 0.11^{c}	-10.63 ± 0.55^{c}
40m-30	141.07 ± 13.37^{e}	0.283 ± 0.01^{d}	1.67 ± 0.03^{fg}	-12.25 ± 0.47^{d}
0m – 45	84.33 ± 7.91^{f}	0.24 ± 0.03^{e}	1.72 ± 0.10^{d}	-10.64 ± 0.86^{c}
20m-45	83.3 ± 7.81^{f}	0.225 ± 0.04^{f}	1.70 ± 0.09^{e}	-12.51 ± 1.32^{d}
40m-45	79.53 ± 8.21^{f}	0.182 ± 0.04^{h}	1.68 ± 0.10^{f}	-14.72 ± 0.95^{e}
0m – 60	63.47 ± 2.23^{g}	0.216 ± 0.02^{g}	1.70 ± 0.21^{e}	-14.21 ± 2.60^{e}
20m-60	59.57 ± 2.59^{g}	0.145 ± 0.01^{i}	1.66 ± 0.12^{g}	-18.46 ± 1.21^{f}
40m-60	46.47 ± 5.85^{h}	0.111 ± 0.02^{k}	1.63 ± 0.12^{h}	-22.33 ± 2.71^{g}

Mean with different letters within in the same column represent significant differences at $p<0.05$

Physical analysis of cookie

The results (Table 3) disclosed that the diameter and thickness of the cookies prepared from the flour with roselle seed powder had dramatically varied among formulations. The data regarding the values of the diameter and thickness of the cookies (Table 3) showed that the diameter was slightly rising, whilst the thickness was steadily declining following the replacement of RSP0, RSP20 and RSP40 from 0% to 60%

When the RSP was supplied, the capability of dough's cross-links dropped, that led to molten dough and was stickier at a high baking temperature. During baking progress, the weaker gluten structure had brought the less capability of leavening in dough performance. Moreover, the moisture content was held after baking which made cookies softer. As a result, the thickness of the cookies went down when the supplement of RSP0; RSP20 and RSP40 increased.

The diameter of cookies (Table 3) prepared from different treatments revealed a gradual increase as the level of substituted RSP. The mean values of the diameter of the cookie formulations were found between 408 and 432 mm. The largest diameter cookie was produced along with 60% of RSP40. The trend in spread factor rose considerably when the amount of replaced RSP was ranging from 0% to 60%. Comparing samples with the same replacement of RSP, the spread factor increased gradually following the maltodextrin content. Compared with the control cookie, the highest spread factor (90) was

Table 3. Effects of roselle seed powder on thickness, diameter, spread factor and hardness of cookies

Formulations	Thickness (mm)	Diameter (mm)	Spread factor	Hardness (g)
Control (0m-0)	66 ± 1^{a}	405 ± 1^{a}	61.42 ± 0.85^{a}	985.43 ± 0.51^{a}
0m – 15	63 ± 1^{b}	408 ± 1^{b}	64.82 ± 1.11^{b}	798.43 ± 0.51^{b}
20m-15	61.06 ± 0.11^{c}	411 ± 1^{c}	67.36 ± 0.19^{b}	732.53 ± 0.50^{c}
40m-15	57 ± 1^{e}	414 ± 1^{d}	72.70 ± 1.67^{d}	769.35 ± 0.56^{b}
0m – 30	58.6 ± 0.53^{d}	414 ± 1^{d}	70.71 ± 0.73^{c}	697.60 ± 0.53^{d}
20m-30	57 ± 1^{e}	417 ± 1^{e}	73.23 ± 1.37^{de}	577.35 ± 0.55^{e}
40m-30	54 ± 1^{f}	420 ± 1^{f}	77.86 ± 1.35^{f}	620.38 ± 0.54^{d}
0m – 45	57 ± 1^{e}	420 ± 1^{e}	73.75 ± 1.21^{de}	553.62 ± 0.54^{e}
20m-45	55.06 ± 0.11^{f}	426 ± 1^{f}	77.42 ± 0.23^{f}	423.49 ± 0.51^{f}
40m-45	57.53 ± 0.5^{de}	429 ± 1^{g}	74.63 ± 0.74^{e}	512.66 ± 0.57^{c}
0m – 60	54 ± 1^{f}	426 ± 1^{f}	78.97 ± 1.56^{f}	390.47 ± 0.50^{f}
20m-60	49.93 ± 0.11^{g}	429 ± 1^{g}	85.98 ± 0.17^{g}	311.45 ± 0.51^{g}
40m-60	48 ± 1^{g}	432 ± 1^{h}	90.09 ± 1.98^{h}	355.57 ± 0.52^{g}

Mean with different letters within in the same column represent significant differences at p<0.05

observed in the cookie prepared from 40m-60 and the lowest (64.76) had been found in 0m-15.

As the results shown (Table 3), there was a substantial difference in the cookies' hardness among formulations compared with the control cookie (p<0.05). The hardness of cookies dropped significantly throughout the replacement from 0% to 60%. In the group of the same levels of the substituted amount, there was a fluctuation in hardness among cookies added RSP0, RSP20 and RSP40. The highest number of hardness (control cookie) was over three times as high as the lowest value of hardness (311.37 g) which belonged to the formulation 20m-60.

Sensory evaluation of cookie

The data of small-scale sensorial evaluation was based on the results of a 9-assessor council displayed in Table 4. The results illustrated that there was no significant disparity in overall acceptance of samples with 15-45% substitute of RSP20 compared with the control cookie. There was a substantial variation in appearance and color between the control cookie and the samples prepared from the 60% replacement of RSP0, RSP20 and RSP40 (p<0.05). The high replacement of RSP led to the change in texture and appearance of the cookies, which contrasted the control one. The higher the replacement was carried out, the darker color the cookies were. This could explain that cookies changed color depending on the ingredients including RSP, which has a darker color than wheat flour. As the figures shown, there was a crucial decrease in aroma and flavor of the cookies during the substitute rising. Roselle seed has a bitter taste, which affected the flavor of the cookies. Generally, the replaced 15-45% RSP 20 samples approached approximately 7 in overall acceptance (p<0.05).

The aim of this study was to maximize the ability of roselle seed applied in a cookie with the suitable replacement amount for the next sensory evaluation. According to the effects of the amount maltodextrin on physical characteristics of dough and cookies discussed and the previous aim mentioned, the formulations 20m-30 and 20m-45 were chosen for further sensory evaluation with a larger scale council.

The numbers of a large-scale sensory evaluation based on results of a 60- assessor council is displayed in Table 5. The formulation 20m-30 had the highest score (7.01), the second one (6.44) was the control cookie. The evaluation of formulation 20m-45 was marginally lower than the control cookie. These results showed that the cookie replaced with 30% of RSP20 would be acceptable for consumers

Proximate chemical composition analysis of cookies

The results of the proximate chemical analysis are shown in Table 5 including crude protein, crude lipid, total dietary fiber, total phenolic content and DPPH radical scavenging capacity in the cookie with 30% substitute of RSP20 (added 20% maltodextrin). The results showed that RSP20 affects the composition of cookies. The protein amount (9.51%) was dramatically increased (p<0.05) by the replacement of RSP20. Besides, there was a growth of the lipid and fiber content in the cookies 20m-30 (23.8% and 1.25%, respectively).

Table 4. A small scale sensory evaluation of various formulations of cookies

Formulations	Appearance	Color	Aroma	Flavor	Overall acceptance
Control (0m-0)	7.05 ± 0.69^{de}	7.15 ± 0.94^{cd}	7 ± 0.67^{cdef}	7.2 ± 0.79^{de}	6.95 ± 0.69^{cd}
0m-15	7.05 ± 1.12^{de}	7.15 ± 1.45^{cd}	7 ± 0.82^{cdef}	7.4 ± 0.84^{e}	7.15 ± 0.88^{d}
0m-30	6.95 ± 0.96^{cde}	6.95 ± 0.90^{bcd}	6.9 ± 0.74^{bcde}	7.1 ± 0.74^{cde}	7.05 ± 0.73^{cd}
0m-45	6.6 ± 1.08^{cde}	6.2 ± 0.92^{bcd}	6.6 ± 0.84^{bcd}	6.8 ± 0.63^{cde}	6.55 ± 0.64^{cd}
0m-60	5.2 ± 1.32^{a}	5.2 ± 1.32^{a}	5.5 ± 1.08^{a}	5.0 ± 1.33^{a}	5.25 ± 1.11^{a}
20m-15	7.5 ± 0.85^{e}	7.1 ± 1.29^{d}	7.6 ± 0.84^{f}	7.1 ± 0.99^{de}	7.25 ± 0.64^{d}
20m-30	6.9 ± 1.29^{de}	6.6 ± 1.68^{bcd}	7.2 ± 0.79^{def}	6.9 ± 0.99^{de}	6.85 ± 0.75^{cd}
20m-45	7.05 ± 0.90^{de}	6.2 ± 0.95^{bcd}	7.1 ± 0.57^{cdef}	6.8 ± 0.79^{cd}	6.85 ± 0.58^{cd}
20m-60	5.9 ± 0.99^{ab}	5.9 ± 0.99^{ab}	6.1 ± 0.88^{ab}	5.75 ± 0.64^{b}	5.75 ± 0.79^{bc}
40m-15	6.3 ± 0.82^{bcd}	7.1 ± 1.37^{d}	7.6 ± 1.26^{de}	6.95 ± 0.96^{de}	7.15 ± 0.82^{d}
40m-30	5.8 ± 0.92^{abc}	6.4 ± 1.59^{bcd}	6.6 ± 1.27^{bcd}	6.6 ± 1.08^{cde}	6.26 ± 1.00^{d}
40m-45	7 ± 0.18^{de}	6.55 ± 1.30^{bcd}	6.8 ± 0.79^{bcd}	6.95 ± 0.69^{cde}	6.9 ± 0.81^{cd}
40m-60	6.3 ± 0.95^{bcd}	6.3 ± 0.95^{abc}	6.35 ± 0.88^{bc}	6.35 ± 0.58^{bc}	6.35 ± 0.58^{bc}

Mean with different letters within in the same column represent significant differences at $p<0.05$

Sensory evaluation (n=9) based on 9-point scale: 1=dislike extremely, 2=dislike very much, 3=dislike moderately, 4=dislike slightly, 5=neither like nor dislike, 6=like slightly, 7=like moderately, 8=like very much, 9=like extremely

Table 5. A large scale sensory evaluation and proximate composition of various formulations of cookies

Formulations	Control (0m-0)	20m-30	20m-45
Appearance	6.32 ± 1.37^{b}	6.12 ± 1.32^{b}	5.27 ± 1.57^{a}
Color	5.73 ± 1.89^{a}	6.97 ± 1.43^{b}	7.03 ± 1.41^{b}
Aroma	6.63 ± 1.53^{a}	6.85 ± 1.65^{a}	6.53 ± 1.75^{a}
Flavor	6.55 ± 1.60^{a}	7.02 ± 1.65^{ab}	5.95 ± 2.10^{b}
Overall acceptance	6.44 ± 1.33^{a}	7.01 ± 1.34^{b}	6.03 ± 1.52^{a}
Crude protein (%)	6.23 ± 0.52^{a}	9.51 ± 0.72^{b}	
Crude lipid (%)	21.59 ± 0.53^{a}	23.80 ± 0.95^{a}	
Total dietary fiber (%)	0.8	1.25	
DPPH radical scavenging capacity (%)	54.04 ± 0.97^{a}	73.98 ± 1.11^{b}	
Total phenolic content (mgGAE/g)	1.25 ± 0.07^{a}	1.91 ± 0.07^{b}	

Mean with different letters within in the same column represent significant differences at $p<0.05$

Sensory evaluation (n=60) based on 9-point scale: 1=dislike extremely, 2=dislike very much, 3=dislike moderately, 4=dislike slightly, 5=neither like nor dislike, 6=like slightly, 7=like moderately, 8=like very much, 9=like extremely

The cookies supplied with RSP20 improved antioxidant properties. There was a significant increase in the antioxidant activity in cookies subtitled with RSP20 which illustrated higher total phenolic content (1.91 mgGAE/g cookie) and stronger radical scavenging capacity (73.98%) than control cookie (1.21 mgGAE/g cookie, 54.04%, respectively).

In previous study of Nyam *et al*. (2012), the result show that the roselle cookie with 20% of whole seed shell powder was added, contained 9.4% of protein, 26.6% of lipid, 5.6% of fiber and 0.602 mgGAE/g total phenolic. Compared with our study, the cookie supplied with 30% RSP20 has a lower fiber content (1.25%) due to removal of seed shell in which contains most of fiber. However, the removal of seed shell also caused an increase of total phenolic content in roselle seed powder, because of most of the total phenolic content is occupied in endosperm, so the content of total phenolic in cookie with 30% RSP20 (1.91 mgGAE/g) is higher than cookie in result of Nyam *et al.* (2012).

Conclusion

Roselle seed powder dramatically affected the dough and cookie texture. Based on sensory evaluation, the appropriate amount used was 30% replacement of RSP20 (contains 20% maltodextrin). The use of roselle seed in cookie products is intriguing for recent food industries which have been coping with consumers' demands for health and diversity in food choices. The product of the roselle seed cookie might improve the nutritional quality and adapt to the consumers' demands nowadays. Moreover, this waste byproduct can be recycled usefully in developing countries' food industry.

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