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Research Article

Effects of Nutmeg and Coconut Milk Powder on Wheat-Rice Cookies

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ABSTRACT

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This study aimed to investigate the quality of wheat-rice cookies with the addition of natural colorants, Nutmeg, and coconut milk powder (CMP). In the experiment of evaluating the impact of natural colorants on cookie quality, the Khai-mod-rin rice-wheat cookie recipe was used as the control. The addition of natural colorants did not significantly affect cookie color or sensory evaluations (P>0.05). Therefore, the control formula was chosen for studying the effects of nutmeg addition. Nutmeg addition decreased L* and b* values while increasing a* values. Cookies with 4% nutmeg had a significantly higher spreading ratio (P<0.05), but the % baking loss was similar across treatments. Sensory evaluations indicated similar acceptance scores for cookie color. Acceptance scores for odor, taste, texture, and overall quality were higher for cookies containing 2% and 3% nutmeg, with no significant difference in overall acceptability between these two treatments. Therefore, the 2% nutmeg cookie formula was chosen for studying the effects of CMP addition. CMP was supplemented at four levels: 0%, 15%, 30%, and 45% (w/w as margarine substitution). Results showed that increasing CMP levels tended to decrease L* values and increase a* values. The spreading ratio decreased with higher CMP levels, and the % baking loss was lowest in the 45% CMP cookies. Sensory evaluation scores showed that cookies with 30% CMP had the highest scores average liking scores for color, odor, taste, texture and overall acceptance being 7.50, 7.30, 7.13, 7.13, and 7.60 respectively. The Nutmeg-CMP wheat-rice cookies had a moisture content that conformed to the Community Product Standard 118/2003 guidelines. In conclusion, this study shows that nutmeg and CMP can be effectively applied to produce an acceptable product: the Nutmeg-CMP wheat-rice cookie.

1. Introduction

In Thailand, "Cookies" according to the Community Product Standard 118/2003 means a type of baked goods made from wheat flour or wheat flour mixed with other types of flour, sugar, fat or edible oil, milk, eggs, baking powder, baking soda, flavoring agents, salt. They may also contain other ingredients such as cocoa, grains, herbs, dried fruits, dried shrimp, shredded fish. Cookies are formed into pieces by dropping, cutting, molding, pressing with a mold or other appropriate methods, and then baked until crisp (Thai Industrial Standards Institute, 2003). In 2023, the biscuit market was worth 15 billion baht, growing by only 6%, consisting of crackers worth 5-6 billion baht, growing 9%, cookies worth 4 billion baht, growing 3%,

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and wafers worth 4 billion baht, growing 4% (MGROnline, 2024). Cookies are widely accepted and consumed in nearly all parts of the world due to being ready to eat, affordable, having good nutritional qualities, offering a wide range of tastes, and having a long shelf life. However, due to the problem of gluten allergy in wheat flour, which poses a risk for some consumers, cookies have been developed in many forms to reduce the amount of wheat flour used as the main ingredient in cookie recipes, such as using rice flour, cereal flour, and others. Bolarinwa *et al*. (2019) reported that a blend of 75% germinated brown rice flour and 25% potato starch was used to prepare high-quality and acceptable gluten-free cookies. Sresatan *et al*. (2024) reported that the optimal ratio of gluten-free flour was 90% rice flour, 5% corn starch and 5% modified tapioca starch as a substitute for wheat flour in cookies when using physical quality as the evaluation criterion.

Also, in the consumer market situation, consumers have continuously changed their preferences when choosing products, following trends that emphasize visual appearance, such as color, size, packaging, taste perception during consumption, as well as consideration of health effects after consumption. Therefore, product development that fulfills consumers' needs and responds to their behavior is essential. The development of products with natural plant substances has been accepted for their safety when used as food ingredients. However, the amount used in each product must take into account its effect on the product's characteristics and consumer acceptance. Fathonah *et al*. (2018) reported that the 7-point quality scale of sensory evaluation of pumpkin cookies showed differences in the quality of yellow color, crispness, and taste. The substitution of 10% pumpkin flour was most preferred across four sensory quality characteristics: aroma, crispness, sweetness and pumpkin taste, with scores ranging from 4.5 to 5.2. Kulkarni *et al*. (2010) reported that cookies enriched with 10% of mushroom powder scored highest for all sensory quality attributes. Farheena *et al*. (2015) reported high acceptability in the organoleptic properties of cookies when 15% date paste was used in the formulation.

In the southern region of Thailand, 12% of the total rice planting area is used for native rice cultivation. Khai-mod-rin rice accounts for 55% of the native rice planting area. Khai-mod-rin rice is a local rice variety from Nakhon Si Thammarat Province which is commercially sold as milled rice for consumption (Nooake *et al*., 2009). Khai-mod-rin rice is gluten-free. Its nutritional composition is as follows: 12.10% moisture content, 74.11% carbohydrate, 4.47% fat, 7.63% protein, 1.70% ash, and 4.66% fiber. It contains 0.75 mg FAE/g DW of total phenolic content and exhibits 14.62% antioxidant activity (2,2-diphenyl-1-picrylhydrazyl, DPPH) (Chooklin *et al*., 2019). Local rice has the advantage of being available and gluten-free. Chuajedton and Purinthrapibal (2017) reported the use of Khai-mod-rin rice flour as an ingredient in wheat-rice baked products, thereby increasing the utilization of local rice and reducing the gluten content in bakery products.

Nutmeg (*Myristica fragrans*) is abundant in the south of Thailand, particularly in Chumphon, Surat Thani, Phang Nga, Nakhon Si Thammarat, and in the three southern border provinces. A popular OTOP product of Ron Phibun District is dried edible nutmeg pulp, which is opaque and reddish brown. Assa *et al*. (2014) reported that nutmeg pulp extracts were very effective in inhibiting linoleic peroxidation and had a relative similar ability to Butylated hydroxytoluene (BHT). Sipahelut *et al*. (2020) reported that nutmeg fruit pulp-derived oil had a greater capability to inhibit oxidation process than α-tocopherol. Nur *et al*. (2023) reported that the ethanol extract of that the pulp at doses of 450, 900 and 1,800 mg/kg wb showed significantly different anti-ulcer activity compared to the negative control group ($P<0.05$) in acetocal-induced rats.

Fat is an important ingredient in baked goods, playing a role in giving them a soft texture. Margarine is a processed palm oil fat that is commonly used in cookies. Current research has found the effects of palm oil on the health of experimental animals. Memedi (2023) reported that studies in mice indicate palm oil increased the activity of xanthine oxidase (XOD) in the blood and caused changes in the glucose tolerance test related to carbohydrate metabolism. Analysis of the results from two studies on XOD and carbohydrate metabolism showed a correlation between increased XOD levels and the development of prediabetes. Coconut milk is obtained from coconuts, a local plant in the south of Thailand. Its use in food can be obtained by squeezing fresh coconut milk, commercial coconut milk powder, or commercial sterilized coconut milk in a box. Laboratory studies have indicated the health benefits of coconut milk. Karunasiri *et al*. (2020) reported that the results showed the phenolic compounds in all coconut milk preparations (domestic coconut milk, powdered coconut milk, and liquid coconut milk) provided protection against oxidative damage to lipids and inhibited oxidative damage to both proteins and DNA. Alyaqoubi *et al*. (2015) reported that antioxidant properties evaluated by the ferric reducing power (FRAP) assay and 1,1-diphenyl-2-picrylhydrazyl (DPPH) assay indicated that coconut milk displays higher antioxidant properties than cow's milk.

The research aimed to investigate wheat-rice cookie quality through three primary aspects: (1) the impact of natural colorants on cookie quality, (2) the influence of nutmeg on cookie quality, and (3) the effect of coconut milk powder as a margarine substitute on cookie quality.

2. Materials and Methods

2.1 Cookie process

In this experiment, the wheat-rice cookie formula was chosen as the control cookie. The main ingredient for making the cookie was wheat flour. Other ingredients were specified as a percentage of the wheat flour weight as follows: 30% Khai-mod-rin rice flour, 35.70% icing sugar, 37.80% margarine, 8.40% milk powder, 1.20% baking powder, 4.20% evaporated milk, and 12.60% eggs (Chuajedton and Purinthrapibal, 2017). The steps for making cookies were as follows: all-purpose wheat flour, Khai-mod-rin rice flour, milk powder, and baking powder were sifted together as a dry mixture and set aside. Margarine, in a mixer bowl, was beaten with a paddle attachment until it was slightly fluffy. Icing sugar was gradually added and beaten until the margarine was very fluffy. The speed of the paddle attachment was then reduced. The eggs were added to the mixture and beaten until well blended. The dry ingredients were added alternately with the evaporated milk (starting and ending with the dry ingredients). The dough was divided into small pieces of equal weight. Each piece was shaped with a spoon to make a spoon cookie and to control the consistency of the cookie diameter. The cookies were baked in an electric oven at 170˚C for 15 min (Bolarinwa *et al*., 2019) and cooled at room temperature for 1 hour. Finally, they were packed in aluminum foil bags for further analysis.

2.2 Study of the effect of natural colorants, Nutmeg and CMP on the quality of cookies

2.2.1 Natural colorants

Two types of plants were selected to prepare natural colorants: dried red roselle extract and fresh turmeric extract. The extracts were prepared by boiling 3 g of each plant material in 100 g of clean water for 10 minutes. The extracted solution was filtered through a thin cloth and then used for soaking the Khai-mod-rin rice (using a ratio of extract to Khai-mod-rin rice 2:1 w/w) for 1 hour at room temperature. The solution was then drained and the dyed rice was reduced in moisture using a hot air oven, 70°C for 3 hours (Chalermsaen and Kitnok, 2016). The dried dyed rice was ground and sized by sifting through a flour sieve. The dyed rice flour was packed in aluminum foil bags for further experiments.

2.2.2 Nutmeg

Commercial dried nutmeg pulp product was coarsely chopped and added to the dough before shaping. The Nutmeg supplement was tested at 2%, 3%, and 4% levels based on the wheat flour weight. The control cookie formula contained no nutmeg.

2.2.3 Coconut milk powder (CMP)

The commercial CMP was used in this experiment. The CMP was added at levels of 15%, 30%, and 45% (w/w as a margarine substitute). The control cookie formula contained no CMP. In the cookie-making process, the dry ingredients wheat flour, Khai-mod-rin rice flour, milk powder, baking powder, and CMP were sifted together.

2.3 Quality analysis

2.3.1 Color of cookies

The color was measured using a MiniScan EZ Hunter Lab (Hunter Associates Laboratory Inc., USA) and recorded the value in L*, a*, and b* CIE coordinates. The L* value represents lightness versus darkness, where a low number (0-50) indicates darkness and a high number (51-100) indicates lightness. The a* value represents red versus green, where a positive number indicates red and a negative number indicates green. The b* value represents yellow versus blue, where a positive number indicates yellow and a negative number indicates blue.

2.3.2 Baking loss

Baking loss (BL) was determined by measuring the cookie weight before and after baking (Saric *et al*., 2014). It was calculated according to the following equation:

$$BL\ (\%) = (m_0 – m_t)/\ m_0 * 100$$

Where m_0 is the initial cookie weight (g) and m_t is the weight (g) after baking time t (min).

The cookie weight (m_0 and m_t)" was determined as average value of six cookies each time and measured in triplicate.

2.3.3 Spread Ratio

The cookie diameter (width) was determined by placing six cookies horizontally (edge to edge) in a row and the diameter was measured in cm. The thickness of cookies was determined by stacking six cookies on top of one another and measuring the thickness in centimeters (Inyang *et al*., 2018). The spread ratio was calculated by dividing the average diameter by the average thickness of the cookies (Bolarinwa *et al*., 2019). The experiments were carried out in triplicate, and the mean values were reported.

2.3.4 Nutritional compositions

The nutritional analysis of the samples was conducted according to the AOAC method (AOAC, 2000) to determine their moisture, crude protein, crude fat, ash, and crude fiber content. Moisture content was determined by subjecting the samples to oven drying at 105°C until a constant weight was achieved. Crude protein was determined using Kjeldahl equipment (GERHARDT, Germany). Crude fat was determined using an automated Soxhlet method (FOSS, Sweden). Ash content was determined Inc., dry-ashing method at 550°C for 24 hours. Total dietary fiber was measured using a fiber analyzer (FOSS, Sweden). Carbohydrate content was calculated by difference [100 – % (moisture + fat + crude protein + ash)]. Data were expressed as g/100 g in wet weight. Water activity of the cookies was measured with Aqualab water activity analyzer (Aqualab, USA). The experiments were carried out in triplicate, and the mean values were reported.

2.3.5 Sensory evaluation

For the sensory evaluation of the cookies, a panel of 50 participants consisting of students and staff from Rajamangala University of Technology Srivijaya, Faculty of Agro-Industry, in the Major of Food Innovation and management The cookies were evaluated for color, odor, taste, texture and overall acceptability using a 9-point hedonic scale, with 1 representing the least score (dislike extremely) and 9 representing the highest score (like extremely) (Anprung, 2008).

2.3.6 Statistical analysis

A Completely Randomized Design (CRD) was used for physical and chemical quality analysis, while a Completely Randomized Block Design (RCRD) was used for sensory quality analysis. The obtained data were statistically analyzed in terms of mean, standard deviation, and variance (Analysis of variance, ANOVA). The difference in mean values between groups was analyzed using Duncan's Multiple Range Test at the 95% ($P<0.05$) level of significance.

3. Results and Discussion

3.1 Effect of natural colorants on the sensory quality of cookies

Khai-mod-rin rice-wheat cookies were the product described in the report by Chuajedton and Purinthrapibal (2017). Their color characteristics were acceptable to the panelists. However, developing products with a variety of colors is one of the characteristics that attracts consumers' attention. In addition, the use of natural colorants to develop product colors is safer for consumers compared to the use of synthetic colors. Natural dyes can be obtained from plant tissues (e.g. Curcumin, Carotenoids, Anthocyanins, Betalains, or Chlorophyll). In this study, inexpensive and abundant food plants in this area were selected: red Roselle (*Hibiscus sabdariffa* Linn.) and Turmeric (*Curcuma longa* L). Red Roselle provides a red color from the anthocyanin group, which has antioxidant properties (Jindamung and Thipbharos, 2012). Turmeric has a orange-yellow color from Curcumin, which has antioxidant properties (Manasa *et al*., 2023). The colorants can be prepared in the form of an extract and powder. Jindamung and Thipbharos (2012) reported that the ratio of fresh red Reselle residue to distilled water was 1:4 w/v and the optimal extraction was 100˚C for 30 min. To avoid the influence of plant tissue on the evaluation of the textural characteristics of cookies, the extraction method was chosen. Red Roselle and Turmeric were extracted at 100˚C using the water extraction method (Jindamung and Thipbharos, 2012; Tanongkankit and Poonnoi, 2014; Manasa *et al*., 2023). The extractants are presented in Figure 1. The roselle extract had a purple-red color with an a* (reddish tone) value of 1.39. According to the report by Tang (2019), using dried roselle extract at the ratio of 25 g dried roselle to 100 ml water, the extracted solution had an a* value of 8.50 The Turmeric extractant had an orange-yellow color with a b* (yellowish tone) value of 13.40. Fresh Turmeric raw materials have different yellow colors depending on the variety and the place of cultivation. As reported by Thammapat *et al*. (2021), fresh Turmeric had a b* value of 21.21, while Madhusankha *et al*. (2018) reported that the color of fresh Turmeric from Indian source had b* values ranging from 41.24 to 42.04, and from Sri Lanka, it had b* values ranging from 31.46 to 46.06. The dyed rice colorants are presented in Figure1. The addition of colorants resulted in cookies with L*, a* and b* values that were significantly different from the control cookies (Table 1). The red Roselle cookies had decreased L* and b* values, whereas a* values increased. The turmeric cookies had decreased L* values, whereas a* and b* values increased.

Sensory properties of the cookies were not significantly ($P>0.05$) affected by the addition of natural colorants (Table 2). This result was inconsistent with the report of Renzo *et al*. (2022), which found that cookies product developed with 1% turmeric extract (based on total formula weight) were more acceptable in terms of color and flavor than control cookies without added Turmeric extract. Based on the results of this experiment, the color characteristics of colorant cookies changed according to instrumental measurement, but the sensory acceptability of the colorant cookies was not better than that of the control formula

Figure 1 Effect of the natural colorants on appearance quality of cookies

Table 1 Effect of the natural colorants on Moisture (%), L*, a*, and b* values of cookies

	Cookie treatment	Moisture ^{ns} (%)	L*value	a* value	b* value
1	Control	1.67±0.50	63.90±0.05^{a}	6.38±0.02^{c}	26.78±0.04^{b}
2	Roselle	1.70±0.20	31.32±0.01^{c}	10.21±0.03^{a}	7.55±0.03^{c}
3	Turmeric	2.60±0.20	59.86±0.10^{b}	7.56±0.24^{b}	42.60±0.11^{a}

Mean value of 3 replicate measurements ± standard deviation

$^{a,b\ldots}$ Means within a column followed by different letters are significantly different (p<0.05).

Table 2 Effect of the natural colorants on Sensory evaluation of cookies

	Cookie treatment	Color^{ns}	Odor^{ns}	Taste^{ns}	Texture^{ns}	Overall acceptance^{ns}
1	Control	7.48±1.18	7.32±1.32	7.42±1.01	7.44±0.88	7.50±0.84
2	Roselle	7.42±0.97	7.30±1.18	7.58±1.01	7.14±1.07	7.50±0.86
3	Turmeric	7.58±1.16	7.36±1.21	7.46±1.11	7.44±1.03	7.50±0.79

Mean value of 50 replicate measurements ± standard deviation

^{ns} Not significant (p>0.05)

3.2 Effect of Nutmeg on the quality of cookies

Nutmeg is a plant commonly used in pharmaceuticals, as well as in products like Mac and nutmeg.The Nutmeg pulp is not usually consumed fresh because of its sour and astringent taste. Currently, there is a Community Product Standard (1058/2005) guideline for dried nutmeg seasoning (Thai Industrial Standards Institute, 2005). Commercial dried nutmeg pulp seasoned with sugar have a reddish-brown color due to the Maillard reaction (Gupa *et al*., 2022). In this experiment, the appearance of nutmeg cookies is shown in Figure 2. The rise in nutmeg. content led to significant variations in the L*, a* and b* values (Table 3). The L* value of the control cookies was 58.16, which was statistically different from that of the nutmeg cookies. The addition of nutmeg, characterized by its reddish-brown and opaque pulp, resulted in a decrease in the L* values, indicating increased darkness in the cookies. The L* values of nutmeg cookies with the addition of 2%, 3% and 4% nutmeg were 54.40, 54.41, and 52.82, respectively. However, addition of 2-4% Nutmeg did not cause a significant difference in the L* values of nutmeg cookies. Thongnok (2024) reported that substituting wheat flour with reddish Sungyod rice flour in cookies resulted in a decrease in the L* value. The results showed that increasing the amount of Sungyod rice flour led to a decrease in the L* values of the cookies. The a* value of cookies was affected from Nutmeg addition. The a* values of the control cookies was 11.52, which was significantly different from the nutmeg cookies. Cookies containing 2-4% nutmeg had a* values of 13.41-14.65, which were not statistically different from each other. These results are consistent with the findings of Thongnok (2024), who reported that substituting wheat flour with reddish Sungyod rice flour resulted in an increase in the a* values of cookies. Nutmeg addition resulted in a decrease in the b* values of cookies. The control cookies had a b* value of 38.60. The addition of 4% nutmeg led to a statistically significant difference in the b* value compared to the other cookie treatments. The 4% nutmeg cookies had the lowest b* value at 35.15.

The spread ratio or spread factor of cookies has been used as an important characteristic for determining the quality of cookies. Cookies with higher spread ratios are considered to be more desirable than those with lower values. In the present study, the addition of nutmeg significantly affected the spread ratio (Table 4). The 4% nutmeg cookies had the highest spread ratio (2.22) that was significantly different from those of the other cookies. The spread ratio of the control cookies was 2.14, while 2% and 3% Nutmeg cookies were 2.21, and 2.12, respectively (Table 4). This result may be attributed to the nutmeg pulp seasoned with sugar. Akesowan (2002) reported that a decrease in the amount of sucrose in cookies resulted in a decrease in the spread ratio. Similarly, Panghal *et al*. (2018) found that increasing the sugar content from 40 g to 70 g increased the spread factor of cookies from 6.42 to 8.17. Baking loss refers to the moisture loss during baking. A higher water-binding capacity of the dough is associated with lower baking loss. Both rice and wheat flour have the ability to bind and hold water that characterizes the ability of system to retain moisture in the formed structure after heat treatment (Sedlacek and Svec, 2023). The main composition of nutmeg is dietary fiber. Therefore, the addition of 2-4% nutmeg did not significantly affect the percentage of baking loss in the cookies.

The sensory evaluation of Nutmeg cookies is presented in Table 5. The results showed that the color score of cookies were not significant different. The sensory attributes evaluated in terms of color, odor, taste, texture, and overall acceptability indicated that the cookies with 2% and 3% nutmeg were the most preferred cookies and were significantly different from the other treatments. This was due to the essential oils in the nutmeg pulp. Sipahelut *et al*. (2020) reported that nutmeg pulp oil contains 32 components, with major constituents including α-pinene (18.0%), myristicin (14.1%), α-terpineol (9.4%), β-pinene (8.9%), limonene (8.5%), and terpinene-4-ol (8.4%). However, excessive nutmeg negatively affected the cookies' odor, taste, texture, and overall acceptance. The cookies with 4% nutmeg showed no significant difference in these characteristics compared to the control cookies. Based on the experimental results at this stage and considering the raw material cost, the 2% Nutmeg cookie formula was selected for further experimental study.

Commercial Dried Nutmeg pulp	Control **Cookie Treatment1**	2%Nutmeg **Cookie Treatment2**	3%Nutmeg **Cookie Treatment3**	4%Nutmeg **Cookie Treatment4**

Figure 2 Nutmeg Cookies

Table 3 Effect of Nutmeg on L*, a* and b* values quality of cookies

	Cookie treatment	L* value	a* value	b* value
1	Control	58.16±0.27^{a}	11.53±0.32^{b}	38.60±0.65^{a}
2	2 % Nutmeg	54.40±1.42^{b}	13.41±0.71^{a}	36.77±0.96^{ab}
3	3 % Nutmeg	54.41±1.25^{b}	14.16±0.62^{a}	37.05±1.52^{ab}
4	4 % Nutmeg	52.82±2.65^{b}	14.65±0.12^{a}	35.15±0.75^{b}

Mean value of 3 replicate measurements ± standard deviation

^{a,b}…Means within a column with different letters are significantly different ($p<0.05$).

Table 4 Effect of Nutmeg on Spread ratio and Baking loss (%) of cookies

	Cookie treatment	Spread ratio	Baking loss (%)^{ns}
1	Control	2.14±0.06^{b}	13.76±0.23
2	2 % Nutmeg	2.12±0.05^{b}	12.72±0.93
3	3 % Nutmeg	2.12±0.01^{b}	13.38±0.28
4	4 % Nutmeg	2.22±0.03^{a}	13.36±0.42

Mean value of 3 replicate measurements ± standard deviation

^{a,b}… Means within a column with different letters are significantly different ($p < 0.05$).

Table 5 Effect of Nutmeg on Sensory evaluation of cookies

	Cookie treatment	Color^{ns}	Odor	Taste	Texture	Overall acceptance
1	Control	6.46±1.07	6.54±1.11^{c}	6.16±1.17^{b}	6.46±1.01^{b}	6.48±0.97^{b}
2	2 % Nutmeg	6.96±1.50	7.00±1.36^{a}	7.08±1.10^{a}	7.12±1.01^{a}	7.30±1.09^{a}
3	3 % Nutmeg	7.02±0.92	7.50±0.96^{a}	7.16±0.98^{a}	7.34±1.04^{a}	7.34±0.98^{a}
4	4 % Nutmeg	6.96±1.11	6.88±1.08^{b}	6.12±1.15^{b}	6.38±1.03^{b}	6.50±0.84^{b}

Mean value of 50 replicate measurements ± standard deviation

$^{a,b…}$ Means within a column with different letters are significantly different ($p < 0.05$).

3.3 Effect of coconut milk powder (CMP) on the quality of cookies.

The results of color measurements of cookies made with different levels of CMP are given in Table 6. It was found that the lightness L* value of the cookies exhibited a decreasing trend with increasing substitution levels of CMP. The reduction in L* value indicated that the cookies became darker at higher substitution levels compared to the control sample. There was no significant difference in the b* value between the control and CMP cookies. The changes in color of cookies made with CMP were consistent with the findings of Phungamngoen *et al*. (2009), who reported that coconut milk heated above 110° C results in a significant decrease in L* and a* values, while the b* value tended to increase. From the color analysis of coconut milk, it was found that the color changed to brown when the temperature was higher. The sterilization temperature which was higher than 100°C caused a browning reaction (non-enzymatic browning), resulting in a decrease in the L* value and a significant increase in the a* and b* values (Phuttarakmongkol *et al*., 2008).

Commercial CMP had Maltodextrin as an ingredient. Maltodextrin is widely used for partial replacement of fats in variety of processed foods because of its ability to form a particle gel cream in food systems (Hye *et al*., 2001). The increasing amount of CMP caused the spread ratio to decrease (Table 7). Control cookies and cookies with 15%, 30% and 45% CMP had spread ratios of 2.14, 2.06, 2.05 and 1.70, respectively, which was consistent with the findings reported by Alyaqoubi *et al*. (2015). They found that the addition of Maltodextrin at 0%, 4.5%, 9%, 13.5%, 18% and 22.5% of wheat flour caused the spread ratio of cookies to tend to decrease, with values of 3.03, 2.90, 2.79, 2.67, 2.57 and 2.50, respectively. Baking loss in control, 15%, and 30% CMP cookies was 13.54%, 13.14%, and 13.80% respectively, with no statistically significant differences. In cookies with 45% CMP, the baking loss was 10.75%, which was statistically different from the other treatments (Table 7). Charoenphun and Kwanhian (2019) reported that in a study on Alpinia nigra Burt cookies, the weight loss of cookies varied directly with the amount of butter.

The sensory properties of cookies can be affected by the CMP addition. The data on sensory scores as shown in Table 8 indicated that there were significant differences in color, odor, taste, texture, and overall acceptability between the control cookies and those prepared with 15%, 30%, and 45% CMP. Color is an important quality indicator of food system that can affect consumer acceptance. The color scores of the cookies ranged from 6.93 to 7.50; control sample had the lowest value (6.93) while the 30% CMP cookies had the highest value (7.50). There was no significant difference between control and 45% CMP cookies. Odor is a key process control parameter. The presence and character of odors indicate how well the process is being managed. The odor rating of 15% and 30% CMP cookies were significantly different from those of the control and 45% CMP cookies, with no significant difference between the control and 45% CMP cookies. The odor scores for the 15%, 30%, and 45% CMP were 7.05, 7.30, and 6.45, respectively. Taste is the primary factor determining the acceptability of any product and has the greatest impact on its market success. There was a significant difference in taste among the treatments. The 30% CMP cookies had the highest taste score (7.13), while the 45% CMP cookies had the lowest (6.38). Texture is the sensory manifestation of the structure of food and the manner in which the structure reacts to the applied force. It is one of the most important parameters connected to product quality. Texture analysis involves measuring the properties related to how a food feels in the mouth during the initial bite. There was no significant difference in the texture scores between the cookies made with 30% CMP, which showed the highest texture score, and those made with 15% CMP. The cookies made with 45% CMP showed the lowest texture score. Overall acceptability includes many factors and is the important parameter in organoleptic evaluation. The overall acceptability expresses how the consumers or panelists accept the product generally. Commercial CMP contained maltodextrin as an ingredient. A-sa *et al*. (2023) reported that the drying condition that produced the greatest quality and highest powder recovery was the application of 20 g of maltodextrin per 100 g of coconut milk. The 30% CMP cookies had the highest score for overall acceptability (7.60) while the lowest was recorded from the 45% CMP cookies (6.15). The result was consistent with the findings of Thongnok (2024), who reported that substituting Maltodextrin at 30% in cookies led to the highest overall preference, while the substitution of Maltodextrin at 50% and 70% in cookies resulted in decreased overall preference compared to the control cookies. The nutritional composition, expressed as g/100 g in weight, of the Nutmeg-CMP wheat-rice cookies were 5.66% moisture content, 69.70% carbohydrate, 18.24 % fat, 6.10 % crude protein, 1.30 % ash, and 0.88 % dietary fiber.

The water activity was 0.38 (Table 9). The nutritional value of cookies varies depending on the ingredients used. According to the Community Product Standard No.118/2003 guidelines for cookies, only the moisture content is specified, which should not exceed 7%

Table 6 Effect of CMP on L*, a* and b* values of cookies

Cookie treatment	L* value	a* value	b*^{ns} value
1 Control	56.04±0.04^{a}	13.43±0.02^{c}	37.08±0.03
2 Margarine substitution with 15% CMP	55.73±0.37^{a}	13.65±0.05^{c}	36.38±0.74
3 Margarine substitution with 30% CMP	54.69±0.11^{b}	14.53±0.10^{b}	35.91±0.02
4 Margarine substitution with 45% CMP	52.58±0.45^{c}	15.57±0.35^{a}	36.21±2.20

Mean value of 3 replicate measurements ± standard deviation

$^{a,b...}$ Means within a column with different letters are significantly different ($p < 0.05$).

Table 7 Effect of CMP on Spread ratio and Baking loss (%) of cookies

Cookie treatment	Spread ratio	Baking loss (%)
1 Control	2.14±0.02^{a}	13.54±0.06^{a}
2 Margarine substitution with 15% CMP	2.06±0.05^{ab}	13.14±0.50^{a}
3 Margarine substitution with 30% CMP	2.05±0.06^{b}	13.80±0.22^{a}
4 Margarine substitution with 45% CMP	1.70±0.02^{c}	10.75±0.90^{b}

Table 8 Effect of CMP on Sensory evaluation of cookies

Cookie treatment	Color	Odor	Taste	Texture	Overall acceptance
1. Control	6.93±0.76^{b}	6.68±1.20^{bc}	6.10±1.32^{c}	6.50±1.29^{b}	6.70±1.94^{c}
2. Margarine substitution with 15% CMP	7.20±0.79^{ab}	7.05±1.74^{b}	6.65±1.07^{ab}	6.73±1.88^{ab}	7.13±1.76^{b}
3. Margarine substitution with 30% CMP	7.50±0.93^{a}	7.30±1.22^{ab}	7.13±1.27^{a}	7.13±1.99^{a}	7.60±1.90^{a}
4. Margarine substitution with 45% CMP	6.95±0.88^{b}	6.45±1.30^{c}	6.25±1.92^{bc}	6.38±1.84^{b}	6.15±1.12^{d}

Mean value of 50 replicate measurements ± standard deviation

$^{a,b...}$ Means within a column with different letters are significantly different ($p < 0.05$).

Table 9 Nutritional compositions of Nutmeg-CMP wheat-rice cookies

Nutritional compositions	
Water activity	0.38±0.00
Moisture (%)	5.66±0.04
Carbohydrate (%)	69.70±1.76
Fat (%)	18.24±0.09
Crude Protein (%)	6.10±0.13
Ash (%)	1.30±0.05
Dietary fiber (%)	0.88±0.02

4. Conclusion

This study has shown that the products from locally grown plants dried nutmeg pulp and CMP affect the quality of wheat-rice cookies. According to the results of sensory evaluation, the wheat-rice cookies containing 2% nutmeg and 30% CMP as a margarine substitution received the highest score from the panelists. These findings provide values insights for enhancing guidelines on utilizing nutmeg and CMP in cookie formulations, as well as expanding their application in various baked products.

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6. References

Akesowan, A. 2002. Effect of reducing levels of sugar content on quality characteristics of reduced-calorie cake and cookie made with konjac flour, sorbitol, and polydextrose. **Food** 32(4): 291-299. (in Thai)

Alyaqoubi, S., Abdullah, A., Samudi, M., Abdullah, N., Addai, R.Z. and Musa, H.K. 2015. Study of antioxidant activity and physicochemical properties of coconut milk (*Pati santan*) in Malaysia. **Journal of Chemical and Pharmaceutical Research** 7(4): 967-973.

Anprung, P. 2008. **Principle of sensory evaluation of food** (2nd ed). Chulalongkorn University Printing House, Bangkok. (in Thai)

AOAC. 2000. **Official methods of analysis of AOAC international** (17th ed). Maryland.

A-sa, K., Jittanit, W. and Charoensiddhi, S. 2023. Processing of coconut milk powder using spray drying technique and Carboxymethylcellulose produced from coconut residue, pp. 681-689. *In* **The Proceeding of 61st Kasetsart University Annual Conference Science, Engineering and Architecture, Agro-Industry, Natural Resources and Environment.** Kasetsart University. (in Thai)

Assa, J.A., Widjanarko, S.B., Kusnadi, J. and Berhimpon, S. 2014. Antioxidant potential of flesh, seed and mac of nutmeg (*Myristica fragrans* Houtt.). **International Journal of ChemTech Research** 6(4): 2460-2468.

Bolarinwa, I.F., Lim, P.T. and Muhammad, K. 2019. Quality of gluten-free cookies from germinated brown rice flour. **Food Research** 3(3): 199-207.

Chalermsaen, P. and Kitnok, A. 2016. **Research Report on Drying of rice noodle (Khanom jeen).** Rajabhat Maha Sarakham University. (in Thai)

Charoenphun, N. and Kwanhian, W. 2019. Production of gluten free cookies supplemented with durian rind flour. **Science and Technology RMUTT Journal** 9(2): 23-38. (in Thai)

Chooklin, S., Purintrapibal, P. and Maudsri, T. 2019. **Research Report on Optimum production of snack food from indigenous brown rice flour of southern of Thailand with twin screw extruder.** Rajamangala University of Technology Srivijaya. (in Thai)

Chuajedton, J. and Purinthrapibal, P. 2017. **Research Report on Local rice cookie.** Faculty of Agro- Industry, Rajamangala University of Technology Srivijaya. (in Thai)

Farheena I., Avanish, K. and Uzma, A. 2015. Development and quality evaluation of cookies fortified with date paste (*Phoenix dactylifera* L). **International Journal of Science, Engineering and Technology** 3(4): 975-978.

Fathonah, S., Rosidah, Setyaningsih, D.N., Paremita, O., Istighfarin, N. and Litazkiyati. 2018. The sensory Quality and Acceptability of pumpkin in flour cookies, pp.439-445. *In* **Proceeding of the 7th Engineering International Conference on Education**, **Concept and Application of Green Technology.** Universitas Negeri Semarang.

Gupa, S.S., Sood, M., Gupta, N., Bandral, J.D. and Langeh, L. 2022. Food browning, its type and controlling measure: A review. **Chemical Science Review and Letters** 11(41): 29-45.

Hye, K., Hyeon, Y., Hyesook, L. and Seung-Taik, L. 2001. Replacement of shortening in yellow layer cakes by corn dextrins. **Cereal Chem** 78(3): 267-271.

Inyang, U.E., Effiong, C.E. and Edima-Nyah, A.P. 2018. Physical properties, nutritional composition and sensory evaluation of cookies prepared from rice, unripe banana and sprouted soybean flour blends. **International Journal of Food Science and Biotechnology** 3(2): 70-76.

Jindamung, Y. and Thipbharos, P. 2012. Stability of Anthocyanin from red Roselle (*Hibiscus sabdariffa* Linn.) residue in the sweet sticky rice. **Suthiparithat Journal** 26(80): 129-146. (in Thai)

Karunasiri, A.N., Gunawardane, M., Senanayake, C. M., Jayathilaka, N. and Seneviratne, K.N. 2020. Antioxidant and nutritional properties of domestic and commercial coconut milk preparation. **International Journal of Food Science** 2020(4): 1-9.

Kulkarni, S.W., Sakhale, B.K., Pawar, V.D., Miniyar, U. G. and Patil, B.M. 2010. Studies on sensory quality of cookies enriched with mushroom powder. **Food Science Research Journal** 1(2): 90-93.

Madhusankha, G.D.M.P., Thilakaratha, L.T. and Navaratne, S.B. 2018. Analysis of Curcumin content in Sri Lankan and Indian Turmeric rhizomes and investigating its impact on the colour. **International Journal of Food Science and Nutrition** 3(4): 3-5.

Manasa, P.L., Kamble, A.D. and Chilakamarthi, U. 2023. Various extraction techniques of Cucumin-A comprehensive review. **American Chemical Society** 8: 34868-34878.

Memedi, B. 2023. Comparative studies of influence of palm oil on activity of xanthine oxidase and free radicals in liver and blood: Diabetes and metabolic syndrome. **Electronic Journal of General Medicine** 20(6): em551.

MGRonline. 2024. **Biscuit market expected to grow by 10% to billion, URC Shows off its No.1 from, invents 500 million to enter the market. MGRonline.** Available Source: https://mgronline.com/business/detail/9670000004120, January 15, 2024. (in Thai)

Nooake, S., Posiri, W., Saeton, S., Ratanasammicng, R., Panitcmkil, R., Boonyanupong, U., Preecha, R., Sengzim, P. and Rammanee, Y. 2009. **Khai Mod Rin (NSRC95001-1-3) Local rice for Muang Nakhon.** Available Source: https://tarr.arda.or.th/preview/item/3t_CqaoVFTAOQFCkbd60_, January 15, 2024. (in Thai)

Nur, A., Fiskia, E., Rahman, I. and Sapsuha, Y. 2023. Gastroprotective activity of nutmeg flesh extract (*Myristica fragrans* Houtt.) on acetosal-induced white rat. **Azerbaijan Medical Journal** 63(2): 7359-7365.

Panghal, A., Chhikara, N. and Khatkar, B.S. 2018. Effect of processing parameters and principal ingredients on quality of sugar snap cookies: A response surface approach. **Journal of Food Science** 55(8): 3127-3134.

Phungamngoen, C., Choosuk, N. and Suwan, T. 2009. Effect of thermal processing on the color of coconut milk. **KKU Research Journal** 14(9): 861-870. (in Thai)

Phuttarakmongkol, S., Hemkhot, S., Phungamngoen, C. and Kittipongpittaya, K. 2008. Effect of fat content and sterilizing temperature on the color of coconut milk. **The Journal of KMUTNB** 18(1): 80-88. (in Thai)

Renzo, A., Tedjakusuma, F. and Surya, R. 2022. Cookies product development with the addition of turmeric extract, pp.1-6. *In* **The 6th International Conference on Eco Engineering Development.** Institute of Physics Publishing Ltd., BINUS University.

Saric, B.M., Nedeljkovic, N.M., Simurina, O.D., Pestoric, M.V., Kos, J.J., Mandic, A.I., Sakac, M.B., Saric, L.C., Psodorov, D.B., Misan, A. C. 2014. The influence of baking time and temperature on characteristics of gluten free cookies enriched with blueberry pomace. **Food and Feed Research** 41(1): 39-46.

Sedlacek, T. and Svec, I. 2003. Water absorption of food wheat flour- comparison of direct and indirect methods**. Croation Journal of Food Science and Technology** 15(2): 163-172.

Sipahelut. G.S., Kastanja, Y.A. and Patty, Z. 2020. Antioxidant activity of nutmeg fruit flesh-derived essential oil obtained through multiple drying methods. **EurAsian Journal of BioSciences** 14: 21-26.

Sresatan, P., Dhamvithee, P., Nualkaekul, S., Hudthagosol, C. and Sanporkha, P. 2024. Optimization of rice flour, corn starch and modified tapioca starch to produce gluten free cookie. **Natural and Life Science Communications.** Available Source: https://cmuj.cmu.ac.th/nisc/journal/article/1051, November 27, 2024.

Tang, D.S. 2019. The usage of Anthocyanin in extracted from Roselle Calyx in carbonated Roselle juice. **Journal of Home Economic Technology** 1(2): 18-26. (in Thai)

Tanongkankit, Y. and Poonnoi, P. 2014. **Research Report on Production of Natural food colorant from gac aril.** Maejo University. (in Thai)

Thai Industrial Standards Institute. 2003**. Guidelines of Thai community standard product (No.118/2003) Title: Cookie.** Ministry of Industry Institute, Bangkok. (in Thai)

Thai Industrial Standards Institute. 2005. **Guidelines of Thai community standard product (No. 1058/ 2005) Title: Dried nutmeg seasoning.** Ministry of Industry Institute, Bangkok. (in Thai)

Thammapat, P., Saenmahachai, W., Boryai, S. and Ponkham, K. 2021. Effects of far-infrared and hot air drying methods on physical chemical and antioxidant properties of Turmeric (*Curcuma longa* L.). **Prawarun Agricultural Journal** 18(2): 8-15. (in Thai)

Thongnok, S. 2024. Effects of Sungyod rice flour and maltodextrin on quality of cookies. **Rajamangala University of Technology Srivijaya Research Journal** 16(1): 243-254. (in Thai)