International Food Research Journal 23(2): 475-481 (2016)

Journal homepage: *http://www.ifrj.upm.edu.my*

Development of a fat reduced cheese shake biscuit from germinated Homnin brown rice flour

[1*]On-nom, N., [2]Nualkaekul, S., [3]Chalermchaiwat, P., [1]Nitithamyoung, A. and [4]Murtaza, M.A.

[1]*Institute of Nutrition, Mahidol University, 999 Phutthamonthon 4Rd., Nakhon Pathom, 73170, Thailand*

[2]*Department of Home Economics, Faculty of Sciences, Srinakarinvirot University, 114 Sukhumvit 23, Bangkok, 10110, Thailand*

[3]*Food and Nutrition Program, Department of Home Economics, Faculty of Agriculture, Kasetsart University, 50 Ngam Wong Wan Rd., Bangkok, 10900, Thailand*

[4]*Institute of Food Science and Nutrition, University of Sargodha, Sargodha-40100, Pakistan*

Article history

Received: 1 June 2015
Received in revised form: 19 September 2015
Accepted: 7 October 2015

Keywords

Fat reduced
Cheese shake biscuit
Germinated Homnin brown rice flour
Gamma-aminobutyric acid
Glycemic index

Abstract

The objective of this study was to develop a cheese shake biscuit formulation by reducing sugar and fat content, reducing saturated fat ingredients and partially replacing wheat flour with germinated Homnin brown rice flour (GHNF), which can be utilized in healthy biscuit products and are acceptable to the consumer. A completely randomized design (CRD) was used to study 3 levels of sugar:fat ratio (1:1.2, 0.5:1.2, 0.5:0.6) on the sensory properties of a calorie reduced cheese shake biscuit. The ratio of fat and sugar at 0.5:0.6 was selected as the control formula in this study as there was no significant difference in its overall liking score ($p>0.05$) and it was healthier and was lower cost than other formulas. Then, the effect of the ratio of wheat flour: GHNF at 3 levels (86:14, 72:28 and 58:42) on the qualities of fat reduced cheese shake biscuit was determined. The result showed that the peak viscosity of cheese shake biscuit made from wheat flour and substituted flour, measured by rapid ViscoAmylograph (RVA), was not significantly different ($p>0.05$). The crispness of cheese shake biscuit was slightly increased when increasing amount of GHNF. All sensory attribute scores of 14% substituted GHNF in cheese shake biscuit were higher than other levels of substituted GHNF. The fat reduced GHNF cheese shake biscuit consisted of 11% GHNF, 67% wheat flour, 7% rice bran oil, 6% white sugar, 1% low sodium salt and water. The physical properties of the developed cheese shake biscuit were crispness of 617.45±118.08 g, water activity of 0.203±0.02 and L^*, a^* and b^* values of 61.53±1.80, 8.76±1.33 and 31.12±0.91, respectively. The nutritive value of the developed product in 100 g was 435.37±1.08 kilocalories, 8.37±0.40 g sugar, 11.04±0.10 g fat, 3.69±0.04 g crude fiber, 11.37±0.34 g protein and 472.42±0.48 mg sodium. The gamma-aminobutyric acid (GABA) content and glycemic index (GI) of the developed product were 2.58±0.02 mg/100 g and 62.98±0.12, respectively. Sensory evaluation indicated that the overall liking of the developed product was "like moderately" (7.1). This study revealed that total sugar, fat and energy were reduced by 25, 50 and 13%, respectively while fiber was increased by 33% from the commercial formulation.

Introduction

Biscuits are one of the popular cereal food categories, consumed as breakfast items and as snacks. The major constituents are typically wheat flour, sucrose and fat, making them a rather energy dense cereal food (Fardet, 2010). Cheese shake biscuit could be described as a flat golden color biscuit with a distinct flavor/aroma of cheese, slightly salty, having a crisp initial bite and crumbling quickly to form a slow paste texture. According to one study the consumption of biscuits might be associated with several chronic diseases such as coronary heart disease, obesity and diabetes due to overconsumption of fat and sugar (Melanson, Astrup and Donahoo, 2009; World Health Organization, 2003). Thus, authorities encourage people to reduce fat and sugar consumption in public campaigns such as World Health Organization and the National Nutritional Health Program in France (World Health Organization, 2003; French Ministry of Health, 2006; Hercberg, Chat-Yung and Chauliac, 2008).

Reducing the sugar and fat content in biscuits resulted in structural, textural, sensory and preference consequences. Sensory consequences of fat and sugar reduction depend on the product and the level of

*Corresponding author.
Email: *nattira.onn@mahidol.ac.th*
Tel: 081-9812631; Fax: 02-4419344

reduction. In biscuits, a 50% butter reduction was not distinguishable, whereas a 25% sugar reduction was perceived as significantly less sweet than a standard biscuit (Drewnowski *et al*., 1998). Nevertheless, Holt *et al.* (2000) noticed that more consumers had difficulty discriminating different sucrose levels in a solid, high fat biscuit than in water, orange juice or custard. Moreover, industries are also encouraged to improve the nutritional composition of well-known commercial biscuits. Over the years, there were a number of studies that have been reported to improve nutritive values of biscuit by incorporating inulin, β-glucan, potato fiber, mango peel, wheat bran (Brennan and Samyue, 2004; Ajila *et al*., 2008; Marangoni and Poli, 2008). According to US Food and Drug Adminstration (FDA), when a food has been altered to take out at least 25% of a certain component such as fat, salt or calories, the companies can use the term "reduced" on a product.

Homnin Brown rice is a Thai rice variety which contains various health-promoting components such as dietary fiber, phytic acid, vitamins, gamma-aminobutyric acid (GABA), gamma-oryzanol and anthocyanin. However, it is not widely consumed due to its poor cooking and textural properties. Geminated brown rice has been consumed as an alternative because it can help to improve eating quality and health-promoting function (Komatsuzaki *et al*., 2007). Germinated Homnin brown rice has a medium glycemic index (GI). Therefore, it might be suitable in the development of a cheese shake biscuit by substituting wheat flour with germinated Homnin brown rice flour. Phornweenat (2001) stated that wheat flour can be substituted by Hommali rice flour at 30% in bread with consumer acceptability. Whereas butter cake can be replaced with 100% Hommali rice flour (Sae-Eaw *et al*., 2007; Turabi *et al*., 2008). Thailand exports rice more than other countries in the world. However, rice products are not much found in the market. Therefore, the development of product from rice can be beneficial to health and increase the value of Thai rice.

It is a food science challenge to reduce fat and sugar content and also increase the nutritional value of a biscuit without affecting structural and sensory characteristics such as texture, color and taste. Moreover, there is still no reports on utilizing germinated Homnin brown rice flour (GHNF) in a cheese shake biscuit. Thus, this study was designed to develop a cheese shake biscuit by partially substituting wheat flour with GHNF, reducing sugar and fat content and reducing saturated fat ingredients. The physical properties and sensory characteristics of the calorie reduced GHNF cheese shake biscuits were also examined.

Materials and Methods

Raw materials

The materials used were wheat flour, baking powder, vanilla flavor and milk powder (Jang Charoen Preserve Co., Ltd, Thailand), germinated Homnin brown rice flour (GHNF) (Nuttakeitkhan agritech Co., Ltd, Thailand), butter and rice bran oil (Thai Edible Oil Co., Ltd.), sugar (Thai Roong Ruang Sugar Group) and low sodium salt (Ampol Food Processing Ltd, Thailand).

Preparation of fat reduced cheese shake biscuits

The commercial formulation of Jang Charoen Preserve Co., Ltd was used for preparation of sugar and fat reduced cheese shake biscuits. Rice bran oil was used to replace butter and palm oil in the commercial formula. Fat reduced biscuits were prepared in 3 different formulas. The first formula used the same concentration of sugar and fat as the commercial formula while there was a 50% sugar reduction in the second formula and a 50% reduction in both sugar and fat in the third formula. In all cases, reduction in sugar and fat content was achieved simply by reducing the amount of sugar and fat expressed in common household measures per batch of biscuits, as normally done in food preparation in the home. Moreover, other ingredients remained constant as in the commercial formulation. The pre-weighed ingredients were mixed properly. The baking chemicals and sugar were dissolved in water. All the ingredients were mixed at room temperature (25±2°C) to obtain uniform dough and the dough was allowed to rest for 15 min before rolling out. The dough was then kneaded and rolled to a uniform thickness of 1 nm. The rolled out dough was allowed to rest for 5 min. Then the biscuits were cut out with a rectangular cutter of 4 cm width and 6 cm length. The cut biscuits were placed on a greased or paper lined pans about 1.5 cm apart. The biscuits were allowed to rest on the pan about 10 min and baked at 180-200°C for 10-15 min, cooled to ambient temperature and packed in aluminum boxes. These biscuits were used for sensory evaluation in order to select the control formula of fat reduced cheese shake biscuit.

Preparation of fat reduced GHNF cheese shake biscuits

The fat reduced cheese shake biscuit formulation (from previous experiment) was used to prepare germinated Homnin brown rice flour (GHNF) cheese shake biscuit. The GHNF biscuit was prepared by partially replacing wheat flour (WF) with 0, 14, 28 and 34% GHNF. GHNF, WF and other ingredients were weighed accurately (data not shown). Then, the preparation of GHNF biscuit was the same as the above process. The accepted GHNF biscuits formula was selected by sensory analysis.

Pasting properties

The effects of 0, 14, 28 and 34% GHNF replacement in wheat flour on the pasting properties (gelatinization, pasting, and setback properties) of the biscuit flour mix were assessed using a Rapid ViscoAnalyzer (RVA) (RVA-Super 4, Newport Scientific, Australia). Mixed flour blends (3.5 g, 14% moisture basis) were transferred into aluminum cups and 25±0.1 ml of distilled water were added. The suspension was heated to 50°C, stirred at 160 rpm for 10 s, then held at 50°C for up to 1 min, and heated to 95°C for 222 s. The temperature was held at 95°C for 150 s, and finally the gelled sample was cooled to 50°C in 228 s, and held at 50°C for 120 s. The peak viscosity (maximum viscosity during heating and holding at 95°C), final viscosity (viscosity at the end of the testing profile), setback (the drop in apparent viscosity from peak viscosity) and breakdown (hot paste) viscosity were determined from the pasting curve using Thermocline v.2.2 software.

Sensory analysis of biscuits

Sensory characteristics of three different formulas of fat reduced biscuits and 0, 14, 28, and 34% GHNF biscuit were assessed. Sensory quality characteristics were evaluated by a 1-9 point hedonic scale of liking , where 9 = like extremely; 8 = like very much; 7 = like moderately; 6 = like slightly; 5 = neither like nor dislike; 4 = dislike slightly; 3 = dislike moderately; 2 = dislike very much; 1 = dislike extremely. The biscuits were evaluated for their color, appearance, odor, sweetness, crispness and overall liking by 30 semi-trained panelists. The sensory panelists, both female and male, from Srinakarinvirot University having some knowledge of food evaluation and were also consumes of cheese shake biscuit were recruited to evaluate the acceptability of calorie reduce and 0, 14, 28, and 34% GHNF cheese shake biscuit.

Physicochemical analysis

Water activity of the control biscuits and calorie reduced GHNF biscuits were determined by using a portable water activity meter set Aw (model ms1, Novasina, Switzerland). Color values of top surface of biscuits were measured by a spectrophotometer (ColorFlex EZ, Hunter Associates Laboratory Inc., Virginia, USA). Three replicates of each biscuit type were determined from three different locations. The CIE color values were recorded as L^* (lightness), a^* (redness) and b^* (yellow). The crispness of 20 pieces of biscuits was determined by a texture analyzer (TA. XT plus, Stable Micro Systems Ltd, YL, UK).

Composition analysis

The compositions of the commercial biscuits were compared with calorie reduced GHNF biscuits. Total energy (per 100 g), protein (micro- Kjeldahl, x 6.25), fat (solvent extraction), sugar, sodium and crude fiber were determined by the AOAC (2005) methods. The GABA content and glycemic index were calculated by the methods of Tsukatani *et al.* (2005) and Granfeldt *et al*. (1997), respectively.

Statistical analysis

Data were analyzed using analysis of variance and t-test. Duncan multiple range test was used to determine significant difference among the various samples in triplicate. Data were analyzed using the software, statistical package for social science (SPSS) version 19 SPSS Inc., Chicago, II, USA at the 0.05 level.

Results and Discussion

Effects of sugar and/or fat reduction on sensory attributes of the cheese shake biscuits

The sensory attributes of cheese shake biscuits prepared with reduction of sugar and/or fat (as well as replacing butter and palm oil with rice bran oil) are shown in Table 1. With the decrease in the level of sugar in the formulation, all the sensory attributes score (appearance, color, odor, sweetness, crispness and overall liking) of cheese shake biscuit decreased while the decrease in the level of both sugar and fat resulted in the increase of odor and crispness score. Moreover, all sensory scores for the reduction of both sugar and fat showed higher scores than for the reduction of sugar only in the cheese shake biscuit formulation. Comparing between the first formula (replacement of rice bran oil) of calorie reduced biscuits and the reduction of both sugar and fat formula, they were not significantly different in the appearance, color, odor, crispness and overall liking ($p>0.05$), except for sweetness ($p<0.05$). Sugar reduced biscuits were perceived as less sweet than commercial biscuits. These results are similar to those previously observed in the study of Drewnowski *et al*. (1998) on six types of laboratory biscuits with reduced sugar and/or fat content. Moreover, Biguzzi *et al.* (2014) observed that sugar reduction had no effect on fat perception, whereas fat reduction

Table 1. Sensory attributes scores of liking of cheese shake biscuit containing different ratios of sugar and fat (rice bran oil)

Attributes	Ratio of sugar and fat (rice bran oil) (w/w)		
	1:1.2	0.5:1.2	0.5:0.6
Appearance	7.0±1.5[a]	6.5±1.5[a]	6.6±1.9[a]
Color	7.1±1.3[a]	6.3±1.6[b]	6.6±1.5[ab]
Odor	5.2±1.9[ab]	5.0±2.1[b]	5.7±2.0[a]
Sweetness	5.8±1.7[a]	5.0±1.8[b]	5.3±1.5[b]
crispness	5.6±1.7[a]	5.5±2.2[a]	5.9±2.0[a]
Overall liking	6.7±1.7[a]	5.8±1.5[b]	6.0±1.7[ab]

[a,b,c] Means followed by a different letter within the same row are significantly different (p<0.05).

Table 2. Pasting viscosity of cheese shake biscuit flour mixes obtained from germinated Homnin brown rice flour (GHNF) substituted for wheat flour at different levels

Pasting viscosity (RVU)	Substitution (% GHNF by weight of total flour)			
	0	14	28	34
Peak viscosity (RVU)	330.02±0.68[a]	330.19±2.57[a]	323.69±6.05[a]	326.58±1.34[a]
Trough (RVU)	189.62±1.70[a]	186.97±2.25[a]	178.89±6.81[a]	184.75±3.25[a]
Breakdown (RVU)	140.30±0.88[a]	143.22±1.04[a]	144.80±3.64[a]	141.83±2.16[a]
Final viscosity (RVU)	329.15±7.84[d]	350.17±2.04[c]	369.03±2.63[b]	406.17±4.76[a]
Setback (RVU)	139.50±6.12[d]	163.19±2.26[c]	190.14±4.80[b]	221.42±5.10[a]
Peak time (min)	6.27±0.00[a]	6.22±0.08[a]	6.11±0.14[a]	6.11±0.06[a]
Pasting temperature(°C)	63.30±0.14[a]	68.35±2.46[a]	65.15±1.99[a]	68.33±5.59[a]

[a,b,c] Means followed by a different letter within the same row are significantly different (p<0.05).

sometimes induced a decrease of sweetness response by the participants. The sensory analysis indicated that there were no significant differences in appearance and crispness between three different ratios of sugar and fat in cheese shake biscuit formulation (p>0.05). Whereas some previous studies showed that sugar and fat reduction has important structure and textural consequences for biscuits (Maache-Rezzoug *et al*., 1998; Pareyt *et al*., 2009). This methodological difference could be explained by the fact that in our study, biscuits were manufactured by biscuit producers, contrary to the study of Maache-Rezzoug *et al.* (1998) and Pareyt *et al*. (2009) in which biscuits were prepared in the laboratory without any additional ingredients (emulsifier, bulking agents or fibers). Finally, the ratio of fat and sugar 0.5:0.6 was selected for use as the control formula of fat reduced biscuits in the next study due to the fact that there was no significant difference in overall liking score (p>0.05) between three different formulas and it was healthier and had a lower cost than other formulas.

Pasting properties of the mixed flour

In order to elucidate the influence of GHNF substitution on starch water interactions in biscuit dough, a rapid ViscoAnalyzer (RVA) was used and the result is shown in Table 2. Partial substitution of GHNF for wheat flour increased the peak viscosity and breakdown of mixed flour but there was not a significant difference (p>0.05). This result may be explained by the fact that, with an increase in protein content, some rice proteins could protect starch granules from being broken and increase pasting viscosity (Zhu *et al*., 2010). Also the increase of peak viscosity might indicate a higher resistance to deformation and higher stability of the paste during baking. The setback increased from 140 RVU (control) to 221 RVU when 34% GHNF was substituted for wheat flour. Another important finding was that the retrogradation phenomenon could be significantly increased in the final product, where setback which is an indication of this retrogradation phenomenon increased after addition of GHNF. This was in disagreement with Ilowefah *et al.* (2014) who observed that setback was reduced after addition of fermented brown rice flour. This might due to fermentation reduces retrogradation phenomenon.

Sensory attributes of germinated Homnin brown rice flour (GHNF) cheese shake biscuits

The sensory attribute scores of cheese shake biscuit substituted with different amount of GHNF are shown in Table 3. The analysis indicated that cheese shake biscuit with 14% GHNF received a

Table 3. Sensory attribute scores of liking of cheese shake biscuit obtained from (GHNF) substituted for wheat flour at different levels

Attributes	Substitution (% GHNF by weight of total flour)		
	14	28	34
Appearance	6.2±1.6[c]	5.6±1.6[b]	4.3±1.7[a]
Color	6.2±1.8[c]	5.4±1.5[b]	4.1±1.6[a]
Odor	6.2±1.6[a]	6.2±1.4[a]	6.2±1.6[a]
Sweetness	6.3±1.2[a]	5.6±1.6[a]	4.2±2.1[b]
Crispness	6.7±1.5[a]	6.3±1.5[a]	5.3±1.6[b]
Overall liking	6.6±1.4[c]	5.8±1.4[b]	4.7±1.7[a]

[a,b,c] Means followed by a different letter within the same row are significantly different ($p<0.05$).

Table 4. Physical properties and sensory attributes score of cheese shake biscuit (commercial) and GHNF cheese shake biscuit

Physical characteristics	Cheese shake biscuit (commercial)	GHNF cheese shake biscuit
Water activity	0.162±0.00	0.203±0.02*
Color		
$L*$	66.46±1.86	61.53±1.80*
$a*$	8.19±1.03	11.76±1.33*
$b*$	43.64±0.42	31.12±0.91*
Crispness (g)	627.34±83.54	617.45±118.08
Sensory score		
Appearance	7.73±0.87	7.03±1.16*
Color	7.23±1.17	6.93±1.05*
Odor	7.63±0.76	6.80±1.10*
Sweetness	7.5±31.07	7.00±1.17*
Crispness	8.27±0.58	8.10±0.71
Overall liking	8.07±0.78	7.10±1.06*

*Significantly different ($p<0.05$).

higher score than other formulas in appearance, color, odor, sweetness, crispness and overall liking. The odor scores for cheese shake biscuit with 14, 28 and 34% GHNF were statistically similar. The score for crispness was reduced from 6.7 to 6.3 and 5.3 at 14, 28 and 34% concentration of GHNF, respectively. This was because of cracks formed with the addition of gluten free brown rice flour. The use of low gluten composite flours in cookie preparation reduced the textural strength of cookies where such strength is dependent upon appropriate levels of gluten development. This is because in contrast to bread, the gluten network in cookies is to be only slightly cohesive without being too elastic (Schober *et al.*, 2003). The biscuit with addition of 14% GHNF had the highest score for overall liking of 6.6.

Physical properties and sensory attributes of fat reduced GHNF cheese shake biscuits

Both commercial cheese shake biscuit prepared from wheat flour and substituting wheat flour with 14% of GHNF were produced at Jang Charoen Preserve Co., Ltd. The physical properties and sensory attribute scores of commercial and 14% GHNF cheese shake biscuit are shown in Table 4. The water activity increased from 0.162 (control) to 0.203 (14% GHNF). The increase in water content in GHNF cheese shake biscuit may be due to the increase of protein content from GHNF. Vongsudin *et al.* (2012) reported that the germination results in protein increased which may be due to synthesis of enzymes or a compositional change following the degradation of other constituents (Kaushilk *et al.*, 2010). This is in agreement with Islam *et al.* (2012) who found that the moisture content of biscuits reduced from 4.40% to 3.27% when the protein content decreased from 9.37% to 7.87%. The color is one of the important characteristic in determining the acceptability of biscuit (Zucco *et al.*, 2011). The color of a biscuits is generated mainly during baking process from the Maillard reaction between reducing sugars and protein. Starch dextrinization and caramelization which are induced by heating also affected the biscuits color (Chevallier *et al.*, 2000). The germination of Homnin brown rice significantly affected the color of the cheese shake biscuits

Table 5. Nutrition values of cheese shake biscuit (commercial) and GHNF cheese shake biscuit

Nutrition values (per 100 g)	Cheese shake biscuit (commercial)	GHNF cheese shake biscuit
Total energy (kilocalories)	499.76±0.32	435.37±1.08*
Total sugar (g)	11.11±0.48	8.37±0.40*
Total fat (g)	22.06±0.07	11.04±0.10*
Total fiber (g)	2.78±0.09	3.69±0.04*
Protein (g)	8.33±0.45	11.37±0.34
Sodium (mg)	500.50±0.53	472.42±0.48*
Gamma-aminobutyric (GABA) (mg)	0±0.00	2.58±0.02*
Glycemic index	72.72±0.27	62.98±0.12*

*significantly different ($p<0.05$).

containing the GHNF. The cheese shake biscuits containing GHNF displayed slightly lower lightness (L^*) and yellowness (b^*) values but higher redness (a^*) than the commercial cheese shake biscuit (wheat flour cheese shake biscuits). It was hypothesized that the inherent oxidative enzymes in brown rice such as polyphenol oxidase and peroxidase became activated during germination producing pigment (Chung, Cho and Lim, 2014). Moreover, Islam *et al*. (2012) stated that the small molecules produced by thermal degradation of starch and proteins during germination induced the pronounced Maillard reactions during baking.

The sensory analysis showed that GHNF cheese shake biscuit obtained a lower score in all attributes (appearance, color, odor, sweetness, crispness and overall liking) than the commercial biscuits. However, the results were shown to be not statistically different ($p>0.05$). The score for appearance and color were reduced from 7.73 to 7.03 and 7.23 to 6.93 at 14% GHNF addition, respectively. This may be due to the darker color of the biscuit with added GHNF. Moreover, the specific smell of GHNF could be one reason for the reduction in odor score. For sweetness, crispness and overall liking, the scores decreased to 7, 8.1 and 7.1 at 14% GHNF. However, all sensory attribute scores of GHNF cheese shake biscuit were over the set score of 6, which corresponds to like slightly.

Proximate compositions of fat reduced GHNF cheese shake biscuits

The proximate composition of commercial and 14% GHNF cheese shake biscuit are shown in Table 5. The total energy, sugar, fat and sodium decreased from 500 kcal to 435 kcal, 11 g to 8 g, 22 g to 11 g and 500 mg to 472 mg per 100 g in commercial and GHNF cheese shake biscuit, respectively. This was due to the reductions of sugar and fat in the formula. GHNF cheese shake biscuits showed an increase in protein, fiber and GABA content when GHNF was added. Moreover, glycemic index (GI) of the GHNF cheese biscuit was lower than the commercial cheese shake biscuit. The low level of GI in cheese shake biscuits could also be linked to the presence of fat and fiber which slows the gastric emptying rate. On the other hand, high levels of sugar which limited the available water for starch would also limit its digestibility rate (Garsetti *et al*., 2005).

Conclusion

The present study concluded that GHNF can be successfully incorporated and substituted for wheat flour up to a level of 14% to yield cheese shake biscuits of enhanced nutritional quality with acceptable sensory attributes. Hence, development and utilization of such functional foods will not only improve the nutritional status of the population but also helps those suffering from degenerative diseases. The findings of this research may help to generate technology to diversify the use of GHNF by food processing enterprises, specially baking industries. Moreover, studies should be conducted to investigate the possibility of using GHNF as an ingredient in other food products in order to increase applications of such value-added food ingredients.

Acknowledgements

The authors gratefully acknowledge to the Institute of Nutrition, Mahidol University for providing the facilities to carry out this research, the Office of the Higher Education Commission for funding this research and Jang Charoen Preserve Co., Ltd for the production of cheese shakes biscuits.

References

Ajila, C. M., Leelavathi, K. and Rao, P. U. J. S. 2008. Improvement of dietary fiber content and antioxidant properties in soft dough biscuits with the incorporation of mango peel powder. Journal of Cereal Science 48: 319-326.

AOAC 2005. Official Methods of Analysis, 18th ed. Association of Official Chemists International. Gaithersburg, Maryland.

Biguzzi, C., Schlich, P. and Lange, C. 2014. The impact of sugar and fat reduction on perception and liking of biscuits. Food Quality and Preference 35: 41-47.

Brennan, C. S. and Samyue, E. 2004. Evaluation of starch degradation and textural characteristics of dietary fiber enriched biscuits. International Journal of Food Properties 7(3): 647-657.

Chung, H. J., Cho, A. and Lim, S. T. 2014. Utilization of germinated and heat-moisture treated brown rices in sugar-snap cookies. LWT-Food Science and Technology 57: 260-266.

Drewnowski, A., Nordensten, K. and Dwyer, J. 1998. Replacing sugar and fat in cookies: Impact on product quality and preference. Food Quality and Preference 9(1–2): 13–20.

Fardet, A. 2010. New hypotheses for the health-protective mechanisms of wholegrain cereals: what is beyond fibre? Nutrition Research Reviews 23(01): 65-134.

French Ministry of Health. 2006. Second National Nutrition and Health Programme (2006–2010). Paris: French Ministry of Health.

Garcia-Alonso, A., Jimenez-Escrig, A., Martin-Carron, N., Bravo, L. and Saura-Calixto, F. 1999. Assessment of some parameters involved in the gelatinization and retrogradation of starch. Food Chemistry 66: 181–187.

Garsetti, M., Vinoy, S., Lang, V., Holt, S., Loyer, S. and Brand-Miller, J. C. 2005. The glycemic and insulinemic index of plain sweet biscuits: relationships to *in vitro* starch digestibility. Journal of the American College of Nutrition 24(6): 441-447.

Hercberg, S., Chat-Yung, S. and Chauliac, M. 2008. The French National Nutrition and Health Program: 2001–2006–2010. International Journal of Public Health 53: 68–77.

Holt, S. H. A., Cobiac, L., Beaumont-Smith, N. E., Easton, K. and Best, D. J. 2000. Dietary habits and the perception and liking of sweetness among Australian and Malaysian students: A cross-cultural study. Food Quality and Preference 11: 299–312.

Kaushik, G., Satya, S. and Naik, S.N. 2010. Effect of domestic processing techniques on the nutritional quality of the soybean, Food Chemistry 3: 39-46.

Komatsuzaki, N., Tsukahara, K., Toyoshima, H., Suzuki, T., Shimizu, N. and Kimura, T. 2007. Effect of soaking and gaseous treatment on GABA content in germinated brown rice. Journal of Food Engineering 78(2): 556-560.

Ilowefah, M., Chinma, C., Bakar, J., Ghazali, H. M., Muhammad, K. and Makeri, M. 2014. Fermented brown rice flour as functional food ingredient. Foods 3: 149-159.

Islam, M. Z., Taneya, M. L. J., Shams-Ud-Din, M., Syduzzaman, M. and Hoque, M. 2012. Physicochemical and functional properties of Brown rice *(Oryza sativa)* and Wheat *(Triticum aestivum)* flour and quality of composite biscuit made thereof. A Scientific Journal of Krishi Foundation 10(2): 20-28.

Maache-Rezzoug, Z., Bouvier, J. M., Allaf, K. and Patras, C. 1998. Effect of principal ingredients on rheological behavior of biscuit dough and on quality of biscuits. Journal of Food Engineering 35: 23-42.

Marangoni, F. and Poli, A. 2008. The glycemic index of bread and biscuits is markedly reduced by the addition of a proprietary fiber mixture to the ingredients. Nutrition, Metabolism and Cardiovascular Diseases 18: 602-605.

Melanson, E. L., Astrup, A., and Donahoo, W. T. 2009. The relationship between dietary fat and fatty acid intake and body weight, diabetes, and the metabolic syndrome. Annals of Nutrition and Metabolism 55(1-3): 229-243.

Pareyt, B., Talhaoui, F., Kerckhofs, G., Brijs, K., Goesaert, H., Wevers, M., et al. 2009. The role of sugar and fat in sugar-snap cookies: Structural and textural properties. Journal of Food Engineering 90: 400-408.

Phornweenat Panya 2001. Development of bread from Wheat-Fragrance rice composite flour. Bangkok, Thailand: Kasetsart University, MSc thesis.

Sae-Eaw, A., Chompreeda, P., Prinyawiwatkul, W., Haruthaithanasan, V., Suwonsichon, T., Saidu, J. E. and Xu, Z. 2007. Acceptance and purchase intent of US consumers for non-wheat rice butter cakes. Journal of Food Science 72(2): 92-97.

Schober, T. J., Brien, C. M., McCarthy, D., Barnedde, A. and Arendt, E. K. 2003. Influence of gluten free flour mixes and fat powders in the quality of gluten free biscuits. European Food Research Technology 5: 369-376.

Tsukatani, T., Higuchi, T. and Matsumoto, K. 2005. Enzyme-based microtiter plate assay for γ-aminobutyric acid: application to the screening of g-aminobutyric acid-producing lactic acid bacteria. Analytica Chimica Acta 540: 293-297.

Turabi, E., Sumnu, G. and Sahin, S. 2008. Rheological properties and quality of rice cakes formulates with different gums and an emulsifier blend. Food Hydrocolloids 22: 305-312.

United States Food And Drug Adminstration. 1997. Code of Federal Regulations 21 CFR Part 101 Subpart D: Specific Requirements for Nutritent Content Claims.

Vongsudin, W., Ratthanatham, P., Laohakunjit, N. and Kerdchoechuen, O. 2012. Change of bioactive compounds in germinated rice. Journal of Agricultural Science 43(2)(Suppl.): 553-556.

World Health Organisation (2003). Diet, nutrition and the prevention of chronic diseases. In: W. T. R. Series (Ed.). Geneva: WHO.

Zhu, K., Huang, S., Peng, W., Qian, H. and Zhou, H. 2010. Effect of ultrafine grinding on hydration and antioxidant properties of wheat bran dietary fiber. Food Research International 43(4): 943-948.

Zucco, F., Borsuk, Y. and Arntfield, S. D. 2011. Physical and nutritional evaluation of wheat cookies supplemented with pulse flours of different particle sizes. LWT - Food Science and Technology 44: 2070-2076.