Kasetsart J. (Nat. Sci.) 35 : 188 - 194 (2001)

Feasibility Study on Snack Production by Using Dietary Fiber Concentrate from Soymilk Residue

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ABSTRACT

The production of high dietary fiber snack was studied by using corn grit and broken rice as the bases and composed of dietary fiber concentrates (DFC) from soy milk residue which were defatted and non-defatted. The amounts of the dietary fiber concentrates were 5 %, 10 % and 15 %, respectively. The mixtures were extruded by using a twin screw extruder. It was found that the total dietary fiber and the protein contents of the snack samples were increased with the increasing quantity of the DFC in the products. The snack samples that contained 5 % DFC were equal to or even more bulky than the control sample and more bulky than the snack samples that contained 10 % DFC and up . The results were confirmed by measuring the bulk density of the snacks. From the color measurement of the snack samples, it was found that the lightness (L*) of the snacks were decreased with the increasing amount of DFC in the samples. Snacks made from corn grit as the base had a golden yellow color, while snacks made from broken rice as the base were white.

From the sensory evaluation, it was found that there was no significant difference in the preferential scores in color, odor and taste between the snack samples that contained 5 – 15 % DFC and the control sample at $p < 0.05$. However, adding DFC in the snacks could improve the snack's texture as the texture preferential scores of all the snack samples which contained 10 %DFC were higher than of the control ones.

The high dietary fiber snacks made from the defatted DFC contained more protein and total dietary fiber than the snacks made from the non-defatted DFC.

Key words : dietary fiber concentrate, high dietary fiber snack

INTRODUCTION

Nowadays, snack is a popular food item which still get a steady increase in the market size. In fact, snack have many varieties which are different in shape, size, taste, aroma and food compositions. Normally their bases are dehulled cereals, either in the forms of flour or grit, and tubers from which the main composition is starch and low in protein and fiber content. For example, potato chips contain 45.9 % carbohydrate, 3.6 % protein and 0.9 % fiber (FAO and US. Dept. of Health, Education and Welfare, 1972), while the composition of extruded snacks varies greatly with the kinds of the raw materials being used. However, the main composition of the extruded snacks is still carbohydrate with only 3.3 – 8.3 % protein (Boonyasirikool *et.al.*, 1986). Lee (1994) studied on the effects of extrusion conditions on the solubility and cholesterol – lowering potential of dietary

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fiber. She found that soluble dietary fiber (SDF) was maximized at low dough moisture content, high barrel temperature and high screw speed. These high shear conditions produced a greater than 3 fold SDF in soy (to 11.0 %) and wheat (to 8.3 %) snacks as compared with SDF in the raw mixes (3.4 and 2.3 % respectively)

The amount of soymilk residue in Thailand is increasing the same time as the drinking of soymilk becomes more and more popular. This could be due to the knowledge of people to avoid the diseases that are caused from animal products . Trongpanich *et al*. (2000) studied the production of dietary fiber concentrate (DFC) from soymilk residue by water extraction process. They found that the DFC they produced contained more than 40 % total dietary fiber (TDF) and more than 45 % protein content. The shelflife of the DFC was about 3 months and a longer shelflife could be obtained if the DFC is defatted. In order to increase the protein content of the extruded snack., many researches have been done and have had some success by adding of a limited amount of defatted soy flour in the base of raw mixes. However, none have been done yet on the DFC from soymilk residue from which properties might change after passing the soymilk extraction process.

The objective of this study is to find the feasibility of using DFC from soymilk residue as a raw material in the extruded snack production, in order to increase the TDF and protein content of the snack, and to utilize the soymilk residue, as well.

MATERIALS AND METHODS

1. Materials

1.1 DFC and defatted DFC powder from water extraction process .

1.2 Corn grit (yellow color with particle size about 30 – 40 mesh)

1.3 Broken rice (Kaw – tha – hang) with the size particle about 30 – 60 mesh.

1.4 Barbecue flavor and soybean oil for coating.

1.5 Other flavoring agents such as sugar, salt and minerals.

2. Methods

2.1 Formulation

Corn grit and broken rice were used as the bases. Each base was mixed with either DFC or defatted DFC powder at 5 %, 10 % and 15 % DFC or defatted DFC concentration, respectively. Each raw mix was mixed with 1 % flavoring agents (item 1.5). For the controls, 2 % vegetable oil was added in each formula, and for the defatted formulas 0.725 % vegetable oil was added. Fourteen formulas were used for this study.

2.2 Extrusion

The raw mixes were extruded by using Hermann Berstorff Laboratory Twin Screw Extruder (Co – rotating ZE 25 x 33 D). The samples were fed at the speed of 375 gm./min., and with a screw speed of 300 rpm. Water was fed to the control and the composite raw mixes at the speed of 19.2 gm./min. The highest barrel temperature was 165°C at the barrel 6. The melting temperature was at the range 155 – 160°C.

After extrusion, the products were dried with an electric carbinet dryer at 80°C for 15 – 20 min., and coated with the barbecue flavor at the concentration of 10 % by wt. Then they were packed in plastic bags.

2.3 Sensory evaluation

Twenty food scientists were involved for the sensory evaluations. The tasters evaluated the products by using the hedonic scale method, from which the scores were 1 – 9. The low scores showed, undesirable or dislikable products' characters, while the high scores showed more desirable or preferable products' characters. The scores were analysed for the statistical significant difference by using the Analysis of Variance and Duncan's Multiple Range Test.

2.4 Chemical and other characters analysis

The samples were analysed for moisture, protein, fat, fiber and ash (AOAC, 1990), total dietary fiber (AOAC, 1995), and color was measured from the ground samples by a Data Color International Spectroflash. Bulk density (10 replications) was calculated from the volume of replacement and the weight of the samples, and texture (10 replications) by the Instron 1140 with 5 kg. weighing, head speed of 50 mm/min. and chart speed of 200 mm/min.

RESULT AND DISCUSSION

Table 1 shows the results from the proximate analysis, TDF and the color of the main raw materials, i.e. corn grit, broken rice and defatted and non-defatted soymilk residue (DFSR and SR respectively). The DFSR and SR showed a higher protein, fiber, ash and TDF content than corn grit and broken rice. The color of DFSR and SR had the same shade of the broken rice, i.e., white and pale yellow,respectively. The color of the corn grit was golden yellow.

Table 2 shows the results from the proximate analysis, the TDF and the color of the snack samples made from the corn base and SR at 5, 10 and 15 % concentration. It was found that the protein, fiber and TDF content of the samples increased with the steady increase of SR in the raw mixes, while the lightness (L*) of the sample decreased with the increase of SR in the samples. However, since the amount of SR in the sample was not much, the color of all samples were still yellow.

Table 3 shows the sensory evaluation of the snacks made from corn grit and SR. The scores of the samples in color, odor, taste and acceptability

Table 1 The proximate analysis (based on dry basis) and the color of the corn grit, broken rice, soymilk residue and defatted soy milk residue.

Samples	Moisture	Protein	Fat	Fiber	Ash	TDF	Color		
	%	%	%	%	%	%	L	a	B
Corn grit	12.46	7.50	2.22	0.63	0.62	3.24	84.04	9.70	38.49
Broken rice	10.57	8.75	0.91	0.56	0.45	1.53	92.73	-0.13	7.61
Soymilk residue (SR)	9.86	39.34	23.31	6.89	2.59	43.10	91.22	0.64	16.13
Defatted soymilk residue (DFSR)	11.73	48.50	3.11	8.17	2.70	46.12	94.99	0.23	7.02

Table 2 The proximate analysis (based on dry basis) TDF and the color of the snacks made from corn grit and the soymilk residue (SR).

Samples	Moisture	Protein	Fat	Fiber	Ash	TDF	Color		
	%	%	%	%	%	%	L	a	B
100 % corn	5.33	7.19	4.31	0.63	1.58	3.12	85.60	5.33	39.15
5 % SR	3.84	8.41	3.16	0.84	1.71	4.82	84.03	5.78	37.54
10 % SR	5.16	9.75	4.10	0.98	1.68	6.23	82.78	6.29	38.93
15 % SR	3.39	11.06	5.32	1.01	1.82	8.64	82.07	6.10	37.57

were not significantly different. However, the adding of SR seemed to have an advantage in improving the texture of the product. The taster preferred the samples with SR more than the control with significant difference ($p < 0.05$). The sample with 10 % SR had the highest score, although there was no significant difference with the other samples with SR.

Table 4 shows the results from the proximate analysis, TDF and color of the snacks made from corn grit and defatted soymilk residue (DFSR). It was found that the protein, fiber, and TDF of the samples increased with the increasing amount of DFSR in the products, while the lightness (L*) of the samples decreased with the increasing amount of DFSR. All samples were yellow. The preference test of the samples were evaluated and the result are shown in Table 5. Scores of all characters of the control sample were not significantly different than the samples of DFSR. However, the scores of the controls were lower than the scores of the samples with DFSR at 5 and 10 % concentration in all

Table 3 The sensory evaluation of the snacks made from corn grit and soy milk residue (SR).

Samples	Texture	Color	Odor	Taste	Acceptability
100% corn	6.55^{b}	7.47^{a}	6.72^{a}	7.19^{a}	6.94^{a}
5% SR	6.71^{a}	7.45^{a}	6.92^{a}	7.08^{a}	6.94^{a}
10% SR	6.74^{a}	7.42^{a}	6.68^{a}	7.00^{a}	6.97^{a}
15% SR	6.68^{a}	7.10^{a}	6.47^{a}	6.47^{a}	6.16^{b}

In a column, means followed with the same letter are not significantly different at $p < 0.05$

Table 4 The proximate analysis (based on dry basis), TDF and the color of the snacks made from corn grit and the defatted soy milk residue (DFSR).

Samples	Moisture	Protein	Fat	Fiber	Ash	TDF	Color		
	%	%	%	%	%	%	L	a	b
100% Corn	5.33	7.19	4.31	0.63	1.58	3.12	85.60	5.33	39.15
5% DFSR	4.23	8.60	3.09	1.07	1.87	5.09	84.55	5.54	37.92
10% DFSR	3.75	10.69	4.01	1.11	1.98	7.19	84.03	5.15	36.69
15% DFSR	3.37	11.50	4.81	2.13	1.78	9.11	83.23	5.10	35.89

Table 5 The sensory evaluation of the snacks made from corn grit and defatted soymilk residue (DFSR).

Samples	Texture	Color	Odor	Taste	Acceptability
100 % corn	6.68^{a}	7.08^{a}	6.60^{a}	6.85^{a}	6.63^{ab}
5 % DF-SR	6.78^{a}	7.08^{a}	6.93^{a}	6.90^{a}	6.85^{a}
10 % DF-SR	6.90^{a}	7.00^{a}	6.90^{a}	6.90^{a}	6.75^{ab}
15 % DF-SR	6.45^{a}	7.08^{a}	6.80^{a}	6.55^{a}	6.25^{b}

In a column, means followed with the same letter are not significantly different at $p < 0.05$

characters, except color.

Table 6 and 8 shows the proximate analysis and TDF content, and color of the snacks made from broken rice and SR, and broken rice and DFSR, respectively. The protein, fiber, TDF of the samples increased with the increasing amount of SR and DFSR, while the addition of SR and DFSR had a reverse effect to the lightness (L*) of the samples.

Table 7 shows the scores from the sensory evaluation of the snacks made from broken rice and soymilk residue. There was no significant difference between scores of the samples in color, odor, taste and acceptability, but there was a significant difference ($p < 0.05$) between the texture scores of the control and 15 % SR. SR improved the texture of the products, from which it let us know that the snacks can have an addition of SR up to 15 % and

Table 6 The proximate analysis (based on dry basis), TDF and the color of the snacks made from broken rice and the soymilk residue (SR).

Samples	Moisture	Protein	Fat	Fiber	Ash	TDF	Color		
	%	%	%	%	%	%	L	a	b
100% rice	4.08	8.44	2.24	0.56	2.29	1.01	90.16	-0.96	11.87
5% SR	4.07	10.31	2.73	0.57	1.52	2.40	88.86	-0.69	13.66
10% SR	3.35	11.56	3.23	0.74	1.22	3.24	87.13	-0.23	14.96
15% SR	4.01	13.31	4.12	0.89	1.48	4.78	84.96	0.44	16.27

Table 7 The sensory evaluation of the snacks made from broken rice and soymilk residue (SR).

Samples	Texture	Color	Odor	Taste	Acceptability
100% rice	5.80^{b}	6.50^{a}	6.75^{a}	6.60^{a}	6.00^{a}
5% SR	6.25^{ab}	6.50^{a}	6.65^{a}	6.60^{a}	6.35^{a}
10% SR	6.00^{ab}	6.55^{a}	6.65^{a}	6.60^{a}	6.10^{a}
15% SR	6.43^{a}	6.55^{a}	6.60^{a}	6.85^{a}	6.55^{a}

In a column, means followed with the same letter are not significantly different at $p < 0.05$

Table 8 The proximate analysis (based on dry basis), TDF and the color of the snacks made from broken rice and the defatted soymilk residue (DFSR).

Samples	Moisture	Protein	Fat	Fiber	Ash	TDF	Color		
	%	%	%	%	%	%	L	a	b
100% rice	4.08	8.44	2.24	0.56	2.29	1.01	90.16	-0.96	11.87
5% DFSR	4.88	10.63	1.14	0.58	1.48	3.84	89.51	-0.04	14.08
10% DFSR	4.12	12.50	1.25	0.78	1.21	5.12	87.77	0.18	14.68
15% DFSR	3.75	15.56	1.29	0.85	1.46	7.49	85.94	0.40	15.41

receive the higher preference test than the control one.

Table 9 shows the result from the sensory evaluation of the samples made from broken rice and DFSR. Again, there was no significant difference between the snacks in color, odor and taste characters. DFSR improved the texture and acceptability of the product from which the scores of these characters of the DFSR added samples were higher than of the control.

There was a significant differences between the control and the DFSR-added samples ($p < 0.05$) in texture and in acceptability scores and the results showed that a 10 % addition of DFSR was the best.

Table 10 shows the bulk density of the snack samples. The bulk density had a relationship with the size of the snack. The less density sample received a bigger size,and a 5 % addition of SR and DFSR increased the size and decreased the bulk density of the products with a significant difference ($p < 0.05$), except the samples of corn with DFSR. Upon increasing the added amount of SR and DFSR, the size decreased with the increasing bulk density.

Table 11 shows the result from the texture testing of the products. There was no significant difference among the corn base samples. For the rice base samples, there was a significant differences ($p < 0.05$) between the control and the 10 % and 15 % SR samples, and between the control and the DFSR- added samples. Snacks from 100 % rice were more crispy than 100 % corn, thus were easily broken. The SR and DFSR addition improved the structure and texture of the rice base products.

Table 9 The sensory evaluation of the snacks made from broken rice and the defatted soymilk residue (DFSR).

Samples	Texture	Color	Odor	Taste	Acceptability
100% rice	5.15^{c}	6.50^{a}	6.53^{a}	6.45^{a}	5.55^{c}
5% DFSR	5.98^{b}	6.55^{a}	6.35^{a}	6.60^{a}	6.05^{bc}
10% DFSR	6.75^{a}	6.65^{a}	6.70^{a}	6.70^{a}	6.65^{a}
15% DFSR	6.48^{ab}	5.95^{b}	6.30^{a}	6.55^{a}	6.33^{ab}

In a column, means followed with the same letter are not significantly different at $p < 0.05$

Table 10 The bulk density (gm/ml) of the snacks samples.

Samples	Corn base with SR	Corn base with DFSR	Rice base with SR	Rice base with DFSR
Control	0.054^{b}	0.054^{b}	0.074^{a}	0.074^{a}
5 % adding	0.042^{c}	0.054^{b}	0.068^{b}	0.064^{b}
10 % adding	0.056^{b}	0.056^{b}	0.073^{a}	0.073^{a}
15 % adding	0.077^{a}	0.067^{a}	0.074^{a}	0.075^{a}

In a column, means followed with the same letter are not significantly different at $p < 0.05$

Table 11 The texture (kg.) of the snack samples using the Instron measurement.

Samples	Corn base with SR	Corn base with DFSR	Rice base with SR	Rice base with DFSR
Control	1.50[a]	1.50[a]	1.39[c]	1.39[b]
5 % adding	1.46[a]	1.41[a]	1.61[c]	1.82[a]
10 % adding	1.46[a]	1.54[a]	1.93[b]	1.85[a]
15 % adding	1.71[a]	1.70[a]	2.58[a]	1.93[a]

In a column, means followed with the same letter are not significantly different at $p < 0.05$

CONCLUSION

Dietary fiber concentrate from soymilk residue either defatted or non-defatted, can be used to increase the dietary fiber and protein content of snacks from cereals. However, in order to improve the texture of the products and receive the consumer acceptability, the amount of its use should not be more than 10 % by wt.

ACKNOWLEDGEMENT

The researchers wish to thank Research and Development Institute of Kasetsart University for supporting the research fund for this project.

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Received date : 02/05/01
Accepted date : 29/06/01