

GLUTEN FREE CRACKER FROM MIXTURE OF LEGUME FLOURS

Jiranart Boonkong,^{1,*}

¹Department of Food Technology, Faculty of Science, Siam University, Bangkok 10160, Thailand.

*e-mail: jiranart.boo@siam.edu

Abstract: The effect of replacement of wheat flour by different proportions of legume flours on physicochemical and sensory characteristics for gluten free cracker produced was studied. Also, the experiment was varied proportion of three types of legume flours (soybean; S: red bean; R: Navy bean; N). The legume flours were formulated at proportion of 30:50:20 for SRN1, 30:40:30 for SRN2, 30:30:40 for SRN3 and 30:20:50 for SRN4 respectively. Results revealed that the legume crackers had the higher A_w and hardness than control. The L^* value was decreased while the a^* value was increased when increasing of red kidney bean flour. The SRN4 had the highest liking score from sensory evaluation. The SRN4 was the optimal formulas for gluten free cracker production. The chemical composition analysis show that the legume cracker (SRN4) had the higher protein, fat, ash and fiber content than control.

Introduction: Celiac Disease is the autoimmune digestive disease that damages the villi of the small intestine and interferes with absorption of nutrients from food. Its inherited genetic disorder that responds well to gluten diet.¹ The resolve of this problem is avoiding the gluten foods for long life.

Grain legumes, like soybean is an excellent source of protein (40-45%). It's free of gluten, also rich in calcium, iron, phosphorus and most of the vitamins.² Soybean has been reported to be composed of 30–40% protein, 18–20% oil, 35% carbohydrate, enriched of dietary fiber. Red kidney bean is containing 18.2% protein, 2.2% lipid, 63% carbohydrate and 23.8% fiber. Navy bean is well known as source of α -amylase inhibitors (Phaseolamin), that compose of 61% carbohydrate, 22% protein.³ Moreover, the legumes flour is enrich of the carbohydrate that known as resistant starch which release the glucose into the blood slowly after 2 hours. A lot of researches have been reported to consumption of whole grains, cereals and legume grains help to decrease the cholesterol level, defend blood clotting and promote the intestine system function prior to defend colon cancer.²

Cracker is the one type of bakery products. The wheat flour is the major composition of cracker, other side it's compose of water, fat, expansion substance and others ingredient such as nuts dry fruit and flavors. The quality of biscuits or cracker depends on quantity and quality of ingredients, especially the flour. It was found that mixing two or more different materials will help to solve the deficiency problem of cereals as low nutritional value by used legumes as food protein source.⁴ There are many previous researches on cracker and biscuit from cereals and legumes flour such as wheat biscuit supplemented by fenugreek seed flour, corn-fenugreek flour composite biscuits production, rice crackers development from black glutinous rice.^{4, 5, 6} Besides, use of soybean and chickpea flour for biscuits and crackers production.^{2, 7} The result show that all of products had the good quality, got well in consumer's perception and the most benefit is the gluten free diets.

This study was focus on a research for protein from other sources, such as soybean, red kidney bean and navy bean flours. The objective was to produce the gluten free cracker from those legume flours. The experiment was designed to evaluate the effect of replacement wheat flour by 100% of three legume flours on the physicochemical properties of produced crackers. Also, investigating the nutritional quality of the final products.

Methodology:

1. The legumes flour preparation

Soybean, red kidney bean and navy bean seed from Rai Tip Co., Ltd. were used as raw material. They were dried at 60 °C in the oven until the moisture was decreased to 13%

and then grounded using a stoner milling and passed through a 80 mesh screen size of a sieve tester. The grinded powder at > 80 mesh screen size was used for other experiments and a percent yield was calculated.

2. Procedure for preparation of cracker

The wheat flour and other ingredients were weighed accurately. (Table 1) The ingredients were mixed and then shortening was added into the dry ingredients. Water was added accurately to form dough. The dough was then kneaded and rolled to a uniform thickness of 3 mm. The crackers were cut out with round shape 3.5 cm diameter. Then the crackers were baked at 205°C for 10 minutes, cooled to ambient temperature and packed in high density polyethylene bags.

The gluten free crackers production was evaluate the effect of replacement wheat flour by 100% of three legume flours, The formulation of cracker was fixed soybean flour at 30% The proportion of red kidney bean and navy bean flours were varied; SRN1 (30:50:20), SRN2 (30:40:30), SRN3 (30:30:40) and SRN4 (30:20:50). The preparation was followed the wheat flour cracker. A batch was produced for 1,000 gram and then gluten free cracker was analyzed in term of physical and chemical properties.

Table 1: Basic formulation of wheat flour crackers

Ingredients	Quantity in percentage (%)
Wheat flour	59.8
Sugar	8.50
Shortening	16.42
Salt	0.26
Sodium bicarbonate	1.64
Water	13.38

3. Analysis of physical properties and sensory evaluation of gluten free cracker

The production of gluten free cracker was studied on physical properties and sensory evaluation was followed

3.1 Water activity, (CX3TE Model HR-200) Jarpa-Tech. center Co., Ltd.

3.2 Spread factor, (AACC, 2000)⁸

3.3 Hardness, Texture Analyzer Model TA-XT2

3.4 Color measurement with colorimeter (Hunterlab Model, ColorFlex).

3.5 Sensory evaluation was studied by Food Technology students (40 persons). The 9-point hedonic scale was used and considered in term of color, taste, expansion, crispiness and overall liking.

4. Chemical composition analysis of wheat cracker and gluten free cracker from legume flours

The chemical composition of wheat cracker and gluten free cracker was determined by AOAC (2000)⁹ and calculated the carbohydrate content by subtracting from 100.

5. Statistical Analysis

The statistic analysis data was followed, the physicochemical properties measurements and sensory evaluation was analyzed using analysis variance. Duncan's Multiple Range Test was employed to determined significant different between samples at the 5% level. The chemical analysis between control and the optimal formulas was applied to determined significant different by Independent-Sample T-Test.

Result, Discussion and Conclusion:

1. The appearance and yield of legume flours

On producing of legume flours showed that the flours were finely pale yellow power for soybean, pale red power for red kidney bean and white powder for navy bean, tasteless and odorless. The yields of the soybean flours, red bean flour and navy bean flour were 20.81, 65.38 and 78.12 respectively. (Figure 1)

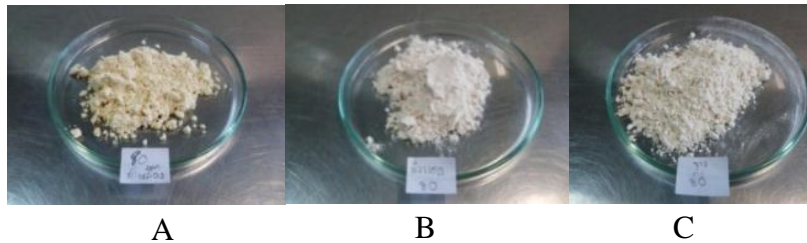


Figure 1. Appearance of three types of legume flours (A: soybean B: red bean C: navy bean)

2. The appearance of gluten free cracker from legume flours

The crackers had thin circle shape, hard crispy and light brown color to dark brown color. (Figure 2; A-E). The baking temperature influenced on color, texture of crackers because of the chemical compositions of batter was changed. The water was evaporated that affected the decreasing of moisture. The cracker was brown color because Millard browning reaction of sugar and amino acid, otherwise the brown color was affected from caramelization of sugar and dextrin in food.¹⁰

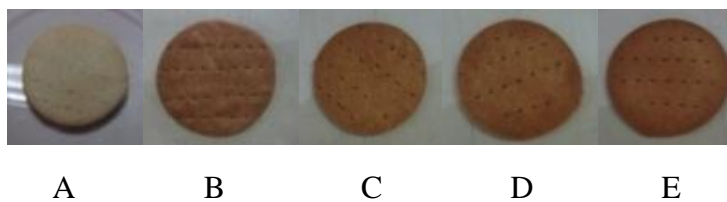


Figure 2. Appearance of legume flour crackers (A: Control, B: SRN 1, C: SRN 2, D : SRN 3 and E : SRN 4)

3. The physical properties of gluten free cracker from legume flours

Table 2:Water activity, spread factor and hardness of gluten free cracker from legume flours

Formulae	Water activity	Spread factor ^{ms}	Hardness (N)	<i>L</i> *	<i>a</i> *
control	0.24±0.014 ^d	10.40±1.04	0.53±0.11 ^b	70.41±1.67 ^a	2.87±0.36 ^d
SRN 1	0.36±0.002 ^a	9.19±1.80	0.61±0.13 ^{ab}	52.96±1.52 ^c	12.33±0.37 ^a
SRN 2	0.33±0.010 ^b	9.01±1.96	0.87±0.16 ^a	53.55±2.31 ^c	10.56±0.02 ^b
SRN 3	0.32±0.011 ^b	9.60±1.97	0.82±0.15 ^a	56.77±1.78 ^b	10.49±0.33 ^b
SRN 4	0.27±0.010 ^c	9.33±1.64	0.85±0.14 ^a	57.91±2.93 ^b	8.45±0.17 ^c

Means in the same column followed with a common letter are significantly different (p<0.05)
 Mean ± standard deviation (SD)

The spread factor of cracker is the most important quality parameter. The spread factor of all crackers gradually decreased with increasing the addition of legumes flour but was not significantly different between samples. The water activity content of legume flour crackers was higher than wheat flour cracker (control). The increasing of water activity maybe comes from increasing water absorption with higher level of legume flours.⁷

The hardness was increased by increasing the addition of legume flours, because of rich protein and fiber content.² The fiber distributed between starch granules and changed the starch structure, which affected hard texture. The control cracker might has less dense texture than legume flour crackers.

The *L** value decreased by replacing wheat flour with legume flours (Table 2). The red kidney bean flour was majority affected color in cracker. Particularly, the *a** value of SRN1 (30:50:20) was also highest. Because anthocyanin pigment in the red kidney bean flour was affected on color of cracker. This result agrees with previous research.¹¹ The color of pasta from red kidney bean flour was influenced from anthocyanin pigment and *a** value was increased when increasing red kidney bean flour.

4. The sensory evaluation of gluten free cracker from legume flours

The expansion and crispiness were not significantly different between the samples. When considered in term of color, flavor and overall liking found that SRN 3 and SRN 4

were not significantly different, however the SRN 4 had higher liking score than SRN 3. Therefore, SRN 4 was used for chemical analysis. (Table 3)

Table 3: The liking score of gluten free cracker from legume flour

Formulae	Color	Flavor	Expansion ^{ns}	Crispiness ^{ns}	Overall liking
SRN 1	5.68±1.72 ^c	4.78±1.80 ^b	5.53±1.30	6.00±1.43	5.58±1.65 ^{ab}
SRN 2	6.03±1.83 ^{bc}	5.43±1.80 ^{ab}	5.65±1.64	6.03±1.80	5.85±1.73 ^{ab}
SRN 3	6.58±1.45 ^{ab}	5.53±1.58 ^{ab}	5.50±1.55	6.05±1.80	6.13±1.65 ^{ab}
SRN 4	6.95±1.57 ^a	5.95±1.50 ^a	5.45±1.52	6.05±1.77	6.78±1.16 ^a

Means in the same column followed with a common letter are significantly different ($p < 0.05$)

Mean ± standard deviation (SD)

5. The chemicals composition of cracker

The results indicated that moisture, protein, fat and fiber content of cracker were obviously increased by increasing the addition of legume flours as compared with control. (Table 5) Because of the legume was full of protein, fat and fiber.² Especially, the increase in fat content could be due to the increase in the proportion of soybean in the flour blend. Soy bean is a protein rich oil seed that contained higher percentage of fat than wheat flour.² The increase of moisture content may result from the increased water absorption by the higher level of legumes flour. This indicates that the larger particles have higher water holding capacity than smaller particles. In present study it was observed that the result was more similar to the reported by Bose and Shams-Ud-Din (2010).⁷

Table 5: The chemical composition of wheat cracker and legume flours cracker

Cracker	Moisture (%)	Protein (%)	Fat (%)	Ash ^{ns} (%)	Fiber (%)	Carbohydrate (%)
Control	2.67±0.35 ^b	8.61±0.05 ^b	20.44±1.97 ^b	0.008±0.01	35.11±0.89 ^b	33.17±2.43 ^a
SRN 4	2.90±0.58 ^a	20.85±2.33 ^a	22.32±0.64 ^a	0.034±0.03	38.13±0.75 ^a	15.77±5.88 ^b

Mean ± standard deviation (SD)

It could conclude that, the cracker was thin circle shape, hard crispy and light brown to dark brown color. In physical properties of legume flour cracker, the water activity content of legume flour crackers was higher than wheat flour cracker (control). Addition of legumes flour affected increasing of hardness but it does not influence on spread ratio. Result of sensory evaluation was found that SRN 4 had the highest score for color, flavor and overall liking. The SRN4 is the best formulas for gluten free cracker production. The replacing of wheat flour with legumes flour resulted in improving their nutritional composition.

References:

1. Alaedini A, Green PH. *Ann Intern Med.* 2005; 142: 289-98.
2. Banureka VD, Mahendran T. *Tropical Agricultural Research & Extension.* 2009; 12(2): 62-66.
3. Rysova J, Ouhrajkova J, Gabrovskaa D, Paulickova I, Winterova R, Vymyslicky T, Prokes J, Hutar M, *Agronomy Research.* 2010; 8: 339-344.
4. Hegazy AI, Ibrahim MI. *World J. Dairy & Food Sci.* 2009; 4(2): 129-135.
5. Hussein AMS, Amal S Abd El-Azeem, Amany MH, Abeer AA, Gamal HR. *Aust. J. Basic & Appl. Sci.* 2011; 5(4): 84-95.
6. Sattasuwan N, Nuengjamnong N, Suksomboon A. *Agricultural Sci.J.* 2010; 41(3/1): 165-168.
7. Bose D, Shams-Ud-Din M. *J. Bangladesh Agril. Univ.* 2010; 8(1): 147-152.
8. AACC. 2000. *Approved method of American Association of Cereal Chemists*, 10th ed., American Association of Cereal Chemists, Inc., St Paul, Minnesota, USA.
9. AOAC. 2000. *Official methods of analysis*, 17th ed. The Association of Official Analytical Chemists, Washington, D.C.
10. Hernandez EG, Corzit N, Vikkanova BG, *J. Cereal Sci.* 1999; 29: 171-176.
11. Boonkong J, Nuduangkao S. *J. Food Tech.* 2009; 4(1): 16-22.

Acknowledgements: We gratefully acknowledge the Institute of Research and Development, Siam University for funding this research.

Keywords: gluten free cracker/soybean flour/red bean flour/navy bean flour/Crisp film