Kasetsart J. (Nat. Sci.) Vol. 24 : 253 - 260 (1990)

Production of Protein Fortified Corn Snacks by Village Texturizer

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ABSTRACT

Corn snacks were prepared by using a village texturizer. Corn snacks were fortified by adding either 30, 35% full fat soy flour, 30% mungbean flour with 10% defatted sesame flour or 15.63% defatted peanut flour and 3.12% defatted sesame flour. Protein and fat contents of fortified corn snacks ranged from 17.84 to 21.74% and 6.04 to 10.42%, while those of unfortified corn snack were 10.63 and 5.33%, respectively, Protein of fortified corn snack flour also showed higher chemical scores of lysine and tryptophan, 73 - 93% and 90 - 120%, compared to 45 and 30% of the unfortified one. Protein and fat contents of fried products were 12.86 - 16.48% and 24.54 - 29.81% for the fortified ones and 6.59 and 26.09% for the unfortified one. The average scores from sensory evaluation of color, flavour, texture and acceptability showed that the corn snacks fortified with 30 and 35% full fat soy flour were not significantly different and were more acceptable than the rest of the samples.

INTRODUCTION

At present, snack is popular in Thailand. Most snacks are fun to eat but are low in nutritive value. If they are eaten in large quantity, they can suppress an appetite for the main meal. For this reason snack which high nutritive value should be developed for use as a supplementary food to increase nutrient in the diet. But the snack must be acceptable at reasonable price. Corn flour is considered to be a cheap source of carbohydrate. It also has a pleasant aroma that most people are accustomed to.

Maize or corn (*Zea mays* Linnaeus) is an important economic crop of Thailand. Most corns are used for feed domestically as well as for export. A few is used for corn starch and corn flour. It contains about 71% carbohydrate, 9.5% protein and 4.5% fat. (Inglett, 1970). Its protein quality is low due to the deficiency of lysine and tryptophan, which can be improved by addition of other protein sources, such as soybean, mungbean and ground nut proteins (Alexander *et al.*, 1970 ; Jansen, 1974 ; Bressani *et al.*, 1973). Lim *et al.*, (1980) produced high protein snack from corn and mungbean by using an extruder and found the snack to contain 14% protein. Village texturizer was developed by Meals for Millions foundation (Somchai, 1989), and it is originally designed for vegetable protein production at village level. The expansion of dough upon sudden release of pressure, provides porous texture with crispiness after drying.

The purpose of this research is to develop the accepted high protein corn snack by using the village texturizer. The accepted product not only adds the value to the low cost corn produced in Thailand, but also provides nutritive snack to the children, especially in rural area.

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MATERIALS AND METHODS

Preparation of Individual Flour

Corn flour, full fat soy bean flour, mung bean flour defatted sesame flour and defatted groundnut flour were prepared separately by washing, drying, cracking to facilitate hull removing, grinding and sieving. For defatted sesame and groundnut flours, hydraulic press was used to press out oil after drying. All flour samples were sieved through 80 mesh screen. Individual flour was analyzed for proximate and essential amino acid compositions. (essential amino acid compositions were analyzed by the Nutrition Division, Health Department, Minitry of Public Health).

Formulation of Fortified Flours

Six formulations of fortified flours were prepared as showed in Table 1. The quantity of essential amino acids in fortified or composite flours, were determined.

Preparation of Snacks

Twenty two and a half grams of cane sugar and 7.5 grams of salt were dissolved in 185, 175, 175, 175, 175, 165 and 170 mls of water, respectively. Then they were mixed with 600 grams of flour samples 1 to 7 in Kenwood mixer for 3 minutes. The dough was divided into 10 grams portion, rolled into ball shape and pressed into circular before putting in a cup of the village texturizer.

The temperature of the cup and the lid were 170° - 180°C. Center the lid over the cup and press the lid with the pressure 600 - 700 psi and holding time for 10 seconds. Then the lid was released from the cup. The moist snacks were obtained and they were dried in cabinet dryer at the temperature 50° - 60°C for 2 hours. The dried snacks (circular, puffed, crisp texture) formula no. 1 - 7 were obtained and they were packed separately in sealed polyethylene bag

Table 1 Compositions of 7 formula snack flours.

Formula no.	Composition, %						
	CF	FFSF	MBF	DSF	DGF	WF	CS
1	60	35	—	—	—	5	—
2	60	35	—	—	—	—	5
3	60	30	—	—	—	10	—
4	60	30	—	—	—	—	10
5	60	—	30	10	—	—	—
6	60	6.25	—	3.12	15.63	—	15
7	100	—	—	—	—	—	—

CF = corn flour
FFSF = full fat soy flour
MBF = mungbean flour
DSF = defatted sesame flour
DGF = defatted groundnut flour
WF = wheat flour
CS = cassava starch

for determination of proximate composition, characteristics (in term of color, odor, flavor, texture, outer appearance) and acceptability.

The 200 grams of snack formula no. 1 - 7 were fried in soybean oil at the temperature 160° - 170°C and 40 - 50 seconds frying time. Then they were packed in sealed polyethylene bag for determination of their percent of increasing in average weight, diameter and thickness from 4 pieces of snacks. Their characteristics and acceptability were also determined in the same way as dried snack before frying.

Organoleptic Evaluation of the Snacks

The acceptability test was done for 7 formulae of snacks and fried snacks from 10 panelists (researcher from the Institute of Food Research and Product Development, Kasetsart University) for investigation the different characteristics in terms of color, flavor, texture and acceptability by using hedonic scale scoring : score 9- the extreme like, and score 1-extreme dislike The difference in statistics was determined by using LSD (Least significant difference) at 5% significant level.

RESULTS AND DISCUSSION

Qualities of individual and composite flours

Proximate composition of corn flour, full fat soy flour, mungbean flour, defatted sesame flour and defatted groundnut flour on percent dry weight of flour were shown in table 2. It indicated that the protein content of corn flour was only 11.07% which was lower than the other four kinds of flours (% of protein were in the range of 27.96 - 45.05%) about 2.53 - 4.06 times. The fat content of corn flour was 5.56% which was lower than the other three kinds of flour (% of fat were in the range of 23.98 - 38.15% except mungbean flour in which its percent of fat was only 2.77%) at approximately about 4.31 - 6.86 times.

Essential amino acid compositions of the individual flour with their limiting amino acids were shown in Table 3.

These indicated that the protein of different sources were incomplete. The protein quality could be improved by mixing 2 or more flours together as seen in Table 4. The chemical scores of the previous limiting amino acids were increased to higher than 70%.

The proximate composition of the 7 formulae of corn snacks were shown in Table 5. The protein and fat contents of the fortified corn snacks were markedly increased to 17.84 - 21.74%, and 6.04 - 10.42%, respectively due to higher protein and fat content of the added flours.

Characteristics of snacks before and after frying

Before frying the color of corn snack no. 1 - 4 were orange color and corn snack formula no. 5 - 7 were bright yellow. The odor of corn snack formula no. 1 - 5 were roasted corn, but that of corn snack formula no.6 was roasted corn mixed with roasted groundnut. The odor of corn snack formula no.7 was strong roasted corn. In term of flavor, all formulae were salty, sweet and fatty taste. In term of texture, the corn snack formula no. 1,2,3,4 and 7 were good, crisp and puff but the crispiness and puffiness of corn snack formula no.5 and no.6 were fair. The corn snack formulae 1,2,3,4 and 7 showed higher porousity than formulae 5 and 6, in which defatted sesame flour was added.

The results of the organoleptic evaluation of corn snacks before frying were shown in Table 6. It appeared that the corn snack formulae 1,2,3,4 and 7 were satisfactory accepted with average scores in the level of moderately like.

The diameter and thickness of 7 formula corn snacks increased 0 - 1.32% and 8.69% respectively, after frying which were considered small. The small increases were due to already expanded texture of corn snacks leaving the village texturizer.

Table 2 Proximate composition of corn flour (from Suwan - 3 variety of corn), full fat soy flour, mungbean flour, defatted sesame flour and defatted groundnut flour on percent dry weight of flour.

Chemical composition (% Dry weight)	Corn flour (CF) (Suwan-3 variety of corn)	Full fat soy flour	Mungbean flour	Defatted sesame flour	Defatted groundnut flour
Moisture, %	10.59	6.50	9.14	4.09	6.80
Fat, %	5.56	23.98	2.77	38.15	25.93
Protein, %	11.07	45.05	27.96	36.96	41.15
Ash, %	1.22	5.54	3.48	5.08	3.71
Crude fibre, %	0.46	2.64	1.11	4.95	4.52
Carbohydrate, %	81.69	22.79	64.68	14.86	24.69
Energy, Cal/100 gram	421	487	395	551	497

Table 3 Essential amino acid compositions of various kinds of flours and FAO/WHO standard.

Essential amino acid	Amino acid, mg/gm of protein of						
	Corn flour	Full fat soy flour	Wheat flour	Mungbean flour	Defatted sesame flour	Defatted groundnut flour	FAO/WHO[2]
Isoleucine	33	36	29	35	31	40	40
Leucine	117	69	55	55	60	83	70
Lysine	25 (45)[1]	62	20 (36)	57	29 (53)	46	55
Methionine + Cystine	33	23 (66)	26	14 (40)	49	24 (69)	35
Phenylalanine + Tyrosine	58	83	50	90	78	106	60
Threonine	37	38	25 (63)	37	38	36	40
Tryptophan	3 (30)	15	7	11	16	14	10
Valine	39	37	32 (64)	38	38	48	50

[1] (–) limiting amino acid with **chemical score**

[2] Source : Food Composition table for use in East Asia (FAO, 1972)

$$\textbf{Chemical score} = \frac{\text{amino acid content in flour}}{\text{amino acid content in FAO/WHO standard}} \times 100$$

Table 4 Essential amino acid compositions of 7 formulae corn snack flours.

Essential amino acid	Amino acid, mg/gm of protein of corn snack flour formula number						
	1	2	3	4	5	6	7
Isoleucine	35 (88)[1]	35 (88)	35 (88)	35 (88)	33 (83)	36 (90)	33 (83)
Leucine	79 (113)	83 (119)	83 (119)	84 (120)	78 (111)	92 (131)	117 (167)
Lysine	51 (93)	51 (93)	49 (89)	50 (91)	40 (73)	40 (73)	25 (45)
Methionine + cystine	26 (74)	26 (74)	26 (74)	26 (74)	28 (80)	29 (83)	33 (94)
Phenylalanine + Tyrosine	75 (125)	76 (127)	74 (123)	75 (125)	76 (127)	82 (137)	58 (97)
Threonine	37 (93)	38 (95)	37 (93)	38 (95)	37 (93)	37 (93)	37 (93)
Tryptophan	11 (110)	12 (120)	11 (110)	11 (110)	9 (90)	10 (100)	3 (30)
Valine	37 (74)	38 (76)	37 (74)	38 (76)	38 (76)	42 (84)	39 (78)

[1] **Chemical score** in parenthesis

$$\textbf{Chemical score} = \frac{\text{amino acid content in flour}}{\text{amino acid content in FAO/WHO standard}} \times 100$$

Table 5 Proximate composition of seven formulae of corn snacks before frying.

Chemical composition (% Dry weight)	Corn snack formula number						
	1	2	3	4	5	6	7
Moisture, %	5.63	5.67	5.52	5.60	5.86	6.37	5.90
Fat, %	10.42	10.28	9.53	8.92	6.04	8.07	5.33
Protein, %	21.74	21.03	20.18	19.11	17.98	17.84	10.63
Ash, %	4.56	4.22	3.85	4.25	3.31	3.05	1.92
Crude fibre, %	0.80	0.64	0.35	0.45	0.50	0.30	0.44
Carbohydrate, %	62.48	63.83	66.09	67.27	72.17	70.74	81.68
Energy, cal/100 gram	431	432	431	427	415	427	417

Table 6 Organoleptic evaluation of 7 corn snack formulae before frying.

Characteristic	Score of corn snack formula number						
	1	2	3	4	5	6	7
Color	7.10 a	7.30 a	7.00 a	6.60 ab	5.10 c	5.90 b	6.20 b
Flavor	6.10 ab	6.10 ab	6.20 a	6.10 ab	5.10 c	5.30 bc	6.30 a
Texture	6.50 ab	6.20 bc	6.80 a	6.60 ab	5.80 c	6.10 bc	6.30 abc
Acceptability	6.30 ab	6.10 ab	6.40 a	6.20 ab	5.20 c	5.60 bc	6.10 ab
Total average score	6.50 a	6.43 a	6.60 a	6.38 a	5.30 c	5.73 b	6.23 a

The figures on the same row with the same letter showed no significant difference at 5% level.

It appeared that the color of seven formulae of fried snacks were orange red. The odor of fried corn snack formula no. 1,2,3,4 and 7 were fried corn smell. The odor of fried corn snack formula no.5 was fried mungbean and slightly fried corn smell but the odor of fried corn snack formula no.6 was fried groundnut and slightly fried corn smell. The flavor of seven formulae of fried corn snacks were salty, sweet and fatty taste. The texture of fried corn snack formula no.1,6 and 7 were good puff and hard crisp but that of fried corn snack formula no.2,3,4 and 5 were good puff and soft crisp.

The proximate composition of seven formulae of fried corn snack were shown in table 7. It indicated that the protein and fat contents of fried corn snacks formula no. 1 - 6 were in the range of 12.86 - 16.48% and 24.54 - 29.81% on dried weight of fried corn snack respectively but the protein and fat content of fried corn snack formula no.7 was 6.59 and 26.09% on dried weight of fried snack respectively. The increasing of fat content in seven formulae of fried corn snacks cause the reduction of their protein content when they were compared with seven formulae of unfried corn snacks.

The sensory investigation of seven formulae of fried corn snacks in term of color, flavor, texture and acceptability from the panelists were shown in table 8. It appeared that the corn snack formula no. 1 - 4 were well accepted by the panelists with average score trend to the levels of medium like with non significant difference at the 5% level.

CONCLUSIONS

The protein content and protein quality of corn flour could be improved by addition of protein flours (full fat soy flour, mungbean flour, defatted sesame flour and defatted ground nut flour). The protein contents of fortified corn snacks were increased to 17.84 - 21.74% and the chemical scores of the previously limiting amino acids were increased up to more than 70%. Fried corn snacks absorbed oil, thus oil contents increased and protein contents decreased compared to unfried snacks of the same formula. The fried corn snacks fortified with 30 and 35% full fat soy flour were well accepted in term of color, flavor, texture and acceptability.

Table 7 Proximate composition of seven formulae of corn snacks after frying.

Chemical composition (% Dry weight)	Corn snack formula number						
	1	2	3	4	5	6	7
Moisture, %	4.10	2.88	2.37	4.07	1.89	2.59	1.39
Fat, %	26.33	27.51	26.65	24.54	25.73	29.81	26.09
Protein, %	16.48	16.42	14.95	15.61	12.86	12.87	6.59
Ash, %	4.11	4.19	3.89	3.87	3.68	3.48	1.95
Crude fibre, %	0.88	0.72	0.45	0.51	0.62	0.43	0.55
Carbohydrate, %	52.20	51.16	54.06	55.47	57.11	53.41	64.82
Energy, cal/100 gram	512	518	516	505	511	533	520

Table 8 Organoleptic evaluation of 7 corn snack formulae after frying.

Characteristic	Score of corn snack formula number						
	1	2	3	4	5	6	7
Color	6.60 ab	7.00 a	6.80 a	7.00 a	6.50 ab	6.40 ab	6.00 b
Flavor	7.10 a	6.70 abc	6.60 abc	6.80 ab	6.00 cd	5.80 d	6.10 bcd
Texture	6.20 bc	6.70 ab	6.80 a	7.00 a	6.50 abc	6.00 c	6.10 c
Acceptability	6.40 abc	6.70 a	6.70 a	6.50 ab	6.30 abc	5.90 bc	5.80 c
Average score	6.58 ab	6.78 a	6.73 a	6.83 a	6.33 bc	6.03 c	6.00 c

The figures on the same row with the same letter showed no significant difference at 5% level.

LITERATURE CITED

Alexander, D.E., J.W. Dudly and R.G., Creech, 1970. Corn Breeding and Genetics in G.E. Inglett (ed). Corn : Culture, Processing, Products. The AVI Publishing Company, Inc, Westport, Connecticut.

Bressani R., M. Flores and L.G. Elfas, 1973. Acceptability and value of food legumes in the human diet. Paper presented in seminar on Potential of Field Beans and Other Food Legumes in Latin America. Centro Internacional de Agricultura Tropical, Cali, Columbia, Feb 26- Mar 1, 1973.

FAO 1972. Food composition table for use in East Asia. FAO and US Department of Health, Education and Welfare.

Inglett. G.E. 1970. Kernel structure, composition and quality In. G.E. Inglett (ed). Corn : Culture, Processing, Products. The AVI Publishing Company, Inc. Westport, Connecticut.

Jansen G.R. 1974. The amino acid fortification of cereals, new protein foods. vol 1 A. Technology. Academic Press, New York.

Lim, K.K., H.G. Ang and C.Y. Theng, 1980. High protein extruded snack food. Proceeding of 8th. ASEAN Workshop of Extruder Technology, held at Institute of Food Research and Product Development. Bangkok.

Somchai Prabhavat 1989. The effect of moisture of full fat soyflour and temperature of village texturizer on the production of Kaset protein. Proceeding of the 27th Kasetsart University Scientific Meeting. Jan 30 - Feb 1, 1989.

สถานที่พิมพ์ : โรงพิมพ์มหาวิทยาลัยธรรมศาสตร์ โทรศัพท์ 2241350
ผู้พิมพ์ผู้โฆษณา : อรุณี อินทรสุขศรี พ.ศ. 2533