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Development of Chocolate Waffle and Pancake Mix with Riceberry Flour

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ABSTRACT: Riceberry is a good source of fiber and antioxidant components, also is a gluten-free carbohydrate source. Waffle and pancake are mainly made of wheat flour which is a great source of gluten that cause allergy symptoms for people who have gluten intolerance. The main objective of this research was to develop an alternative gluten-free chocolate waffle and pancake mix by using the combination of Riceberry flour and other gluten-free flours such as glutinous flour and tapioca flour. Gluten-free chocolate waffle mix formulations made with Riceberry flour at 0%, 16%, 21%, 24% and 32% of total dry weight of walffle mix, were tested in sensory analysis using 9-point hedonic scale for aroma, color, texture, taste and overall acceptability. The waffle mix made with 24% of Riceberry flour received the highest score in aroma, texture and overall acceptability. The proximate analysis and DPPH assay were conducted to compare chemical composition and antioxidant activity between wheat flour waffle mix and Riceberry flour waffle mix chosen from the sensory evaluation. The fiber content and antioxidant activity of Riceberry flour waffle mix formulation was significantly higher (3.0±1.0 g per 100 g of waffle mix and 3.7±0.2 mg of Trolox equivalent per 100 g of waffle mix, respectively) than the wheat flour waffle mix formulation (0.7±0.2 per 100 g of waffle mix and 2.2±0.6 mg of Trolox equivalent per 100 g of waffle mix). The development of gluten-free chocolate waffle mix using Riceberry flour was possible alternative waffle mix product for people who suffer gluten intolerance and the appropriate level of Riceberry flour improved acceptability of product and added nutritional values to the product.

Keywords: Gluten free waffle mix, Riceberry flour, acceptability, Fiber, Antioxidant activity

INTRODUCTION

Riceberry (*Oryza Sativa* L.) is one of brown rice varieties which contains high levels of fiber and antioxidants, such as beta-carotene, gamma-oryzanol, vitamin E, tannins, as well as zinc and folate [1]. It is a healthy stable food that is suitable for all ages. It can be eaten to maintain health and replace white rice or brown rice. Nutrients found in Riceberry have potential to lower the risks of chronic diseases such as cancer, type 2 diabetes, hypertension, cardiovascular diseases and dementia. Moreover, the development of food products made with Riceberry is a possible way to increase the value of Riceberry for farmer.

Waffle and pancake are the western styled breakfast and snack that have become very popular, and sold in many cafes in Thailand. The waffle and pancake are mainly made with wheat flour which contained gluten. Hence, people who has gluten allergy could not consume this product. The incidence of gluten intolerance was found to be 1% of population [2] and there was increasing more rapid especially in western countries; 6.4 fold increase in case reports of celiac disease between 1990 and 2009 in Scotland [3]. In order to replace the wheat flour in bakery products, the combination of gluten free flour

such as rice flour, glutinous rice flour, tapioca flour was used [4]. Therefore, the goal of this study were to formulate a gluten-free waffle mix with the combination of riceberry flour and other gluten-free flour to wheat flour and compare the chemical composition between waffle mix made with wheat flour and Riceberry flour.
This research brings high-nutritional

Table1: Dry ingredient of each formulation

Ingredients (%)	The combination of flour to replace wheat flour					
	Wheat flour mix	Rice flour mix	Rice berry flour mix 1	Rice berry flour mix 2	Rice berry flour mix 3	Rice berry flour mix 4
Wheat flour	48.2	0	0	0	0	0
Rice flour	0	20.9	16.1	0	0	0
Rice berry flour	0	0	4.8	20.9	24.1	32.1
Glutinous rice flour	0	13.7	13.7	13.7	12.0	8.0
Tapioca flour	0	13.7	13.7	13.7	12.0	8.0
The dry ingredients for every formulations						
Caster sugar	20.1	20.1	20.1	20.1	20.1	20.1
Corn flour	8.0	8.0	8.0	8.0	8.0	8.0
Milk powder	12.0	12.0	12.0	12.0	12.0	12.0
Cocoa powder	8.0	8.0	8.0	8.0	8.0	8.0
Baking powder	2.4	2.4	2.4	2.4	2.4	2.4
Salt	0.4	0.4	0.4	0.4	0.4	0.4
Tartaric acid	0.4	0.4	0.4	0.4	0.4	0.4
Xanthan gum	0.4	0.4	0.4	0.4	0.4	0.4

riceberry flour to develop chocolate waffle and pancake mix. The product can be stored for a long time, easy and convenient to make waffles and pancakes at home. This development could be a possible way to increase the consumption of Riceberry and a way to expand consumer groups in both domestic and international markets.

MATERIALS AND METHODS

Materials

Wheat flour, rice flour, glutinous rice flour, tapioca flour, caster sugar, cocoa powder, salt and soybean oil were purchased from local supermarket (Supercheap store, Phuket). Baking powder, tartaric acid and xanthan gum were purchased from another local shop (Gerbera house shop, Phuket). Organic Riceberry grain was purchased from local shop at Koh Yao, Phanggna. Riceberry flour was ground with a grinder (EM-11, Sharp, Malaysia) for 5 minutes and passed through a 60-mesh sieve.

Waffle mix preparation

The dry ingredient was weighted according to the formulation shown in Table 1. The formulation was adapted from chocolate waffle recipe in Pholfoodmafia.com [5] and gluten free waffle recipe in Glutenfreebaking.com [6]. The wheat flour mix consisted of 48.2% of wheat flour while Rice flour mix and riceberry flour mix contained the combination of rice flour, glutinous rice flour, riceberry flour and tapioca flour to replace wheat flour. The rest of dry ingredients in all mixes were the same. The dry ingredient was mixed using a blender for 3 minutes. Every mixed dry ingredient of each formulation was made in to a batter by mixing with 90 ml of water and 30 ml of soy bean oil. The batter was rested for 15 minutes, then was added to a waffle maker (HOM-WS06, Homemate, China) to cook for 3 minutes.

Sensory evaluation

Acceptability of waffle was tested in terms of color, texture, aroma, taste and overall acceptability. Each attribute was evaluated with 9-point hedonic scales where 1 is dislike extremely and 9 is like extremely with 20

untrained panel (Gender: 18 females and 2 males). The water was provided between each sample for volunteers to rinse mouth.

Chemical composition analysis

Wheat flour waffle mix and Riceberry flour waffle mix 3 selected from the sensory evaluation were analyzed for proximate composition (moisture, ash, protein, fiber and fat) using standard AOAC methods [7]. The content of total carbohydrate was calculated by: 100 – (moisture + protein + fat +ash). The energy value was determined in kcal to the formula: energy = (%protein × 4) + (%carbohydrate × 4) + (%fat × 9). Antioxidant activity of the waffle mix was determined the scavenging activity by DPPH assay following the protocol described in previous study [8]. Water activity of waffle mix was measured by a water activity meter (Aqualab, Serie 4TEV, USA). The measurements were made at room temperature (28 ^{o}C). The difference in color of waffle mix was measured in CIE color system using a Hunterlab Colorimeter (MiniScan® XE Plus, USA). The color values were expressed as L* (brightness and darkness), a* for redness and greenness, and b* for yellowness and blueness. Each formulation of waffle mix were measured 4 times.

Statistical analysis

All data obtained in this study were analysed statistically using SPSS programme (version 18). The result are presented as mean± standard deviation. The difference among average were determined by Analysis of Variance (ANOVA) following by the Duncan's Multiple Range Test (DMRT) at 95% confidence interval. Randomized Complete Block Design (RCBD) was used for sensory analysis. The differences among average of proximate composition, antioxidant activity, water activity and color values of wheat flour waffle mix and Riceberry waffle mix were determined by sample mean t-test ($p<0.05$).

RESULTS AND DISCUSSION

Sensory evaluation

The result of sensory evaluation is shown in

Table 2: Acceptability of waffle made with different flour mix

Formulation	Acceptability				
	Color	**Aroma**	**Taste**	**Texture**	**Overall**
Wheat flour mix	6.9±1.3^{c}	5.8±1.3^{a}	5.4±1.3^{a}	5.9±1.5^{a}	5.8±1.1^{a}
Rice flour mix	6.8±1.3^{bc}	6.0±1.3^{ab}	5.9±1.5^{ab}	6.0±1.5^{ab}	6.2±1.1^{ab}
Riceberry flour mix 1	5.9±1.1^{a}	6.1±1.4^{ab}	6.2±1.0^{bc}	6.5±0.9^{abc}	6.4±0.9^{bc}
Riceberry flour mix 2	6.3±1.1^{abc}	6.4±1.1^{abc}	6.8±1.2^{c}	6.7±1.1^{bc}	6.8±1.1^{c}
Riceberry flour mix 3	6.4±1.0^{abc}	6.7±1.1^{c}	6.7±1.3^{c}	6.9±1.0^{c}	6.9±1.0^{c}
Riceberry flour mix4	6.1±1.0^{ab}	6.6±1.1^{bc}	6.2±1.3^{bc}	6.5±1.2^{abc}	6.4±1.0^{abc}

^{abc} indicates the significant difference ($p<0.05$) of the acceptability between formulation in the same column

Table 2. The waffle made with Riceberry flour mix 3 received the highest average acceptability score in terms of aroma (6.7±1.1), texture (6.7±1.1) and overall (6.9±1.0) acceptability, which is 'slightly like' to 'moderately like'. These acceptability of waffle made with Riceberry flour mix 3 was significantly higher than waffle made with wheat flour mix or waffle made with white rice flour. The acceptability between waffle made with wheat flour and white rice flour was not significantly different. The color of cooked waffle made with rice berry flour was darker (L* = 14.10±0.74, a* = 6.44±1.14, b* = 5.39±1.10) than the waffle made with wheat flour (L* = 18.30±0.61, a* = 12.39±0.34, b* = 12.15±0.53) due to the pigment called anthocyanin found in Riceberry. This may lead to lower average score in color acceptability of waffle made with Riceberry flour compared with waffle made with wheat flour and white rice flour. However, the difference of color acceptability between wheat flour mix waffle and Riceberry flour mix 3 waffle was not significantly different ($p<0.05$). Therefore, the Riceberry flour mix 3 was selected to be analysed for chemical composition and compared with wheat flour mix.

Chemical composition

As shown in Table 3, the Riceberry flour mix contained significantly higher fiber and lower protein content, compared with wheat flour mix. Due to the amount of protein found in Riceberry flour was lower than wheat flour. Tasiri *et al. (*2015) found that Riceberry flour contained 8.9 % of protein [9], while white rice flour and glutinous flour contained 6-8% of protein. However, wheat flour was found to have 12-14% of protein. This could explain the reason of lower protein in Riceberry flour mix. Moreover, the fiber content of Riceberry flour mix was significantly higher and approximately 3 times higher than wheat flour mix.

Table 3: Chemical composition of waffle mix

Chemical composition (%)	**Waffle mix**	
	Wheat flour mix	Riceberry flour mix
Moisture	6.9±0.2	6.6±0.6
Ash	3.8±0.1	3.8±0.1
Fat	1.5±0.5	1.8±0.1*
Protein	13.0±1.3	6.6±0.7*
Fiber	0.7±0.2	3.0±1.0*
Carbohydrate	74.8	81.2
Energy (kcal per 100g of waffle mix)	366	367

* indicates the significant difference ($p<0.05$) of mean value in the same row

The result shown in table 4 reported that antioxidant activity of Riceberry flour mix was higher than wheat flour mix. This could be due to the phenolic compounds such as anthocyanin that contributes to dark color of Riceberry. As a result, L* (brightness) of Riceberry flour mix was lower than wheat flour mix. The water activity of both waffle mixes (dry ingredients) was 0.4 which indicates that product has low moisture that microbes cannot grow in this product [10]

CONCLUSIONS

The chocolate waffle mix made with Riceberry flour was acceptable from consumer. The formulation made with 24% of Riceberry flour received the highest score of overall acceptability. This can be applied to make a commercial instant waffle mix for people with gluten intolerance and increase the use of Riceberry which add the nutritional values (fiber and antioxidant compounds) to the waffle mix.

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Table 4: Water activity, color and antioxidant activity of waffle mix

	Waffle mix	
	Wheat flour mix	Riceberry flour mix
Water activity	0.4±0.1	0.4±0.0
L*	65.5±0.4	62.5±0.3*
a*	8.5±0.1	8.4±0.1
b*	12.6±0.2	12.5±0.1
Antioxidant activity using DPPH assay (mg Trolox equivalent per 100 g of waffle mix)	2.2±0.6	3.7±0.2*

* indicates the significant difference ($p<0.05$) of mean value in the same row

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