JELLOSE AS BINDER FOR THIN-CRISPY CRACKER FROM BLACK GLUTIOUS FLOUR USING MICROWAVE TECHNIQUE

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Abstract

This project aims to find the condition of electric power on the qualities of black glutinous rice (BGR) gluten free cracker with microwave technique and using jellose as binder. The experimental design to optimize the electric power on the qualities of BGR gluten free cracker using household microwave oven at 2450 MHz was used. In the experiment, the experimental units were set 2X3 in factorial in completely randomized designs, there were electric power which was divided to 2 levels (450 watt and 600 watt) and heating time in 3 levels were 3, 3.5 and 4 minutes. The results revealed that electric power at 600watt for 4 minutes was the optimum condition for baking cracker. The optimization level of jellose as binder in BGR gluten free cracker were also studied in completely randomized design with 3 levels was 1 ,1.5 and 2% (%w/w) based on BGR gluten free flour. Measurement physical characteristics and sensory evaluation of BGR gluten free cracker were done. After tested by 9-points hedonic scales and just about right (JAR), the results of overall acceptance were shown that ready-to eat BGR gluten free cracker (expansion ratio 22.71±1.59%, hardness 1979.27±279.97g. force) using jellose1.5% (%w/w) based on BGR flour as binder baked from raw sheeted BGR gluten free cracker thickness 1.53±0.02 mm. was accepted in all attributes. Moreover, the BGR gluten free cracker was also sensory tested comparing with wheat gluten cracker which baked in the same method with microwave oven (600 watt, 4 minutes) by 9-points hedonic scale with untrained 50 panelists, the acceptable BGR gluten free cracker was reached by 98% of panelists.

Keywords : cracker, gluten free, black glutinous rice, jellose, microwave

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Introduction

Biscuits market has been popular in Thai food industry which has demanded among the consumers because they are part of the major and minor ingredients on almost all dishes every day. As a result of their recipes, Thai biscuit market share was valued at 12,303 million THB in 2015 with baked goods, including cracker about 16% for its sales. Crackers are defined as thin, crisp wafers or biscuits, usually made of unsweetened and unleavened dough. Crackers can be divided into three main categories based on their differences in ingredients and methods of production (Shukla, 1994).

Celiac disease is increasingly interested in the world food industry, the celiac disease diagnosis rate may reach 50-60% by 2019 (Data monitor Group, 2009).There are no pharmaceutical treatments or cures for them, whereas 100% gluten-free diet is the only existing treatment for celiac disease today. In the area of bakery products this trend is still relatively underdeveloped (Siro et al., 2008).

Rice production in Thailand is among the world's three leading well known of food crops exporting, also the most important and fastest consumption of over half the world's population, especially in Asia and Latin America. There is detailed analysis of nutrient content advises that the nutrition value of rice varies based on type of them between white, brown, red, and black (or purple) varieties of rice and nutrient quality of the soil rice is grown as well .In particular black glutinous rice also known as sticky black rice or Khao-Niao-Dam which has opaque grains, very low amylose and high amylopectin content. As the result, it is especially sticky when cooked. The dark color of black glutinous rice means it is rich in anthocyanins and also gamma oryzanal, which are mixture of natural antioxidants compounds. According to a study a recent trial demonstrated that anthocyanin supplementation exerts beneficial metabolic effects in subjects with type 2 diabetes by improving dyslipidemia,inhibitory effect on cancer cell proliferation (Chen et al., 2006), a high protection of endothelial cells from oxidative stress events (Zhang et al., 2006) and a considerable protection against angiogenesis induced by vascular endothelial growth factor (Tanaka et al., 2011), while in vivo protocols using rats have shown that pigmented rice varieties reduce the risk of atherosclerosis (Xia et al., 2006) and efficiently reduce the total cholesterol, low-density cholesterol, and total triacylglycerol contents of rats fed a high-cholesterol diet (Zawistowski, Kopec, and Kitts, 2009). Therefore, different alternative crops like black glutinous rice, as raw materials, is in a new focus for development of special bakery products.

Moreover, by products from the tamarind seed and tamarind seed gum which called jellose is secondary product from a manufacturing process after recovered the polysaccharide from the extract obtained by treating tamarind seeds with hot water. It is polysaccharide composed of glucose, xylose and galactose in the structure chemical. While it is useful as a gelling agent, it is also valuable as a thickening agent and stabilizer. (Mohamed HA et al, 2015).

Hence jellose is useful as alternative ingredient for being food thickening agent and stabilizer instead of commercial chemicals.

The objective of this project was formulated gluten-free crackers from black glutinous rice flour and using jellose as binder by baking with house hold microwave oven. Texture and sensory evaluation of BGR gluten-free cracker will be done.

Materials and Methods

Materials

Black glutinous rice (BGR, *Oryza sativa* var. *glutinosa*) was harvested in Phatthalung province of Thailand during 2014 to 2015. Grains were de-husked and coarse milled using commercial Grain Miller. Further grinding with local milling apparatus and sieving through 100 mesh sieve was done to make black glutinous rice flour using in the experiment. With proximate analysis with AOAC methods (AOAC, 2000), it consisted of 11.70%, protein 13.43%, fat 0.03%, ash 0.95%, fiber1.23% and carbohydrate 72.66% (%w/w, dry basis)

Jellose powder was obtained from Pinphet Ltd, Phetchaboon province of Thailand. It was recovered from the tamarind seed polysaccharide. It had 6.70$\pm$0.57%moisture content after investigated by a moisture analyzer (Moisture IR MJ33, Mettler, Swisszerrland). Jellose was used in paste form. The paste was prepared by boiling jellose powder in water at 85 °C and stirring speed up to 2000 rpm, 4 minutes with rotor as paste.

Commercially available sugar, Rice Bran Oil, salt and baking powder were purchased from the local market in Ladkrabang, Bangkok, Thailand.

Preparation of black glutinous rice gluten free cracker

In Table 1 the formulation of gluten free cracker was modified from Han et al. (2016). All dry ingredients of BGR gluten free cracker were mixed in a mixer bowl of house hold bakery apparatus (Cuizimate Mixer model RBSM) at a high-speed setting for 30 seconds, except sugar. The liquid ingredients (water and oil), and sugar were mixed separately for 10 min to form an emulsion. Before mixed the liquid ingredients and the dry ingredients, mixed with volume of jellose paste for 30 seconds, after that continuously mixing was gradually incorporated into the emulsion for 4 min and kneaded by hand to form a mixture. The mixed dough was rested for 10 minutes at room temperature to ensure uniform distribution of the liquids. The mixture was sheeted to approximately lessthan 2 mm thickness using smooth stainless pasta sheeter roller at level 1. After that cut the mixture sheet using a dough cutter (5x5 cm^2), and transferred onto a mesh-wired baking sheet.

Table1 Formulations for BGR gluten free cracker used in the study

Ingredients	Weight (gram)
Black glutinous rice flour	100
Water	100
Rice bran oil	20
Sugar	4
Salt	3
Baking soda	1
Jellose	Varied by condition

Conditions of electric power on BGR gluten free cracker

In this study, BGR gluten free cracker was conducted with microwave oven (Samsung, model MW712N) at 2450 MHz, to find suitable electric power (450 and 600 watt) and heating time condition (3.0, 3.5 and 4.0 minutes). The formulation of BGR gluten free cracker used jellose 1% (%w/w) based on BGR flour. The crackers were baked in microwave. After cooling to room temperature for 3-5 minutes, crackers were packed and sealed in PE plastic bag and kept at room temperature. The evaluation was determined surface temperature and elementary sensory.

Effect of Jellose on textural characteristics and expansion of cracker

In order to study the effect of jellose on expansion ratio, various level of jellose powder 1.0, 1.5 and 2.0% (%w/w) based on BGR flour. After baking with microwave oven and cooling to room temperature, crackers were packed in PE plastic bag for further measurements hardness with Texture Analyzer (model TA-XT2i Stable Micro Systems, England) and expansion ratio. Texture profile analysis of finished BGR gluten free crackers were examined hardness properties by Texture analyzer (Model TAXT2i, CharpaTechcenter Ltd., Thailand) equipped with a stainless ball probe (P=0.25 s) attachment. The average peak force curves were determined and reported as fracture force (g). Data was subject to analysis of variance to assess the effect of cracker formulation on quality parameters. The expansion ratio analysis of black glutinous rice cracker prototypes were examined thickness of all finished BGR gluten free cracker as average using Vernier Caliper and calculated as the expansion ratio using a formula below.

Expansion ratio = thickness of finished BGR cracker/ thickness of BGR cracker sheet (1)

Effect of jellose on sensory acceptability of cracker

BGR gluten free crackers was conducted with microwave technique using various level of jellose as binder, after cooling for 3-5 min to room temperature, the crackers were sealed in PE plastic bag and kept at room temperature for sensory evaluation. They were determined based on evaluation of appearance, texture (hardness), overall acceptability and preference test. Quality category was determined to evaluate the attributes of the samples and to rate each attribute. 9-points hedonic scales with 1 (dislike extremely), 5 (neither like nor dislike), 9 (like extremely) and just about right (JAR) were used in this study with 30 untrained panelists.

Statistical analysis

All experiments were analyzed data by one way analysis of variance (ANOVA) and means comparison was tested by Duncan's multiple range test (DMRT) at 95% confidence level by using a SPSS software (SPSS version 21.0).

RESULTS AND DISCUSSIONS

The optimization condition of electric power and heating time on BGR gluten free cracker and sensory acceptability.

BGR gluten free cracker was conducted with microwave technique at various condition using jellose 1% (%w/w) based on BGR flour as binder (Table 2). The evaluation was considered at 600 watt 4 minutes baking all part of cracker had done and range of surface temp is about 147.35 Degree Celsius. When baked at 450 watt, their physical inside were not ready to eat and at 600 watt for 3 and 3.5 minutes, their edge were not ready to eat as well. Hence, the best condition is using at 600 Watt for 4 min because all part of cracker is ready to eat.

The Correlation of electric power and heating time on BGR gluten free cracker

The interaction of electric power and heating time which were calculated by correlation of Surface temp. The result revealed electric power, heating time and interaction value were highly significant increasing with surface temperature at less than 0.01 (Table 3). Increasing electric power and heating time. The surface temperature will be significantly increase at $p<0.01$, there were 0.788**, 0.472** and 0.882** respectively.

Effect of jellose on textural properties of cracker

Jellose is one of the main factors affecting BGR gluten free cracker production. Various level of jellose were selected 1.0, 1.5 and 2.0% (w/w) which was based on BGR flour and thickness less than 2mm using microwave at 600 watt 4 min for this study. Texture analysis is one of the most important experiment that analyzed hardness properties by Texture analyzer (Model TAXT2i, CharpaTechcenter Ltd., Thailand) equipped with a stainless steel ball probe

(P=0.25 s) attachment. The result is shown in Table 4, fracture force of BGR cracker was not significant at P < 0.05 with the incorporation of jellose level. They were obtained from the maximum force which was 1.5% jellose as 9973.91 g.force followed by 2.0% and 1.0%. However, their results were not significantly different at P<0.05. The fracture force values of BGR crackers might have increased with increasing jellose level. As expected, jellose composed of glucose, xylose and galactose which is useful as a gelling agent, it is also valuable as a thickening agent and stabilizer (Sukhawanli and Thamakorn, 2014) which may decrease the hardness of BGR gluten free cracker.

Table 2 Surface temperature and ready-to-eat ability of BGR gluten free cracker

Power (Watt)	Time (min)	Surface Temperature (°C)	Ready to eat ability
450	3.0	103.02±4.90	-
	3.5	106.33±5.28	-
	4.0	114.40±5.47	-
600	3.0	121.64±8.24	-
	3.5	130.60±5.86	-
	4.0	147.35±2.75	+

Note: + mean Ready to eat cracker, - mean Not Ready- to- eat cracker

Table 3 Correlation analysis the optimization of electric power state on the qualities of black glutinous rice cracker

	Factors		
	Electric power (EP)	Time	EP*Time
Surface temperature	0.788**	0.472**	0.882**

Note: ** mean highly significant at p <0.01, N = 24

Table 4 Effect of jellose on hardness and volume expansion of BGR cracker

Jellose (%w/w, based on flour)	Hardness^{ns} (g.force)	Expansion ratio^{ns}
1.0%	8477.77±922.42	34.05±13.80
1.5%	9973.91±985.43	39.26±9.57
2.0%	9511.46±917.51	47.29±13.49

Note: *ns: not significant (P > 0.05); *: Significant at P <0.05

Effect of jellose on expansion ratio of cracker

Cracker is defined as thin, crisp wafers or biscuits, usually made of unsweetened and unleavened dough. Meanwhile, expansion ratio is the essential experiment to examine the thickness of mixture previous and after process using Vernier Caliper which was calculated as average percentage (%). The result is shown effect level of jellose on BGR gluten free cracker baking at 600 watt for 4 min was not significantly different ($p \leq 0.05$) of expansion ratio (Table 4). As expected, 2.0% of jellose (%w/w) based on BGR flour was the highest value which was 34.05±13.80, following by 1.5% (39.26±9.57) and 1.0% (34.05±13.80) respectively. In table 5, the correlation among level of jellose and study factor which are hardness and volume expansion relationship is shown in Table 6. The level of jellose was not highly significant increasing at $P< 0.05$ with both study factors. Itmean that increasing thickness. Hardness and Expansion ratio will be non-significantly increase. The results revealed that microwave heating at 450 and 600 watt. Increasing power of microwave heating, the surface temperature will be increased.

Effect of jellose on sensory evaluation of cracker

BGR cracker was conducted with microwave technique at 600 watt for 4 minutes using various value of jellose as binder and tested by 9-points Hedonic scales (1=dislike extremely, to 9=like extremely) and just about right method (not enough, enough, too much) with untrained 30 panelists, to select and improve the appreciate formulation of sensory evaluation. The attributes of hardness, aroma, flavor and overall acceptability of BGR cracker prototypes that varied by level of jellose are shown in Table 6. The results revealed 1.5% of jellose as binder, was the highest scores in all attributes evaluation by 9-points Hedonic scales and the percentage of aroma and flavor enough more than 70% in JAR test (Table 7) as well. However, hardness attributes of 1.5% jellose was significant at $P < 0.05$ with 1.0 and 2.0% jellose. Hence the optimum formulation of BGR gluten free cracker using jellose 1.5% was selected to continuously analyze method.

Table 5 Correlation analysis among quality factors of finished cracker; hardness And expansion ratio

	Factors	
	Hardness (g.foce)	**Expansion ratio (%)**
Level of jellose	0.410^{ns}	0.448^{ns}

Note: ^{ns}mean non-significantat $p<0.05$, N= 12

Table 6 Hardness, aroma, flavor and overall acceptability of BGR gluten free cracker containing various jellose levels

Level of jellose (%w./w.) based on BGR flour	Acceptability of [A]			
	Hardness	Aroma[ns]	Flavor[ns]	Overall
Jellose1.0%	5.30±1.26[b]	6.00±1.39	5.97±1.38	5.60±1.25[b]
Jellose1.5%	6.27±1.20[a]	6.30±1.09	6.33±1.37	6.40±1.07[a]
Jellose2.0%	5.47±1.79[b]	6.23±1.25	6.07±1.62	6.07±1.26[ab]

Note: [a-b]:Across row mean followed by different letters are significantly different (P<0.05).
[ns] not significant (P<0.05), comparing mean by Ducan's Multiple-Range Test (DMRT) at P < 0.05.

Table 7 Result of a three-point category JAR* scale for hardness, aroma and flavor on BGR gluten free cracker using 1.5% jellose (%w/w), based on flour

Acceptability of [B]	"not enough"	"enough"	"too much"
hardness	2	14 (46.67%)	14
aroma	9	21 (70.00%)	0
flavor	2	22 (73.35%)	8

Note: *the results were tested with untrained 30 panelists.
[B] Scored on just about right scales (not enough, enough, too much)

As the result of JAR scale for hardness (Table 7), the percentage of hardness was enough less than 70%. A large proportion of panelists commented that samples were hard too much. Hence this formulation must improve to reduce its unsuitable.

Improvement to find the appropriate formulation of the black glutinous rice cracker processing

According to the BGR cracker using 1.5% jellose (%w/w) based on BGR flour, Data was shown "too much" in JAR scale for hardness attribute, it must be improved by reducing the thickness of mixture. In sheeting process of BGR mixture was sheeted to approximately 1.53 ±0.02 mm (level 4 of sheeter) instead of 1.91±0.05 mm. thickness using formulation in Table 1.

In Table 8 mixture which sheeted to 1.91±0.05 mm. was harder than 1.53 ±0.02 mm. thickness, so improvement is exactly affected to the characteristic properties (Surface temperature, Hardness and Volume expansion) which were significantly different.

Table 8 Physical effect of BGR gluten free crackers after developed thickness attribute

Thickness[1] (mm.)	Hardness (g.foce)
1.91±0.05 (Control)	9973.91±985.43[b]
1.53±0.02	1979.27±279.97 [a]

Note:[a-b]:Across row mean followed by different letters are significantly different (P<0.05).
[ns] not significant (P<0.05), comparing mean by Ducan's Multiple-Range Test (DMRT) atP<0.05.

According to evaluation, reducing thickness of BGR gluten free cracker as 1.53 ±0.02 mm (level 4 of sheeter) was affected the physicial characteristic. Surface temperature and hardness was significantly different at P<0.05 with 1.91±0.05 mm. thickness. However, expansion ratio was not significantly different, comparing their ratio revealed that 1.91±0.05 mm thickness was decreased about 16.55±7.98%. Increasing thickness of BGR gluten free cracker was affected increasing expansion ratio and decreasing surface temperature. Moreover, increasing thickness will be increased hardness as well. The correlated result of thickness and study factor was observed at P<0.05 that thickness affected to hardness of 0.988**.

After that, the appreciate BGR cracker formulation was further analyzed by JAR scale for hardness, aroma and flavor. The percentage of all acceptability "enough" more than 70% including hardness (76.67), aroma (80.00), and flavor (76.67) in JAR test which tested with untrained 30 panelists. Hence this formulation was determined to conduct continuously step. Furthermore, 9-points Hedonic scales was shown the results of all acceptability (hardness, aroma, flavor and overall) of BGR cracker, thickness 1.53 ±0.02 mm (Table9).

Table 9 Hardness, aroma, flavor and overall acceptability of BGR cracker, thickness 1.53 ±0.02mm.

Thickness[1](mm.)	Acceptability of [A]			
	Hardness	Aroma[ns]	Flavor[ns]	Overall
1.91±0.05 (Control)	6.17±0.91[b]	6.23±0.97	6.33±0.92	6.03±0.96[b]
1.53±0.02	6.70±1.09[a]	6.57±0.97	6.57±0.93	7.47±0.57[a]

Note:[a-b]: Across s row means followed by different letters are significantly different (P<0.05).
[ns] not significant (P<0.05), comparing mean by Ducan's Multiple-Range Test (DMRT) at P < 0.05.

Conclusion

This project was formulated gluten-free crackers from black glutinous rice flour and using jellose as binder with household microwave oven at 2450 MHz. The results revealed that electric power at 600 wattfor 4 minuteswasthe optimum condition for baking cracker and surface temperature. The optimization of jellose as binder in BGR gluten free cracker was 1.5% jellose (%w/w) based on BGR flour after improved with reducing thickness as 1.53±0.02 mm. The organoleptic test (hardness, aroma and flavor) were enough more than 70% in just about right (JAR) test.

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