

**DEVELOPMENT OF CORN BEVERAGE FROM PURPLE CORN
(ZEA. MAYDIS L.)**

BY

**MS. PAWEETIDA TEEPAWATTANASET
ID 5113739**

**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 Corn Beverage from Purple Corn (*ZEAMAYDIS L.*)
By : Ms. Paweetida Teepawattanaset
Project Advisor : Dr. Aussama Soontrunnarudrungsri
Level of Study : Bachelor of Science
Department : Food Technology
Faculty : Biotechnology
Academic year : 2012



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(Dr. Aussama Soontrunnarudrungsri)

Advisor

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Assumption University

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Abstract

Purple corn has been used in the many kinds of food such as pop corn, chip, and porridge. However, there is not very many food products that made by purple corn in Thailand unlike yellow corn that was made into different types of snack and beverage. Purple corn is high in phenolic compounds and anthocyanin; therefore, it would be an excellent for product development. The aim of this project was to develop the corn beverage in order to provide the new variety of purple corn product in markets. According to the study, the most appropriate ratio between purple corn beverage was purple corn and yellow corn or sweet corn is 60:40 since it gave the non significant in liking from the sensory with sample with 100% yellow corn. The final formulation that obtained from this study is 31.5% of corns consist of 60% purple corn and 40% yellow corn, 4.7% sugar, 0.6% salt and 63.2% water. During the development process, it was found that the important attributes of purple corn milk were corn aroma, viscosity and corn flavor according to weighted penalty analysis of JAR scale. Acacia gum was added at 0.05% of total weight in order to improve viscosity, increase the flavor and made the corn beverage smoother in term of texture. To make purple corn, it started with made cooked corn with steaming technique, separated the corn on cob and weigh the corn according to the formula. 31.6% of water was used to dissolve sugar (4.7%) and salt (0.6%) to the solution. Blended corns and solution together with high speed for 1-2 minutes filtered the mixture with the sheeting cloth to get rid of corn residues. Pasteurization was used in order to pasteurize the beverage ($\sim 72^{\circ}\text{C}$ for 15 sec). Then, filtered the beverage again with sheeting cloth to get rid of particles from pasteurization and receive the final purple corn beverage. Final prototype product has the dynamic viscosity of 3.9 ± 1.8 mPa \cdot s. Consumer test was conducted with 120 consumers to see the degree of acceptability on purple corn milk by the consumer. It was found that 97.5% of consumer accepted the product with liking score of 7.06 ± 1.09 . This group of consumer consumed corn beverage occasionally (42%). Majority of consumers thought that flavor and quality were the two most important attributes affecting their purchasing. The majority of the consumers (80%) would buy the product if it will be launched in markets. The appropriate price range of purple corn milk is between 14 to 16 baht for 30 ml.

Acknowledgement

This project, Development of Corn Beverage from Purple corn (*ZEAMAYDIS L.*) attained the achievement with the help of several co-operations. I feel thankful to those people who assigned and taught me with sincerity.

First of all, I would like to thank my lovely advisor, A. Aussama Soontrunnarudrungsri who always spent her time and sacrifice herself to guide me and suggest me since the beginning of the project. A. Tatsawan Tipvarakarnkoon who gave me the consult about the rheology in Corn Beverage. My project had not been completed successfully without their guidance and supporting.

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(Paweetida Teepawattanaset)

2012

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CHAPTER 1

Introduction

Corn is one of most popular agriculture crops that people are interested in. Consuming corn provides a lot of health benefits such as controlling diabetes, prevention of heart ailments, lowering hypertension and prevention of neural – tube defect at birth. Corn also acts as the source for nutrients that not only provide the necessary calorie for daily metabolism but corn is a source of vitamins A, B, E and many minerals. Purple corn is the type of corn that contains not only similar level of nutrients as normal corn but also contains anthocyanins and phenolic compound which normal corn does not have (<http://purplecorn.wordpress.com>.2007). Phenolic compounds in purple corn are associated with reduced cardiovascular disease and colon cancer. Anthocyanins are the chemical compound that responsibility for purple color. Thus, it is excellent to produce the corn's innovative product that necessary for human health (Nature 4 science “we nature and science meet”. ebookbrowse.com).

Therefore, the aim of this project is to develop corn beverage from purple corn in order to provide a new variety of purple corn product in markets.

Objectives

1. To formulate corn beverage that contain purple corn
2. To develop the appropriate process for purple corn beverage
3. To conduct the acceptance test for purple corn beverage

CHAPTER 2

Literature Review

1. Sweet Corn (*Zea mays*, var. *rugosa*)

Sweet corns normally have yellow, white or bicolor types. They provide well in yield, taste sweet and store longer than the past. Sweet corns suitable grow in any well-drained soil and they can adapt to the wide range of pH which the optimum pH is 6.0 to 6.5 for planting of sweet corn, sweet corn is a warm season crop that they require a minimum soil temperature around 50°F and seed should not be planted earlier than 10 days to 2 weeks after the average date of killing frost. Another factor that important is harvesting, sweet corn should be harvested at proper stage of maturity when harvesting should break the shank close the ear without breaking stalk and after picking the sweet corn should be eaten or used immediately for fresh, eating, canning or freezing(B. Rosie Lerner and Michael N. Dana,1998). Normally people usually consume corn after it was boiling with syrup and was separated out from cob.

1.1 The production of sweet corn

Sweet corn is the warm sweet crop that easily to kill by frost. So to increase the yields of sweet corn, the limitation factors of production are very important. Site and soils, sweet corn can grow in the wide range of well-drained of site and soils, sandy soils is very necessary for early production. Insect, the insecticides are very important for production that used for protection the seed corn maggots, cutworms and corn earthworm. For harvest and handling, sweet corn which is one type of vegetable that has short period of optimum harvest maturity. Thus, period of harvesting of sweet corn should be considered to maintain the quality. Sweet corn can be both harvested by hand and chemical harvester but grower should select method depend on availability of labors, size and the operation etc (J.E. Motes, Warren Roberts, and Bob O. Cartwright, 1914).

1.2 Health benefits of sweet corn

Corn which is one types of maize that very popular cereal in the world. Corn has lots of health benefits for example control of diabetes, prevention of heart of aliment hypertension, prevention of neural-tube defect at birth, prevention of haemorrhoids and colorectal cancer and prevention of anemia. Corn is helpful in curing sever kidney problems

like renal dysfunction. Eating a soft boiled corn everyday can help curing major kidney problems (<http://www.ayushveda.com/dietfitness/benefits-of-corn>, 2008). Corn is not only has health benefit but corn is the sources of nutrients.

Corn is source of calories; the calorific of corn is 342 calories per 100 grams that highest in every types of cereal. Corn is source of fiber and vitamins; corn has the highest level of vitamin B which are thiamin; necessary for nerve system and niacin; deficiency leads to Pellagra. Not only vitamin B yellow corn is the source of beta-carotene form of vitamin A and the kernel is rich in vitamin E; which is necessary for human growth.

(<http://www.organicfacts.net/health-benefits/cereal/health-benefits-of-corn.htm>, 2011)

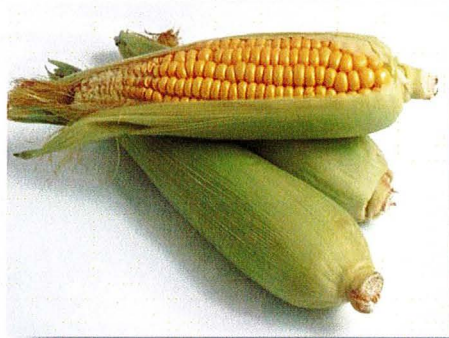


Figure 1: Sweet corn (*Zea mays*, var. *rugosa*)

Source: <http://statepolitics.lohudblogs.com/files/2011/04/sweet-corn.jpg>

2. Import and Export of corn products in Thailand

2.1 Canned sweet corn and frozen sweet corn

Corn's product that are popular in Thailand's market are canned sweet corn and frozen sweet corn. Canned sweet corn (CSC) in general, Thailand cultivates three crops of fresh sweet corn a year. However, in some region particularly in Northern Thailand cover about 30-35 percent of total production. In 2003, fresh sweet corn production is forecast to continue to increase to 217,000 metric tons (whole cob weight) but anyway, the average yield of fresh corn in 2003 is expected to be lower at approximately 7.5 mt/hectare from the average yield of 8-9 mt/hectare. For frozen sweet corn (FSC) is expected to increase slightly to 1,250 metric tons (McSherry, 2003).

- **For consumption**

Fresh sweet corn (FSC) is more popular among Thai consumer. Domestic consumption of fresh sweet corn reportedly account for about 15 percent of total fresh sweet corn production (McSherry, 2003).

2.2 Canned baby corn

In May 2003 the production of baby corn (CBC) trend to increase more than 2002, thus the production increase moderately to 69,500 metric tons, as many baby corn packers shift their production lines to produce more CSC due to anticipates stronger return from the good export potential, as compare to CBC. Moreover, baby corn packers reportedly faced strong price competition from cheaper CBC from China, Indonesia, Vietnam and African countries (McSherry, 2003).

- **For consumption**

CBC is similar to CSC the consumption is significant as fresh baby corn is more popular among Thai consumers (McSherry, 2003).

3. The market types of sweet corn

In U.S and Canada, sweet corn is one of the most popular vegetable. The consumption rate of sweet corn is increasing in areas around the world. Sweet corn can be consumed in many forms of product for example fresh, processed corn and canning so, it has wide range of distributions. In U.S. sweet corn is produced for three distinct markets which are fresh, canning and freezing (Wen-fei Uva, 2000).

For fresh market sweet corn in U.S, more than 64 percent of sweet corn that were grew in New York, sold in supermarket, the other is famer to customer is 20 to 21 percent. To get the best quality of sweet corn, growers mostly check for weather, price competition, pest and disease problems (Wen-fei Uva,2000).

For processed sweet corn market, the majority of markets around 13 percent of sweet corn growers, they produce the processed corn for fresh market and sell directly to consumers and supermarkets. The limited of processing corn mostly are increased input cost, weather, yield and decreasing demand (Wen-fei Uva,2000).

To increase the demand of sweet corn, the improving of quality, consistency taste and marketing are very necessary for reduce retail shrinkage and improve customer satisfaction (Wen-fei Uva,2000).

4. Purple corn ((*Zea maysdis* L. (Latin)/maiz morado (Spanish))

The native of purple corn is Peru and they were also used in Pre-Indian period .Purple corn has high in phenolic compound and anthocyanin content more than blueberries. The average of anthocyanin content of whole purple corn was 1640 mg/100g fresh weigh. (Cevallos-Casals and Cisneros-Zevallos, 2003 and Jones, 2005)

Table 1: Anthocyanin content (mg/100 g fresh weight) is selected from edible plant
(Pu Jing, M.S, 2006)

Source	Scientific name	Anthocyanin	Reference
Fruits			
Apple	<i>Malus pumila</i> P. Mill.	1 ~ 17	(Wu et al, 2006)
Bilberry	<i>Vaccinium myrtillus</i> L.	300 ~ 808	(Prior et al,1998; Maatta-Riihinen et al, 2004)
Blackberry	<i>Rubus spp.</i>	72 ~ 1221	(Clark et al., 2002)
Black chokeberry	<i>Aronia melanocarpa</i> (Michx.) Elliot	307 ~ 1480	(Strigl et al,1995; Wu et al, 2004)
Blackcurrant	<i>Ribes nigrum</i> L.	96 ~ 452	(Kampuse et al., 2002; Wu et al., 2004)
Blackberry	<i>Rubus spp.</i>	72 ~ 1221	(Clark et al, 2002)
Black raspberry	<i>Rubus occidentalis</i> L.	145 ~ 607	(McGhie et al, 2002; Moyer et al, 2002)
Blueberry	<i>Vaccinium corymbosum</i> L.	63 ~ 430	(Prior et al, 1998 Moyer et al, 2002)
Cranberry	<i>Vaccinium macrocarpon</i> Aiton.	20 ~ 360	(Prior et al., 2001 Wang and Stretch, 2001)
Elderberry	<i>Sambucus nigra</i> L.	332 ~ 1374	(Maatta-Riihinen et al, 2004 Wu et al, 2004)
Grape	<i>Vitis vinifera</i>	27 ~ 120	(Wu et al, 2006)
Lingonberry	<i>Vaccinium vitis-idaea</i> L.	31 ~ 92	(Wang et al, 2005)
Marion berry	<i>Rubus ursinus</i>	62 ~ 155	(Deighton et al, 2000; Wada and Ou, 2002)
Strawberry	<i>Fragaria × ananassa</i> D.	13 ~ 55	(Cordenunsi et al, 2002)

The variety of purple corn is maize. For the use of purple corn, mostly people used purple corn for consumption, they used to reduce the risks of developing cardiovascular disease, cancer, obesity, hypoglycemia and diabetes. For the health benefit of purple corn, cyanidins which is one type of anthocyanins, are four times those more powerful than vitamin E that found to function a potent antioxidant in vivo. (Nature 4 science “we nature and science meet”. ebookbrowse.com)

4.1 Health Benefit of Purple corn

Purple corn which is one type of corn varieties that classified as functional food. Purple corn provides energy and essential of nutrients. In case of this study, purple corns are rich in anthocyanins, anthocyanins are responsible for purple, violet and red color which is larger class of plant chemical know as flavonoids. Purple corns have powerful antioxidant, which displays signification in vitro activity. Anthocyanins pigments are also used to inhibit cancer. Obesity is one of the most important factors that people concern. So from research, after rat was fed with purple corn it showed significantly less sign of developing obesity. (Kenneth Jones, 2005)



Figure 2: Purple corn (*Zea Maydis L.*)

Source: <http://healthmaven.blogspot.com/2011/07/amazing-health-benefits-of-purple-corn.html>

5. Quality in Corn

Observation of quality of corn, high quality corn has a tender kernel that is milky and well develops and kernel should be large enough to be compact to develop on cob with no space between the rows and the ear should be filled to the tip with no rows of missing kernels. The kernel should be firm enough for slight pressure to puncture, not too large which will effect to texture in chewy and pasty like dough. While kernel is firmed, corn releases the milky white juice. If juice is watery, the sweet corn is not ready. So, when buy the corn in husk, look for the bright green color, snug husk and dark brown silk.

For the corn that should not be eaten right away. Canning, freezing and drying sweet corn will extend the shelf life throughout the year.

5.1 Freezing corn

Sweet corn can be both frozen with cob and without cob. Before corn is frozen, it should been wash with pure water. Husk, trim the ear and silk are removed. Corn should be packed in moisture-vapor proof wrapping or container for freezer storage. However, freezing corn is not the method to improve the quality of corn, freezing is only the preservation method.

5.2 Canning processed corn

Corn can be canned as whole in kernel or as cream which is the cream style corn. Corn is one type of grain that is low-acid, it should process in a pressure canner for safety and only hot packed method that has been chosen or recommended for filling in jar. Canning method, the tender, freshly gathered corn in milk stage should be selected for canning.

In term of cream, because it thicker than whole kernel corn. It should be canned in pint jar only so that heat can be penetrated throughout the product.

5.3 Drying corn

The selection of corn for drying is same as canning and freezing method. For the best quality of drying corn, do not dry corn that has been freshly harvest. Husk and silk should be removed and wash the corn thoroughly. During drying, moisture in corn will be removed and package of dried corn should be in moisture-vapor proof container and store in cool dry place. Dried corn should be rehydrated or refreshed before using in recipe for fresh, canned or frozen corn. Drain any water left after rehydration is completed.

Thus, sweet corn is delicious when prepared on cob. Without add butter or salt, one ear of corn contains 150 calories. It contributes as carbohydrate, amount of vitamin A (yellow variety of corn only) and trade of sodium

(<http://missourifamilies.org/features/nutritionarticles/harvesttohealth/corn.htm>, 2009).

For the bad quality of corn, the mould will be presented; the silk on corn will be turned to brown or black color. Moreover in the extreme case, the kernel show the sign of decay and some part of kernel may appear to be eaten away.

(<http://shelflifeadvice.com/content/how-can-i-tell-if-corn-cob-has-gone-bad>, 2009)

6. Storage time of Corn

Grain has shelf life like any food product. Shelf life determine by the moisture content and temperature of products. (www.extension.iastate.edu, 2008) Mold and insect can damage corn storage at improper temperature and moisture level which can lead to health problems.

Thus, to protect all issues, farmers should be consider and aware of corn storage management including preparation, monitoring and aeration .(www.hpj.com, 2011) Period of time for consuming fresh corn after purchasing; corn should be consumed or frozen within 1-2 days of purchase and corn should be frozen at 0 degree F or lower may keep up to 8 months.

(<http://shelflifeadvice.com/content/how-can-i-tell-if-corn-cob-has-gone-bad>, 2009)

7. Aflatoxins in corn

Aflatoxins is a group of chemical that is produced from a group of mold fungi; *Aspergillus flavus* and *Aspergillus parasiticus*. Aflatoxins is normally harm with livestock and also considered as carcinogenic or cancer- causing. Aflatoxins has highest rate in summer, the prime conditions for the fungus to produce toxin are warm August nights in a period of drought. For aflatoxins testing, scientist normally use two types of screening test which are black light test and commercial test kit. For prevention, one factor is very important is temperature. Temperature should be controlled in proper range to avoid the growth of mold (Gary Munkvold and Charles Hurburgh, 2009).

8. Application of corn in beverage

Corn beverage, corn juice or maize juice sometime referred as “beauty drink” which is the juice that extracted from corn. The corn beverage has the similar level of nutrition as corn. However, corn juice has more nutrients that corn does not which are fatty acid, complex carbohydrate. Corn juice has ability to prevent heart disease because juice that made from yellow corn has high level in lutein; lutein protect bodies against heart disease. Corn juice benefits include protection and relief in macular degeneration which refers to the condition of eye during old age. Healthy teeth and bones- Maize juice enables the growth of healthy teeth and bones of infants (http://www.ifood.tv/network/corn_juice,2010) seed corn has high level in carbohydrate. Form of starch is a mixture of amylopectin and amylose but in corn most of starch is amylopectin know as lower in fitogliogen and sucrose. (fazaniken.wordpress.com, 2011)

In order to keep juice, juice should be drink as soon as possible after the juice is made. Juice is easily oxidized by air especially vitamin A and vitamin C. when juice is stored too long, enzymes that are contain inside will be damaged, the color is changed and it feels sour when tasted. So it must has a best way in order to save nutrients in juices such as placed juice in sealed container or placed in glass and wrap with plastic food wrap. (fazaniken.wordpress.com, 2011)

9. Acacia Gum

Acacia gum or Arabic gum is a tree gum exudates and has been an important article of commerce since ancient time. The gum has been obtained mainly from *Acacia Senegal* spices more than *Acacia seyal* spiecs. The trees grow widely across the Sahelian belt of Africa situated north of the equator up to the Sahara desert and from Senegal in the west to Somalia in the east (P. A. Williams and G. O. Phillips, 1986).

Acacia is the one of the most popular of food addictive and stabilizer. Acacia gum powder act as the stabilizer when mixed with liquid and it is commonly used in liquid medication like cough syrup (www.drfloras.com/herbs/gum-acacia/). In addition, acacia gum is water solubility; it is insoluble in alcohol and form colorless and tasteless solution (www.bostick-sullivan.com/articles/gum_ancient.html).

The usages of acacia gum, most of acacia gum is used in food industry as multi functional ingredients; emulsifier, flavoring agent, thickener, humectants and surface-finishing agent. For other area; acacia gum is used for pharmaceutical and the printing

industry. In application of acacia gum, it has been used in five main food areas; confectionery; acacia gum is used to bind water and prevent sugar crystallization and also used in beverage and emulsion, flavor encapsulation, bakery products and brewing (www.bostick-sullivan.com/articles/gum_ancient.html). Acacia gum has recently found a new range of application in the dietetic food and health sub-sector because of its high fiber content (Policy note, March 2007).

World trade of acacia gum, Sudan has been the larger producer and exporter of acacia gum. However, Europe and USA buy raw gum for the further transformation and also re-sale as additive for food industry. Confectionery represents for the major use of gum in Europe and soft drink is the largest production in USA (Policy note, March 2007).



Figure 3: Acacia or Arabic gum

Source: <http://www.drfloras.com/herbs/gum-acacia/>

10. Sensory Evaluation

Sensory evaluation is a scientific discipline that used to analyze and measure the human response for composition for food and drink such as appearance, touch, odor, taste and sound (www.foodafactoflife.org.uk). For food or beverage product appearance is the most important factor aspect of food quality as it is the first subjective evaluation made of food quality. The product has to pass visual assessment before the consumer can or will consider other parameter such as taste and texture (David R. Peryam, May 1998). For sensory evaluation method, there have lots of methods to analyze data such as paired preference test, ranking for preference, rating for preference (9-point hedonic test).

10.1 Rating of preference or 9-point hedonic test

Rating of preference or 9-point hedonic test is scale that most widely use for acceptability of product that not only for food and beverage but include personal care of products, household products and cosmetic. The hedonic scale is conducted at the Quartermaster showed that longer scales up to nine intervals tended to be more discriminating than shorter scale so, 9-point hedonic scale become the standard of Quartermaster because it fit better on typing paper used to print the ballot. In the scale, it has vales (1, 2, 3... 9) to the scale points and testing difference in average acceptability using parametric statistic that showing from “like extremely” to “dislike extremely” in both vertical and horizontal version (www.sensorysociety.org/ssp/wiki/Verbal_Hedonic_Scale/, 2007)

10.2 Just about right test (JAR)

Just about right (JAR) scale is used to measured the appropriateness of attributes and JAR scale used to indicate the optimum level attribute of products (Meullenet JF, Xiong R and Findlay C, 2007). In consumer testing, consumers asked to evaluate the sensory characteristic of product such as aroma in term of “much too little”, “moderately too little”, “somewhat too little”, “just right”, “somewhat too much”, “moderately too much”, “much too much”. Due to there have many variation of JAR scale but just right is on the center where used to indicate the suitable of each attribute (Johnson L and Vickers Z 1987, Vickers Z ,1988).

Although JAR scales have been criticized on several grounds, including that these diagnostic questions place too great a demand on consumers to know what they ideally would like and that consumers have to have a consensus understanding of the attributes in question,

they continue to be extremely popular, both among sensory and market research professionals(Lawless HT, Heymann H, 1998).

11. Rheology Evaluation

Rheology is the study of flow matter: mainly liquids but also soft solids or solid under conditions in which their flow rather than deform elastically. It applies to the substances which have complex structure including mud, sludge, suspensions, polymer, many foods, bodily fluids and other biological materials. In practice, rheology is principally concerned with extending the classical disciplines of elasticity and Newtonian fluids mechanic to materials whose mechanical behavior cannot be described with the classical theories (D. Vader, H.Wyss, Introduction to Rheology2). For rheometry is used to describe measuring method device used to determine rheological properties (RheoTec Messtechnik Gmbh, Ottendof-Okrilla, introduction to rheology V2). For rheometer is the measurement for measuring rheological properties of fluid and soft solid so, the typical of rheological properties are viscosity, modulus, compliance and yield stress. These properties also depend on microstructure of material (H. Henning Winter, 2008).

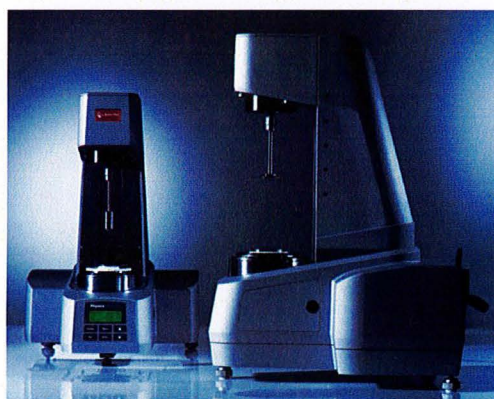


Figure 4: Rheometer

Source: <http://en.wikipedia.org/wiki/File:Rheometer.jpg>

CHAPTER 3

Materials and Methods

Materials

1. Raw Materials

- | | |
|-----------------|----------------------------------|
| 1.1 Purple Corn | (<i>Zea Maydis L.</i>) |
| 1.2 Sweet Corn | (<i>Zea mays, var. rugosa</i>) |
| 1.3 Sugar | (Mitr Phol) |
| 1.4 Salt | (Prung Thip) |
| 1.5 Acacia Gum | (CIT&SIGN Co.,Ltd) |

2. Equipment

2.1 Equipments for corn beverage

- Blender (Verasu, Buono : Buo-12KP6-1)
- Digital Balance (OHAUS Model GT2100 Serial No.5758)
- Thermometer (0-100°C)
- Sheeting Cloth
- Kitchenware

2.2 Equipments for rheology measurement

- Rheometer (double cap : DG26.7-SN1195)
 - Physica MCR301; Anton Paar company

2.3 Equipments for sensory evaluation

- Corn Beverage sample (30ml)
- Cylinder
- Questionnaires

Materials and Method

Method

1. Development of corn beverage from purple corn

Screening the basic technique of cooked corn

Two techniques of making cooked corn which are boiling and steaming were screened by preliminary lab for the most appropriate technique for the further development.

- Boiling corn

Corns were separated and blasted with water in order to remove stubborn silk. Find the pot that large enough to hold all corn, water was poured in amount to cover corns, covered it and used high heat to heat water to 100°C. Put corns inside allow for boiling. Boiling time was 10-15 minutes depend on the softness of corns. Remove cooked corns with tongs, let them cooled down and separated corns out of their cobs.

(www.cornonthecobrecipe.com/boiled-corn-on-the-cob/)

- Steaming corn

Corns were separated and blasted with water in order to remove stubborn silk. Prepare the pot by adding water and bringing into a boil. Corns were placed onto the steam rack or basket then placed the rack or basket into the pot and covered it. Corns were cooked by steam inside the pot. Steaming time was 15 minutes. Remove cooked corns with tongs, let them cooled down and separated corns out of their cobs.

(www.howtocookcornonthecob.com/steamed-corn-on-the-cob/)

It found that steaming technique was chosen for the further step because of the appearance and purple color from purple corn was obvious than boiling technique while boiling technique did not preserve purple color and aroma did not good than steaming technique.

2. To formulate the corn beverage that contain purple corn

2.1 Production of based corn beverage

- Main ingredient

Table 2: Show weight in gram and percentage of each ingredient of based corn beverage

Ingredients	Weight in gram (g)	%
Yellow corn	500	31.5
Sugar	75	4.7
Salt	9	0.6
Water	1000 ml	63.2
total	1584	100

Source: <http://www.kroobannok.com/blog/24207,2009>

- Process of corn beverage

Cooked corns were separated from cobs then weigh according to the formula. While sugar and salt were made into the solutions. Water 500 ml divided into 250ml to dissolve sugar into syrup with 6-7 brix and another 250 ml was used to dissolve salt into solution. Blended the mixture with the blending by using high speed for 1to 2 minutes then filtered with sheeting cloth to eliminate corn’s residue. Corns drink was pasteurized with 72 °C for 15 seconds and the last step, the corn beverage was filtered again to get rid the particles from pasteurization (www.kroobannok.com/blog/24207, 2009). The final product was served.

2.2 Select the optimum percentage of purple corn for corn beverage

Corn beverages were prepared by using process show in the beginning (a. Production of based corn beverage: Process of corn beverage) and using Randomized block design (RCBD) experimental design to vary purple corn substitution as 20%, 40%, 60% and 80% of total weight of yellow corn.

Four samples were evaluated by sensory evaluation using 9-point hedonic scale test (appendix 1C) with 30 panelists. The percentage that obtained the highest acceptance was chosen to develop in further step.

2.3 Adjust the purple corn beverage

The formula that obtained the highest acceptance was served to 30 panelists. Panelists were asked to test the sample by using 9-point Hedonic scale test and Just about right scale (JAR scale) (appendix 2B). After obtain the finding from 9-point hedonic testing and JAR scale, the sample will be reformulated according to the opinion from JAR scale. The weighted penalty was applied to JAR data in order to specify important attributes and effect of too much and/or too little presence of those attributes on 9-point hedonic scale.

3. **To determine the suitable stabilizer between carrageenan and acacia gum corn beverage**

3.1 Determine the suitable stabilizer by preliminary laboratory

Two stabilizers which are carrageenan and acacia gum were screened or prelim to pick type of stabilizer to use in purple corn beverage. The most appropriate stabilizer was used in the process for the further step.

3.2 Select the optimum percentage of stabilizer for corn beverage

The last process of corn beverage was prepared by using process that show in the beginning and using RCBD experimental design to vary the percentage of stabilizer substitution.

4. Conduct Consumer Acceptance for purple corn beverage

4.1 Consumer Test

This studied was conducted in Thailand with 120 consumers and the test was taken place at Assumption University and the places nearby.

The test was divided into 3 sessions. Session 1, consumer behavior; consumers were asked to choose the best answer in each question, which brand(s) of corn beverage that you prefer, how often that you drink corn beverage, where do you buy corn beverage and choose factor that affecting on purchasing corn beverage. Session 2, product acceptance; they were asked to rate overall liking using 9-point hedonic scale for how much do you like this corn beverage. They were asked to choose and gave reasons for the acceptance of the product, if this product is launched in the market, will you buy this product and choose the suitable price of corn beverage and comment. Session 3, demographic information; in this part consumers were asked for gender, age, education, occupation, income monthly and nationality.

The consumer test one sample was served at approximately 4-8°C. The consumers were asked to clean their palates before test the sample and should be finished during complete the questionnaire.

4.2 Statistic Analysis

This experiment was used SAS[®] (Statistic Analysis System for Windows, Version 9.2,2010, SAS Institute Inc, Cary, NC) to analyze the different between samples and least significant difference for mean separation of samples to indicate different mean of the attribute intensities among the product at p-value < 0.05.

CHAPTER 4

Result and discussion

Experiment 1: Development of corn beverage from purple corn

Screening the basic technique of cooked corn

For the screening part of basic technique of making cooked corn; boiling and steaming were made according to their techniques respectively. Characteristics of each technique were recorded by preliminary lab.

Table 3: Characteristics of each technique of making cooked corn

Techniques	Characteristic of cooked corn
Boiling	<ul style="list-style-type: none">• Color of corn was not deep• Aroma was not strong• The beverage that made from boiling corn, the color was not deep in purple
Steaming	<ul style="list-style-type: none">• Corn was deep in color• Aroma was strong• The beverage was deep in purple color

It was founded that the steaming technique of making cooked corn had better characteristics for corn beverage: corn was deep in color and corn’s aroma was strong than boiling technique and when steamed corn was used for making beverage, color was deeper in purple color. So, steaming technique was chosen for the further step.

Experiment 2: To formulate the corn beverage that contains purple corn

2.1 Production of based corn beverage

For the production step of corn beverage, the basic formula of making corn beverage was screened to observe the characteristic by using preliminary lab.

- Main ingredient

Table 4: Show weight in gram and percentage of each ingredient of corn beverage

Ingredients	Weight in gram (g)	%
Yellow corn	500	31.5
Sugar	75	4.7
Salt	9	0.6
Water	1000 ml	63.2
total	1584	100

Source: <http://www.kroobannok.com/blog/24207,2009>

- Process of corn beverage
 - Cooked corns were separated from cobs then weigh according to the formula. While sugar and salt were made into the solutions. Water 500 ml divided into 250ml to dissolve sugar into syrup with 6-7 brix and another 250 ml was used to dissolve salt into solution. Blended the mixture with the blending by using high speed for 1to 2 minutes then filtered with sheeting cloth to eliminate corn’s residue. Corns drink was pasteurized with 72 °C for 15 seconds and the last step, the corn beverage was filtered again to get rid the particles from pasteurization ([www.kroobannok.com/blog/24207, 2009](http://www.kroobannok.com/blog/24207,2009)). The final product was served.

The appearance of corn beverage was good; smooth texture, good aroma, high intensity for color and the corn beverage from this process contain mellow taste, it was not too sweet and salty. Then the experiment was adjusted by substituting 20%, 40%, 60% and 80% of purple corn of total weight of yellow corn in order to find appropriate percentage of purple corn for further step.

2.2 Select the optimum percentage of purple corn for corn beverage

The corn beverage production used the basic process that referred from the final process of Ms. Jiraporn H. (2009) source: <http://www.kroobannok.com/blog/24207>. By using the RCBD experimental design to vary the purple corn substitution as 20%, 40%, 60% and 80% of total weight of yellow corn. The Liking score was given by 30 panelists by using 9-point hedonic scale test on overall liking, color, overall aroma, viscosity, sweetness and overall flavor. For statistic analysis, SAS[®] was used to analyze the difference between samples.

Table 5: Liking score (9-point Hedonic scale) of corn beverage by varied purple corn

Treatment Attribute	Treatment				Pr > F
	20% of purple corn	40% of purple corn	60% of purple corn	80% of purple corn	
Overall liking	6.6±0.3 ^a	6.2±0.3 ^a	5.9±0.3 ^a	4.9±0.3 ^b	0.002*
Color	6.7±0.4 ^a	5.2±0.4 ^b	5.7±0.4 ^b	5.3±0.4 ^b	0.0135*
Overall aroma	6.0±0.4	5.8±0.4	5.4±0.4	5.3±0.4	0.4552 ^{n.s}
Viscosity	6.1±0.3	5.9±0.3	6.3±0.3	5.5±0.3	0.4662 ^{n.s}
Sweetness	6.5±0.3 ^a	6.0±0.3 ^{ab}	5.9±0.3 ^b	5.1±0.3 ^b	0.0485*
Overall flavor	6.6±0.3 ^a	6.2±0.3 ^a	5.8±0.3 ^{ab}	5.1±0.3 ^b	0.0183*

Note: P-value in this experiment is equal 0.05 or 95% confidence level

If Pr > F value is more than 0.05, then null hypothesis is accepted as there is not significant different between the samples.

If Pr > F value is less than 0.05, then null hypothesis is rejected as there is significant different between the samples.

The result of liking score was analyzed by SAS[®] program. It was founded maximum level of purple corn that was accepted by panelists was 60%. So, 60% of purple corn was selected.

2.3 Adjust the purple corn beverage

After the optimum percentage of purple corn beverage was obtained. The sample was tested by 30 panelists by using 9-point hedonic scale and JAR scale (appendix 2B) again for reformulated the formula according to the result.

Liking score was given on overall liking, color, overall aroma, corn aroma, viscosity, sweetness, corn flavor, cob flavor with the score of “dislike extremely” to “like extremely” as follow table 6.

Table 6: Average (mean) and standard deviation (SD) of liking score (9-point hedonic scale) on purple corn beverage

Attribute	Average score(mean)	Standard deviation (SD)
Color	6.3	1.1
Overall aroma	6.2	1.2
Corn aroma	6.2	1.1
Viscosity	6.0	1.5
Sweetness	6.5	1.5
Corn flavor	6.5	1.0
Cob flavor	6.0	1.3
Overall liking	6.7	1.1

JAR scale was conducted formulation that applied from the basic formula. From table 7, percentage of each attribute on JAR scale. It was founded that panelists though that corn aroma was “just Right” to “somewhat too little”. Viscosity attribute, panelists though that it was “moderately too little” to “somewhat too little”. Sweetness attributes, panelists though that it was “somewhat too little” to “just right”. For corn flavor, panelists though that “just right” to “somewhat too little” and for cob flavor, panelists though that “somewhat too much” to “just right” respectively.

Therefore the following result of JAR scale; corn aroma, viscosity and corn flavor would be studied in the next experiment. The weighted penalty was applied to JAR data in order to specify important attributes and effect of too much and/or too little presence of those attributes on 9-point hedonic scale.

Table 7: Percentage of each attribute on Just About Right test (JAR test)

Attribute	Just about right test (JAR) (%)						
	Much too little	Moderately too little	Somewhat too little	Just right	Somewhat too much	Moderately too much	Much too much
Corn aroma	3.3	10	56.7	26.7	0	3.3	0
Viscosity	0	33.4	33.3	30	3.3	0	0
Sweetness	0	6.7	26.7	53.3	3.3	6.7	3.3
Corn flavor	0	10	43.4	43.3	0	3.3	0
Cob flavor	3.3	13.3	10	43.3	23.3	6.7	0

Weighted Penalty Score

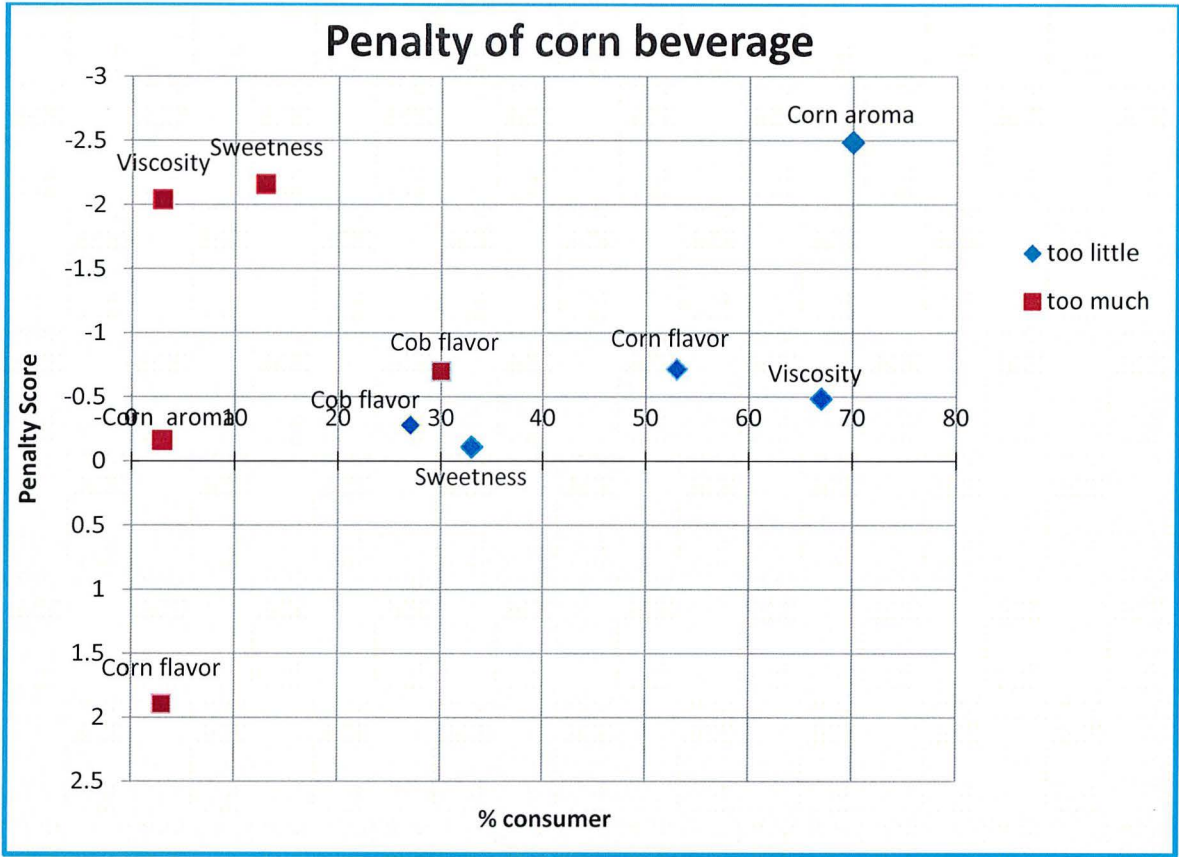


Figure 5: The findings of Weighted Penalty score from JAR result

Figure 5 show the findings from Penalty Analysis of the JAR result. It was found that the attributes that affected consumer in high proportion was corn aroma (70%) with the penalty score of -2.5 if there were not enough corn aroma in the product. If the sample had high corn aroma, it will have weaker impact on both hedonic score and numbers of consumer since the penalty score of too much corn aroma was -0.16 and proportion of consumer who was affected by too strong corn aroma was 3%. Next viscosity attribute, it was found that viscosity also affected consumer in high proportion (67%) with the penalty score of -0.5 if there were not enough viscosity in the product. If the sample had in viscosity, it will have weaker impact on both hedonic score and numbers of consumer since the penalty score of too much viscosity was -2.04 and proportion of consumer who was affected by too strong viscosity was 3%. Sweetness, it was found that sweetness was not the attribute that affected to the consumer. The proportion of sweetness was 33% with the penalty score of -0.49. If the

sample high sweetness, it will have weaker impact on number of consumer since the penalty score of too much sweetness was -2.16 and the proportion of consumer who was affected by too strong sweetness was 13%. Corn flavor, from the result it was found that corn flavor was one of the attribute that also affected to the consumer with the high proportion was 53% with the penalty score -0.72 if there were not enough corn flavor in the product. If the sample had high corn flavor, it will impacted to the hedonic score since the penalty score of too much corn flavor was 1.9 and the proportion of consumer who was affected by too strong corn flavor was 3%. Last attributes cob flavor, it was found that this attribute was not affected the consumer proportion (27%) with the penalty score of -0.28 if there were not enough cob flavor in the product. If the sample had high in cob flavor, it will have weaker impact to both hedonic score and number of the consumer since the penalty score of too much cob flavor was -0.28 and the proportion of consumer who affected by too strong of cob flavor was 30%.

Experiment 3: To determine the suitable stabilizer between carrageenan and acacia gum corn beverage

a. Screening the stabilizer between carrageenan and acacia gum

For the screening part of stabilizer of corn beverage, stabilizers between carrageenan and acacia gum were screened or prelim to pick type of stabilizer to use in purple corn beverage so, characteristics of each stabilizer were recorded.

Table 8: Characteristics of each stabilizer that effect to purple corn beverage

Stabilizer	Characteristic of purple corn beverage
Carrageenan	<ul style="list-style-type: none">• Making soft gel inside beverage• The texture was not smooth
Acacia gum	<ul style="list-style-type: none">• The texture was smooth



Figure 6: Acacia gum as stabilizer



Figure 7: Carrageenan as stabilizer

It was founded that acacia gum suitable stabilizer for purple corn beverage. Purple corn that used acacia gum as stabilizer had better characteristic in order to increase flavor and made the corn beverage smoother. Thus, acacia gum was chosen for the further step.

b. Select the optimum percentage of stabilizer for corn beverage

After the carrageenan and acacia gum were screened by preliminary lab. Acacia gum was the appropriate stabilizer for corn beverage. The optimum percentage of stabilizer substitution was selected by using RCBD experimental design as 0.05% acacia gum, 0.1% acacia gum, 0.2% acacia gum and 0.3% acacia gum of total weight of corn beverage.

Thus, after RCBD experimental design was used, control (no stabilizer) and 0.05% acacia gum was chosen to measure by rheometer in order to find the appropriate viscosity of corn beverage.

After samples were measured by rheometer; the result of viscosity measurement from rheometer. It was founded that 0.05% acacia gum was chosen for further development. Product had dynamic viscosity of 3.9 ± 1.8 mPa ·s. On other hand, control (no stabilizer) had dynamic viscosity as 1.7 ± 0.07 mPa ·s that very similar to water (1 mPa ·s) at room temperature (25°C).

Experiment 4: Conduct Consumer Acceptance for purple corn beverage

The consumer test was conducted on 120 consumers who drink corn beverage. The questionnaire was consisted 3 parts; consumer behavior, product acceptance and demographic information.

Part 1: Consumer behavior

For the part of consumer behavior, the questions were about brand, frequency, place and factors that affect the buyer decision on purchase of corn beverage.

Table 9: Percentage for consumer behavior on consumer test

Consumer Behavior	Percentage (%)
1.Brand of product that consumer prefer	
Malee I-corn	42.5
Jumbo	11.7
Diamond brand	5.8
Suwan sweet corn brand	35
My garden	1.7
Other	3.3
Total	100
2. Frequency to drink corn beverage	
Daily	10
3-4 per week	22.5
1-2 per week	25.8
Occasionally	41.7
Total	100
3. Place that buy corn beverage	
Supermarket	62.5
Hypermarket	21.7
Other	15.8
Total	100

According to the data, consumer test was conducted on 120 consumers. Three most preferable brands were Malee I-corn (42.5%), Suwan sweet corn brand (35%) and Jumbo (11.67%) respectively. For 41.7% of consumers said that they consumed corn beverage once a month or occasionally (41.7%) and the place that consumers buy corn beverage was supermarket (62.5%). Details were presented in Table 9.

Attributes of corn beverage available in markets were very important as factors that would be involved in consumer’s decision. Seven factors were determined and ranked as this following

Table 10: Factors that affecting decision on purchasing the corn beverage

Factor	Percentage (%)				
	Most important	Very important	Important	Slightly important	Not important
Color	20	28.3	48.3	3.3	0
Odor	25.8	45.8	27.5	0.9	0
Flavor	47.5	38.3	12.5	1.7	0
Quality	53.3	21.7	22.5	2.5	0
Packaging	19.2	45.8	21.7	12.5	0.8
Price	17.5	45	29.2	8.3	0
Brand	10	24.2	42.5	19.2	4.2

From table 10, factors that affecting decision on purchasing the corn beverage. It was founded that the most important factors on purchasing were flavor and quality with 47.5% and 53.3% respectively. Next was followed by odor (45.8%), packaging (45.8%) and price (45%). For least important were color (48.3%) and brand (42.5%).

Part 2: Product Acceptance

The second part of questionnaire was product acceptance. The purple corn beverage was judged by consumers using liking score as “dislike extremely to like extremely” and the questions asked about acceptance and price of product.

Table 11: Percentage for product acceptance on consumer test

Product Acceptance	Percentage (%)
1. Liking score	
Dislike extremely	0
Dislike very much	0.8
Dislike moderately	0.8
Dislike slightly	0.8
Neither like nor dislike	2.5
Like slightly	19.2
Like moderately	44.2
Like very much	26.7
Like extremely	5
Total	100
Mean	7.06
Standard Deviation	1.09
2. Product acceptance	
Yes	97.5
No	2.5
Total	100
3. If the product available in market	
Will buy	80
Not sure	19.2
Will not buy	0.8
Total	100

Table 11: Percentage for product acceptance on consumer test (continue)

Product Acceptance	Percentage (%)
4. Price of product sample 30 ml	
8-10 baht	13.3
11-13 baht	22.5
14-16 baht	40.8
17-19 baht	12.5
More than 20 baht	10.8
Total	100

From table 11, percentage for product acceptance on consumer test. It was founded that consumer accepted product with liking score 7.06 ± 1.09 as like moderately. Successfully with 97.5% of consumers accepted the product as delicious taste, healthy and the product as a new innovation for corn product. On other hand, 2.5% of consumers thought that the product was not acceptable because of the texture and the color of product. For 80% thought that they would buy the product if it was launched in markets because they wanted to try new innovation and also interested in it. 19.2% of consumers thought that they were not sure to buy product because they thought that this product was different than normal corn beverage and 0.8% thought that they would not buy the product if it was launched in market because they were satisfied with normal corn beverage and did not want to try a new one.

For the price of the product (with 30 ml), 40.8% of consumers thought that suitable price should be 14-16 baht. For 22.5% of consumer thought that the price should be 11-13 baht. 13.3% thought that the price should be 8-10 baht, 12.5 % thought that should be 17-19 baht and only 10.8% thought that the price should more than 20 baht.

Part 3: Demographic Information

Table 12: Percentage for demographic information on consumer test

Demographic Information	Percentage (%)
1. Gender	
Male	31.7
Female	68.3
Total	100
2. Age	
Below 15 years	0.8
16-19 years	13.3
20-23 years	61.7
24-27 years	9.2
28-31 years	7.5
More than 31 years	7.5
Total	100
3. Education	
High school or lower	8.3
Bachelor’s degree	78.3
Master’s degree	12.5
Doctorate	0.8
Total	100
4. Occupation	
Student	78.3
Lecturer	2.5
Employee	10.8
Business-owner	4.2
Unemployed	0.8
Housewife/husband	3.3
Total	100

Table 12: Percentage of demographic information on consumer test (continue)

Demographic Information	Percentage (%)
5. Income monthly	
Below 5,000 baht	32.5
5,000-10,000 baht	29.2
10,001-15,000 baht	10.8
15,001-20,000 baht	6.7
20,001-25,000 baht	12.5
More than 25,000 baht	8.3
Total	100
6. Nationality	
Thai	97.5
Non Thai	2.5
Total	100

From table 12, percentage of demographic information on consumer test. It was founded that ratio of gender male and female was about 1:2. The majority age of consumer was 20-23 years old. More than 70% of consumers had the education level concentrated in bachelor degree. In correlation with the level of age and education, the highest percentage of career was student. More than 30% of total consumers had income less than 5,000 baht and more than 90% of total consumers were Thai.

CHAPTER 5

Conclusion

Development of corn beverage from purple corn (*ZEAMAYDIS L.*) which was the project to develop the study about the product quality from development whether it is accepted from consumer and to defined which important attributes that affect to the consumer's need. This project was used purple corn or violet corn as ingredient to formulate the new innovation of corn beverage. The method in this process was screening the basic formula of yellow corn, determine the appropriate of technique to make the cooked corn, determine the optimum percentage of purple corn, determine the suitable stabilizer, develop the appropriate process for corn beverage and conduct the consumer acceptance test for purple corn beverage which the conclusion as the following.

According to the study, the most appropriate ratio between purple corn beverage was purple corn and yellow corn or sweet corn is 60:40 since it gave the non significant in liking from the sensory with sample with 100% yellow corn. The final formulation that obtained from this study is 31.5% of corns consist of 60% purple corn and 40% yellow corn, 4.7% sugar, 0.6% salt and 63.2% water. During the development process, it was found that the important attributes of purple corn milk were corn aroma, viscosity and corn flavor according to weighted penalty analysis of JAR scale. Acacia gum was added at 0.05% of total weight in order to improve viscosity, increase the flavor and made the corn beverage smoother in term of texture. To make purple corn, it started with made cooked corn with steaming technique, separated the corn on cob and weigh the corn according to the formula. 31.6% of water was used to dissolve sugar (4.7%) and salt (0.6%) to the solution. Blended corns and solution together with high speed for 1-2 minutes filtered the mixture with the sheeting cloth to get rid of corn residues. Pasteurization was used in order to pasteurize the beverage ($\sim 72^{\circ}\text{C}$ for 15 sec). Then, filtered the beverage again with sheeting cloth to get rid of particles from pasteurization and receive the final purple corn beverage. Final prototype product has the dynamic viscosity of $3.9 \pm 1.8 \text{ mPa} \cdot \text{s}$.

Consumer test was conducted with 120 consumers. The location of test was Assumption University and places nearby and product was tested with target group of people who consume the corn beverage. It was found that 97.5% of consumer accepted the product with liking score of 7.06 ± 1.09 . This group of consumer consumed corn beverage occasionally (42%). Majority of consumers thought that flavor and quality were the two most

important attributes affecting their purchasing. The majority of the consumers (80%) would buy the product if it will be launched in markets. The appropriate price range of purple corn milk is between 14 to 16 baht for 30 ml.

Suggestion

- To improve odor and flavor of the product, milk powder and other alternative such as cocoa powder might be added.

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Appendix: Part A1

- 9-point Hedonic scale for the variation of purple and yellow corn

Code sample

691 : 20% purple corn, 80% yellow corn

274 : 40% purple corn, 60% yellow corn

495 : 60% purple corn, 40% yellow corn

723 : 80% purple corn, 20% yellow corn

Consumer	Trt	Overall liking	Color	Overall aroma	Viscosity	Sweetness	Overall flavor
1	691	2	4	2	3	1	3
1	274	2	3	1	4	2	3
1	723	2	3	1	4	4	2
1	495	2	3	1	3	3	3
2	691	8	8	7	7	7	7
2	274	7	6	6	7	7	6
2	723	6	8	6	7	7	5
2	495	8	8	7	8	8	8
3	691	8	6	6	7	9	9
3	274	9	7	8	6	7	9
3	723	7	8	7	8	6	8
3	495	6	9	9	9	8	6
4	691	9	8	8	9	8	9
4	274	8	7	7	9	7	7
4	723	7	9	8	9	6	7
4	495	7	7	7	9	6	6
5	691	7	6	7	5	7	8
5	274	6	3	6	5	7	7
5	723	6	7	6	5	6	6
5	495	7	9	6	5	6	6
6	691	8	8	8	7	7	8
6	274	8	9	7	7	8	8
6	723	7	6	7	7	6	8
6	495	9	9	9	8	8	9
7	691	5	8	5	6	7	5
7	274	6	5	7	6	8	7
7	723	5	6	8	8	8	8
7	495	7	8	8	7	9	8
8	691	6	5	7	6	5	7
8	274	7	4	8	7	6	6
8	723	2	1	7	2	2	1
8	495	2	1	3	2	1	1
9	691	7	7	7	7	9	8
9	274	7	6	5	6	5	6

9	723	7	5	6	7	6	5
9	495	8	7	6	5	7	7
10	691	8	7	7	7	8	7
10	274	7	7	7	7	7	7
10	723	7	8	7	7	7	7
10	495	8	8	8	7	8	8
11	691	7	7	7	7	7	6
11	274	6	6	5	7	5	6
11	723	5	5	5	7	5	6
11	495	5	5	5	7	7	5
12	691	6	4	4	8	8	8
12	274	5	4	4	8	6	6
12	723	5	3	4	6	8	8
12	495	7	3	4	9	8	9
13	691	6	8	3	4	5	5
13	274	5	3	4	5	6	6
13	723	1	3	3	2	3	2
13	495	7	3	7	8	6	7
14	691	6	5	4	6	7	5
14	274	7	2	4	5	7	7
14	723	6	3	4	5	2	6
14	495	6	5	3	5	2	4
15	691	6	4	4	4	4	4
15	274	5	5	5	5	4	4
15	723	5	6	5	5	5	5
15	495	7	7	7	6	7	7
16	691	6	6	5	6	6	6
16	274	5	6	5	5	4	4
16	723	6	7	6	4	6	6
16	495	7	8	6	6	6	7
17	691	7	6	4	2	5	7
17	274	6	5	6	2	6	6
17	723	2	3	2	1	4	2
17	495	8	3	1	3	7	8
18	691	8	8	8	8	8	8
18	274	7	7	7	8	8	7
18	723	6	6	7	8	6	6
18	495	6	5	6	8	6	5
19	691	7	8	7	7	7	7
19	274	5	6	5	7	6	7
19	723	3	4	5	1	3	3
19	495	5	3	5	7	5	5
20	691	9	9	9	7	9	8
20	274	8	8	7	9	9	9
20	723	5	6	5	8	7	6
20	495	5	6	5	7	7	5
21	691	7	8	2	7	7	5
21	274	4	2	5	5	4	4
21	723	3	4	1	8	4	1

21	495	1	1	1	7	6	1
22	691	4	7	5	6	5	6
22	274	5	4	4	4	5	5
22	723	5	4	4	4	5	5
22	495	7	6	5	6	6	6
23	691	7	7	6	6	7	8
23	274	6	3	6	6	6	7
23	723	2	6	6	6	4	6
23	495	2	6	6	6	2	6
24	691	6	6	4	2	4	4
24	274	4	2	3	2	3	3
24	723	2	3	2	2	2	2
24	495	2	2	2	2	2	2
25	691	7	7	7	8	8	8
25	274	6	6	6	8	7	6
25	723	6	5	6	8	5	6
25	495	6	5	6	8	7	6
26	691	5	5	8	5	4	5
26	274	8	6	8	5	8	7
26	723	5	7	5	5	5	4
26	495	7	8	5	5	6	4
27	691	7	7	8	6	7	7
27	274	7	6	7	6	6	6
27	723	5	7	7	6	5	6
27	495	5	8	6	6	5	6
28	691	8	9	8	7	8	8
28	274	7	7	7	6	8	7
28	723	8	7	7	6	8	6
28	495	7	8	7	7	8	7
29	691	6	6	6	6	6	6
29	274	6	6	6	6	6	6
29	723	6	5	5	5	5	5
29	495	6	5	5	6	6	6
30	691	6	8	7	6	4	6
30	274	6	6	7	6	3	6
30	723	5	5	6	5	4	6
30	495	6	5	7	7	4	6

Appendix: Part A2

- Just About Right Test : 30 panelists

Attributes	Corn aroma	Viscosity	Sweetness	Corn flavor	Cob flavor
Much too little	I	-	-		I
Moderately too little	III		II	III	
Somewhat too little					
Just right	III		I		
Somewhat too much	-	I	I	-	II
Moderately too much	I	-	II	I	II
Much too much	-	-	I	-	-
Total	30	30	30	30	30

- Total percentage of each attribute on just about right test: 30 panelists

Attribute	Just About Right						
	Much too little	Moderately too little	Somewhat too little	Just right	Somewhat too much	Moderately too much	Much too much
Corn aroma	1	3	17	8	-	1	-
Percentage	3.33	10	56.67	26.67	0	3.33	0

Attribute	Just About Right						
	Much too little	Moderately too little	Somewhat too little	Just right	Somewhat too much	Moderately too much	Much too much
Viscosity	-	10	10	9	1	-	-
Percentage	0	33.33	33.33	30	3.33	0	0

Attribute	Just About Right						
	Much too little	Moderately too little	Somewhat too little	Just right	Somewhat too much	Moderately too much	Much too much
Sweetness	-	2	8	16	1	2	1
Percentage	0	6.67	26.67	53.33	3.33	6.67	3.33

Attribute	Just About Right						
	Much too little	Moderately too little	Somewhat too little	Just right	Somewhat too much	Moderately too much	Much too much
Corn flavor	-	3	13	13	-	1	-
Percentage	0	10	43.33	43.33	0	3.33	0

Attribute	Just About Right						
	Much too little	Moderately too little	Somewhat too little	Just right	Somewhat too much	Moderately too much	Much too much
Cob flavor	1	4	3	13	7	2	-
Percentage	3.33	13.33	10	43.33	23.33	6.67	0

- 9-point Hedonic Scale

Consumer No.	Color	Overall aroma	Corn aroma	Viscosity	Sweetness	Corn flavor	Cob flavor	Overall Liking
1	5	6	4	4	7	5	5	5
2	6	4	6	4	9	7	5	6
3	5	6	6	6	5	5	5	6
4	4	7	7	4	8	8	6	8
5	7	7	7	7	8	8	8	8
6	7	7	7	8	7	7	6	7
7	7	7	8	5	7	8	8	8
8	6	5	5	6	8	6	5	5
9	7	7	7	6	7	7	6	7
10	6	7	7	7	6	7	7	7
11	7	8	8	6	7	8	7	8
12	7	6	5	4	5	6	6	5
13	6	5	5	5	6	6	6	6
14	7	6	6	8	8	7	6	8
15	5	3	5	7	4	5	5	5
16	7	6	7	6	8	6	6	7
17	5	4	5	8	4	7	7	6
18	4	6	6	5	7	6	6	6
19	6	6	6	4	6	6	6	7
20	7	7	6	8	8	7	6	8
21	7	7	6	6	8	7	7	7
22	5	6	6	4	6	6	4	6
23	8	6	7	8	4	5	5	8
24	7	7	6	8	5	7	7	6
25	6	7	7	7	6	7	7	7
26	7	7	8	8	4	6	7	7
27	5	5	4	3	7	5	2	4
28	8	6	6	6	8	8	8	8
29	8	7	7	7	7	6	6	7
30	7	8	6	6	4	7	6	7
Mean	6.3	6.2	6.2	6.0	6.5	6.5	6.0	6.7
SD	1.1	1.2	1.1	1.5	1.5	1.0	1.2	1.1

Weighted Penalty

	Corn Aroma		
	Too little	JAR	Too high
Proportion	0.7	0.27	0.03
Gr & JAR mean	5.67	6.63	8
Grand mean	8.1591		

Too little = (5.67 – 8.1591) = -2.49

Normalized = ((-2.49) x 0.7) / 0.27 = -6.47

Too much = (8- 8.1591) = -0.159

Normalized = ((-0.159) x0.03) / 0.27= -0.017

	Viscosity		
	Too little	JAR	Too high
Proportion	0.67	0.3	0.03
Gr & JAR mean	5.55	7.33	4
Grand mean	6.035		

Too little = (5.55 -6.035) = -0.49

Normalized = ((-0.485) x 0.67) / 0.3 = -1.08

Too much = (4- 6.035) = -2.04

Normalized = ((-2.04) x 0.03)/0.3 = -0.2

	Sweetness		
	Too little	JAR	Too high
Proportion	0.33	0.53	0.13
Gr & JAR mean	6.3	7.13	4.25
Grand mean	6.41		

Too little = (6.3 – 6.41) = -0.11

Normalized = ((-0.11) x 0.33) / 0.53 = -0.07

Too much = (4.25-6.41) = -2.16

Normalized = ((-2.16) x 0.13)/ 0.53 = -0.53

	Corn flavor		
	Too little	JAR	Too high
Proportion	0.53	0.43	0.03
Gr & JAR mean	5.38	7	8
Grand mean	6.1		

Too little = (5.38 – 6.1) = -0.72

Normalized = ((-0.72) x 0.53) / 0.43 = -0.89

Too much = (8-6.1) = 1.9

Normalized = ((1.9) x 0.03)/0.43 = 0.13

	Cob flavor		
	Too little	JAR	Too high
Proportion	0.27	0.43	0.3
Gr & JAR mean	5.75	6.69	5.33
Grand mean	6.03		

Too little = (5.75-6.03) = ~~-0.28~~

Normalized = ((-0.28) x 0.27)/0.43 = -0.18

Too much = (5.33-6.03) = ~~-0.7~~

Normalized = ((-0.7) x 0.3) / 0.43 = -0.49

Appendix: Part A3

Sample	a	b	r	s	Ath	Remark
Corn beverage (no stabilizer (R1-D1))	0.0017125	1	0.99991	0.0071267	171.25	Newton
	0.0060545	0.79304	0.97318	0.11978		Ostwald- De Waele
Corn beverage (no stabilizer (R2-D1))	0.0016104	1	0.99982	0.0092827	161.04	Newton
	0.0074183	0.75002	0.96196	0.13383		Ostwald- De Waele
Corn beverage (no stabilizer (R1-D2))	0.0017834	1	0.99941	0.018434	178.34	Newton
	0.0033361	0.89711	0.99401	0.058438		Ostwald- De Waele
Corn beverage (no stabilizer (R2-D2))	0.0017529	1	0.9985	0.029575	175.29	Newton
	0.0013745	1.0437	0.99918	0.02221		Ostwald- De Waele
Corn beverage (0.05% acacia gum (R1-D1))	0.0052782	1	0.99739	0.10923	527.82	Newton
	0.019874	0.78192	0.98193	0.28652		Ostwald- De Waele
Corn beverage (0.05% acacia gum (R2-D1))	0.0057665	1	0.9436	0.54374	576.65	Newton
	0.019972	0.8016	0.95357	0.4946		Ostwald- De Waele
Corn beverage (0.05% acacia gum (R1-D2))	0.0024476	1	0.99947	0.023713	244.76	Newton
	0.0038821	0.92555	0.99671	0.066801		Ostwald- De Waele

Sample	a	b	r	s	Ath	Remark
Corn beverage	0.0024285	1	0.99993	0.008261	242.85	Newton
(0.05% acacia gum (R2-D2))	0.0027185	0.98318	0.9999	0.011366		Ostwald- De Waele

SAS Code

```

data test;
input con trt$ OV color aroma sweet cocoa soft moist;
cards;
1      A      2      6      5      4      5      8      8
1      B      6      7      6      7      7      2      3
1      C      5      6      5      5      6      7      8
1      D      6      5      5      3      4      3      2
2      A      6      6      4      5      6      3      3
2      B      7      6      7      7      7      6      7
2      C      8      5      7      7      7      7      7
2      D      6      5      5      5      6      5      5
3      A      7      6      5      8      4      9      8
3      B      9      6      6      6      1      4      5
3      C      4      4      7      7      3      6      7
3      D      1      4      3      4      5      5      6
4      A      4      5      7      3      4      5      5
4      B      6      9      8      5      3      8      8
4      C      5      2      2      7      6      6      6
4      D      3      4      3      2      2      6      7
5      A      6      7      8      7      6      7      7
5      B      7      8      8      8      8      8      8
5      C      7      7      7      5      7      8      7
5      D      5      6      7      6      7      .      6
6      A      7      5      8      3      2      2      3
6      B      .      3      6      6      6      6      6
6      C      .      6      5      5      7      7      7
6      D      1      2      1      2      1      1      1
7      A      7      4      6      8      8      8      6
7      B      5      6      4      6      5      4      5
7      C      8      7      7      7      7      7      4
7      D      6      5      3      5      4      3      3
8      A      4      2      5      2      5      5      3
8      B      5      3      5      3      4      5      4
8      C      7      6      8      7      5      4      5
8      D      4      4      .      1      3      1      2
9      A      8      4      8      6      6      8      7
9      B      4      4      5      2      6      1      1
9      C      6      6      6      5      7      7      8
9      D      3      7      2      2      1      7      6
10     A      4      9      7      4      6      4      3
10     B      5      5      5      2      4      5      4
10     C      8      6      7      7      7      8      7
10     D      3      8      9      3      5      3      2
11     A      8      8      8      8      8      7      6
11     B      7      9      9      7      7      6      6
11     C      8      8      6      8      8      8      9
11     D      9      7      6      8      9      9      9
12     A      3      4      2      5      5      3      5
12     B      7      5      4      7      8      4      7
12     C      5      7      6      6      6      6      8
12     D      4      6      8      4      4      7      6
13     A      8      6      7      8      8      7      7
13     B      5      5      5      8      9      8      7
13     C      6      6      6      6      7      6      7
13     D      6      4      5      7      6      8      8
14     A      3      5      7      4      4      6      7
14     B      8      7      6      8      8      7      7
14     C      6      4      5      7      5      3      4
14     D      3      4      4      3      3      4      4
15     A      6      6      4      7      6      4      4
15     B      8      9      9      3      9      1      7
15     C      3      8      7      6      4      7      6
15     D      5      7      5      2      5      6      5
16     A      7      9      7      8      7      4      4
16     B      7      9      8      8      6      9      9
16     C      7      9      8      8      8      9      8
16     D      7      9      8      8      5      4      4
17     A      6      6      8      6      7      7      6
17     B      5      4      4      4      4      5      4
17     C      6      7      5      7      5      6      5
17     D      7      6      7      5      6      7      7
18     A      7      7      7      9      8      8      9

```

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18      B      8      8      7      8      8      8      8
18      C      7      7      7      9      8      8      9
18      D      7      7      7      9      8      8      9
19      A      5      2      5      3      6      5      4
19      B      6      7      4      5      5      2      3
19      C      7      4      6      7      7      7      7
19      D      6      6      3      6      7      3      5
20      A      7      8      8      8      8      7      7
20      B      6      6      6      6      6      6      6
20      C      6      8      7      7      7      6      7
20      D      7      8      8      7      8      7      7
21      A      6      9      7      8      5      4      7
21      B      3      7      6      8      4      4      3
21      C      6      9      5      7      9      2      4
21      D      7      9      4      8      9      7      6
22      A      .      .      6      .      .      .      8
22      B      9      9      7      .      9      8      .
22      C      7      3      9      5      8      9      7
22      D      .      .      5      .      4      .      4
;
proc glm data=test;
class con trt OV color aroma sweet cocoa soft moist;
model OV color aroma sweet cocoa soft moist = trt;
lsmeans trt/stderr pdiff;
run;
quit;

```

Appendix: Part B

- SAS result of variation of purple corn and yellow corn

The SAS System

12:29 Tuesday, February 16, 20121

The GLM Procedure

Class Level Information

Class	Levels	Values
consumer	30	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
27 28 29	30	
trt	4	274 495 691 723
Overallliking	9	1 2 3 4 5 6 7 8 9
Color	9	1 2 3 4 5 6 7 8 9
Overallaroma	9	1 2 3 4 5 6 7 8 9
Viscosity	9	1 2 3 4 5 6 7 8 9
Sweetness	9	1 2 3 4 5 6 7 8 9
Overallflavor	9	1 2 3 4 5 6 7 8 9

Number of observations120

The SAS System12:29 Tuesday, February 16, 20122

The GLM Procedure

Dependent Variable: Overallliking

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	48.2916667	16.0972222	5.26	0.0020
Error	116	355.3000000	3.0629310		
Corrected Total	119	403.5916667			

	R-Square	Coeff Var	Root MSE	Overallliking Mean
	0.119655	29.70506	1.750123	5.891667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
trt	3	48.29166667	16.09722222	5.26	0.0020

Source	DF	Type III SS	Mean Square	F Value	Pr > F
trt	3	48.29166667	16.09722222	5.26	0.0020

The SAS System12:29 Tuesday, February 16, 20123

The GLM Procedure

Dependent Variable: Color

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	42.3000000	14.1000000	3.72	0.0135
Error	116	440.2000000	3.7948276		
Corrected Total	119	482.5000000			

R-Square	Coeff Var	Root MSE	Color Mean
0.087668	33.87881	1.948032	5.750000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
trt	3	42.30000000	14.10000000	3.72	0.0135

Source	DF	Type III SS	Mean Square	F Value	Pr > F
trt	3	42.30000000	14.10000000	3.72	0.0135

The SAS System 12:29 Tuesday, February 16,

2012 4

The GLM Procedure

Dependent Variable: Overallaroma

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	9.7666667	3.2555556	0.88	0.4552
Error	116	430.6000000	3.7120690		
Corrected Total	119	440.3666667			

R-Square	Coeff Var	Root MSE	Overallaroma Mean
0.022178	34.30278	1.926673	5.616667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
trt	3	9.76666667	3.25555556	0.88	0.4552

Source	DF	Type III SS	Mean Square	F Value	Pr > F
trt	3	9.76666667	3.25555556	0.88	0.4552

The SAS System 12:29 Tuesday, February 16,

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The GLM Procedure

Dependent Variable: Viscosity

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	9.2666667	3.0888889	0.86	0.4662
Error	116	418.6000000	3.6086207		
Corrected Total	119	427.8666667			

	R-Square	Coeff Var	Root MSE	Viscosity Mean		
	0.021658	31.83749	1.899637	5.966667		
Source	DF	Type I SS	Mean Square	F Value	Pr > F	
trt	3	9.26666667	3.08888889	0.86	0.4662	
Source	DF	Type III SS	Mean Square	F Value	Pr > F	
trt	3	9.26666667	3.08888889	0.86	0.4662	
The SAS System						
12:29 Tuesday, February 16, 2012 6						

The GLM Procedure					
Dependent Variable: Sweetness					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	27.7666667	9.2555556	2.71	0.0485
Error	116	396.6000000	3.4189655		
Corrected Total	119	424.3666667			

	R-Square	Coeff Var	Root MSE	Sweetness Mean		
	0.065431	31.42852	1.849044	5.883333		
<hr/>						
Source	DF	Type I SS	Mean Square	F Value	Pr > F	
trt	3	27.76666667	9.25555556	2.71	0.0485	
<hr/>						
Source	DF	Type III SS	Mean Square	F Value	Pr > F	
trt	3	27.76666667	9.25555556	2.71	0.0485	
The SAS System 12:29 Tuesday, February 16,						

The GLM Procedure					
Dependent Variable: Overallflavor					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	34.6916667	11.5638889	3.48	0.0183
Error	116	385.6333333	3.3244253		
Corrected Total	119	420.3250000			

	R-Square	Coeff Var	Root MSE	Overallflavor Mean		
	0.082535	30.77301	1.823301	5.925000		
Source	DF	Type I SS	Mean Square	F Value	Pr > F	
trt	3	34.69166667	11.56388889	3.48	0.0183	
Source	DF	Type III SS	Mean Square	F Value	Pr > F	
trt	3	34.69166667	11.56388889	3.48	0.0183	

The GLM Procedure
Least Squares Means

trt	Overallliking LSMEAN	Standard Error	Pr > t	LSMEAN Number
274	6.16666667	0.31952731	<.0001	1
495	5.86666667	0.31952731	<.0001	2
691	6.63333333	0.31952731	<.0001	3
723	4.90000000	0.31952731	<.0001	4

Least Squares Means for effect trt
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Overallliking

i/j	1	2	3	4
1		0.5081	0.3039	0.0059
2	0.5081		0.0925	0.0345
3	0.3039	0.0925		0.0002
4	0.0059	0.0345	0.0002	

trt	Color LSMEAN	Standard Error	Pr > t	LSMEAN Number
274	5.23333333	0.35566031	<.0001	1
495	5.70000000	0.35566031	<.0001	2
691	6.73333333	0.35566031	<.0001	3
723	5.33333333	0.35566031	<.0001	4

Least Squares Means for effect trt
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Color

i/j	1	2	3	4
1		0.3554	0.0035	0.8428
2	0.3554		0.0422	0.4675
3	0.0035	0.0422		0.0063
4	0.8428	0.4675	0.0063	

trt	Overallaroma LSMEAN	Standard Error	Pr > t	LSMEAN Number
274	5.76666667	0.35176076	<.0001	1
495	5.43333333	0.35176076	<.0001	2
691	6.00000000	0.35176076	<.0001	3
723	5.26666667	0.35176076	<.0001	4

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The GLM Procedure
Least Squares Means

Least Squares Means for effect trt
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Overallaroma

i/j	1	2	3	4
1		0.5041	0.6399	0.3169
2	0.5041		0.2570	0.7382
3	0.6399	0.2570		0.1432
4	0.3169	0.7382	0.1432	

trt	Viscosity LSMEAN	Standard Error	Pr > t	LSMEAN Number
274	5.96666667	0.34682468	<.0001	1
495	6.30000000	0.34682468	<.0001	2
691	6.06666667	0.34682468	<.0001	3
723	5.53333333	0.34682468	<.0001	4

Least Squares Means for effect trt
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Viscosity

i/j	1	2	3	4
1		0.4981	0.8388	0.3788
2	0.4981		0.6352	0.1208
3	0.8388	0.6352		0.2791
4	0.3788	0.1208	0.2791	

trt	Sweetness LSMEAN	Standard Error	Pr > t	LSMEAN Number
274	6.03333333	0.33758779	<.0001	1
495	5.90000000	0.33758779	<.0001	2
691	6.46666667	0.33758779	<.0001	3
723	5.13333333	0.33758779	<.0001	4

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The GLM Procedure
Least Squares Means

Least Squares Means for effect trt
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Sweetness

i/j	1	2	3	4
1		0.7805	0.3659	0.0619
2	0.7805		0.2377	0.1110
3	0.3659	0.2377		0.0061
4	0.0619	0.1110	0.0061	

trt	Overallflavor LSMEAN	Standard Error	Pr > t	LSMEAN Number
274	6.16666667	0.33288763	<.0001	1
495	5.80000000	0.33288763	<.0001	2
691	6.60000000	0.33288763	<.0001	3
723	5.13333333	0.33288763	<.0001	4

Least Squares Means for effect trt
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Overallflavor

i/j	1	2	3	4
1		0.4376	0.3592	0.0302
2	0.4376		0.0919	0.1594
3	0.3592	0.0919		0.0023
4	0.0302	0.1594	0.0023	

NOTE: To ensure overall protection level, only probabilities associated with pre-planned comparisons should be used.

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The GLM Procedure
Least Squares Means

trt	Overallliking LSMEAN	Standard Error	Pr > t	LSMEAN Number
274	6.16666667	0.31952731	<.0001	1
495	5.86666667	0.31952731	<.0001	2
691	6.63333333	0.31952731	<.0001	3
723	4.90000000	0.31952731	<.0001	4

Least Squares Means for effect trt
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Overallliking

i/j	1	2	3	4
1		0.5081	0.3039	0.0059
2	0.5081		0.0925	0.0345
3	0.3039	0.0925		0.0002
4	0.0059	0.0345	0.0002	

trt	Color LSMEAN	Standard Error	Pr > t	LSMEAN Number
274	5.23333333	0.35566031	<.0001	1
495	5.70000000	0.35566031	<.0001	2
691	6.73333333	0.35566031	<.0001	3
723	5.33333333	0.35566031	<.0001	4

Least Squares Means for effect trt
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Color

i/j	1	2	3	4
1		0.3554	0.0035	0.8428
2	0.3554		0.0422	0.4675
3	0.0035	0.0422		0.0063
4	0.8428	0.4675	0.0063	

trt	Overallaroma LSMEAN	Standard Error	Pr > t	LSMEAN Number
274	5.76666667	0.35176076	<.0001	1
495	5.43333333	0.35176076	<.0001	2
691	6.00000000	0.35176076	<.0001	3
723	5.26666667	0.35176076	<.0001	4

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The GLM Procedure
Least Squares Means

Least Squares Means for effect trt
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Overallaroma

i/j	1	2	3	4
1		0.5041	0.6399	0.3169
2	0.5041		0.2570	0.7382
3	0.6399	0.2570		0.1432
4	0.3169	0.7382	0.1432	

trt	Viscosity LSMEAN	Standard Error	Pr > t	LSMEAN Number
274	5.96666667	0.34682468	<.0001	1
495	6.30000000	0.34682468	<.0001	2
691	6.06666667	0.34682468	<.0001	3
723	5.53333333	0.34682468	<.0001	4

Least Squares Means for effect trt
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Viscosity

i/j	1	2	3	4
1		0.4981	0.8388	0.3788
2	0.4981		0.6352	0.1208
3	0.8388	0.6352		0.2791
4	0.3788	0.1208	0.2791	

trt	Sweetness LSMEAN	Standard Error	Pr > t	LSMEAN Number
274	6.03333333	0.33758779	<.0001	1
495	5.90000000	0.33758779	<.0001	2
691	6.46666667	0.33758779	<.0001	3
723	5.13333333	0.33758779	<.0001	4

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The GLM Procedure
Least Squares Means

Least Squares Means for effect trt
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Sweetness

i/j	1	2	3	4
1		0.7805	0.3659	0.0619
2	0.7805		0.2377	0.1110
3	0.3659	0.2377		0.0061
4	0.0619	0.1110	0.0061	

trt	Overallflavor LSMEAN	Standard Error	Pr > t	LSMEAN Number
274	6.16666667	0.33288763	<.0001	1
495	5.80000000	0.33288763	<.0001	2
691	6.60000000	0.33288763	<.0001	3
723	5.13333333	0.33288763	<.0001	4

Least Squares Means for effect trt
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: Overallflavor

i/j	1	2	3	4
1		0.4376	0.3592	0.0302
2	0.4376		0.0919	0.1594
3	0.3592	0.0919		0.0023
4	0.0302	0.1594	0.0023	

NOTE: To ensure overall protection level, only probabilities associated with pre-planned comparisons should be used.

Appendix: Part C1

- Sensory Evaluation form

Questionnaire for Hedonic scale 9-points

Panel number..... Date:

Instruction : - Please drink water before taste the sample and between each sample.

- Please rate linking score on each attribute by

- 1. Dislike Extremely
- 2. Dislike Very Much
- 3. Dislike Moderately
- 4. Dislike Slightly
- 5. Neither Like nor Dislike
- 6. Like Slightly
- 7. Like Moderately
- 8. Like Very Much
- 9. Like Extremely

Sample	691	274	723	495
Overall liking	_____	_____	_____	_____
Color	_____	_____	_____	_____
Overall aroma	_____	_____	_____	_____
Viscosity	_____	_____	_____	_____
Sweetness	_____	_____	_____	_____
Overall flavor	_____	_____	_____	_____

Comment :

Appendix: Part C3**Consumer Questionnaire**

Dear Participants,

According to the development of “ development of corn beverage from purple corn” which has been carried out by Ms. Paweetida Teepawattanaset, a student of school of Biotechnology, Assumption University, Thailand. Your cooperation for this questionnaire is extremely essential to this research in the aspect of consumer’s view

I would like to ask for your cooperation in answering this questionnaire subjected to your real opinion and behavior. All of your information provided to me will be beneficial to such research and be kept confidentially

Your cooperation will be highly appreciated

Paweetida Teepawattanaset

Faculty of Biotechnology

Assumption University

Consumer Test Questionnaire

Panelist no.....

Instruction: Please √ in the box according to your opinion

Part I: Consumer behavior

1. Which brand(s) of corn beverage that you prefer?

☐ Malee I-corn

☐ Jumbo

☐ Diamond brand

☐ Suwan sweet corn brand

☐ My garden

☐ Other_____

How often that you drink corn beverage?

☐ Daily

☐ 3-4 per week

☐ 1-2 per week

☐ Occasionally

2. Where do you buy corn beverage?

☐ Supermarket

☐ Hypermarket

☐ Other_____

3. Please √ in the box about the factor that affecting on purchasing “corn beverage”

Factor	Importance Rating				
	Most important	Very important	Important	Slightly important	Not important
Color					
Odor					
Flavor					
Quality					
Packaging					
Price					
Brand					
Other please specify_____					

Part II: Product Acceptance

1. How much do you like this corn milk product?

Dislike extremely	Dislike very much	Dislike moderately	Dislike slightly	Neither like nor dislike	Like slightly	Like moderately	Like very much	Like extremely
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2. Do you accept this product? Please give the reason.

☐ Accept

☐ Do not accept

Because:

3. If this product is launched in market, will you buy this product?

- ☐ Will buy because _____
- ☐ Not sure because _____
- ☐ Will not buy because _____

4. What should be the suitable price of this corn milk beverage of this showing package?

- ☐ 8-10 baht ☐ 11-13 baht ☐ 14-16 baht
- ☐ 17-19 baht ☐ More than 20 baht

5. Comment

Part III: Demographic information

Gender

☐ Male

☐ Female

Age

☐ Below 15 years

☐ 16-19 years

☐ 20-23 years

☐ 24-27 years

☐ 28-31 years

☐ More than 31 years

Education

☐ High school or lower

☐ Bachelor's degree

☐ Master's degree

☐ Doctorate

Occupation

☐ Student

☐ Lecturer

☐ Employee

☐ Business-owner

☐ Unemployed

☐ Housewife/husband

Income monthly

☐ Below 5,000 baht

☐ 5,000-10,000 baht

☐ 10,001-15,000 baht

☐ 15,001-20,000 baht

☐ 20,001-25,000 baht

☐ More than 25,000 baht

Nationality

☐ Thai

☐ Non Thai please specify _____

