Kasetsart J. (Nat. Sci.) 37 : 72 - 83 (2003)

Using of Extrusion Process for Preparation of Instant Cereal Beverage Powders based on Corn and Soybean

Chulaluck Charunuch, Pracha Boonyasirikool and Chowladda Tiengpook

ABSTRACT

Preparation of the instant cereal beverage powders based on corn and soybean from extrusion process has been studied. To examine the effect of particle size of corn grit (13, 23 and 33 mesh) and the composition between corn grit and isolated soy protein (84:10, 74:20 and 64:30) on the properties of product and evaluate nutritional value of acceptable product. The results showed that the differences in particle size of corn grit were not significant effect ($p > 0.05$) on the chemical composition (moisture and protein content) and most of the physical properties of product but the differences in the composition between corn grit and isolated soy protein were significant effect ($p \leq 0.05$) on the protein content and the physical properties of product (bulk density, reconstitution index, water absorption index, water solubility index and viscosity). The highest acceptable product consists of particle size of corn grit equaled to 13 mesh and the composition between corn grit and isolated soy protein equaled to 84:10 which reconstituted well, good soluble and moderate viscosity had adequate protein content and appropriate pattern of essential amino acid for good nutritive consuming.

Key words: instant cereal beverage powders,extrusion process,corn,isolated soy protein

INTRODUCTION

In the present Thai social condition is competitive, the way of life is urgent and urban citizens are faced with chronic traffic problems. Hence their need for food which can be easily prepared and convenient for consumption is ever increasing. In the aspect of food industry, more technologies for food product research and development are needed satisfy needs of consumers. Apart from being convenient to prepare and easy for consumption, these food products should also have sufficiently high nutrition, to result in good quality of life for the consumers. Especially for school age children who are often faced with traffic problems, causing them not to have time for breakfast before going to school. And not having breakfast reduces the sugar level in the blood, resulting in learning, and working effiency in working age people are also reduced. With this reason, instant beverage powders are another choice for consumers who need convenience and quickness in food preparation for family members. They are also health food for consumers in all gender and age groups.

In the current bad economic condition, agro - industry promotion is vital for the country's economic development. Because the agricultural sector is the source of principle income for the country, and be the economic sector creating large

Institute of Food Research and Product Development, Kasetsart University, Bangkok 10900, Thailand.

Received date : 27/01/03 Accepted date : 27/03/03

number of employment. Therefore, according to the 8th National Economic and social Development Plan (Year 1997-2001), the government policies stress increased value of agricultural goods according to market demands, and to promote agricultural goods processing. Because of this reason, the research work stresses development of food products from corn and soybean, which are important agricultural raw materials in Thailand, whose prices are low and production quantities are sufficient for domestic consumption. They are processed into instant beverage powders which can be prepared in short length of time by dissolving in water. The products are suitable for those who have no time for food preparation. Moreover, they are also developed into high nutrition protein drinks for those who are health conscious. In the aspect of instant food processing from cereals which can dissolve well in water, the traditional process is to make the food hot, cooked and dried by drum drier. Flaked product is obtained, and the product is then grounded and sifted through a mesh with required size. After extrusion, cooking technology was introduced in the food industry, diverse production processes and various instant food products from cereals were developed (Hauck, 1980), including instant beverage powders. This is because extrusion system (Harper, 1981) has the ability to make cereals gelatinize and form expanded products with the property of good water absorptibility. Moreover, it is also beneficial in the aspects of its high productivity, energy efficient and production step reduction.

Concerning foreign research works related to instant beverage powder production, most of raw materials used are in the form of liquid or high viscosity liquid. Therefore they tend to be made hot and dried by using spray drier (Holsinger *et al*., 1974; Guy and Vetterl 1975; King, 1985). But if the main raw materials used were cereals and in characteristics of powders, the process used tend to be one of the two systems (Anderson *et al*., 1971) which one is the drum drying system, making them hot and then dry by using roller machine, and the another is extrusion cooking system, making them hot and reduce moisture within the extruder, such as in the research work "Instant Beverage Mixes" (Bookwalter et al., 1971) which used cereals as raw materials, and they are made hot and cooked by using single screw extruder. The product obtained is then grounded and flavored and improved nutritive value by mixing with other food materials such as milk powder. This product can be dissolved in hot water and ready for consumed. The research works in Thailand are rather few and often use drum drying system in production, such as the research work " Development of instant high fiber processed food" (Tangkanakul *et al*., 2000) which boiled and steamed agricultural raw materials mix, after which water was added and grounded until fine. The food was then dried by using double drum drier, and made into powder which was also consumed as instant beverage powder. And from the result of survey on instant cereal beverage powders available in Thailand, it was found that most of the products use drum drier production system. Imported products such as the brand names "GOLD ROAST", "SUPER" and "VITAMAX" are imported from Singapore, while other products manufactured locally are "NESVITA", "INNA", "MONIEGOLD" and "GOOD TIME". With "NESVITA", which is a rather popular brand manufactured by Nestle Foods (Thailand) Co., Ltd., being produced by using cereal mix and made hot, cooked and dried by using double drum drier. After which it is grounded to the required size, obtaining the instant cereal powders (Cereal Base Type 02) which can be flavored with other ingredients and be consumed as instant beverage powders. Moreover, the Cereal Base Type 02 is also sold to other manufacturers for flavored and sold as instant cereal beverage powders with brand names "MONIEGOLD" and "GOOD TIME".

For this reason the research work used extrusion technology to produce instant cereal

beverage powders, in order to develop domestic production and make them more diverse. This can also help to reduce import quantity of this type of products and is also greatly beneficial for solving the country's economic problems.

MATERIALS AND METHODS

Preparation of raw materials

Corn grit (13 and 33 mesh) were supplied by Thai Maize Products Ltd. Corn grit (23 mesh), getting from corn grit (13 mesh) which was grounded and sieved for screening the required size. Isolated soy protein (Profam 974), full fat soy flour and flavorings were supplied by Heinz Win Chance Ltd., the Royal Project and Givaudan Roure Ltd. respectively. After preparation, raw materials were examined by proximate analysis (A.O.A.C., 1990) and particle size distribution.

Experimental design

To study the production of instant cereal beverage powders from extrusion process, the 3× 3 factorial in randomized complete block design was employed with two independent variables at three levels of variation. The independent variables were size of corn grit (13, 23 and 33 mesh) and the composition between corn grit and isolated soy protein (84 : 10, 74 : 20 and 64 : 30). Dependent variables were moisture and protein content, bulk density, reconstitution index, water absorption index, water solubility index and viscosity. Experimental data were analyzed by using the Statistical Analysis System (SAS) and a second order polynomial equation was fitted to each response variable.

Extrusion process

For each test run of experimental design (9 experimental units/1 replicate; 3 replicates), the weighed raw materials (the composition between corn grit and isolated soy protein equaled to 84 : 10, 74 : 20 or 64 : 30, full fat soy flour 4%, vegetable oil 1% and mixture of vitamins and minerals 1%) at each size of corn grit were thoroughly mixed by a mixer before fed into a laboratory co – rotating twin – screw extruder (Hermann Berstorff Laboratory Co-rotating Twin Screw Extruder ZE25×33D). This extruder comprises of 7 parts of barrel ended with a 24.5 mm thick die plate with one circular die hole (diameter 3.0 mm). The barrel length – to – diameter ratio (L/D) of the extruder was 870 : 25. The mixture of raw materials were fed into the extruder with a volumetric twin screw feeder (K- Tron soder AG5702, type 20, Switzerland) and water was pumped to the ingredients to achieve required moisture content. Temperature of barrel 1-7 and 9 was 30, 35, 65, 135, 155, 175, 130 and 125°C respectively. The other operating condition were adjusted at screw speed 350 rpm, feed rate 319-375 g/min, water rate 19-26 g/min, feed moisture 15-17% and melting temperature 152-155°C. After extrusion, the extruded samples were dried in the electric oven at 80°C for 10 min and grounded by Fitz Mill (mesh size 0.6 mm) to obtain instant cereal powders. Finally, the instant cereal powders (50%) was mixed with sugar (25%), skim milk powder (10%), creamer (14.4%), malt flavor (0.2%) and milk cream flavor (0.4%) to produce the instant cereal beverage powders.

Chemical and physical properties examination

The final products, instant cereal beverage powders were examined chemical and physical properties as below.

Moisture and protein content (A.O.A.C. 1990).

Bulk density (Akpapunum and Markakis, 1981). The loose bulk density of product was determined by transferring 50 g product into a 250 ml graduated glass cylinder and measuring the volume of the products off the scale. The packed bulk density was determined in a similar way, but the volume was measured after tapping the cylinder until the products settled (about 2 min). Both of the

loose and packed bulk density were calculated as:

$$\text{Bulk density (g/ml)} = \frac{\text{mass of sample}}{\text{Volume occupied by sample}}$$

Reconstitution index (Ihekoronye and Oladunjoye, 1988). The reconstitution index was determined by mixing 7.5 g of products with 50 ml. of warm water (50°C) for 90 sec and measuring the sediment formed in a graduated cylinder, 10 min after the mixing.

Water absorption index and Water solubility index (Anderson *et al*., 1969 and Damardjati and Luh, 1987). A 2.5 g of the ground sample was suspended in 30 ml of water in a 50 ml tared centrifuge tube. The sample was stirred intermittenly over a 30 min period and centrifuged at 3000×g for 10 min. The supernatant was poured carefully into a tared evaporating dish. The remaining gel was weighed and the WAI was calculated as follows:

Water absorption index (WAI) =

$$\frac{\text{Weight of gel - Weight of ground dry sample}}{\text{Weight of ground dry sample}}$$

The supernatant liquid from the WAI study was vacuum dried at 70°C until constant weight was reached. The amount of dried solid (%) recovered from evaporating the supernatant was expressed as water solubility index.

Viscosity. The viscosity of dispersions containing 7.5 g of product in 50 ml of water was measured by Brookfield Digital Viscometer, model RVDV-III (Operating conditions:- U-L Adaptor, ULA Spindle, 16 ml sample, 25°C and 10 rpm).

Sensory evaluation

The final products, instant cereal beverage powders at each size of corn grit and each composition between corn grit and isolated soy protein were conducted with trained panels (18) in balanced incomplete block experimental design (t=9, k=4, r=8, b=18, λ=3) who have experienced with food product development by using 9-point hedonic scale (1-extremely dislike to 9-extremely like) to determine the preference in color, odor, flavor, texture and overall acceptant of products.

Nutrition labeling and protein quality

The nutritive value of the most appropriate instant cereal beverage powder was evaluated in the forms of nutrition labeling and pattern of essential amino acids. The nutrition labeling based on the Announcement of the Public Health Ministry No.182, 1998. Additionally, the protein quality was assessed by comparing essential amino acids of this product with standard pattern of essential amino acids set by joint FAO/WHO committee.

RESULTS AND DISCUSSION

Chemical composition and particle size of raw materials using for instant cereal powders from extrusion process

The principal raw materials using for production of instant cereal powders from extrusion process in this research work was corn grit. This is because apart from being an important agricultural raw material in Thailand with cheap price and sufficient production quantity for domestic consumption, corn also has properties suitable for extrusion process. Because it can expand well and gives good corn flavor retained after extrusion (Moore, 1993). The raw material used together with corn was soybean which improve extruded product for higher nutritive value in case of protein content and pattern of essential amino acids than product made from only one type of cereal. Moreover, the heat from extrusion process also reduced trypsin inhibitor which is a toxic substance in soybean not required by the body (Konstance *et al*., 1998). Types of soybean using in this research were in the form of isolated soy protein and full fat soy flour. Usage of isolated soy protein gave benefits in the aspects of increasing protein quantity (Table 1), without the disadvantage of bean smell in the product. While apart from being raw material with high nutritional value concerning protein and

Table 1 Chemical composition and particle size of raw materials.

Raw materials	Chemical composition (%)					Average particle size (mesh)
	Moisture	Fat	Protein	Ash	Dietary 1/ fiber	
Corn grit (Large)	11.95	1.43	6.26	0.40	3.89	13
Corn grit (Medium)	11.67	1.30	6.46	0.45	2.42	23
Corn grit (Small)	11.80	1.64	6.36	0.54	2.88	33
Isolated soy protein	3.46	3.02	86.75	4.94	4.60	> 100 2/
Full fat soy flour	2.65	22.10	40.14	5.06	17.20	> 100 3/

Source : 1/ Food and Nutrition Technical Services, Institute of Nutrition, Mahidol University.
2/ Protein Specialties Division, Archer Daniels Midland Company, USA.
3/ Sahaviriya Pure Science Co., Ltd.

fat, full fat soy flour is also source of dietary fiber (Table 1). Furthermore, usage of oil from full fat soy flour together with vegetable oil which added to the raw materials about 1-2 percent, was also beneficial in the aspect of food material lubrication, helping the food product to expand well and consistently, and have good texture (Boonyasirikool and Charunuch, 1999)

The effect of particle size of corn grit and the composition between corn grit and isolated soy protein on the product qualities

Due to the interactions between particle size of corn grit (13, 23 and 33 mesh) and the composition between corn grit and isolated soy protein (84:10, 74:20 and 64:30) did not have significant effect ($P>0.05$) on the moisture content and the physical properties of product (bulk density, reconstitution index, water absorption index, water solubility index and viscosity) but only had significant effect ($P\leq0.05$) on the protein content as shown in Table 2, so it should be considered additionally on the effect of main factors (particle size of com grit or the composition between corn grit and isolated soy protein) as shown in Table 3 and 4. It was found that particle size of com grit did not have significant effect ($P>0.05$) on the chemical composition (moisture and protein content) and most of the physical properties of product, but the differences in the composition between corn grit and isolated soy protein had significant effect ($P\leq0.05$) on the protein content and the physical properties of product , except the moisture content. Isolated soy protein has increased protein content which caused the product less soluble and reconstitute not well, reduced viscosity also. Because of this, raw material which consists of starch molecules such as corn can expand and absorb water well, while raw material which consist of protein molecules such as isolated soy protein has less expand after extrusion and the property of dissolving into homogeneous solution with difficulty (Moore, 1993). Thus, the composition between corn grit and isolated soy protein was an important factor for producing high quality of instant cereal beverage powders.

Because the studied factors (particle size of corn grit and the composition between corn grit and isolated soy protein) were quantitative factors, hence response surface could be studied to show trends of response when levels of studied quantitative factors changed as shown in Table 5.

Moreover, the effect of particle size of corn grit and the composition between corn grit and isolated soy protein caused the product difference significantly ($P\leq0.05$) on sensory evaluations as

Table 2 Effect of interactions between particle size of corn grit and the composition between corn grit and isolated soy protein on some chemical and physical properties of instant cereal beverage powders.

Treatment		Moisture (%)	Protein (% db)	Bulk density (g/ml)		Reconstitution index (ml)		Water absorption index	Water solubility index (%)	Viscosity (Cps)
Size of corn grit (mesh)	Corn grit : Isolated soy protein			Loose bulk density	Packed bulk density	Sediment	Clear			
13	84:10	3.33±0.39^{A}	12:98±0.30^{D}	0.44±0.01^{A}	0.52±0.04^{A}	53.00±0..25^{A}	1.00±0.25^{A}	1.95±0.05^{A}	55.97±2.78^{A}	168.33±9.95^{A}
13	74:20	3.15±0.42^{A}	17.61±0.32^{C}	0.40±0.06^{A}	0.47±0.08^{A}	52.08±0.14^{A}	1.92±0.14^{A}	1.40±0.18^{A}	56.79±2.20^{A}	94.97±9.12^{A}
13	64:30	3.27±0.24^{A}	20.45±0.77^{B}	0.42±0.03^{A}	0.49±0.06^{A}	49.58±1.59^{A}	4.42±1.59^{A}	1.54±0.26^{A}	53.79±2.65^{A}	48.43±8.73^{A}
23	84:10	3.19±0.37^{A}	12.65±0.31^{D}	0.43±0.03^{A}	0.52±0.06^{A}	52.92±0.14^{A}	1.08±0.14^{A}	2.00±0.02^{A}	56.13±2.67^{A}	175.13±19.92^{A}
23	74:20	3.11±0.49^{A}	17.26±0.69^{C}	0.40±0.04^{A}	0.48±0.06^{A}	51.75±0.25^{A}	2.25±0.25^{A}	1.39±0.12^{A}	56.40±1.03^{A}	88.07±20.90^{A}
23	64:30	3.34±0.14^{A}	21.45±0.27^{A}	0.40±0.04^{A}	0.48±0.06^{A}	48.17±2.36^{A}	5.83±2.36^{A}	1.68v0.12^{A}	52.59±0.37^{A}	30.97±6.85^{A}
33	84:10	3.17±0.22^{A}	12.60±0.26^{D}	0.44±0.02^{A}	0.54±0.05^{A}	52.58±0.29^{A}	1.42±0.29^{A}	1.86±0.04^{A}	57.75±0.81^{A}	140.57±15.40^{A}
33	74:20	3.14±0.02^{A}	17.23±0.20^{C}	0.42±0.05^{A}	0.52±0.08^{A}	50.83±0.76^{A}	3.17±0.76^{A}	1.39±0.18^{A}	56.14±0.91^{A}	87.07±28.53^{A}
33	64:30	2.82±0.24^{A}	21.45±0.48^{A}	0.41±0.05^{A}	0.50±0.09^{A}	48.08±2.27^{A}	5.92±2.27^{A}	1.66±0.28^{A}	53.98±1.69^{A}	28.60±5.47^{A}

In a column, means with the same letter are not significantly different at 0.05 significance level.

Table 3 Effect of main factor (size of corn grit) on some chemical and physical properties of instant cereal beverage powders.

Size of corn grit (mesh)	Moisture (%)	Protein (% db)	Bulk density (g/ml)		Reconstitution index (ml)		Water absorption index	Water solubility index (%)	Viscosity (Cps)
			Loose bulk density	Packed bulk density	Sediment	Clear			
13	3.25±0.32^{A}	17.01±3.29^{A}	0.42±0.04^{A}	0.49±0.06^{B}	51.56±1.73^{A}	2.44±1.73^{A}	1.63±0.03^{A}	55.51±2.59^{A}	103.91±52.96^{A}
23	3.21±0.33^{A}	17.12±3.84^{A}	0.41±0.03^{A}	0.49±0.05^{B}	50.94±2.45^{A}	3.05±2.45^{A}	1.69±0.28^{A}	55.04±2.34^{A}	98.06±64.60^{AB}
33	3.04±0.24^{A}	17.09±3.85^{A}	0.42±0.04^{A}	0.52±0.07^{A}	50.50±2.30^{A}	3.50±2.30^{A}	1.64±0.26^{A}	55.96±1.94^{A}	85.41±51.21^{B}

In a column, means with the same letter are not significantly different at 0.05 significance level.

Table 4 Effect of main factor (composition between corn grit and isolated soy protein) on some chemical and physical properties of instant cereal beverage powders.

Corn grit : Isolated soy protein	Moisture (%)	Protein (% db)	Bulk density (g/ml)		Reconstitution index (ml)		Water absorption index	Water solubility index (%)	Viscosity (Cps)
			Loose bulk density	Packed bulk density	Sediment	Clear			
84:10	3.23±0.30^{A}	12.74±0.31^{C}	0.44±0.02^{A}	0.52±0.04^{A}	52.83±0.28^{A}	1.17±0.28^{C}	1.94±0.07^{A}	56.62±2.15^{A}	161.34±20.85^{A}
74:20	3.13±0.32^{A}	17.36±0.43^{B}	0.41±0.04^{B}	0.49±0.07^{B}	51.56±0.69^{B}	2.44±0.69^{B}	1.39±0.14^{C}	56.44±1.33^{A}	90.03±18.64^{B}
64:30	3.14±0.31^{A}	21.12±0.69^{A}	0.41±0.03^{B}	0.49±0.06^{B}	48.61±1.96^{C}	5.39±1.96^{A}	1.63±0.21^{B}	53.45±1.71^{B}	36.00±11.24^{C}

In a column, means with the same letter are not significantly different at 0.05 significance level.

Table 5 Response surface function of some chemical composition and physical properties of products when particle size of corn grit and the amount of isolated soy protein changed.

Chemical composition and physical properties	Response surface function
Moisture	$Y = 3.0213+0.0352A-0.0086B-0.0007A^2-0.0007AB+0.0005B^2$
Protein	$Y = 8.4514-0.0348A+0.5124B-0.0007A^2+0.0035AB-0.0043B^2$
Bulk density	
- Loose bulk density	$Y = 0.5225-0.0041A-0.0065B+0.0001A^2-0.00004AB+0.0002B^2$
- Packed bulk density	$Y = 0.6076-0.0037A-0.0085B+0.0001A^2-0.00005AB+0.0002B^2$
Reconstitution index	
- Sediment	$Y = 52.7978-0.0369A+0.1845B+0.0008A^2-0.0027AB-0.0083B^2$
- Clear	$Y = 1.2022+0.0369A-0.1845B-0.0008A^2+0.0027AB+0.0083B^2$
Water absorption index	$Y = 3.2531+0.0147A-0.1842B-0.0006A^2+0.0006AB+0.0039B^2$
Water solubility index	$Y = 54.8528-0.2184A+0.4963B+0.0070A^2-0.0040AB-0.0141B^2$
Viscosity	$Y = 264.6380+0.2398A-10.1789B-0.0339A^2+0.0198AB+0.0864B^2$

When A = particle size of corn grit
B = amount of isolated soy protein

shown in Table 6. That is difference in products, when the composition between corn grit and isolated soy protein changed, could be seen more clearly when compared to changing of the particle size of corn grit. Product with the composition between corn grit : isolated soy protein equaled to 84:10 had more trend of higher liking scores of product concerning color, odor, flavor, texture and overall acceptance, when compared to product with the composition between corn grit : isolated soy protein equaled to 74:20 and 64:30, for all values of particle size of corn grit (13, 23 and 33 mesh). Because of increasing protein quantity such as the result in Table 4, it caused the product to have the property of dissolving into homogeneous solution with difficulty or poor reconstitution which brought the organoleptic properties of product get worse.

Nutritive value of instant cereal beverage powders in the forms of nutrition labeling and pattern of essential amino acids

Choose the representative product of instant cereal beverage powders from extrusion process for nutritional evaluation by using size of corn grit equaled to 13 mesh and composition between corn grit and isolated soy protein equaled to 84:10 due to the results of the effect of main factors on Table 4 which stated that the product using composition between corn grit and isolated soy protein equaled to 84:10 had more trend for good reconstitution with less separation and sensory evaluation on Table 6 which showed that the product using size of corn grit equaled to 13 mesh and composition between corn grit and isolated soy protein equaled to 84:10 had higher score of preference in color, odor, flavor, texture and overall acceptance. From nutritional evaluation of this products in the forms of nutrition labeling (Announcement of the Pulbic Health Ministry, No.182, 1998), it was found that this product has good nutrition condition for health (The Committee, 1989) because it consists of higher protein quantity (4g per one serving) when compared to other available products. And the quantity of protein is equaled to 8 percent of Thai RDI which is nearly to protein quantity in food

Table 6 Sensory evaluation of instant beverage powders based on corn and soybean from extrusion process.

Treatment		Organoleptic properties				
Size of corn grit	Corn grit : Isolated soy protein	Color	Odor	Flavor	Texture	Overall acceptance
13	84:10	7.42 ± 0.49^{A}	7.14 ± 0.63^{A}	7.19 ± 0.78^{A}	7.26 ± 0.39^{A}	7.39 ± 0.43^{A}
13	74:20	7.32 ± 0.34^{AB}	6.76 ± 1.06^{AB}	6.67 ± 0.80^{B}	6.42 ± 0.88^{B}	6.64 ± 0.79^{B}
13	64:30	7.12 ± 0.21^{AC}	6.67 ± 0.55^{AC}	6.47 ± 0.44^{BC}	6.59 ± 0.68^{BC}	6.50 ± 0.35^{B}
23	84:10	7.40 ± 0.35^{A}	7.11 ± 0.64^{A}	7.12 ± 0.65^{AD}	6.90 ± 0.46^{ACD}	7.02 ± 0.51^{AB}
23	74:20	7.19 ± 0.53^{AD}	6.96 ± 0.68^{A}	6.72 ± 0.94^{BD}	6.76 ± 0.52^{BDE}	6.74 ± 0.84^{BC}
23	64:30	6.69 ± 0.49^{E}	6.20 ± 0.58^{C}	6.04 ± 0.53^{CE}	6.07 ± 0.84^{B}	6.01 ± 0.59^{D}
33	84:10	7.34 ± 0.54^{AF}	6.92 ± 0.59^{A}	6.80 ± 0.57^{AB}	7.01 ± 0.53^{ACE}	6.91 ± 0.40^{B}
33	74:20	6.92 ± 0.59^{BCDEF}	6.78 ± 0.44^{AD}	6.62 ± 0.46^{B}	7.06 ± 0.30^{AE}	6.80 ± 0.39^{B}
33	64:30	6.89 ± 0.54^{CDE}	6.31 ± 0.58^{BCD}	6.40 ± 0.50^{BE}	6.11 ± 0.48^{B}	5.90 ± 0.40^{CD}

In a column, means with the same letter are not significantly different at 0.05 significance level.

claimed as source of protein (according to Nutrition claim, appendix to announcement of the Public Health Ministry No.182, 1998, which stated that food claimed as source of protein must consist of 10-19 percent of protein quantity required for Thai RDI). Furthermore, the product was considered to have suitable protein quantity, because nutritional regulation stated that approximately 12 percent of total energy should be received from protein (Whitney and Hamilton, 1981). In the aspects of quantities of fat, saturated fat, and sodium, they are in "low" of nutrition claim standard, and there was no cholesterol. This product also had Vitamin A, B_1, B_2, Ca and Fe in the quantities of 20, 4, 8, 8 and 4 percent of Thai Recommended Daily Intakes respectively. Concerning with dietary fiber, it was found that there was rather little (0.4 g per 100 g of product) which is stated to zero value in the form of nutrition labeling. Hence for further product development, more dietary fiber reinforcement raw materials should be added.

Moreover, the protein quality was assessed by comparing essential amino acids of this product with standard pattern of essential amino acids set by joint FAO / WHO committee, as shown in Table 8. It was found that this product has good quality of protein because of nearly every type of essential amino acids be according to the standard set by FAO/WHO, except threonine, which is deficient in small amount and showed the chemical score equaled to 97.5 percent.

CONCLUSION

Production of instant cereal beverage powders based on corn and soybean by using extrusion process showed that the differences in particle size of corn grit (13, 23 and 33 mesh) did not have significant effect ($P>0.05$) on the chemical composition (moisture and protein content) and most of the physical properties of products but the differences in the composition between corn grit and isolated soy protein have significant effect ($P\leq0.05$) on the protein content and the physical properties of product (bulk density, reconstitution index, water absorption index, water solubility index and viscosity). The suitable product should have the composition between corn grit and isolated soy protein equaled to 84:10 because it can reconstitute well, good soluble and moderate

Table 7 Nutrition labeling of instant beverage powders based on corn and soybean from extrusion process compared with marketable products.

Nutrition facts			
A_1B_1[1/]	Marketable Products		
	NESVITA	GOOD TIME	P.P.CORN MILK
Serving size : 1 package (30 g)	Serving size : 1 package (30 g)	Serving size : 1 package (30 g)	Serving size : 1 package (30 g)
Serving per package : 1	Serving per package : 1	Serving per package : 1	Serving per package : 1
Amount per serving	Amount per serving	Amount per serving	Amount per serving
Calories 120 Calories from Fat 20	Calories 120 Calories from Fat 20	Calories 130 Calories from Fat 16	Calories 140 Calories from Fat 40
% Daily Value*	% Daily Value*	% Daily Value*	% Daily Value*
Total Fat 2 g 3 %	Total Fat 2 g 3 %	Total Fat 2 g 3 %	Total Fat 4.5 g 7 %
Saturated Fat 0.5 g 3 %	Saturated Fat 1.5 g 7 %	Saturated Fat 0 g 0 %	Saturated Fat 4 g 20 %
Cholesterol 0 mg 0 %	Cholesterol 0 mg 0 %	Cholesterol 0 mg 0 %	Cholesterol Less than 5 mg 1 %
Protein 4 g	Protein 2 g	Protein 3 g	Protein 2 g
Total Carbohydrate 23 g 8 %	Total Carbohydrate 23 g 8 %	Total Carbohydrate 20 g 7 %	Total Carbohydrate 22 g 7 %
Dietary Fiber 0 g 0 %	Dietary Fiber Less than 1 g 4 %	Dietary Fiber 3 g 12 %	Dietary Fiber 1 g 4 %
Sugar 11 g	Sugar 13 g	Sugar 5 g	Sugar 9 g
Sodium 60 mg 3 %	Sodium 150 mg 6 %	Sodium 120 mg 3 %	Sodium 130 mg 5 %
% Daily Value*	% Daily Value*	% Daily Value*	% Daily Value*
Vitamin A 20 % • Vitamin B_1 4 %	Vitamin A 0 % • Vitamin B_1 2 %	Vitamin A 0 % • Vitamin B_1 12 %	Vitamin A Less than 2% • Vitamin B_1 4 %
Vitamin B_2 8 % • Calcium 8 %	Vitamin B_2 4 % • Calcium 20 %	Vitamin B_2 12 % • Vitamin C 0 %	Vitamin B_2 4 % • Calcium Less than 4 %
Iron 4 %	Iron 20 % • Folic Acid 20 %	Calcium 20 % • Iron 4 %	Iron Less than 2 %

*Percent Daily Values are based on a 2000 calorie diet.

Your daily values may be higher or lower depending on your calorie needs.

Total Fat	Less than	65 g
Saturated Fat	Less than	20 g
Cholesterol	Less than	300 mg
Total Carbohydrate		300 g
Dietary Fiber		25 g
Sodium	Less than	2,400 mg

Calories per gram :
Fat = 9 ; Carbohydrate = 4; Protein = 4

1/ Instant beverage powders operate at particle size of corn grit equaled to 13 mesh and the composition between corn grit and isolated soy protein equaled to 84:10

Table 8 Comparison of essential amino acid contents between instant beverage powders (A_1B_1) and FAO/WHO standard (1972) in milligrams per gram of protein.

Essential amino acids	A_1B_1[1/]	FAO/WHO[2/]
Isoleucine	43	40
Leucine	104	70
Lysine	57	55
Methionine + Cystine	55	35
Phenylalanine + Tyrosine	78	60
Threonine	39 (97.5)[3/]	40
Tryptophane	15	10
Valine	50	50

Source : 1/ Division of Nutrition, Department of Health, Ministry of Public Health,
2/ Food Composition Table for use in East Asia (FAO, 1972)
3/ Limiting amino acid with chemical score in parenthesis

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

viscosity. Moreover, the acceptable score is the highest also. Even though the protein content is less than other products but it is still more than marketable products, and it has adequate protein content and appropriate pattern of essential amino acids for good nutritive consuming, Therefore, this research work is beneficial in the aspects of application of extrusion process for diversity of products in food industry and promote Thai agricultural raw materials by giving them value added.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial support of the Kasetsart University Research and Development Institute (KURDI).

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