Development of Chinese Cereal Bar

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A special project submitted to the Biotechnology of Biotechnology, Assumption University in part of fulfillment of the requirement for the degree of Bachelor of Science in Biotechnology

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Title: Development of Chinese Cereal Bar

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Level of study: Bachelor of Science

Department: Food Technology

Faculty: Biotechnology

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ABSTRACT

In the development of Chinese Cereal Bar, the main ingredients were determined by using ranking test and 50 panelists. Formulation of prototype product was performed using just about right test, preference test and 30 panelists. The prototype formulation of Chinese cereal bar composed of Job's tear (140 g), oat meal (140 g), cashew nut (100 g), crispy pork (70 g), dried shrimp (70 g), salt (10 g), sugar (30 g), pork flavor (10 g), red pork flavor (10 .g), glucose syrup (15 g),pepper (10 g) and water (60 g). The Chinese Cereal Bar obtained the preference score of texture, appearance, flavor and overall as 7.3, 7.4, 7.4 and 7.7, respectively, which referred to like very much. Moreover, the cost of product is 21 Bath per piece.

CONTENT

Introduction

Growth in the population of the product's target market and consumers' continued quest for healthy and portable foods as prime reasons for cereal bar. Cereal bar sales in the food channel are predicted to be rose at an inflation-adjusted annual rate of 4% through 2011 (Mintel, 2011). Between 2004 and 2006, cereal bar sales increased 9.6%. Cereal bar growth is likely to be hampered by a consumer perception of fewer appropriate consumption times and fewer perceived health attributes. Cereal bars are consumed for a host of reasons, all of which are likely to continue to be relevant. Commonly cited reasons include meal replacement, snack, weight loss, energy boost, metabolism regulation and convenience. Although cereal bar is now considered as regular components of the diet of most Americans and European, due to its sensory characteristics, less Asian consume the cereal bar. Moreover, most of cereal bars contain only cereal or some fruits, nuts and dairy product like muesli and granola bars, cereal bars that contain meat have not been reported elsewhere. Therefore, this research aimed to develop Chinese cereal bar containing meat.

Objectives

1. To develop the Chinese cereal bar product

Literature Review

1. Definition

Cereal bar is defined as a prepackaged food item similar in shape to a chocolate bar, made of cereal and, typically, fruit (Oxford dictionary, 2011). This product has become popular because it has resonated with the consumer's changing lifestyle; however, the market growth of this product is quite slow. The new trend for consumption of healthy, innovative and practical food, which has occurred recently, has leaded the market of cereal-bars to a gradual growth. Cereal-bars are considered healthy type of food, because they are rich in fiber (Bower and Whitten, 2000; Palazzolo, 2003; Gomes and Montenegro, 2006).

2. Cereal bar market

Based on a consumer survey commissioned for its report, Mintel says cereal bars can now be considered a regular component of the diet of most Americans. It bases that on the survey finding that 65% of adult respondents say they eat some kind of cereal bar, a figure that includes products fitting the protein/energy bar definition. Consumption is the highest among those aged 18 to 34, teens and those who head households with children. In USA, the growth of cereal bar market during 2006 – 2011 was quite slow (Table 1).

Table 1: Market growth of cereal bar in USA during 2006-2011 (Mintel, 2011)

Year	Sale at current price ($ Millions)	% Change
2011	2,046.3	-
2010	1,912.7	8.3
2009	1,785.3	8.1
2008	1,657.1	7.7
2007	1,532.5	7.1
2006	1,414.7	7.0

There are many reasons for cereal bar consumption. Consumers consume cereal bar or granola bar mainly as snack (66% and 88% for cereal bars and granola bars, respectively), followed by as a meal replacement (48% for cereal bars and 31% for granola bars) (Table 2).

Table 2: Reason for cereal bar consumption (n=1637) (Mintel, 2011)

Reasons	Cereal bars or Breakfast bars (%)	Granola bars (%)
As a snack	66	88
As a meal replacement	48	31
As an energy boost	19	26
For weight-loss or maintenance	17	16
Maintain blood sugar	15	17
Maintain metabolism	10	13
With exercise or fitness	9	11
Other	11	8

On the other hands, the cereal bars market in Thailand increased at a compound annual growth rate of 7.1% between 2004 and 2009. The sports and energy bars segment led the cereal bars market in Thailand in 2009, with a share of 51.5%. The leading player in cereal bars market in Thailand in Kellogg Company (Marketresearch.com, 2012).

3. Main ingredients

Cereal-bars are made of processed cereal grains that can be incorporated with different ingredients, such as whole cereals, dehydrated or crystallized fruits, chestnuts, nuts, almonds, sugar, candies, chocolates, etc. (Ferreira, 2004). These ingredients must be suitably combined to assure a mutual complementation or supplementation as far as flavor, texture and physical characteristics are concerned, particularly the point of balance of water activity (Esteller et al., 2004).

3.1 Cereal

Cereals are grasses that cultivated for the edible components of their grain which composed of the endosperm, germ, and bran. Cereal grains are grown in greater quantities and provide more food energy worldwide than any other type of crop; they are therefore staple crops. In their natural form (as in whole grain), they are a rich source of vitamins, minerals, carbohydrates, fats, oils, and protein. However, when refined by the removal of the bran and germ, the remaining endosperm is mostly carbohydrate and lacks the majority of the other nutrients.

Some grains are deficient in the essential amino acid lysine. That is why a multitude of vegetarian cultures, in order to get a balanced diet, combine their diet of grains with legumes. Many legumes, on the other hand, are deficient in the essential amino acid methionine, which grains contain. Thus a combination of legumes with grains forms a well-balanced diet for vegetarians. Common examples of such combinations are

dal (lentils) with rice by South Indians and Bengalis, dal with wheat in Pakistan and North India, and beans with corn tortillas, tofu with rice, and peanut butter with wheat bread (as sandwiches) in several other cultures, including Americans.[6] The amount of crude protein found in grain is measured as Grain Crude Protein Concentration.

3.1.1 Production of Cereal

The following table shows annual production of cereals, in 1961, 2008, 2009, and 2010 ranked by 2010 production.

Grain	Worldwide production (millions (10^6) of metric tons)				Notes
	2010	2009	2008	1961	
Maize	844	820	827	205	A staple food of people in America, Africa, and of livestock worldwide; often called corn or Indian corn in North America, Australia, and New Zealand. A large portion of maize crops are grown for purposes other than human consumption.
Rice	672	685	689	285	The primary cereal of tropical and some temperate regions. Staple food in Japan and China
Wheat	651	687	683	222	The primary cereal of temperate regions. It has a worldwide consumption but it is a staple

					food of North USA, EU, and Australia.
Barley	123	152	155	72	Grown for malting and livestock on land too poor or too cold for wheat
Sorghum	56	56	66	41	Important staple food in Asia and Africa and popular worldwide for livestock
Millet	29	27	35	26	A group of similar but distinct cereals that form an important staple food in Asia and Africa.
Oats	20	23	26	50	Formerly the staple food of Scotland and popular worldwide as a winter breakfast food and livestock feed
Triticale	13	16	14	12	Hybrid of wheat and rye, grown similarly to rye
Rye	12	18	18	35	Important in cold climates
Buckwheat	1.5	1.8	2.2	2.5	A pseudocereal, as it is a Polygonacea and not a Poaceae or Gramineae, used in Eurasia. Major uses include various pancake and groats

Fonio	0.53	0.46	0.50	0.18	Several varieties of which are grown as food crops in Africa
Quinoa	0.07	0.07	0.06	0.03	Pseudocereal, grown in the Andes

Maize, wheat and rice together accounted for 87% of all grain production worldwide, and 43% of all food calories in 2003, while the production of oats and rye have drastically fallen from their 1960s levels. Other grains that are important in some places, but that have little production globally (and are not included in FAO statistics), include:

- Teff, popular in Ethiopia but scarcely known elsewhere. This ancient grain is a staple in Ethiopia. It is high in fiber and protein. Its flour is often used to make injera. It can also be eaten as a warm breakfast cereal similar to farina with a chocolate or nutty flavor. Its flour and whole grain products can usually be found in natural foods stores.
- Wild rice, grown in small amounts in North America
- Amaranth, ancient pseudocereal, formerly a staple crop of the Aztec Empire and now widely grown in Africa
- Kañiwa, close relative of quinoa

3.1.2 Nutrition fact

Some grains are deficient in the essential amino acid lysine. That is why a multitude of vegetarian cultures, in order to get a balanced diet, combine their diet of grains with legumes. Many legumes, on the other hand, are deficient in the essential amino acid methionine, which grains contain. Thus a combination of legumes with grains forms a well-balanced diet for vegetarians. Common examples of such combinations are dal (lentils) with rice by South Indians and Bengalis, dal with wheat in Pakistan and North

India, and beans with corn tortillas, tofu with rice, and peanut butter with wheat bread (as sandwiches) in several other cultures, including Americans. The amount of crude protein found in grain is measured as Grain Crude Protein Concentration.

3.1.3 Farming

While each individual species has its own peculiarities, the cultivation of all cereal crops is similar. Most are annual plants; consequently one planting yields one harvest. Wheat, rye, triticale, oats, barley, and spelt are the "cool-season" cereals.[citation needed] These are hardy plants that grow well in moderate weather and cease to grow in hot weather (approximately 30 °C but this varies by species and variety). The "warm-season" cereals are tender and prefer hot weather. Barley and rye are the hardiest cereals, able to overwinter in the subarctic and Siberia. Many cool-season cereals are grown in the tropics. However, some are only grown in cooler highlands, where it may be possible to grow multiple crops in a year.

For a few decades, however, there has also been increasing interest in perennial grain plants. This interest developed due to advantages in erosion control, reduced need of fertilizer, and potential lowered costs to the farmer. Though research is still in early stages, The Land Institute in Salina, Kansas has been able to create a few cultivars that produce a fairly good crop yield.

Oat

Oat is a species of cereal grain grown for its seed, which is known by the same name (usually in the plural, unlike other grains). While oats are suitable for human consumption as oatmeal and rolled oats, one of the most common uses is as livestock feed. Oats typically make up a part of the daily diet of domestic horses, about 20% of daily intake or smaller, and are regularly fed to cattle as well. Oats are also used in some

brands of dog food and chicken feed. Oat seeds are commonly marketed as cat grass to cat enthusiasts, since cats readily harvest and eat tender young oat, wheat, and some other grass sprouts.

Oats have numerous uses in food; most commonly, they are rolled or crushed into oatmeal, or ground into fine oat flour. Oatmeal is chiefly eaten as porridge, but may also be used in a variety of baked goods, such as oatcakes, oatmeal cookies, and oat bread. Oats are also an ingredient in many cold cereals, in particular muesli and granola. Oats may also be consumed raw, and cookies with raw oats are becoming popular.

Oats are also occasionally used in several different drinks. In Britain, they are used for brewing beer. Oatmeal stout is one variety brewed using a percentage of oats for the wort. The more rarely used oat malt is produced by the Thomas Fawcett & Sons Maltings, and was used in the Maclay Oat Malt Stout before Maclays Brewery ceased independent brewing operations. A cold, sweet drink called Avena made of ground oats and milk is popular refreshment throughout Latin America. Oatmeal caudle, made of ale and oatmeal with spices, was a traditional British drink and a favourite of Oliver Cromwell.

Historical attitudes towards oats have varied. Oat bread was first manufactured in Britain, where the first oat bread factory was established in 1899. In Scotland, they were, and still are, held in high esteem, as a mainstay of the national diet.

In Scotland, a dish called sowans was made by soaking the husks from oats for a week, so that the fine, floury part of the meal remained as sediment to be strained off, boiled and eaten. Oats are also widely used there as a thickener in soups, as barley or rice might be used in other countries.

Oats are also commonly used as feed for horses when extra carbohydrates, and the subsequent boost in energy, are required. The oat hull must be crushed ("rolled" or "crimped") for the horse to digest the grain, and may be given alone or as part of a

blended food pellet. Cattle are also fed oats, either whole, or ground into coarse flour using a roller mill, burr mill, or hammer mill.

Oat straw is prized by cattle and horse producers as bedding, due to its soft, relatively dust-free, and absorbent nature. The straw can also be used for making corn dollies. Tied in a muslin bag, oat straw was used to soften bath water.

Oat extract can also be used to soothe skin conditions. It is the principal ingredient for the Aveeno line of products.

Oat grass has been used traditionally for medicinal purposes, including to help balance the menstrual cycle, treat dysmenorrhoea, and for osteoporosis and urinary tract infections.

Processing of Oat

Oats processing is a relatively simple process:

1. Cleaning and sizing

Upon delivery to the milling plant, chaff, rocks, other grains, and other foreign material are removed from the oats.

2. Dehulling

Centripetal acceleration is used to separate the outer hull from the inner oat groat. Oats are fed by gravity onto the centre of a horizontally spinning stone, which accelerates them towards the outer ring. Groats and hulls are separated on impact with this ring. The lighter oat hulls are then aspirated away, while the denser oat groats are taken to the next step of processing. Oat hulls can be used as feed, processed further into insoluble oat fibre, or used as a biomass fuel.

3. Kilning

The unsized oat groats pass through a heat and moisture treatment to balance moisture, but mainly to stabilize them. Oat groats are high in fat (lipids), and once removed from their protective hulls and exposed to air, enzymatic (lipase) activity begins to break down the fat into free fatty acids, ultimately causing an off-flavour or rancidity. Oats begin to show signs of enzymatic rancidity within four days of being dehulled if not stabilized. This process is primarily done in food grade plants, not in feed grade plants. Groats are not considered raw if they have gone through this process; the heat disrupts the germ, and they cannot sprout.

4. Sizing of groats

Many whole oat groats break during the de-hulling process, leaving the following types of groats to be sized and separated for further processing: whole oat groats, coarse steel cut groats, steel cut groats, and fine steel cut groats. Groats are sized and separated using screens, shakers and indent screens. After the whole oat groats are separated, the remaining broken groats get sized again into the 3 groups (coarse, regular, fine), and then stored. "Steel cut" refers to all sized or cut groats. When there are not enough broken groats to size for further processing, whole oat groats are sent to a cutting unit with steel blades that evenly cut groats into the three sizes mentioned above.

5. Final processing

Three methods are used to make the finished product:

- Flaking

This process uses two large smooth or corrugated rolls spinning at the same speed in opposite directions at a controlled distance. Oat flakes, also known as rolled oats, have

many different sizes, thicknesses and other characteristics depending on the size of oat groats passed between the rolls. Typically, the three sizes of steel cut oats are used to make instant, baby and quick rolled oats, whereas whole oat groats are used to make regular, medium and thick rolled oats. Oat flakes range from a thickness of 0.36 mm to 1.00 mm.

- Oat bran milling

This process takes the oat groats through several roll stands to flatten and separate the bran from the flour (endosperm). The two separate products (flour and bran) get sifted through a gyrating sifter screen to further separate them. The final products are oat bran and debranned oat flour.

- Whole flour milling

This process takes oat groats straight to a grinding unit (stone or hammer mill) and then over sifter screens to separate the coarse flour and final whole oat flour. The coarser flour is sent back to the grinding unit until it is ground fine enough to be whole oat flour. This method is used often in India and other countries. In India whole grain flour of oats (Jau) used to make Indian bread known as Jarobra in Himachal Pradesh.

Job 's tears

Job's Tears is a tall grain-bearing tropical plant of the family Poaceae (grass family) native to Southeast Asia but elsewhere cultivated in gardens as an annual. It has been naturalized in the southern United States and the New World tropics. In its native environment it is grown in higher areas where rice and corn do not grow well. Job's tears are also commonly sold as Chinese pearl barley in Asian supermarkets, although C. lacryma-jobi is not closely related to barley (Hordeum vulgare).

There are two main varieties of the species. (1)Wild type Coix lacryma-jobi var. stenocarpa and var. monilifer has hard shelled pseudocarps which are very hard, pearly white, oval structures used as beads for making rosaries, necklaces, and other objects. Cultivated type Coix lacryma-jobi var. ma-yuen is harvested as a cereal crop, has soft shell, and is used medicinally in parts of Asia.

Use

Besides the use for ornamental purposes, Job's tears grains are useful as a source of food (cereals) and folk medicine.

Throughout East Asia, Vyjanti beads are available in dried form and cooked as a grain. The grains are generally spherical, with a groove on one end, and polished white in color, though in Japan unpolished yuuki hatomugi, which is unpolished and brown in color, is also available. In Korea, a thick drink called yulmu cha (율무차, literally "Job's tears tea") is made from powdered Job's tears. A similar drink, called yì mí shǔi (薏米水), also appears in Chinese cuisine, and is made by simmering whole polished Job's tears in water and sweetening the resulting thin, cloudy liquid with sugar. The grains are usually strained from the liquid but may also be consumed separately or together. In both Korea and China, distilled liquors are also made from the grain. One such example is the South Korean liquor called okroju (옥로주; hanja: 玉露酒), which is made from rice and Job's tears. In Japan, aged vinegar is made from the grain. In southern Vietnam, a sweet, cold soup called sâm bổ lượng has Job's tears as one of its ingredients. This dish derives from the southern Chinese tong sui called qīng bǔ liáng (清補涼; Cantonese: ching1 bou2 leung4).

In Thailand, it is often consumed in teas and other drinks, such as soy milk. It is also used alongside other herbs in traditional Chinese medicine.

3.2 Legume

Legume is a plant in the family *Fabaceae* (or *Leguminosae*), or a fruit of these specific plants. A legume fruit is a simple dry fruit that develops from a simple carpel and usually dehisces (opens along a seam) on two sides. Legumes contain relatively low quantities of the essential amino acid methionine - however, this should not be a problem if an adequate amount of protein is consumed.

Legumes contain relatively low quantities of the essential amino acid methionine - however, this should not be a problem if an adequate amount of protein is consumed. According to the protein combining theory, legumes should be combined with another protein source such as a grain in the same meal, to balance out the amino acid levels. Protein combining has lost favor as theory (with even its original proponent, Frances Moore Lappé, rejecting the need for protein combining in 1981) - a variety of protein sources is considered healthy, but these do not have to be consumed at the same meal. In any case, vegetarian cultures often serve legumes along with grains, which are low in the essential amino acid lysine, creating a more complete protein than either the beans or the grains on their own.

Common examples of such combinations are dal with rice by Indians, and beans

3.2.1 Nutrition Fact

Legumes contain relatively low quantities of the essential amino acid methionine, as compared to whole eggs, dairy products or meat. This means that a smaller proportion of the plant proteins, compared to proteins from eggs or meat, may be used for the synthesis of protein in humans. The portion of plant proteins not suitable for the synthesis of human proteins is instead used as fuel in the human metabolism.

Nevertheless, legumes are among the best protein sources in the plant kingdom. The low concentrations of the amino acid methionine in legumes may be compensated for simply by eating more of them. Since legumes are relatively cheap compared to meat, eating more legumes may be an alternative to meat for some.

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Common examples of such combinations are dal with rice by Indians, beans with corn tortillas, tofu with rice, and peanut butter with wheat bread.

3.2.2 Production of Legume

1. Human Food

Legume seeds (also called pulses or grain legumes) are second only to cereals as a source of human and animal food. When legumes and cereals are eaten together, they provide complete protein nutrition. Nutritionally, legume seeds are two to three times richer in protein than cereal grains. Some legumes, such as soybeans and peanuts, are also rich in oil. Kidney beans and other legumes are a major source of food in Latin America, while lentils, pigeon peas, and chickpeas are important in South Asia. In the Middle East and North Africa, faba beans, lentils, and chickpeas are particularly important. Common food products made from legumes include tofu, peanut butter, and soymilk.

2. Animal Feed

As standards of human nutrition improve in all countries, there is a corresponding increase in demand for animal products such as milk, butter, eggs, and meat. This demand can only be met by using animal feeds with a high protein content. Among the grain legumes, soybeans are the most extensively used in animal feed. Forage legumes are commonly provided to animals in grass-legume mixtures. In the temperate regions, clovers, medics, trefoils, and vetches are important. In tropical and subtropical pastures,

Stylosanthes, Pueraria, Lablab, Desmodium, and other tropical pasture crops are important sources of livestock fodder.

3. Other Uses

Many species in the Mimosoideae and Caesalpinoideae subfamilies provide valuable timber, dyes, tannins, resins, gums, insecticides, medicines, and fibers. Many provide green manure for crops, such as Sesbania rostrata in rice cropping systems and Gliricidia sepium and Leucaena leucocephala in alley cropping. Many tree legumes have been identified as useful multipurpose species, and these are being introduced through agroforestry, soil restoration, and erosion control programs in many countries.

Cashew Nut

The cashew is a tree in the family Anacardiaceae. Its English name derives from the Portuguese name for the fruit of the cashew tree, caju, which in turn derives from the indigenous Tupi name, acajú. Originally native to Northeast Brazil, it is now widely grown in tropical climates for its cashew seeds and cashew apples.

Nutrition Fact

The fats and oils in cashew nuts are 54% monounsaturated fat (18:1), 18% polyunsaturated fat (18:2), and 16% saturated fat (9% palmitic acid (16:0) and 7% stearic acid (18:0)).

Cashews, as with other tree nuts, are a good source of antioxidants. Alkyl phenols, in particular, are abundant in cashews. Cashews are also a good source of dietary trace minerals copper, iron and zinc.

cashew nuts, raw					
Nutritional value per 100 g (3.5 oz)					
Energy 2,314 kJ (553 kcal)					
Carbohydrates	30.19 g	Fat	43.85 g	Protein	18.22 g
- Starch	23.49 g	- saturated	7.78 g	Water	5.2 g
- Sugars	5.91 g	- monounsaturated	23.8 g		
- Dietary fiber	3.3 g	- polyunsaturated	7.85 g		

** Percentages are relative to US recommendations for adults

Materials and Methods

1. Survey of the ingredient information for Chinese cereal bar development

The main ingredients preference survey was performed by using ranking test and 50 panelists. These ingredients were classified as cereal, nut, bean and seed, meat and flavor. Cereals were rice flake, rice cracker, puffed rice, oat, wheat germ and Job's tears. Nut, bean and seed were peanut, green pea, red bean, white bean, black pea, soy bean, white sesame, black sesame, pumpkin seed and cashew nut. Meats were dried shrimp, crispy pork, dried squid and dried fish. Flavors were Chinese herbal medicine, cinnamon, star anise, red pork, curry and others. The panelists were asked to rank these ingredients based on their preferences.

2. Just about right test (JAR)

2.1 Raw material preparation

One hundred grams of Job's tear were soaked in water for 24 h and then boil until they were cooked. After that, they were dried in an oven at 50°C for 24 h. in the following day, the dried Job's tear were deeply fried until the golden color was obtained. Salt (approximately 5 g) was then added thoroughly.

Oat meal preparation was done by baking the oat meal in an oven at 160°C for 12-15 min, which was the same process as that of cashew nut. For cashew nuts, they were crushed after baking.

Crispy pork was crushed into small pieces. For dried shrimps, they were deep fried until the crispy texture was obtained.

2.2 Production of Chinese cereal bar

Chinese cereal bar was produced by using the following formula as Job's tear (140 g), oat meal (140 g), cashew nut (100 g), crispy pork (70 g), dried shrimp (70 g), salt (10 g), sugar (40 g), pork powder (20 g), glucose syrup (15 g) and water (60 g). Sugar, water and glucose syrup were heated in the sauce pan using medium-high heat until sugar was completely dissolved. The mixture was then removed from the heat. After that the other ingredients were added and mix well. The mixture was then poured into a 9″ x 13″ pan that had been greased. The product was cut in a bar shape after cooling and stored in an air-tight container.

2.3 Sensory evaluation

Chinese cereal bars were sensory analyzed using Just About Right Test and 30 panelists.

3. Formulate the prototype product

3.1 Ingredient adjustment

There were four attributes from JAR result that needed to be adjusted, which were pork flavor, saltiness, sweetness and crispness. Therefore, amounts of salt and sugar were varied as 6, 8 and 10 g; 30, 35 and 40 g, respectively. For pork flavor, red pork flavor was mixed with pork flavor as 0, 50 and 100%. Cereals, nut and meat ingredients were either deep fried or baked before mixing with the others.

3.2 Sensory analysis

Sensory analysis was performed by using 9-point hedonic scale and 30 panelists.

4. Statistical analysis

A randomized block design with 2 replications was used in this research. The mean differences were analyzed using Duncant's Multiple Range test.

Result and discussion

1. Ingredient survey information for Chinese cereal bar development

The main ingredients preference survey was performed by using ranking test and 50 panelists. These ingredients were classified as cereal, nut and seed, meat and flavor. The result was shown in Table 1. From 50 panelists, it was recognized that oat meal (27.7%) was ranked at the first order, followed by Job's teat (21.7%). This might be caused by that the panelists were familiar with oat meal when it was refereed as one of the main ingredients in cereal bar. Due to this is cereal bar product, therefore two cereals were chosen as oat meal and Job's tear.

For nut, it was observed that cashew nut obtained the highest rank with 24.7%, followed by pumpkin seed (14.7%). While the lowest rank was white bean (1.3%) So, the cashew nut was chosen for the further experiment.

For meat, it was noticed that dried shrimp and crispy pork obtained the highest equal rank with 35.3%, followed by dried fish (21.7%) and the lowest rank was dried squid (7.7%). Therefore, dried shrimp and crispy pork were chosen.

For flavor, it was recognized that red pork obtained the highest rank with 25.3%, followed by curry (20.0%) and star anise (18.0%).

So the final ingredient for making Chinese cereal bar were oat meal, Job's tear, cashew nut, dried Shrimp, crispy pork and red pork.

Table 1: Ingredient survey result for Chinese cereal bar development

Cereal	Rice flake	Rice cracker	Puffed rice	Oat meal	Wheat germ	Job's tear				
%	7.0	19.3	8.6	27.7	15.7	21.7				
Nut, bean and seed	Peanut	Cashew nut	Green pea	Red bean	White bean	Black bean	Soy bean	White sesame	Black sesame	Pumpkin seed
%	10.3	24.7	8.7	10.3	1.3	5.7	7.3	11.7	13.3	14.7
Meat	Dried shrimp	Crispy pork	Dried squid	Dried fish						
%	35.3	35.3	7.7	21.7						
Flavor	Chinese herbal medicine	Cinnamon	Star anise	Red pork	Curry	Others				
%	15.3	17.7	18.0	25.3	20.0	3.7				

2. Just about right test

The Chinese cereal bar was produced by using Job's tear (140 g), oat meal (140 g), cashew nut (100 g), crispy pork (70 g), dried shrimp (70 g), salt (10 g), sugar (40 g), pork powder (20 g), glucose syrup (15 g) and water (60 g) (Figure 1). The evaluation was performed by using Just about right test with 30 panelists. The attributes were classified as saltiness, sweetness, crispness, pork flavor and chewiness. The result was shown in Table 2. From 30 panelists, it was recognized that saltiness, sweetness, pork flavor and chewiness obtained just right scores as 53.4, 40.0, 46.7 and 50.0%, respectively. In the other hand, crispness obtained 46.7% somewhat too weak followed by just right (33.3%). Therefore, crispness and chewiness were adjusted by frying and baking some ingredient such as Job's tear and dried shrimp. The just right of saltiness (53.4%) and sweetness (40.0%) both followed by somewhat to strong as 33.3% and 33.4%, respectively. Therefore, saltiness and sweetness attributes were concluded somewhat to strong. In another hand, the just right of pork flavor was 46.7%, followed by somewhat to weak (30.3%). Therefore, pork flavor attribute was concluded that somewhat to weak. Finally, three attributes were required to be adjust, which were saltiness, sweetness and pork flavor.

Figure 1: Chinese cereal bar

Table 2: Just about right test result (%) of Chinese cereal bar (n=30)

Attributes	Much too weak	Moderately too weak	Somewhat too weak	Just right	Somewhat too strong	Moderately too strong	Much too strong
Saltiness	0.0	0.0	10.0	53.4	33.3	3.3	0.0
Sweetness	3.3	3.3	13.3	40.0	33.4	6.6	0.0
Crispness	0.0	10.0	46.7	33.3	10.0	0.0	0.0
Pork flavor	0.0	6.7	30.0	46.7	10.0	3.3	3.3
Chewiness	0.0	0.0	13.3	50.0	33.3	3.4	0.0

3. Formulation of prototype product

3.1 Ingredient adjustment

There were four attributes from JAR result that needed to be adjusted, which were pork flavor, saltiness, sweetness and crispness. Therefore, amounts of salt and sugar were varied as 6, 8 and 10 g; 30, 35 and 40 g, respectively. For pork flavor, red pork flavor was mixed with pork flavor as 0, 50 and 100%. Cereals, nut and meat ingredients were either deep fried or baked before mixing with the others.

For salt, the levels of variation were 6 g, 8 g and 10 g. From 30 panelists, it was recognized that salt 10 g obtained the highest score with 7.2, followed by salt 8 g and salt 6 g (with scores of 5.6 and 4.5, respectively) (Table 3). Therefore, salt 10 g was chosen for the further experiment.

Table 3: Preference score of saltiness attribute of Chinese cereal bar produced by using varied salt level (n=30)

Salt 6 g	Salt 8 g	Salt 10 g
4.5[c]	5.6[b]	7.2[a*]

* The same letter means no significant difference at 95% confidential level.

For sugar, the levels of variation were 30 g, 35 g and 40 g. The result was shown in Table 4. From 30 panelists, it was recognized that sugar 30 g obtained the highest score with 7.2, followed by sugar 35 g and sugar 40 g with the scores of 5.6 and 4.5, respectively. Therefore, sugar 30 g was chosen for the further experiment.

For pork flavor, the variations were red pork, mixture of red pork and pork, and pork flavors. The result was shown in Table 5. From 30 panelists, it was recognized that red pork and pork obtained the highest score with 8.0, followed by pork and red pork

with the score of 6.7 and 5.3, respectively. Therefore, the mixture of red pork and pork flavor was chosen for the further experiment.

Table 4: Preference score of sweetness attribute of Chinese cereal bar produced by using varied sugar level (n=30)

Sugar 30 g	Sugar 35 g	Sugar 40 g
7.2^{a}	5.6^{b}	4.5^{c}

* The same letter means no significant difference at 95% confidential level.

Table 5: Preference score of pork flavor attribute of Chinese cereal bar produced by using mixed pork flavor (n=30)

Red pork	Red pork and Pork	Pork
5.3^{c}	8.0^{a}	6.7^{b}

3.2 Sensory analysis of prototype product

Chinese cereal bar was produced by using Job's tear (140 g), oat meal (140 g), cashew nut (100 g), crispy pork (70 g), dried shrimp (70 g), salt (10 g), sugar (30 g), pork flavor (10 g), red pork flavor (10 g), glucose syrup (15 g),pepper (10 g) and water (60 g). Sensory analysis was performed using 9-point hedonic scale and 30 panelists. The result was shown in Table 6.

It was notice that the preference scores of texture, appearance, flavor and overall were 7.3, 7.4, 7.4 and 7.7, respectively, which referred to like very much.

Table 6: Preference scores of Chinese cereal bar (n=30)

Texture	Appearance	Flavor	Overall
7.3	7.4	7.4	7.7

3.3 Cost of production

The raw material cost was 452 Baht for 30 pieces, which was 15 Baht a piece. The cost including operating cost was 18 Baht and after addition of advertisement cost as 21 Baht.

Conclusion

The prototype formulation of Chinese cereal bar was Job's tear (140 g), oat meal (140 g), cashew nut (100 g), crispy pork (70 g), dried shrimp (70 g), salt (10 g), sugar (30 g), pork flavor (10 g), red pork flavor (10 g), glucose syrup (15 g),pepper (10 g) and water (60 g). The Chinese Cereal Bar obtained the preference score of texture, appearance, flavor and overall as 7.3, 7.4, 7.4 and 7.7, respectively, which referred to like very much. Moreover, the cost of product is 21 Bath per piece.

Appendix

Variation of Saltiness

RCBD Test
Ho: $\mu A = \mu B = \mu C$
Ha: At least two μS are not the same.
Critical region
$t = 3$ $r = 30$ $tr = 90$ $df_{trt} = t - 1 = 2$ $df_{error} = (t-1)(r-1) = 58$
$y\ldots = 522$ $df_{blk} = r - 1 = 29$ $df_{total} = tr - 1 = 89$
$C = y^2\ldots/(tr) = 3027.9$
$TSS = \sum\sum yij^2 - C = 3354 - 3027.9 = 326.1$
$SST = \sum yi^2/r - C = (94146/30) - 3027.9 = 110.3$
$SSB = \sum yj^2/t - C = (9424/3) - 3027.9 = 113.433$
$SSE = TSS - SST - SSB = 326.1 - 110.3 - 113.433 = 102.37$
$MST = SST/ df_{trt} = 55.15$
$MSB = SSB/ df_{blk} = 3.91$
$MSE = SSE/ df_{error} = 1.765$
$f_{table} = f_{\alpha(V1,V2)} = f_{0.05}(2,58) = 3.158$

ANOVA

SOV	df	SS	MS	f
Trt	2	110.3	55.15	31.24645892
Block	29	113.433	3.91	significant
Err	58	102.37	1.77	
Total	89	326.1		

Conclusion

$f_{compute}$ 31.24 > f_{table} 3.158

Reject Ho and conclude that type of salt has significant different effect on the product. So the recipe is going to use 10g of salt.

Variation of Sugar

RCBD Test
Ho: $\mu A = \mu B = \mu C$
Ha: At least two μS are not the same.
Critical region
t = 3 r = 30 tr = 90 $df_{trt} = t - 1 = 2$ $df_{error} = (t-1)(r-1) = 58$
y… = 593 $df_{blk} = r - 1 = 29$ $df_{total} = tr - 1 = 89$
C = y2…/(tr) = 3907.21
TSS = $\sum\sum yij2 - C$ = 4113-3907.21 =205.79
SST = $\sum yi2/r - C$ = (120147/30) - 3927.21 = 77.69
SSB = $\sum yj2/t - C$ = (11841/3) - 3927.21 = 19.79
SSE = TSS - SST - SSB = 205.79 - 77.69 - 19.79 = 108.31
MST = SST/ df_{trt} = 38.845
MSB = SSB/ df_{blk} = 0.682
MSE = SSE/ df_{error} = 1.867
$f_{table} = f_{\alpha(V1,V2)} = f0.05(2,58) = 3.158$

ANOVA

SOV	Df	SS	MS	f
Trt	2	77.69	38.845	20.80610605
Block	29	19.79	0.68	significant
Err	58	108.31	1.87	
Total	89	205.79		

Conclusion

$f_{compute}$ 20.8061 > f_{table} 3.158

Reject Ho and conclude that type of salt has significant different effect on the product.So the recipe is going to use 30g of sugar.

Variation of Pork Flavor

RCBD Test
Ho: $\mu A = \mu B = \mu C$
Ha : At least two μS are not the same.
Critical region
t = 3 r = 30 tr = 90 $df_{trt} = t - 1 = 2$ $df_{error} = (t-1)(r-1) = 58$
y… = 593 $df_{blk} = r - 1 = 29$ $df_{total} = tr - 1 = 89$
C = y2…/(tr) = 3973.37
TSS = $\sum\sum yij2$ - C = 4164-3973.37 = 190.63
SST = $\sum yi2/r$ - C = (122486/30) - 3973.37 = 109.496
SSB = $\sum yj2/t$ - C = (11986/3) - 3973.37 = 21.963
SSE = TSS - SST - SSB = 190.63-109.496-21.963 = 59.171
MST = SST/ df_{trt} = 54.748
MSB = SSB/ df_{blk} = 0.757
MSE = SSE/ df_{error} = 1.02
$f_{table} = f_{\alpha(V1,V2)} = f0.05(2,58) = 3.1504$

ANOVA

SOV	Df	SS	MS	f
Trt	2	109.49	54.75	29.32512051
Block	29	21.96	0.68	significant
Err	58	59.17	1.87	
Total	89	190.62		

Conclusion

$f_{compute}$ 29.325 > f_{table} 3.1504

Reject Ho and conclude that type of Pork seasoning has significant different effect on the product. So the recipe is going to use 1/3 red pork + pork flavor

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