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Development of Instant Nutritious Beverage from Germinated Jasmine Brown Rice for Elderly Consumers

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ABSTRACT

A rise in the number of elderly consumers (age 60+) will drive the need for healthy, convenience and good taste foods. Germinated brown rice provides good source of nutrients especially dietary fiber and γ-aminobutyric acid (GABA). Thus, the objective of this study was to develop instant nutritious beverage from germinated jasmine brown rice (GJBR) as a new choice of healthy drink for elderly consumers. An optimum formulation of instant nutritious beverage from GJBR was formulated by using linear programming to minimize cost and energy and maximize protein and dietary fiber. Cooked GJBR flour was prepared by steaming GJBR, removing husk, cooking, drying and grinding. Cooked GJBR flour (150 mesh) 100 grams contained protein 9.03 grams and dietary fiber 3.52 grams. According to survey study, the important factors which elderly consumers used for selection the instant beverage were nutritive value, good taste and convenience to use. The optimal formulation of the instant beverage from GJBR consisted of 20% cooked GJBR flour, 20% sugar, 44.6% skim milk powder, 5.1% vanilla powder, and 10% inulin. Premixed of vitamin B6, vitamin B12, folic acid and L-Carnitine was added to the instant beverage. One serving (35g) of the instant beverage composed of energy 120 Kcal, protein 5.64 g, dietary fiber 3.72 g, carbohydrate 24 g, fat 0.18 g, vitamin B6 1 mg, vitamin B12 0.82 μg, folic acid 59.3 μg and calcium 203 mg. The water activity of the product was 0.28. All of 50 elderly consumers that tested product accepted the product. If the product available in the market, 80% of them decided to purchase this product at the price equal to commercial ones after they had learned about the nutritional quality of the instant GJBR beverage.

Key words: nutritious beverage, germinated jasmine brown rice, elderly consumer, formulation, acceptance test

INTRODUCTION

The number and proportion of the elderly raised rapidly in Thailand within the last 20 years. The increase in that population is the result of high fertility rate after World War II. They are also receiving better health care system as well as more commercial healthy and anti-aging products available. Several marketing researches indicated that products for elderly consumer are in trend for this century and the next (Manager, 2004).

Germinated brown rice (GBR) is a very popular product in Japan. During the process of being germinated, nutrients in the brown rice

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change drastically. Those major nutrients that increase in content in the GBR are γ-aminobutyric acid (GABA), dietary fiber, inositols, ferulic acid, phytic acid, tocotrienols, magnesium, potassium, zinc, γ-oryzanol and prolyendopeptidase inhibitor (Kayahara and Tukahara, 2000). Accordly, they concluded that continuous intake of GBR could accelerate metabolism of brain, relieve constipation, lowering blood pressure, and prevent colon cancer, heart disease, and Alzheimer's disease.

Kao Dawk Mali (KDML) 105 is one of the most popular rice varieties in Thailand. Owing to its pleasant aroma and soft texture, the KDML 105 Thai aromatic rice cultivar is commonly referred to as "Jasmine rice". Varanyanond *et al.* (2005) studied GABA content of germinated jasmine brown rice (GJBR) and found that the change of GABA content had the greatest increase after 72 hr. Germination changed texture of brown rice from hard to soft resulting in easier chewing. Development of germinated rice could be an alternative way to add value of Thai rice and also to create the new product of rice for consumers.

The healthy drink is taken up a large market share of food at present. From the research of Kasikorn bank research center in topic "Bangkok people and healthy drink consumption", they expected that in year 2000 healthy drink market had 2,700 million baht with 10-15% of expansion rate (Naewna, 2000). The encouraged factors are the awareness of consumers concerning their health and beauty.

Lerswanichwatana (2003) developed the beverage from KDML 105 germinated for 48 hrs that was selected as raw material of beverage. The optimum formulation of dry mix beverage consists of germinated rice powder 33.65%, instant milk powder 14.42%, non-dairy creamer 9.62%, gum arabic 9.62%, sugar 28.85% and cocoa powder 3.84%. Nutritive values of the dry mix beverage were 13.44% protein, 4.82% fat, 1.25% dietary fiber, 2.06% ash, 74.26% carbohydrate; thiamin and riboflavin content were 0.65 and 0.69 mg/100g, respectively.

The McNemar test represents a comparison of dependent proportions for binary response variables. It is a two-related sample difference test that follows a Chi-square distribution with degree of freedom (df) of 1. The same consumers are categories, "before" and "after" condition. The McNemar test can be performed to analyze the change in probability of consumer purchase intent before and after they have been informed about product health benefits (Agresti, 1996).

Therefore, the objective of this research was to formulate the nutritious beverage using germinated jasmine brown rice and investigation acceptability and purchase intent of elderly consumer.

MATERIALS AND METHODS

Materials

Paddy rice, Kao Dawk Mali 105 was obtained from Rice Research Institute Bangkhen, Bangkok, Thailand. Sugar, non-fat milk powder and vanilla powder were purchased from local market in Bangkok, Thailand. Inulin and L-carnitine were obtained from Helm-Mahaboon Co., Ltd. Premixed of vitamin B6, vitamin B12 and folic acid was prepared by Adinop Co., Ltd.

Methods

Consumer survey

The consumer survey using questionnaire was conducted with 80 elderly consumers (>60 years old) at Elderly Club of Thammasat-Chalermprakeit hospital, Pathum Thani province. Questionnaire used contained questions related to demographic, consumption behavior and used for cereal beverage.

Cooked germinated jasmine brown rice (CGJBR) flour preparation

CGJBR flour was prepared from germinated Kao Dawk Mali 105 rice as elaborate in Figure 1. Qualities of CGJBR flour and ungerminated Jasmine brown rice (JBR) flour were measured including proximate analysis (AOAC, 2000), reducing sugar (Somogyi and Nelson, 1952), water activity (a_w), color: L*, a*, b* and ΔE*, water solubility index (WSI) (Anderson *et al.*, 1969) and water absorption index (WAI) (Damardjati and Luh, 1987). GABA content of CGJBR was also analyzed by method based on Cohen and Michaud (1993).

Selection of prototype formulation

Two commercial brands of instant cereal beverage were selected as base formulation. Brand A was the most popular brand as indicated by consumer survey and it was frequently consumed by elderly. Brand B was the commercial instant beverage that had fine powder form, no artificial flavor and color as resulted from product survey. Malt extract in both formulations were substituted by CGJBR flour. Two prototypes instant cereal beverage using CGJBR flour were prepared by mixing all ingredients (dried forms) using flour mixer. The beverages prepared from dry mix were evaluated by 50 elderly panels using pair preference test (Resurreccion, 1998).

Formulation of instant nutritious beverage using CGJBR

The selected prototype formula was formulated to obtain the lowest cost and optimum nutritive value for elderly consumer using linear programming (the software LINDO version 6.10). The price and allowed amount of ingredients in formulation is shown in Table 1. Inulin that are soluble, dietary fibre with texturising properties providing added health benefits (Sensus, 2007), was selected to be the source of dietary fiber of

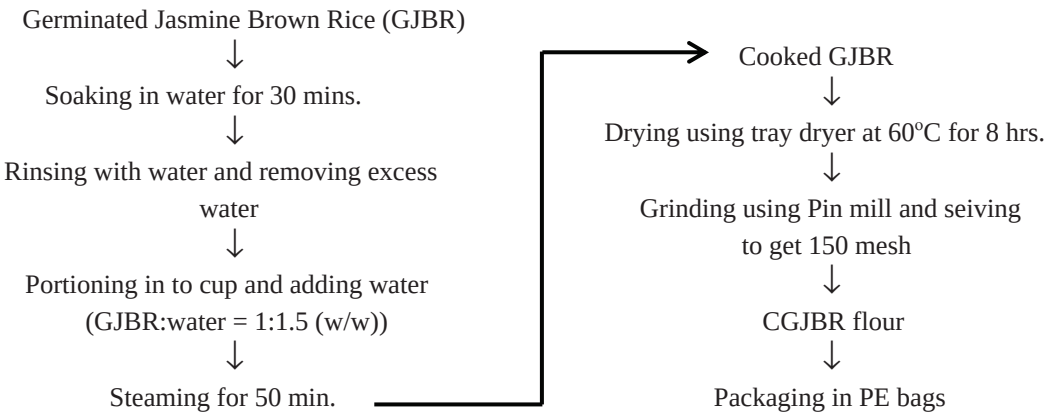

Figure 1 Processing of cooked germinated Jasmine brown rice flour.

Table 1 Price and allowed amount of ingredients of Instant GJBR beverage.

Ingredient	Price per kilogram (Baht)	Allowed amount of ingredient used (%)
CGJBR	25	15-20
Sugar	20	10-20
Non-fat milk powder	150	20-60
Inulin	170	±10
Vanilla powder	280	= 5.4

beverage other than to take from CGJBR. Required nutritive value of formulated beverage 100 g were energy less than 400 Kcal, dietary fiber more than 6 g and protein more than 5 g.

Then the formulated CGJBR beverage was fortified with premixed of vitamin B6, vitamin B12, folic acid and L-carnitine. Functional ingredients were added in amount as shown in Table 2, that can claim based on the Notification of the Ministry of Public Health No. 182/2541 (1998).

The fortified CGJBR beverage was evaluated by 50 elderly consumers of Elderly Club Thammasat-Chalermprakeit hospital. They rated the likeness for color, vanilla flavor, sweet, viscosity, oiliness and overall liking of the product using 9-point hedonic scale (1 = dislike extremely to 9 = like extremely) (Resurreccion, 1998). Just about right scale (1 = not enough, 2 = just about right, 3 = too much) was also used to determine the rightness of the mentioned attributes.

Quality measurement of instant nutritious beverage using CGJBR

The instant nutritious beverage using CGJBR was examined for physical, nutritive value, microbiology properties, consumer acceptability and cost of 1 serving size (35 g) beverage as below.

Physical properties: Color L*, a*, b*, ΔE*, water activity and WSI of the powder were determined. And for the beverage preparing by dissolving 35 g powder with 150 ml hot water was measured color L*, a*, b*, ΔE* and Brix. The viscosity (cP) of beverage (at 50°C) was measured using Viscometer Programable Rheometer Model DV-III (Brookfield, U.S.A.).

Chemical composition and nutritive value: The dry mixed of instant nutritious beverage using GJBR was measured for proximate analysis (AOAC, 2000), dietary fiber (AOAC, 2000), cholesterol (GC: Compendium of methods for food analysis, 2003), vitamin B6 (JAFC, 1984), vitamin B12 (AOAC, 2000), folic acid (AOAC, 2000) and calcium (AOAC, 2000). Energy value was calculated from percentage of fat, protein and carbohydrate by multiplying with energy factor for those nutrients.

Microbiological properties: The dry form of instant beverage was evaluated for total plate count, yeast and molds, coliforms, *Eschericia coli*, *Staphylococcus aureus* and *Salmonella* sp. (AOAC, 2000).

Consumer acceptability test: Fifty elderly consumers were recruited from Elderly Club Thammasat-Chalermprakeit hospital. Consumers were asked to provide their demographic information. Consumers were instructed to visually evaluate sample for their overall liking of powder and amount of powder per sachet. Then they prepared beverage according to instruction as well by emptying 1 sachet of product into cup (150 ml) of hot water and stirring. Participants evaluated for degree of liking for time to dissolved beverage, serving size and overall liking of beverage using a 9-point hedonic scale where 1 = "dislike extremely" and 9 = "like extremely". They also asked to rated acceptance and purchase intent using the binomial scale (yes/no).

Table 2 Amount of functional ingredients added the instant GJBR beverage.

Functional ingredient	Fortified amount/100 g	% of Thai RDI
Vitamin B6	0.6 mg	30% Thai RDI
Vitamin B12	0.6 μg	30% Thai RDI
Folic acid	60 μg	30% Thai RDI
L-carnitine	250 mg	250 mg per occasion

RESULTS AND DISCUSSION

Consumer survey

From 50 elderly consumers who participated in this study, 67.5% were female. The majority of the participants (88.8%) were 60-75 years old.

For information of cereal beverage consumption, 42.7% of participants drank the beverage for breakfast. Hot drink (83.8%) and 3 in 1(57.1%) beverage type were mostly selected. About 43.8% of them drank about half of cup of beverage. The amount of hot water used in preparation of beverage was 150-200 ml (33.8%).

The factors that were important to purchase intent consisted of nutritive value, good taste and convenience to use. The requirement of participants for instant nutritious beverage using CGJBR should be fine powder type, natural color and flavor, low fat, no cholesterol, containing calcium and dietary fiber. Product should be instant similar to 3 in 1 product type and packed in aluminum foil laminate bag. The price should equal or lower than market price (4-8 baht).

From consumer survey information, the product concept of instant nutritious beverage from CGJBR was generated. It was instant beverage consisted of CGJBR flour, sugar and milk powder as main ingredients. Characteristic of powder should be fine powder, natural color and flavor, low fat and no cholesterol. The product should also provide calcium and fiber to the consumer.

CGJBR flour properties

Table 3 shows the chemical contents in CGJBR flour and ungerminated JBR flour. Protein, fat, reducing sugar and dietary fiber of CGJBR flour were significant ($P \leq 0.05$) higher and

Table 3 Chemical composition and physical properties of CGJBR and JBR flour.

Chemical composition / Physical properties	CGJBR flour	JBR flour
Moisture (%)	$8.35^{a} \pm 0.55$	$7.48^{b} \pm 0.70$
Protein (%)	$9.03^{a} \pm 0.98$	$7.84^{b} \pm 0.80$
Fat (%)	$2.75^{a} \pm 0.55$	$2.41^{b} \pm 0.60$
Ash^{ns} (%)	1.64 ± 0.88	1.17 ± 0.74
Crude fiber^{ns} (%)	0.79 ± 0.50	0.62 ± 0.67
Carbohydrate (%)	$77.44^{b} \pm 0.89$	$80.48^{a} \pm 0.97$
Reducing sugar (g.glucose/ 100 g.sample)	$3.57^{a} \pm 0.45$	$1.10^{b} \pm 0.55$
Dietary fiber (%)	$3.52^{a} \pm 0.45$	$1.02^{b} \pm 0.30$
GABA (mg/100 g sample)	7.62 ± 0.33	no result
Color		
L*	$83.98^{b} \pm 0.33$	$90.14^{a} \pm 0.35$
a*	$1.79^{a} \pm 0.40$	$0.70^{b} \pm 0.48$
b*	$19.22^{a} \pm 0.44$	$14.18^{b} \pm 0.30$
ΔE*	18.06 ± 0.30	12.43 ± 0.42
Water activity^{ns}	0.36 ± 0.40	0.35 ± 0.60
Water absorption index	$7.35^{a} \pm 0.44$	$2.51^{b} \pm 0.57$
Water solubility index	$9.78^{a} \pm 0.77$	$4.79^{b} \pm 0.85$

* Mean value in the same row with different subscripts are significantly different ($P \leq 0.05$)

L (100-lightness,0-darkness); +a to –a, increasing red to increasing green; +b to –b, increasing yellow to increasing blue

ns = non significantly different

CGJBR : cooked germinated jasmine brown rice

JBR: jasmine brown rice

carbohydrate was lower than that of ungerminated JBR flour. Nutrition stored in brown rice is decomposed by biochemical reaction during germination. Starch breakdown during germination is caused by the synergistic action of hydrolytic enzyme, i.e., α-amylase, β-amylase, debraching enzyme and α-glucosidase. Protein was hydrolyzed to amino acid and peptide. It was found that gamma aminobutyric acid (GABA), tocopherol, tocotrienol and gamma-orazynol were stored during germination (Vangsintaveekul, 2006).

The GABA content (7.62 mg/100 g sample) was found from germinated rice within 5 days. This amount of GABA was higher than non-germinated of Vietnamese ordinary long grain rice: Jasmine rice (3.6 mg/100 g sample) (Shoichi and Ishikawa, 2004).

L* value of CGJBR flour was higher than ungerminated JBR flour but a* and b* value was lower. The color of CGJBR flour was darker of yellowness because of the effect of non-enzymatic browning reaction between the cooking processes of CGJBR. Water absorption index and water solubility index of CGJBR were also higher that in non-germinated one. The result was in agreement with the study of Shigeo and Junji (2001) that chemical structure in GJBR was broken down by enzyme during germination

Formulation of GJBR instant beverage

Result from preference test indicated that the prototype beverage B was significant ($P \leq 0.05$) preferred (44 consumers) to the prototype beverage A (6 consumers) (one tailed t-test, n = 50, df = 1, minimum answer = 32). Therefore, the prototype beverage B was selected for further formulation.

The optimum formulations obtained from linear programming contained 20% CGJBR, 20% sugar, 44.6% non-fat milk powder, 10% inulin and 5.1% vanilla powder. A nutritive value and raw materials of the product that obtained by computer as shown in Table 4.

Figure 2 shows pictures of the GJBR

Table 4 Nutritive value and cost of raw material of the GJBR instant beverage obtained from linear programming.

Nutritive values and cost /100 g. sample	Criteria	Linear programming
Energy (Kcal)	< 400	317.70
Protein (g)	> 5	6.30
Dietary fiber (g)	> 6	9.70
Cost (Baht)	Lowest	10.93

Figure 2 Instant GJBR beverage for elderly consumer.

instant beverage dry and liquid form. Table 5 shows the amount of ingredients in fortified formulation. Preparation of instant beverage was shown in figure 3.

Hedonic scores of fortified product for all attributes ranged from 7-8 (color = 7.68, vanilla flavor = 7.54, sweet = 7.34, viscosity = 7.16, oiliness = 7.50 and overall liking = 7.74). Participants also indicated that all attributed were just right for them. This result indicated that development of the GJBR instant beverage met the designed product specification.

Qualities of the GJBR beverage for elderly consumer

Table 6 shows physical, chemical and microbiological characteristics of GJBR instant beverage for elderly consumer. Dry form of instant beverage had bright-yellowness color and contained water activity of 0.28 which lower than maximum requirement of dry product (a_w = 0.6). Water solubility index of the product was 79.56% indicated there were some particles undissolve due to some proportions of cellulose and hemicellulose was not solubility (Ratanapanon, 2002).

Nutritive values of final product, that calculated from one serving size (35 g) of beverage, were 0.18 g total fat, 5.64 g protein, 3.72 g dietary fiber, 23,.97 g total carbohydrate, 120 Kcal energy, 1.65 mg cholesterol, 1 mg vitamin B6, 0.82 μg vitamin B12, 59.31 μg folic acid and 203 mg calcium.

Microbiological tests indicated the product was accepted by the Notification of Minintry of Public Health No. 301/2549 (2006). Therefore, GJBR beverage was safe for consumption.

In calculation of the product based on price of paddy rice 15 baht per kilogram, 1 kilogram of paddy rice resulted 59.96% CGJBR flour. Then cost of CGJBR flour was 25.02 Baht. Other ingredients costs per kilogram were 20 Baht for sugar, 150 Baht non-fat milk powder, 170 Baht for inulin, 280 Baht for vanilla powder and 3000 Baht for primixed vitamin. Therefore, cost of raw material for GJBR beverage in one serving size (35 g) was 4.28 baht.

Table 5 Ingredients of instant GJBR beverage for elderly consumer.

Ingredient	%
CGJBR flour pre-mixed (CGBR flour 150 mesh+vitamin B6+ vitamin B12+folic acid+L-Carnitine)	20.30
Instant non-fat milk powder	44.60
Sugar	20.00
Vanilla powder	5.10
Inulin	10.00

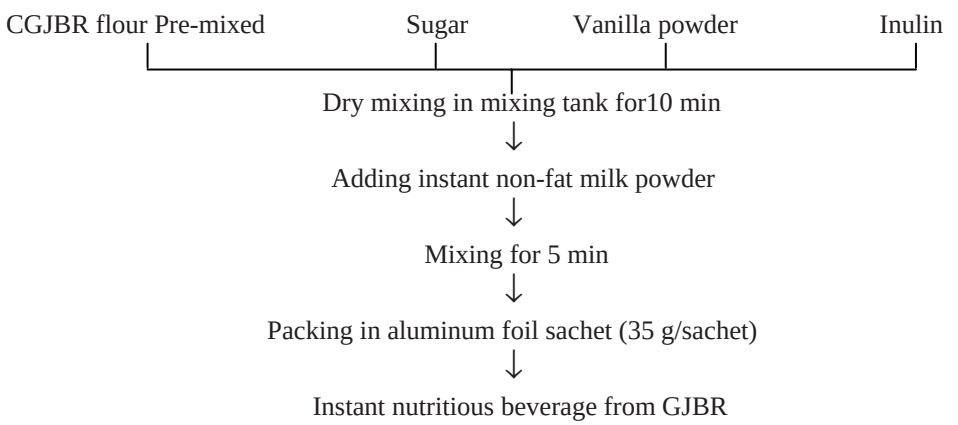

Figure 3 Processing of instant GJBR beverage for elderly consumer.

Table 6 Physical, chemical and microbiological qualities of GJBR beverage for elderly consumer.

Quality	GJBR beverage for elderly consumer
Powder form	89.27
Physical quality	
Color L*	1.14
a*	13.73
b*	12.02
ΔE*	0.28
Water activity	79.56
Water solubility index	
Chemical composition	
Total fat (grams)	0.18
Ash (grams)	1.61
Protein (grams)	5.64
Crude fiber (grams)	2.11
Dietary fiber (grams)	3.72
Total carbohydrate (grams)	23.97
Energy (Kcallories)*	120.00
Cholesterol (miligrams)	1.65
Calcium (miligrams)	203.00
Vitamin B6 (miligrams)	1.00
Vitamin B12 (micrograms.)	0.82
Folic acid (micrograms.)	59.31
Microbiological quality	
Aerobic Total Plate	< 10 CFU/g est.
Yeast and Mold	< 10 CFU/g est.
Coliform	< 3.0 MPN/g
E. coli < 3.0 MPN/g	
Staphylococcus aureus	< 10 CFU/g est.
Salmonella sp. in 25 g. sample	Not found
Beverage (35 g powder : 150 ml hot water)	
Physical quality	
Color L*	-6.52
a*	0.33
b*	0.77
ΔE*	106.42
Viscosity at 50°C (cP)	29.15
°Brix	18.00

* Calculated from [(Protein x 4) + (Total carbohydrate x 4) + (Total fat x 9)

Product was evaluated for consumer acceptance test. Means hedonic score were 7.27 for overall liking of powder, 7.30 for amount of powder per sachet, 7.07 for time to dissolved beverage, 7.30 for serving size and 7.53 for overall liking of beverage. All of respondents totally accepted product before and after they were informed the nutrition (Table 7). Result from McNemar test in Table 8, The decision of buying the instant GJBR beverage to the similar and higher the market price is significantly influenced by the information given to the elderly consumers about product health benefits.

GJBR instant beverage has nutritive value that formulated for elderly consumer but this product has benefit for everyone. Because it is a good source of protein, fiber, vitamin B1, vitamin B6, vitamin B12, calcium without fat and cholesterol.

CONCLUSION

Instant nutritious beverage from GJBR was developed. The optimum formula of producing instant beverage for elderly consumers consists of 20% GJBR flour, 20% sugar, 44.6% non-fat milk powder, 5.1% vanilla powder, 10% inulin, 0.0006% vitamin B6, 0.00006% vitamin B12, 0.00006% folic acid and 0.373% L-carnitine. One serving size (35g) composed of energy 120 Kcal, protein 5.64 g, dietary fiber 3.72 g, carbohydrate 24 g, fat 0.18 g, vitamin B6 1 mg,

Table 7 Consumer acceptance and purchase intent of GJBR beverage for elderly consumer.

Factor	%Consumer acceptance	
	Before	After
Consumer acceptance to instant nutritious beverage from GJBR for elderly consumer		
Yes	100	100
No	0	0
Purchase intent to instant nutritious beverage from GJBR for elderly consumer		
Yes, similar as market price (4-8 Baht/sachet)	70	74
Yes, Lower than market price	26	10
Yes, Higher than market price	0	16
No	4	0

Table 8 McNemar test of purchase intent to similar and higher market price of elderly consumer before and after providing nutritional data.

Purchase intent: Before providing nutritional data	Purchase intent: After providing nutritional data		Total	χ^2	95% CI**
	Yes	No			
Yes	0	0	0	8*(3.84)***	(0.06, 0.26)
No	8	42	50		
Total	8	42	50		

* non significantly different at confidential level 95%

** Confidence interval at confidential level 95%

*** Chi-square at · = 0.05, df = 1

vitamin B12 0.82 µg, folic acid 59.3 µg and calcium 203 mg. Nutrition claim of product is high protein fiber vitamin B1 vitamin B6 vitamin B12, source of calcium, no-fat and no-cholesterol. Acceptance test by 50 elderly consumers indicated that all of them (100%) accepted. This study revealed that technology and product development could add more value to Jasmine brown rice as well as to introduce more nutritious product for target consumers.

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