

Development of Healthy Toddy Palm Cake by Using Germinated Riceberry Flour and Nonsugar Sweetener

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Abstract. The objective of this study was to develop nutritionally enriched toddy palm cake by using germinated riceberry flour (GRF) and a mixture of maltitol and sucralose (MS) to replace rice flour and sugar in toddy palm cake. The replacement of rice flour (RF) with GRF at the levels of 0 (control), 25, 50, 75 and 100% by weight of whole RF was carried out. The results showed that toddy palm cake at various level of GRF provided darker color. However, sensory score of toddy palm cake at 50% GRF was no significant different from that of control sample ($p>0.05$). The use of MS to replace sugar at 5 levels (0, 25, 50, 75 and 100% by weight of sugar) was further investigated. It was found that increase in substitution of MS instead of sugar resulted in denser. Toddy palm cake at 50% GRF and 50% MS was considered suitable for a final product. Proximate analysis of Toddy palm cake at 50% GRF and 50% MS was as followings: protein 3.02%, fat 7.72%, ash 0.53% and carbohydrate 45.25%. The antioxidant activities by DPPH and ABTS assay were 39.13 mg VCE/mg extract and 68.59 mg TE/mg extract, respectively. Total phenolic compound was 97.33 mg GE/mg extract. Consumer test were conducted by 120 consumers in Phetchaburi province and the data showed that the overall liking score of the developed toddy palm was within the range of like highly, 98.3% of testing consumer accepted and 70.8% would buy this product.

1. Introduction

Toddy palm cake is a traditional Thai dessert and widely made and eaten in Phetchaburi, which is major palm growing province. It is made by mixing rice flour with toddy palm flesh, sugar and coconut milk, then fermented and steamed to yield a soft and spongy product [1,2]. Toddy palm cake can be modified by adding other functional ingredients and reducing sugar in order to increase its healthy benefit. Riceberry rice, a Thai black rice (*Oryza sativa* L.), is a combination of Hom Nin rice, with its well-known antioxidant properties, and Thai Hom Mali rice, which is also called Thai Jasmine or Khao Dawk Mali 105. It had been reported to have potential anticancer activity, hypoglycemic, hypolipidemic, antioxidant, and anti-inflammation properties [3,4]. Maltitol is hydrogenated carbohydrates used as sugar replacers, non-cariogenic (sugar-free tooth-friendly), low-glycaemic (potentially helpful in diabetes and cardiovascular disease), low-energy and low-insulinaemic (potentially helpful in obesity), low-digestible (potentially helpful in the colon), osmotic (colon-hydrating, laxative and purifying) carbohydrates [5]. The value of glycemic index of maltitol is 35.27, which is much lower than the GI of sucrose-65.43 [5]. Sucralose is nonnutritive sweeteners which has become a popular approach to help reduce energy intake and glycemic load [6]. Maltitol has a pleasant sweet taste remarkably similar to sucrose, and is about 90% as sweet as sugar

[7], while sucralose is about 600 times sweeter than sugar and is marketed for broad use in food and beverages in over 30 countries worldwide [8]. Blends of sucralose with other sweeteners are often used to compensate for each sweetener's weaknesses to meet the original sucrose sweetness [9]. The objective of this research was to develop nutritionally enriched toddy palm cake and study the effect of germinated riceberry flour and a mixture of maltitol and sucralose substitution on nutritional and sensory property of toddy palm cake.

2. Materials and Methods

2.1 Preparation of germinated riceberry flour

Riceberry used in this study were collected from the Phetchaburi province, Thailand (organic rice) on December 2016. They were washed in tap water and drained, and soaked in cold clean tap water in the ratio of 1:3 (grain to water) for 6 hrs. After soaking, the grains were placed on moist filter paper in covered glass dishes and kept at room temperature in the dark for 24 hrs, and then milled into flour at a local rice mill in Phetchaburi. Germinated riceberry paste was separated and dried with a tray dryer at 50°C overnight to a moisture content of 13.0%. Germinated riceberry flour (GRF) was grounded and sieved (70 mesh screens) and then packaged in labeled air-tight polythene bag.

2.2 Toddy palm cake preparation

The composite flour blends were prepared by supplementing rice flour with a GRF at different levels (0%, 25%, 50%, 75% and 100%) respectively. Toddy palm cake was prepared from each composite flour combination by following the method according to the procedure described by Sukhonthara, 2017 [9]. All ingredients were thoroughly mixed and knead in a bowl and then proofed for 3 h at 35±2°C. The batter was poured into a round cup (4 cm diameter) and steamed for 20 min. The prepared toddy palm cakes were cooled at room temperature (30±2°C) and packed in sealed polypropylene plastic bags. Sensory properties of toddy palm cake were tested on the basis of color, flavor, taste, texture and overall preferences with 5-point hedonic rating scales (1 = extremely dislike the flavor, 2 = slightly dislike the flavor, 3 = neither like nor dislike the flavor, 4 = slightly like the flavor, and 5 = extremely like) by 30 untrained panelists. The suitable samples were then used for further study. A combination of maltitol and sucralose (MS) was used to replace sugar which the relative sweetness of the maltitol-sucralose mixture is calculated to meet the original sweetness of sucrose. MS was added to replace sugar at the level of 0, 25, 50, 75 and 100 % and evaluated for sensory properties, as previously described.

2.3 Chemical analysis

Moisture, protein, fat and ash content of toddy palm cakes were determined following AOAC, 2012 [10] methods. Total carbohydrate (including dietary fiber) calculated by difference (100 - %moisture - %protein - %fat - %ash) according to AOAC, 2005 [11]. The total phenolic contents of the toddy palm cake extract were estimated with Folin-Ciocalteu reagent by a modified method of Zhou *et al.*, 2004 [12] and expressed the result as µg gallic acid equivalent (GAE/mL extract). The DPPH and ABTS radical-scavenging activity of the extracts was measured according to a modified method of Thaipong *et al.*, 2006 [13] and expressed the result as µg Vitamin C equivalent (VCE /mL extract). The GABA content was determined using a modified method of Karladee and Suriyong, 2012 [14] and expressed the result as µg GABA (mg GABA/100 g sample). The starch digestion in the samples was determined using a rapid in vitro digestibility assay based on glucometry [15,16].

2.4 Consumer evaluation

The selected toddy palm cakes were evaluated by 120 consumers in Phetchaburi province and analyzed by mean of sensory acceptance/preference in terms of color, flavor, taste, texture and overall liking score using 5-point hedonic scale ranging from 1 (dislike very much) to 5 (like very much).

2.5 Consumer evaluation

Three replications of each experiment were performed. The analyses of chemical result were done using Completely Randomized Design (CRD). The analysis of sensory evaluation result was done using Randomized Complete Block Design (RCBD). All data were analyzed and tested by analysis of variance (ANOVA). Significant difference ($p \leq 0.05$) among various treatments was detected by using Duncan's multiple range tests.

3. Results and Discussion

3.1 Effect of substituting rice flour with GRF on sensory property of toddy palm cakes

The sensory scores for color, flavor, taste, texture and overall liking of toddy palm cakes are shown in Table 1. The average scores of all sensory parameters were in the range of 4.13-3.38 which fell between neither like or dislike the flavor and slightly like the flavor. The mean taste score was the highest for control, while the texture score was the lowest in toddy palm cakes at 75% GRF substitution. Increasing replacement rice flour with GRF could be cumulative effect of color properties. Sirichokworakit *et al.*, 2016 [17] reported the hue angle of all donuts supplemented with riceberry flour had appeared more red-purplish caused by the natural color of riceberry flour used for donut preparation. The riceberry flour used in this study has high anthocyanin pigment caused dark flour color [18]. The flavor scores of toddy palm cakes at 50% GRF were not significantly different from those of control and toddy palm cakes at 25% GRF substitution ($p > 0.05$) but significantly higher than toddy palm cakes at 75% and 100% GRF ($p \leq 0.05$). In this study, the optimal rice flour to GRF ratio was 50:50, which was chosen for the subsequent part of the study.

Table 1 Sensory attributes of toddy palm cakes at different levels of rice flour and GRF substitution

GRF substitution (%)	Sensory liking scores				
	Color	Flavor	Taste	Texture ^{ns}	Overall liking
0 (control)	4.10±0.87 ^a	4.00±0.81 ^a	4.13±0.88 ^a	3.93±0.93	4.10±0.98 ^a
25	4.00±1.02 ^a	3.97±1.10 ^a	3.87±1.07 ^{abc}	4.03±1.16	4.00±1.05 ^a
50	4.07±0.85 ^a	3.90±0.83 ^a	4.00±0.96 ^{ab}	4.07±0.92	4.10±0.79 ^a
75	3.97±1.06 ^a	3.70±1.02 ^b	3.63±1.06 ^{bc}	3.38±1.15	3.80±1.03 ^{ab}
100	3.53±1.05 ^b	3.40±0.84 ^b	3.53±1.23 ^c	3.80±1.04	3.53±0.96 ^b

^{a-d} Means in same columns followed by different letter superscripts are significantly different ($p \leq 0.05$).

^{ns} Means not significant ($p \leq 0.05$).

3.2 Effect of substituting sugar with MS on sensory property of toddy palm cakes

The sensory scores for color, flavor, taste, texture and overall preferences of toddy palm cakes substituted by sugar with MS are shown in Table 2. Overall liking scores of toddy palm cakes with 50% MS substitution were not significantly different from those of toddy palm cakes at 0% and 25%

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MS substitution ($p>0.05$) but significantly higher than those of others ($p\leq 0.05$). Thus, the optimal sugar to MS ratio was 50:50, thus chosen for the subsequent study.

Table 2 Sensory attributes of toddy palm cakes at different levels of sugar and MS substitution

MS substitution (%)	Sensory attributes				
	Color ^{ns}	Flavor	Taste	Texture ^{ns}	Overall liking
0	3.77±0.84	3.61±0.82 ^a	3.87±0.80 ^a	3.63±0.83	3.93±0.77 ^{ab}
25	3.60±0.66	3.65±0.98 ^a	3.73±0.92 ^a	3.73±0.93	3.70±0.97 ^{a-c}
50	3.67±0.66	3.67±0.84 ^a	3.53±0.73 ^{ab}	3.66±0.66	4.03±0.80 ^a
75	3.97±0.83	3.43±0.88 ^{ab}	3.50±0.95 ^{ab}	3.60±0.87	3.53±0.95 ^{bc}
100	3.73±0.72	3.20±0.74 ^b	3.20±0.94 ^b	3.30±1.00	3.33±0.82 ^c

^{a-c} Means in same columns followed by different letter superscripts are significantly different ($p\leq 0.05$).

^{ns} Means not significant ($p\leq 0.05$).

3.3 Nutrition, antioxidant and glycemic Index

Nutrient contents in terms of moisture, protein, fat, ash, and carbohydrate of original toddy palm cake (control) and developed toddy palm cake (toddy palm cake with 50% GRF and 50% MS substitution) are shown in Table 3. The proximate values including moisture, protein and total carbohydrate of original toddy palm cake were higher than those of developed toddy palm cake. Total phenolic content and antioxidant activities using DPPH radical scavenging and ABTS assay of developed toddy palm cake was higher than that of control. The use of GBR to substitute rice flour in the toddy palm cake products would increase the level of total phenolic content and antioxidant activity. It was found that black pigment on the rice seeds which give color to colored rice were polyphenols and enzyme synthesis could enhance the intrinsic phytochemical compounds and antioxidant activity during germination [19,20]. Sing *et al.*, 2015 [21] reported that rice with pigmented bran stored more ferulic acid and gamma oryzanol than their non-pigmented counterparts. Suttiarporn *et al.*, 2016 [22] reported that seventy-nine constituents were identified in all extracts of riceberry bran, which 4-vinylguaiacol and apigenin were the major simple phenolic and flavonoid, respectively. Phattayakorn *et al.*, 2016 [20] reported that total phenolic content of germinated black waxy rice and Jasmine KDML105 was higher than non-germinated rice. The developed toddy palm cake contained 1.68±0.05 mg GABA/100 g sample, which was significantly higher than that of the control sample, in which GABA was not detected. The predicted glycemic index (pGI) of original toddy palm cake and developed toddy palm cake were 70.17 and 57.26, respectively.

Table 3 Nutritive value, antioxidant activity and predicted glycemic index (pGI) of original toddy palm cake and developed toddy palm cake

Nutritive value	Original toddy palm cake	Developed toddy palm cake
Moisture, %	43.62	43.45
Protein, %	3.08	3.02
Fat, %	7.25	7.72
Ash, %	0.52	0.53
Total carbohydrate, %	45.53	45.25
DPPH* scavenging activity (mg VCE/ml extract)	18.21±0.18 ^b	39.13±0.56 ^a
ABTS* scavenging activity (mg TE/ml extract)	51.43±0.64 ^b	68.59±0.71 ^a

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Total phenolic compound (mg GE/ml extract)	54.67±2.38 ^b	97.33±1.53 ^a
GABA (mg GABA/100 g sample)	Not detected ^b	1.68±0.05 ^a
Predicted glycemic index (pGI)	70.17	57.26

3.4 Consumer acceptance of developed toddy palm cakes

Most of consumers were female, age between 21-40 year old with education level of bachelor degree, married, having income between 15,001 – 20,000 bath per month. The mean scores for consumer acceptability of developed toddy palm cake and the products acceptance and buying decision of developed toddy palm cakes were shown in Table 4 and 5, respectively. The sensory liking scores for color, flavor, taste, texture and overall liking of developed toddy palm cakes ranged between 4.18±0.76 and 4.27±0.68 (indicating ‘slightly like the flavor’ to ‘like extremely’). 98.33% of tested consumer accepted and 70.83% would buy developed toddy palm cakes.

Table 4 Sensory attributes of developed toddy palm cakes

Sensory attributes liking scores	Developed toddy palm cakes
Color	4.18±0.76
Flavor	4.27±0.68
Taste	4.09±0.67
Texture	4.48±0.80
Overall liking	4.19±0.67

Table 5 Products acceptance and buying decision of developed toddy palm cakes

Acceptance	Developed toddy palm cakes
Product acceptance (%)	
Acceptance	98.33
Non acceptance	1.67
Decision of Buying (%)	
Buy	70.83
Not ensure	27.50
Not buy	1.67

4. Conclusion

The healthy food products are increasingly of interest by consumers. The obtained results indicated that it is possible to used GRF and sweetener (MS) to partially substitute rice flour and sugar, and may be useful for developing of new Thai dessert products with improved nutrition.

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