Science and Technology

RMUTT Journal

Vol.9 No.2 (2019): 23-38

www.sci.rmutt.ac.th/stj

Online ISSN2229-1547

Production of Gluten Free Cookies Supplemented with Durian Rind Flour

Narin Charoenphun[1*] and Wiyada Kwanhian[2]

[1] Faculty of Agricultural Technology, Burapha University Sakaeo Campus, Watthananakhon, Sakaeo 27160, Thailand

[2] School of Allied Health Sciences, Walailak University, Thasala, Nakhon Si Thammarat 80160, Thailand

*E-mail: narinch@buu.ac.th

Abstract

This research aimed to optimize the formula to produce gluten free cookies supplemented with durian rind dietary fiber. The seven formulations of cookies consisting of durian rind flour (0-20%), wheat flour (30-50%) and salted butter (25-45%) were studied using Mixture Design. Physical properties and sensory evaluation by 30 untrained panelists were investigated. The results showed that weight loss of cookies and spread ratio varied directly as the amount of salted butter. Furthermore, the hardness of cookies tended to increase when the amount of durian rind flour increased. The brightness of cookies varied directly with the amount of wheat flour. Obviously, an optimum formulation of gluten free cookies supplemented with durian rind dietary fiber was 10% durian rind flour, 47.5% wheat flour and 42.5% salted butter, respectively. This formulation had the highest of overall liking scores. Furthermore, using various types of flour replacement with wheat flour was studied. The results discovered that cookies made from mixed flour were the most suitable formula for wheat flour replacement. Apparently, the sensory evaluation score (appearance, texture and overall liking) of cookies made from mixed flour formulas was similar to the wheat flour formula. The development of the flavor and taste of cookies found that the formulated cookies containing green tea powder and coffee powder had an average score of flavor and taste was higher than other formulas. Therefore, gluten free cookies supplemented with durian rind dietary fiber is an alternative product for consumers who want to avoid gluten foods.

Keywords: durian rind flour, cookies, gluten free food

Received: July 02, 2019

Revised: December 17, 2019

Accepted: December 25, 2019

1. Introduction

Durian (*Durio zibethinus* L.) is a tropical fruit known for its spiky appearance and strong smell. It is found in most Southeast Asia including Thailand. The chemical composition of durian contains a high amount of carbohydrates in the form of starch and sugar. In addition, hemicellulose is also found which is a type of insoluble polysaccharide and cannot be digested in the human gastrointestinal tract [1]. Obviously, proteins play an important role in the taste of durian by the enzyme mechanism [1]. Moreover, durian has 3.9% of fat [1]. Durian is a large fruit consisting of 10-30% flesh, which can be consumed at various stages of ripeness. In terms of by-products, rind and seed of durian are 50-60% and 10-20%, respectively [2]. One of durian fruit has the most part of the rind. Interestingly, it has a chemical composition consisting of 4.84% ash, 13.09% hemicellulose and 15.45% lignin [3]. The processing of durian in the industry has numerous residues that are part of the durian rind. It causes a lot of garbage problems for environment [4]. At present, the utilization of durian rind is not widely used in the food processing. Occasionally, durian rind is transformed into food products that is an interesting alternative way. This choice does not only help reduce the amount of waste, but also add higher value to the agricultural materials.

Cookies are a kind of bakery product that made from wheat flour or wheat flour mixed with other flour [5]. Generally, there is a gluten protein in wheat flour. Disulphide bonds play a key role in determining the structure and properties of wheat gluten proteins [6]. Comparison of the sequences of monomeric gliadins and polymeric glutenin subunits allows the identification of conserved and variant cysteine residues [6]. Wheat dough is viscoelastic which has both viscous and elastic characteristics [7]. Currently, there are many reports of increased gluten intolerance among consumers. Gliadin proteins have an effect on the immune system and are toxic to patients with coeliac disease [8]. There are many causes of the coeliac disease. It may be caused by genetics, stress conditions, pregnancy, viruses, infections, and the stimulation of the passenger in the environment [8]. Interestingly, the durian rind is processed into flour, which are in use as a raw material for the production of cookies. Durian rind flour will enhance the nutritional value of the food product. In addition, it may be used instead of wheat flour in cookie products. It is an alternative food for consumers who want to avoid gluten foods.

This research was conducted to optimize the formula to produce gluten free cookies supplemented with durian rind flour. The physical properties and sensory evaluation by untrained panelists were investigated for selection prototype formula. The effect of various flour substitutes of wheat flour on the quality of the cookies was studied. Moreover, improving the quality of cookies by several herbs, durian flesh, green tea and coffee powder were investigated.

2. Materials and Experiment

2.1 The effect of durian rind flour, wheat flour and salted butter on the quality of cookies

2.1.1 Durian rind flour preparation

Durian rind flour were prepared from unripe Monthong durian (*Durio zibethinus murray*). It was separated from the flesh and seed of durian. The part of edible durian rind was selected and cut to small piece. It was dried in hot air oven at 60 ^{0}C for 18 h. Dried durian rind was grained by fine grinding machine (Dxfill, Model DXM-500, China) at speed level 2 for 2 min.

2.1.2 Production of cookies

The suitable ratio of durian rind flour, wheat flour and salted butter for cookie production were studied by using mixture designs. In terms of mixture experiment, the independent factors were the proportions of different components of durian rind flour (0-20%), wheat flour (30-50%) and salted butter (25-45%), respectively. The points on the designated triangle area were selected for studying. The seven formulations of cookies from mixture design were investigated (Table 1)

Table 1 Formulation of cookies by a 3-component* mixture design

Ingredients	Formulation						
	1	2	3	4	5	6	7
Durian rind flour (%)	5	20	17.5	10	17.5	20	15
Wheat flour (%)	50	35	40	47.5	47.5	50	45
Salted butter (%)	45	45	42.5	42.5	35	30	40
Total	100	100	100	100	100	100	100

* A 3-component mixture (100% in the mixture design) was 100 % of the total formulation.

The ingredients by mixture design, including durian flour, wheat flour and salted butter were weighed according to the formulation in Table 1. In other ingredients, sugar, eggs and baking powder were added at 16%, 13%, and 1% of all ingredients (consisting of durian rind flour, wheat flour and salted butter). In terms of cookies production, durian rind flour, wheat flour and baking powder were sifted. Secondly, salted butter was beaten into a white color. Next, sugar and eggs were added and mixed. After that, durian rind flour, wheat flour and baking powder were added and mixed until homogeneous. Subsequently, the mixed ingredients were pressed by cookie mold. After all, it was baked at 165 ^{0}C for 20 min [5].

The appearance of cookies from seven formulations was observed. Baking loss of cookies was analyzed. The cookies before baking and after baking were weighed by balance (Zepper EPS-3001, China). Baking loss was defined as follows: Baking loss (%) = [(Weigh of cookies before baking - Weigh of cookies after baking)/ Weigh of cookies

before baking] x 100 [9]. Hardness of cookies was measured by using a hardness instrument (Daiichi FG 520K, Japan). The unit of force was newton (N).

The spread ratio of cookies was defined. Width and thickness of cookies were measured with Vernier caliper (Digital Vernier caliper, China). Spread ratio was defined as follows: Spread ratio = [Width of cookies (mm)/ Thickness of cookies (mm)] [10].

Color of cookies was measured by color meter (Colorimeter, WR10QC, China). CIE system was defined by L * or brightness (0 = black, 100 = white), a * (+ a = red, -a = green) and b * (+ b = yellow, -b = Blue). Moreover, sensory evaluation by 30 untrained panelists were investigated. The importance of liking of appearance, flavor, taste, texture and overall liking were expressed by 9-point hedonic scale.

The suitable formulation was selected for developing to gluten free cookies product. The contour plot was overlapped to find the right ratio of the amount of durian flour, wheat flour and salted butter. The quality of cookies composes of weight loss, hardness, spread ratio, color value and sensory evaluation score were used for selecting the appropriate formula of a cookie.

2.2 The effect of using different types of flour in the replacement of wheat flour on the quality of gluten-free cookies

The suitable formula of cookie from previous steps was selected for studying. The completely randomized design (CRD) was used for comparing between wheat flour (control) with other flours on the quality of gluten free cookies. The different flours, including rice flour, glutinous rice flour, potato flour, cassava flour and mixed flour (contains 65% of rice, 25% of potato and 10% of cassava flour) [12] were studied. The method of producing cookies was like the above method.

The appearance of the cookies was observed. In terms of physical properties, baking loss, hardness, spread ratio, and color was investigated by following the method in previous steps. Sensory evaluation by 30 untrained panelists were examined. The importance of liking of appearance, flavor, taste, texture and overall liking were expressed by 9-point hedonic scale. The suitable formulation was selected for developing to gluten free cookies product.

2.3 The effect of adding several herbs, durian flesh, green tea and coffee powder on quality of gluten free cookies

Herb powder preparation, scallion (*Allium ascalonicum*), orchid ginger (*Alpinia nigra* Burrt) parsley (*Coriandrum sativum*) and ginger (*Zingiber officinale* Roscoe) were used. First of all, these were washed and drained. Secondly, herbs were cut to small size and dried in hot air oven (Memmert, ULM400, The Netherlands) at 60 ^{0}C for 8 h. Next, dried herbs were grained by fine grinding machine (Dxfill, Model DXM-500, China) at speed level 2 for 2 min and were kept in sealed container.

The unripe durian flesh powder was prepared from Monthong durian. At first, seed and rind of durian were separated from the flesh. Next, durian flesh was cut to small piece. After that, it was

dried in hot air oven at 60 ^{0}C for 18 h. After all, dried durian rind was grained by fine grinding machine (Dxfill, Model DXM-500, China) at speed level 2 for 2 min and were kept in sealed container.

Green tea and coffee powder preparation, dried green tea leaf and dried coffee seeds were brought from supper market. These were grained by fine grinding machine (Dxfill, Model DXM-500, China) at speed level 2 for 2 min and were kept in sealed container.

The cookie formula was selected in the previous steps (control). Similarly, it was compared with other formula including scallion, orchid ginger, parsley, ginger, durian flesh, green tea and coffee powder. Several herbs, durian flesh, green tea and coffee powder were added at 3% of total flour. Likewise, the method of producing cookies was like the above method. The appearance of the cookies was observed. Sensory evaluation by 30 untrained panelists were investigated. In terms of the sensory characteristics of cookies, appearance, flavor, taste, texture and overall liking were examined by 9-point hedonic scale.

2.4 Statistical analysis

The statistical technique one-way ANOVA was used for calculating. Duncan's new multiple-range Test (DMRT) was used to compare the difference in the average values at the 95% confidence level [11].

3. Results and Discussion

3.1 Effect of durian rind flour, wheat flour and salted butter on the quality of cookies

The results found that seven formulas of cookies had a different appearance (Figure 1). The texture of the cookies in formula 1, it was very soft before baking, and very crispy after baking. Obviously, it had the highest expansion and had a light-yellow color. In terms of formula 2, 3 and 7, forming is easier than formula 1. Texture of cookies after baking were harder than formula 1. Furthermore, it had low expansion. Interestingly, cookies in formula 4 was easy to mold. The texture of the cookies after baking and expansion was appropriated. It had yellow-brown color. Apparently, formulas 5 and 6 were difficult to form before baking because the texture were relatively dry and crumbly. The color of cookies was yellow-brown. It had low expansion and high hardness after baking.

Figure 1 The appearance of cookies from seven formulations

In particular, amount of durian rind flour, wheat flour and salted butter effected on the differing appearance of cookies, and resulted from unit operations during the production including

heating by baking method. In general, hot air during baking caused by changing physiochemical properties of cookies, including gelatinization of starch, denature of protein, weight loss, and color changing [13]. The brown color on the surface of cookies is a common appearance. Generally, the consumers accept the appropriate intensity of color that not too light or too dark.

Baking loss, hardness, spread ratio and color of cookies by a 3-component mixture design were shown in Figure 2. The results showed that weight loss of cookies from seven formulations had significant difference of the 95% confidence interval when $P \leq 0.05$. Obviously, the percentage of weight loss during baking of cookies varied directly with the amount of salted butter. The weight loss of cookies was decreased when the amount of wheat flour in the formula increased. Normally, the moisture content of durian rind flour and wheat flour were 12 % [14]. These had lower moisture than salted butter. Obviously, the moisture content of salted butter was 37-60 % [15].

The heat was transferred by convection and radiation from inside of cookies to surface of the cookies during baking at 165 ^{0}C. Simultaneously, heat from outside was transferred to inside of cookies. In addition, the mass was transferred from the surface of the cookies during baking. Free water in the cookie structure was evaporated. Therefore, weigh loss of cookies was occurred [16]. The results were corresponding to the report of Budzaki *et al.* [17]. They studied factor effecting of the quality of the cookies during baking. They found that weight loss of cookies tended to increase with the moisture content in cookies dough before baking.

As a result, the hardness of cookies varied directly with the amount of durian rind flour (Figure 2). Obviously, the most chemical composition of durian rind was 13.09% of hemicellulose and 15.45% of lignin [3]. These were a polysaccharide that inserted and held between the cellulose molecules in the plant cell wall, thus contributing to the strength of the cell wall. Both hemicellulose and lignin were classified as carbohydrates that do not provide energy [16]. Normally, the human body has no enzymes to digest these two elements. However, it was very important to the human body because it was considered a dietary fiber that helps the excretion [18].

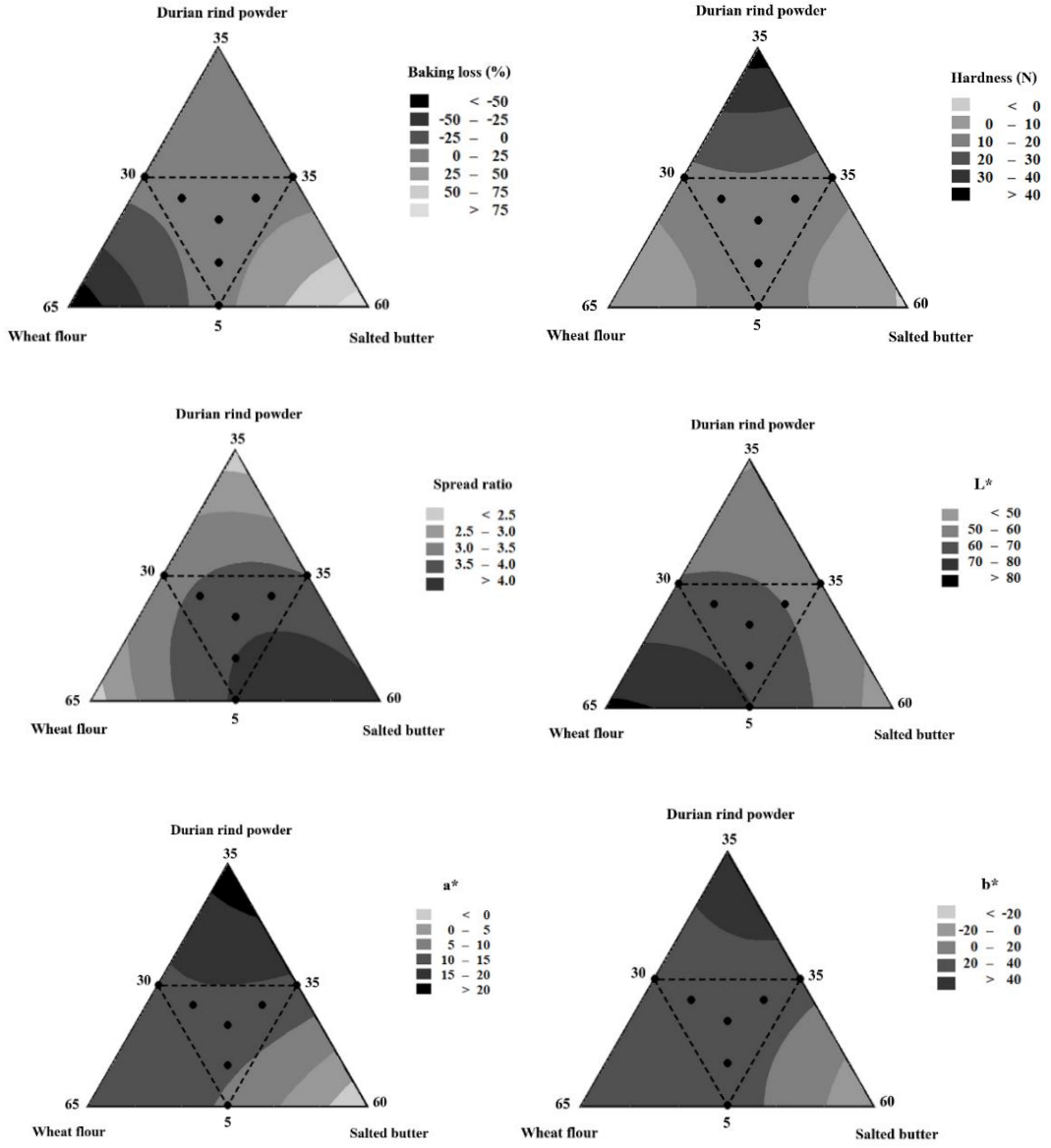

Figure 2 Baking loss, hardness, spread ratio and color of cookies by a 3-component mixture design

Formulated cookies with high amount of durian rind flour had a high amount of dietary fiber that resulting in increased the hardness of cookies. Bunyasawat and Bhoosem [19] reported that the effect of using durian rind flour replaced of wheat flour in tart cups production. They found that the hardness of tart cups varied directly with the amount of durian rind flour.

The results of polysaccharide composition in durian rind flour had the ability to absorb moisture in dough of cookies. Consequently, the texture of dough had dry and crumbly. Therefore,

moisture loss or weight loss of cookies was occurred by heat transfer during baking. The internal structure of the tart cups was attached strongly which resulting in increased hardness. These according to the report of Khumkhom [10], the effect of adding dried Sesbania flower powder on the hardness of butter cookies was studied. It was found that the hardness of butter cookies varied directly with the amount of Sesbania flower powder. Sesbania flowers had a high fiber content (15.7%). In general, the fibers were mainly consisted of cellulose and hemicellulose. It can be inserted between the starch granule structure. Apparently, it was good water aggregation properties. These were a factor that effects on the hardness of butter cookies.

The results showed that the spread ratio of cookies from seven formulations had significant difference of 95% confidence interval when $P \leq 0.05$ (Figure 2). The spread ratio of cookies tended to vary with the amount of salted butter, and tended to inverse with the amount of durian rind flour and wheat flour. Obviously, when increasing the amount of fiber from durian rind flour and wheat flour, the expansion of cookies was decreased. Specifically, the spread ratio of cookies should be at an appropriate level. If a spread ratio of cookies were low or high level, it had an effect on the quality of cookies decreased. The proportion amount of ingredients had an effect on the spread ratio of cookie products. The spread ratio of cookies may depend on the viscosity of dough. The cookie mixing process was investigated. The free water would catch up with the water-like part which resulting in viscosity increased. In addition, the spread ratio of cookies increased [20]. High level of water absorption during the mixing of dough of cookies was caused by the increasing of dry ingredients including durian rind flour and wheat flour. It caused an imbalance system. Obviously, the surface of the dough was dry and rough during mixing and molding. The formula 6 of the cookies had consisted of 20% durian rind flour, 50% wheat flour and 30% salted butter that had the lowest spread ratio. On the other hand, increasing the amount of salted butter caused the viscosity of dough during mixing increased. Increasing water absorption of dry ingredients may result in an increase spread ratio in cookies after baking. The highest level of salted butter in the dough will result in soft and difficult to forming of cookies. In doing this, the formula 1 of the cookies was consisting of 5% durian rind flour, 50% wheat flour and 45% salted butter that had the highest spread ratio.

The color of cookies from seven formulations had significant difference of the 95% confidence interval when $P \leq 0.05$ (Figure 2). The results showed that L * (brightness) tended to increase when the amount of wheat flour increased. The a* value of cookies was red color, and b* value was yellow color. When the amount of durian rind flour increased, the a * and the b * value increased which approached the yellow-red range. It corresponded to the color that was observed for the appearance of color cookies. When the amount of durian rind flour was increased, the cookies had a

yellowish-brown color increased. Changing color of cookies may be caused by Maillard reaction. In this case, durian rind flour had more chemical composition, including 34.15% carbohydrate, 6.42 % protein, 0.38% fat, and 50.81% fiber [21]. In theory, Maillard reaction was a reaction between proteins or amino acids with sugar at high temperature conditions [16]. These results consist with the effect of using durian rind flour instead of wheat flour in the tart cups [19] and brownie cakes [21] production was reported. They found that the brown color of the tart cup and brownie cake varied with increasing amount of durian rind flour in the formulas.

The effect of durian rind flour, wheat flour and salted butter in cookies on sensory evaluation was shown in Table 2. The average score from 30 untrained panelists by 9-point hedonic scale including appearance, flour, taste, texture and overall liking were investigated. The results showed that the liking score for seven formulations of cookies were significant difference of the 95% confidence interval when $P \leq 0.05$. The formula 4 was consisting of 10 g durian rind flour, 47.5 g wheat flour, 42.5 g salted butter, 16 g sugar, 13 g egg and 1 g baking powder. It had the highest score, including appearance (7.53±1.17), flour (7.40±0.97), taste (7.50±0.63), texture (7.57±0.82), and overall liking (7.50±0.94) which were at a moderate level. This corresponding with the appearance of the cookies was observed. The formula 4 was easy to mold. The texture of the cookies after baking and expansion was appropriated. It had yellow-brown color.

Table 2 The liking score (n = 30) for seven formulations of cookies

Formulation	Attribute				
	Appearance	Flavor	Taste	Texture	Overall liking
1	7.07+1.11^{a}	6.77+0.77^{b}	7.03+0.72^{ab}	7.17+1.21^{a}	7.10+0.99^{a}
2	6.33+1.18^{b}	6.07+0.87^{c}	6.60+0.72^{b}	6.37+0.81^{b}	6.23+1.01^{b}
3	6.13+0.97^{b}	6.13+0.82^{c}	6.63+0.72^{b}	6.50+0.73^{b}	6.37+0.96^{b}
4	7.53+1.17^{a}	7.40+0.97^{a}	7.50+0.63^{a}	7.57+0.82^{a}	7.50+0.94^{a}
5	5.83+0.87^{b}	5.97+1.03^{c}	6.03+1.10^{c}	5.43+1.36^{c}	5.47+1.20^{c}
6	4.43+1.30^{c}	4.47+1.66^{d}	4.23+1.72^{d}	3.90+1.88^{d}	3.93+1.91^{d}
7	7.30+1.06^{a}	7.10+0.66^{ab}	7.30+0.75^{a}	7.17+0.75^{a}	7.07+1.11^{a}

note: mean±SD, $^{a-c}$ means within each column indicate significant differences ($P \leq 0.05$) using Duncan's multiple range test.

The weight loss, hardness, spread ratio, and color value were created the contour plot for optimum overlapping (A) of cookie formulations (Figure 3).

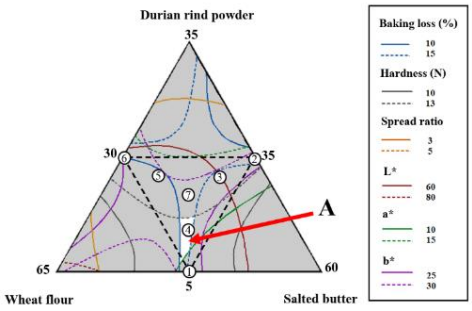

Figure 3 Contour plot for optimum overlapping (A) of cookie formulations

The suitable formula was selected from contour plot. The contour plot for optimum overlapping, weight loss (10-15), hardness (10-13 N), spread ratio (3-5), L * value (60-80), a * value (10-15) and b *value (20-25) were used as the criteria for selecting suitable formula. The results showed that optimum overlapping (A) was a suitable area for cookies production (Figure 3). Formula 4 was in the overlapping area. Durian rind flour, wheat flour, and salted butter were 10, 47.5 and 42.5%, respectively. Obviously, weight loss, hardness, spread ratio, color value and the average score of sensory evaluation were taken into consideration together. All in all, the formula 4 was selected to produce gluten free cookies in the next step.

3.2 Effect of using different types of flour in the replacement of wheat flour on the quality of gluten-free cookies

At this point, cookies from six types of flour consisting of wheat (control formula), rice, glutinous rice, potato, tapioca and mixed flour were observed (Figure 4). Cookies made from six types of flour which had a different appearance. The cookie dough made from rice flour and glutinous rice flour had a rather rough texture. In consequence, the texture of the cookies was quite tight and hard after baking.

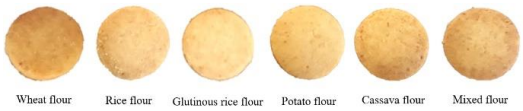

Figure 4 Appearance of cookie from different flours

Moreover, it had a low spread ratio and light-yellow color. The cookie dough made from potato flour and cassava flour had a soft texture that was not rough like rice flour and glutinous rice flour. The texture of the cookies after baking were crumbly and brittle. The cookies had yellowish-brown color. The spread ratio was higher than rice flour and glutinous rice flour. Potato dough was softer than cassava dough. Cookies from potato flour were higher brittle and spread ratio than cookies from cassava flour. Interestingly, dough of cookies made from wheat flour and mixed flour were sticky and flexible texture. The texture of the cookie had a similar appearance after baking. It had a crumbly texture that was not too hard. The cookies had yellowish-brown color. Therefore, the different appearance of cookies produced from different types of flour was found. It may be caused by different chemical composition of each type of flour resulting in different physical and chemical

properties. Normally, the cookies from wheat flour was produced which contained the gluten protein. A gluten protein caused by the combination of glutenin and gliadin. It had a disulfide bond that caused the dough to be sticky, flexible and insoluble in water [16]. Obviously, rice flour, glutinous rice flour, potato flour and cassava flour were without gluten. Cookies from mixed flour consisting of rice flour, cassava flour and potato flour were like cookies from wheat flour. It had the properties similar to wheat flour than using only one type of flour instead of wheat flour.

The effects of various types of flour on weight loss, hardness, spread ratio and color value of gluten free cookies were shown in Table 3. The results found that weight loss, hardness, spread ratio and color value of cookies from different flour were significant difference of the 95% confidence interval when $P \leq 0.05$. Apparently, potato flour cookies had the highest weight loss and spread ratio, but it had the lowest hardness. The color changing of cookies was investigated. The results showed that wheat flour cookies had the lowest brightness value. The a * value of cookies was red color. While the b * value was yellow color. The difference in appearance and physical properties of cookies were observed. It was caused by the chemical composition of each type of flour and the changing structure of the flour during baking. The heat transfer from baking caused by gelatinization of starch. In theory, gelatinization of starch was a process of breaking down the intermolecular bonds of starch molecules in the presence of water and heat. The polymer chain of amylose and amylopectin packed in the starch granules will loosen and combine with the surrounding water. Interestingly, the swelling of starch granule and the viscosity of flour solution had increased continuously. The gelatinization temperature for each type of flour was different. It was depending on the chemical composition and structure of each type of flour [16]. Baking caused the expansion of cookie products. In general, rice flour was a flour from cereal grains that had two steps of swelling. It represented the bonding force within two different starch granules. Crystal bond and amorphous area of starch were found. Cereal flour had the highest amount of bond, but it had the lowest swelling and dissolving. High amylose content caused the strong structure and low swelling of starch.

Table 3 The effect of different flours on the physical properties and the liking score of cookies

physical properties and sensory evaluation	Types of flour					
	Wheat	Rice	Glutinous rice	Potato	Cassava	Mixed
Baking loss (%)	14.27+0.04^{f}	15.3+0.02^{d}	15.57+0.02^{c}	16.77+0.02^{a}	16.06+0.06^{b}	15.04+0.04^{f}
Hardness (N)	12.20+0.26^{d}	15.33+0.21^{a}	14.97+0.06^{b}	9.10+0.10^{f}	9.97+0.15^{e}	12.83+0.15^{c}
Spread ratio	3.83+0.03^{cd}	3.80+0.05^{d}	3.90+0.06^{bc}	4.03+0.04^{a}	3.98+0.07^{ab}	3.96+0.04^{ab}
L*	61.26+0.12^{e}	71.50+0.20^{b}	72.30+0.11^{a}	71.98+0.10^{a}	67.60+0.28^{c}	64.70+0.21^{d}
a*	11.29+0.06^{c}	9.67+0.01^{d}	9.16+0.01^{e}	8.71+0.02^{f}	11.81+0.02^{b}	13.35+0.03^{a}
b*	27.17+0.17^{c}	26.70+0.04^{d}	26.00+0.03^{e}	28.64+0.02^{b}	28.38+0.37^{b}	28.97+0.08^{a}
Appearance	7.53+1.17^{a}	7.03+1.07^{ab}	6.90+0.96^{b}	7.47+1.11^{ab}	7.43+1.07^{ab}	7.50+0.94^{a}
Flavor	7.40+0.97^{ns}	7.20+0.81^{ns}	7.17+0.75^{ns}	7.33+0.88^{ns}	7.20+0.92^{ns}	7.30+0.88^{ns}
Taste	7.50+0.63^{ns}	7.27+0.64^{ns}	7.30+0.65^{ns}	7.37+0.72^{ns}	7.30+0.79^{ns}	7.43+0.77^{ns}
Texture	7.57+0.82^{a}	6.90+1.03^{b}	6.97+0.96^{b}	6.50+1.41^{b}	6.43+1.43^{b}	7.53+0.82^{a}
Overall liking	7.50+0.94^{a}	7.10+1.06^{ab}	7.17+1.05^{ab}	7.00+1.29^{ab}	6.83+1.37^{b}	7.47+0.73^{a}

note: mean±SD, $^{a-f}$ means within each row indicate significant differences ($P \leq 0.05$) using Duncan's multiple range test, and ^{ns} means not statistically significant ($P > 0.05$).

In contrary, potato flour and cassava flour had only one step for swelling. The swelling and dissolving of potato flour and cassava flour were higher than the cereal flour, because there were fewer bonds [22]. In addition, baking also caused the protein denature. It was a structure with an internal air hole and a hard shell on the outer surface of the cookies. Wheat flour was a gluten protein containing which making the sticky and flexible dough. Gluten trapped carbon dioxide gas in dough of cookies [16]. In comparisons wheat flour with other types of flour were used in the experiment, including rice flour, glutinous rice flour, potato flour, cassava flour and mixed flour which were a gluten-free flour. Apparently, the dough from other flour during forming had sticky and flexible less than wheat flour. Consequently, the strength and characteristics of the network structure within the starch granules were related to the amount and type of bonds within the starch granules. At the molecular level, there were many factors that effect on the number of bonds including size, shape, the ratio of amylose and amylopectin, molecular weight, number of branch chains, arrangement, the length of the branch in amylopectin, composition and distribution of the network within the starch granules [22]. The changing color of cookie may be caused by the enzymatic browning reactions. It may occur during durian rind was reduced to a fine. Generally, it was a chemical reaction of enzymes that created melanin and benzoquinone from natural phenols. Enzymatic browning required exposure to

oxygen. It began with the oxidation of phenols by polyphenol oxidase into quinones, whose strong electrophilic state caused high susceptibility to a nucleophilic attack from other proteins. These quinones were then polymerized in a series of reactions, eventually resulting in the formation of brown pigments (melanosis) on the surface of the food. In addition, the Maillard reaction may occur during reducing sugar with amino acids, proteins or other nitrogen compounds under high temperature [16]. The liking score of cookies from different flours was shown in Table 3. The mixed flour cookies had a higher average score on appearance, texture and overall liking than rice flour, glutinous rice flour, potato flour and cassava flour. The average score in appearance, texture and overall liking were non-significant difference of the 95% confidence interval when $P > 0.05$. The untrained panelists suggested for developing the flavor and taste of cookies which may be added durian flesh, herbal or another flavor. Interestingly, it had several of products for the consumer. As a result, the appearance, hardness, spread ratio and sensory evaluation score were considered. The mixed flour cookies had properties non-significant difference with wheat flour. In total, it was a suitable formula for producing gluten free cookies.

3.3 Effect of adding several herbs, durian flesh, green tea and coffee powder on quality of gluten free cookies

The improved quality of gluten free cookies by adding several herbs, durian flesh, green tea and coffee powder were investigated (Figure 5).

Figure 5 Appearance of cookies from eight formulations

The sensory evaluation score, including appearance, flavor, taste, texture and overall liking by 30 untrained panelists were evaluated (Table 4). The results show that the average score in appearance and texture were non-significant difference of the 95% confidence interval when $P > 0.05$. The formula with the addition of green tea and coffee powder were an average score of flour and taste higher than other formulas. The cookie formula containing green tea powder had the highest overall liking score (8.00 ± 0.91) when compared with other formulas. Interestingly, the scallion, orchid ginger, parsley, ginger, durian flesh, green tea and coffee were valuable herbs which had the unique characteristics of flavor and taste. In terms of orchid ginger, it had medicinal properties. Important substances were found in the soft stem. There were essential oils containing most chemical elements, including *tarns*-caryophyllene and β-selinene [23]. Ginger contained monoterpenes and sesquiterpenes. It was an essential substance that was important to flour and taste of ginger [24]. Scallion and parsley were a vegetable with a unique aroma which was

used as seasonings for many food products. In terms of durian flesh, it contained volatile substances, including esters, sulfur, ketone, acetaldehyde and alcohol. Ester was the main component, including ethyl propanoate, butanoate, propyl propanoate, ethyl acetate, and methyl butanoate [25]. Green tea was not fermented tea. Most chemical elements were like fresh tea leaves. It had the most polyphenols in the catechin group [26]. There were tannins in green tea, which caused a bitter taste in tea [27]. In green tea, there was caffeine as in coffee. Caffeine had a slightly bitter taste and odor. Important elements had affected on flavor in coffee, including sulfur compounds, pyrazines, pyridine, pyrrole, oxazole, furan, aldehyde, ketone, and phenol [28]. Therefore, adding several herbs, durian flesh, green tea and coffee powder can improve flavor and taste of gluten free cookies. Accordingly, these enhanced nutrition and creation of variety of products. These cookies can respond to healthy consumers and lead to various options for consuming.

Table 4 The liking score (n = 30) for eight formulations of cookies

Formulations	Attribute				
	Appearance	Flavor	Taste	Texture	Overall liking
Control	7.50+0.94^{ns}	7.30+0.88^{b}	7.43+0.77^{b}	7.53+0.82^{ns}	7.47+073^{b}
Scallion	7.57+1.14^{ns}	7.60+1.07^{ab}	7.63+0.72^{ab}	7.60+0.81^{ns}	7.57+1.01^{ab}
Orchid ginger	7.53+1.20^{ns}	7.67+1.09^{ab}	7.60+0.77^{ab}	7.57+0.86^{ns}	7.63+1.00^{ab}
Parsley	7.53+1.20^{ns}	7.47+0.90^{ab}	7.60+0.62^{ab}	7.57+0.86^{ns}	7.57+0.97^{ab}
Ginger	7.67+1.06^{ns}	7.53+0.82^{ab}	7.60+0.77^{ab}	7.63+1.00^{ns}	7.50+0.94^{ab}
Durian flesh	7.70+1.24^{ns}	7.53+1.04^{ab}	7.70+0.65^{ab}	7.73+0.74^{ns}	7.63+0.85^{ab}
Green tea	7.57+1.17^{ns}	7.97+0.89^{a}	7.90+0.66^{a}	7.57+0.82^{ns}	8.00+0.91^{a}
Coffee	7.67+1.06^{ns}	7.93+0.91^{a}	7.97+0.72^{a}	7.60+0.81^{ns}	7.97+0.72^{ab}

note: mean±SD, $^{a \text{ and } b}$ means within each column indicate significant differences ($P \leq 0.05$) using Duncan's multiple range test, and ns means not statistically significant ($P > 0.05$).

4. Conclusions

The formula of gluten free cookies was consisting of 10 grams of durian rind flour, 47.5 grams of wheat flour, 42.5 grams of salted butter, 16 grams of sugar, 13 grams of eggs, and 1 gram of baking powder were selected. Gluten free cookies supplemented with durian rind dietary fiber were the new choice. It can respond to the consumers who avoid gluten foods. In addition, it helps promote the utilization of durian rind which is a waste from agricultural products. The knowledge gained from this research can be used as a guideline for the development of food products from durian rind that can be further expanded into commercial

production. Moreover, the durian rind can be processed into other diverse food products.

5. References

[1] Pakkaew, Y. Durian: King of fruit How to eat for health benefit. *Food*. 2016. 46: 15-20.

[2] Purnomo, A., Yudiantoro, Y.A.W., Putro, J.N., Nugraha, A.T., Irawaty, W. and Ismadji, S. Subcritical water hydrolysis of durian seeds waste for bioethanol production. *International Journal of Industrial Chemistry*. 2016. 7: 29-37.

[3] Jun, T. Y., Arumugam, S. D., Latip, N. H. A., Abdullah, A. M. and Latif, P. A. Effect of activation temperature and heating duration on physical characteristics of activated carbon prepared from agriculture waste. *Environment Asia.* 2010. 3: 143-148.

[4] Ong, S.T., Keng, P.S., Voon, M.S. and Lee, S.L. Application of durian peel (*Durio zibethinu*s Murray) for removal of methylene blue from aqueous solution. *Asian Journal of Chemistry*. 2011. 23: 2898-2902.

[5] Thai industrial standards institute. *Community product standards: cookie (1 1 8 / 2 5 5 5)*. Available Source: https://www.tisi.go.th, March 1, 2019.

[6] Shewry, P.R. and Tatham, A.S. Disulphide bonds in wheat gluten proteins. *Journal of Cereal Science*. 1997. 25(3): 207-227.

[7] Barak, S., Mudgi, D., and Khatkar, B.S. Influence of gliadin and glutenin fractions on rheological, pasting, and textural properties of dough. *International Journal of Food Properties*. 2014. 17(7): 1428–1438.

[8] Surojanamethakul, V. and Hiraga, C. Coeliac disease & Importance of the gluten-free food. *Food*. 2013. 43(3): 16-21.

[9] Inchuen, S., Naratippakorn, T., and Khewruang, S. Effect of Holy Basil leaf powder on wheat flour property and cookies quality. *Khon Kaen Agriculture Journal*. 2018. 46(Suppl.) (1): 1387-1394.

[10] Khumkhom, S. Effect of additional dried sesbania (*Sesbania Javanica* Miq.) flowers powder on physical, nutritional and organoleptic characteristics of butter cookies. *Phranakhon Rajabhat Research Journal (Science and technology)*. 2018. 13(1): 139-154.

[11] Duncan, D.B. Multiple Range and Multiple F Tests. *Biometrics*. 1995.11: 1 – 42.

[12] Charoenphun, N., and Kwanhian, W. Effect of flour from durian waste on quality of gluten free pasta. *Thai Science and Technology Journal*. 2018. 26(5): 803-814.

[13] Kotoki, D. and Deka, S. C. Baking loss of bread with special emphasis on increasing water holding capacity. *Journal of Food Science and Technology*. 2010. 47: 128-131.

[14] Thai industrial standards institute. *Community product standards: durian flour (872/ 2 5 48)*. Available Source: https://www.tisi.go.th, March 1, 2019.

[15] Ministry of public health. *Announcement-Ministry of public health (No. 209) Cheese*. Available Source: http://food.fda.moph.go.th/law/data/announ_moph/P209.pdf, March 1, 2019.

[16] Rattanapanone, N. *Food chemistry*. Bangkok, Odian store. 504 pp. 2014.

[17] Budzaki, S., Komlenic, D.K., Cacic, J.L., Cacic, F., Jukic, M., and Kozul, Z. Influence of cookies composition on temperature profiles and qualitative parameters during baking. *Croatian Journal of Food Science and Technology*. 2014. 6(2): 72-78.

[18] Suphamityotin, P. *Fruit and vegetable technology*. Bangkok, Odian store. 280 pp. 2013.

[19] Bunyasawat, J. and Bhoosem, C. Effect of substitution durian rind powder with wheat flour on tarts quality. *RMUTP Research Journal*. 2017. 11(2): 48-58.

[20] Pareyt, B. and Delcour, J.A. The role of wheat flour constituents, sugar, and fat in low moisture cerealbased products: a review on sugar-snap cookies. *Critical Reviews in Food Science and Nutrition*. 2008. 48(9): 824-839.

[21] Bunyasawat, J. and Bhoosem, C. Effect of using durian rind powder substitution with wheat flour on brownies cake quality. *RMUTP Research Journal*. 2018. 12(1): 113-124.

[22] Sriroth, K. and Piyachomkwan, K. *Starch Technology*. Kasetsart University Press, Bangkok, 303 pp. 2007.

[23] Pratuangdejkul, A. Orchid ginger. *Medicinal plant newsletter*. 2009. 26(2): 12-17.

[24] Limpaphayom, V., Laohakunjit, N. Duzzadeelawan, P. and Vamasiri, K. Chemical compositions and antioxidant activity of *Zingiber officinale* roscoe essential oils. *KMUTT Research and Development Journal*. 2014. 37(3): 297-312.

[25] Chanapalpun, C., Dhamvithee, P., Jangchud, A. and Boonbumrung, S. *Evaluation of the odorants in durian CV. Monthong by GC-TOFMS and electronic nose*. Available Source: http://www.lib.ku.ac.th/KUCONF/2555/KC4906027.pdf, March 1, 2019.

[26] Theppakorn, T. Green tea catechins and storage stability. *KKU Science Journal*. 2013. 41(1): 46-55.

[27] Bunteongjit, D., Green tea. *Department of Science Service Journal*. 2004. 52(164): 10-14.

[28] Rungsrangtham, N. *Changes of volatile compounds in roasted arabica coffee beans during storage*. Master's Thesis. Silpakorn University. 2006.