RED DRAGON FRUIT (*Hylocereus sp.*) BREAD

BY

THIRANAN SUPANANTAROEK

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

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Title: **Red dragon fruit (*Hylocereus* sp.) bread**

Name: **Thiranan Supanantaroek**

Project advisor: **A.Nootrudee Siriboon**

Academic year: **2010**

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(Ms.Nootrudee Siriboon)

Advisor

Abstract

A study to develop red dragon fruit, *Hylocereus sp.*, bread was conducted to find formula, process, and preference of the product. Some physicochemical properties of red dragon fruit extract included color 10RP 4/11 of purplish red, pH 4.6, and low soluble solid content 7°Brix. Heating the red dragon fruit extract showed that color was stable up to 80°C before it changed to bright red at 90° and 100°C. After 60 minutes fermentation with instant active dry yeast for normal white pan bread, dough containing water and dough containing 25% substitution of red dragon fruit extract provided 109 and 90% expansion, respectively, while 52% expansion was obtained from instant active dry yeast for sweet bun. Bread-maker Severin, Model BM 3983 was used as apparatus to prepare all bread samples using long term program. The amount of red dragon fruit extract was varied from 25, 30, 40, 50, 60, and 70% to substitute water in white pan bread formula. Bread had an increase volume at 30% and reached the highest at 40% substitution. At 50% and above, bread showed a decrease in volume drastically. Crust was thick with color turned to orange pink of red dragon fruit color while crumb lost uniform air cell distribution as more red-dragon fruit was substituted with water. There was no significant difference in the average total scores of bread samples ($p<0.05$) evaluated by Bread scoring system (Pyler, 1973). Preference test on 30% and 40% substitution of red dragon fruit extract bread samples with 30 test panelists resulted in no significant difference ($p<0.05$) in all attributes. A flavor profile of bread with 30% substitution demonstrated that the bread had moderate saltiness, sweetness, and sourness scores, ~6.5, strong yeast odor, ~7, typical for fresh bread, and strong red dragon fruit flavor out of 10. Cost of production for bread with 30% substitution was 31 Baht per serving size of 440-gram loaf while 40% substitution would cost 35.43 Baht, 14.3% more than 30% substitution. The 30% substitution of red dragon fruit bread was accepted by 99% from consumer acceptance test with a price of 45 Baht per loaf and benefit 45% of production cost.

Acknowledgement

With respect, firstly I would like to express my sincere gratitude towards A. Nootrudee Siriboon for dedicated her precious time and provided endless support throughout the project. Without the support and guidance, I would not succeed this special project. I would also like to thank to Asst. Prof. Dr. Wunwisa Krasaekoopt and A. Roungdao Klinjapo and all teachers for the knowledge and guidance during four years of education.

Special thanks to my senior friends, juniors and sophomores who gave up their time for the sensory evaluation tests. Without their corporation, this project would never be completed.

Last but not least, the grateful for my family. Thank you for your love and care every moment I needed. Thank you for your support and encouragement, there will not be strength to battle with the difficulties.

List of Content

List of Table

List of Figure

Introduction

Dragon fruit, *Hylocereus spp.*, is exotic outward fruit that grown in Southeast Asia, Mexico, Central and South America, and Israel. The plant is actually a type of cactus, and the fruit has two skin colors, pink and yellow, while the flesh is either white or deep pink. Ripe dragon fruit is sweet and crunchy with a taste like a cross between kiwi and pear.

Nowadays, dragon fruit is more popular worldwide especially for the diet food with it low in calories that is suitable for all diet, especially for the diabetes and obesity. Moreover dragon fruits are high in antioxidants, which help to fight carcinogenic free-radicals from forming in the body. They are a good source of Vitamin C, and rich in minerals, calcium and phosphorus. The flesh is low in calories and high in fiber while the seeds have high polyunsaturated fatty acids. Aside from its nutritional content, it is stated that the fruit also helps excreting heavy metal toxins from the body, lowering cholesterol and blood pressure. Moreover, dragon fruits are also known to be a natural laxative.

This project is aimed to use red dragon fruit to apply in food product for its color. With the red flesh, dragon fruit is carried another nutritional value that cannot see in the white flesh dragon fruit which is betalain. These vibrant pigments are potent photochemical and antioxidants that work to protect damage to body cells from free radicals. It is known that the more vibrant the colors of our fruit and vegetables, the more they have to offer in terms of nutrients to help protect our bodies from damaging free radicals.

Though its benefits are high, dragon fruit or red dragon fruit is not a popular fruit. Unlike other fruits, dragon fruit or red dragon fruit has mild sweet taste that is not attracted to a lot of people, especially children. Moreover, consumption of dragon fruit or red dragon fruit is also limit, usually consumed fresh. The aim of this project is to transformed red dragon fruit into food product, people are much familiar such as bread. Since bread is a staple food form many countries, increasing varieties of bread would provide more choices to the consumers.

Objectives

1. To develop bread containing red dragon fruit.
2. To increase nutritive value of normal white bread by addition of pigment from red dragon fruit.
3. To introduce new product choice for consumers.

Literature review

1. Dragon fruit

Pitaya fruit or Pitahaya fruit, known in Thailand as dragon fruit, belongs to the cactus family (Cactaceae) with a scientific name of *Hylocereus spp.* Dragon fruits have an oval shape with reddish pink or yellow skin and white and deep reddish pink flesh. The flesh is juicy, light sweet melon taste with several small black seeds. Dragon Fruit is native to Central and South America and cultivated in tropical region around the world (http://www.tropicalfruitnursery.com/dragon/)8/8/2010.

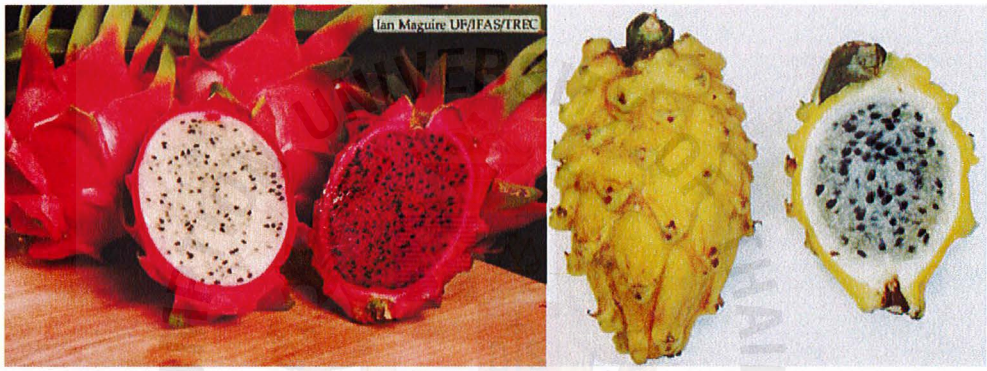


Figure 1: Dragon fruits

Cultivation of dragon fruit in Thailand

Dragon fruit can be grown in every soil condition from sandy soil, clay, to red earth. In the first year, after 8-12 months, the plant will start to produce fruits, approximately 30 fruits. In the second year, it will bear more fruits, 50 fruits per tree, third year 100-200 fruits, and in 4th till 15th year, the plant will give around 300 fruits. In Thailand, on an average with no out-of-season harvest, dragon fruit will give 16 rounds of production from February to October. (http://www.kennydragonfruit.com/main/?page_id=83). 8/8/2010

Dragon fruit of pitaya fruit contains high concentrations of Vitamin C, minerals and fiber content. Table 1 shows a nutritional value of the dragon fruit from 100 g of edible portion. Equally available in affluent in a dragon fruit is phyto albumins. Basically, these nutrients are vital and known world over for the antioxidants they possess which usually help in the prevention of the formation of free radicals that cause cancer. (http://dragon-fruit.biz/) 8/8/2010

Table 1 Nutritional composition of fresh dragon fruit (based on 100 gm of edible portion)

Nutritional	Dragon fruit[1]	Tangerine[2]	Guava[2]
Fiber	0.9 g	0.5 g	2.9 g
Fat	0.61 g	0.4 g	0.1 g
Ashes	0.68 g	trace	0.5 g
Carotene	0.012 g	82 g	21 g
Water	83.0 g	89.9 g	89 g
Phosphorus	36.1 mg	24 g	12 g
Ascorbic Acid	9.0 mg	18 mg	160 mg
Protein	0.229 g	0.6 g	0.6 g
Riboflavin	0.045 mg	0.04 g	0.11 g
Calcium	8.8 g	30 g	2 g
Niacin	0.430 mg	0.4 g	1.3 g
Iron	0.65 mg	0.8 g	0.4 g

Source: 1. http://dragon-fruit.biz/

2. Nutritive value of Thai foods. 1992. Nutrition Division, Department of Health, Ministry of Public Health

Color of dragon fruit

Pink red color of dragon fruit comes from anthocyanin pigments. The main anthocyanin found in dragon fruit skin is 'betalain'. This pigment in the peel is reported to use as a natural dye in several products. Betalains are a class of red and yellow indole-derived pigments found in plants of the Caryophyllales, where they replace anthocyanin pigments. They are most often located in the petals of flowers but may present in fruits, leaves, stems, and roots of plants such as those found in beet root and red dragon fruit. The pigments are powerful antioxidants. Betalains can also be found in some higher order fungi. There are two categories of betalains which are 'betacyanins' - the reddish to violet betalains and 'betaxanthins' - the yellow to orange betalains. (http://en.wikipedia.org/wiki/Betalain 8/8/2010)

In the past, betalains were included in a group of anthocyanins, the reddish pigments found in most plants since both betalains and anthocyanins are water-soluble pigments found in the vacuoles of plant cells. However, betalains are structurally and chemically different from anthocyanins. Molecules of betalains contain nitrogen whereas anthocyanins do not. Betalains are actually aromatic indole derivatives synthesized from tyrosine. They are not related chemically to the anthocyanins nor flavonoids. Apart from being aromatic indole, betalains are glycosides, consisting of sugar and aromatic indole representing colored portion of the pigment. Their synthesis is promoted by light. (http://en.wikipedia.org/wiki/Betalain 8/8/2010)

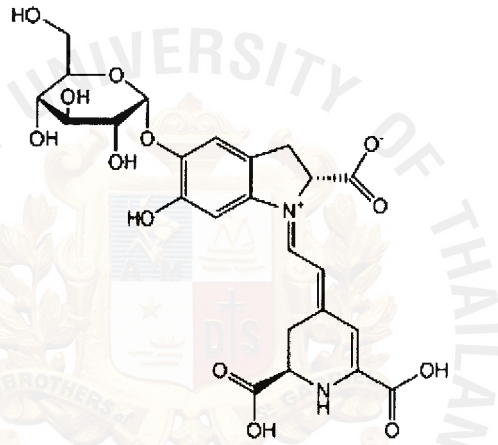


Figure2: Chemical structure of betalain

(Source: http://en.wikipedia.org/wiki/Betalain 8/8/2010)

Betalains may exhibit anti-cancer activity. Betalains from the prickly pear showed considerable free radical scavenger and antioxidant properties *in vitro* to protect endothelium from cytokine-induced redox state alteration. (http://en.wikipedia.org/wiki/Betalain 8/8/2010)

2. Bread

Bread is a basic food prepared by cooking dough of flour and water and frequently additional ingredients. Doughs are usually baked, but it can be steamed, fried, or baked on no oil skillet. It may be leavened or unleavened. Common ingredients for making bread are salt, fat and leavening agents such as yeast and baking soda, in additional bread may contain other ingredients, such as milk, egg, sugar, spice, fruit (such as raisins), vegetables (such as onion), nuts (such as walnuts) or seeds (such as poppy seeds). Fresh bread is give for its taste, aroma, quality, appearance and texture. The importance thing to keep its appetizing is to retain it freshness. Bread stale is the bread that has stiffened or dried. Nowadays to reduce drying rate of bread, the modern bread is sometimes wrapped in paper or plastic film, or stored in a container such as a breadbox. Bread that is kept in warm, moist environments is lead to the growth of mold. Bread kept at low temperatures in a refrigerator will develop mold growth more slowly than bread kept at room temperature, but will turn stale quickly due to retrogradation. (http://en.wikipedia.org/ wiki/Bread 8/8/2010)

For the formulation, the most significant measurement in a bread recipe is the amount of flour, as it most affects texture and crumbs. Professional bakers use a system of percentages known as *Bakers' Percentage* in their recipe formulations, and measure ingredients by weight instead of by volume. Measurement by weight is much more accurate and consistent than measurement by volume, especially for the dry ingredients. Flour is always stated as 100%, and the rest of the ingredients are a percent of that amount by weight. Common table bread in the U.S. uses approximately 50% water, resulting in finely textured, light, bread. In yeast breads, the higher water percentages result in more CO_2 bubbles, and a coarser bread crumb. One pound or 450 g of flour will yield a standard loaf of bread, or two French loaves. (http://en.wikipedia.org/wiki/Bread 8/8/2010)

Dough development is a relatively undefined term. Among other things, there are a lot of complex changes in bread ingredients when the ingredients become mixed. The changes are associated with the formation of gluten, which requires both the hydration of the proteins in the flour and applied energy. Initially, gluten is formed when flour and water are mixed together. The proteins in the flour, glutenin and gliadin cross link, using the water as a vehicle to form gluten. Enhancing this gluten structure is important step to developing a gas retaining structure in the bread. Energy is provided through the process of kneading. Simply put gluten does not form spontaneously, so energy must be provided for its formation. (http://en.wikipedia.org/wiki/Bread 8/8/2010)

The production of a defined cellular structure in the baked bread depends entirely on the creation and retention of gas bubbles in the dough. After mixing has been completed, the only new gas which becomes available is the carbon dioxide gas generated by the yeast fermentation. Carbon dioxide gas has many special properties. At this point we are concerned with two: its high solubility and its relative inability to form gas bubbles. As the yeast produces carbon dioxide gas, the latter goes into solution in the aqueous phase within the dough. (http://en.wikipedia.org/wiki/Bread 8/8/2010)

In bread baking, fermentation occurs due to a conversion of sugars (technically, glucides or sugars, naturally present in the flour) to alcohol and carbon dioxide under the effect of occurring yeast and bacteria. This is classifying as alcoholic fermentation. Fermentation is an anaerobic metabolic pathway that occurs after the process of glycolysis is breaking down a glucose molecule making a pyruvate. During fermentation process a pyruvate will be broken down into either ethanol or lactic acids (which are both toxins). In the case of yeast fermentation, a pyruvate is broken down into ethanol. The smell of baking bread is in part due to the smell of ethanol. Fermentation can produce important nutrients or eliminate anti-nutrients. Depending on the type of fermentation some products can be harmful to people's health. (http://en.wikipedia.org/wiki/Bread 8/8/2010)

Ingredients for bread making

Flour

Flour is a product made from grain that has been ground into a powder. It provides the primary structure to the final baked bread and provides the starch and protein necessary for the production of bread.

All purpose flour

All-purpose or plain flour is blended wheat flour with an intermediate gluten level. In general, flour made from harder wheat (like bread flour) is higher in protein and gluten, making it ideal for crusty breads and yeast-risen products. Flour made from softer wheat (like cake flour) contains less protein and gluten, making it more appropriate for lighter, tendered goods like cakes and biscuits.

A combination of hard and soft wheat is milled to produce all-purpose flour. The resulting medium protein content (between 9% and 12%) offers just the right balance of strength and tenderness for the everyday baker to make chewy breads, delicate tarts and everything between it.

Yeast

Many types of bread are leavened by yeast. The yeast used for leavening bread is *Saccharomyces cerevisiae*, the same species used for brewing alcoholic beverages. This yeast ferments carbohydrates in the flour, including any sugar, producing carbon dioxide. Baker's yeast has the advantage of producing uniform, quick, and reliable results, because it is obtained from a pure culture.

There are 2 main types of yeast in bakery products.

- Fresh yeast
- Dry yeast

Instant-active dry yeast is select to use in red dragon fruit bread for convenience purpose. The yeast is dry powder and very active and does not require rehydration as the active dry yeast so it can be mixed directly with the flour before developing the dough.

Sugar

As a yeast food, the sweetener is consumed by yeast during the fermentation process. Sugar creates tenderness and fineness of texture, partly from weakening gluten structure, promote good crust color. The amount of sugar used is very important because it affects the yeast fermentation as same as the type of yeast used for fermentation. Also sugar helps retention moisture and prolonging shelf life.

Salt

Salt or sodium chloride is used in bakery not only for its salty taste but its highlight of other flavor product. The level of salt used being around 1.0-1.3% of the bread weight. Salt has a retarding effect on fermentation and any change in salt level has to be matched by a change in yeast level to maintain the same rate of fermentation. In addition, salt controls yeast activity by increasing osmotic pressure in dough at the fermentation stage. Without salt dough will be wet and sticky when kneading.

Fats or shortenings

The main function of shortening is to lubricate the dough and shorten the gluten network. It also gives taste and aroma that the consumer preferred. They are fats that derive from plant, such as margarine and animal fat such as butter. Butter is more expensive than other type of shortening but it contributes to a better aroma in bread. If too much fat is included in bread dough, the lubrication effect will cause the protein structures to divide. A fat content of approximately 3% by weight is the concentration that will produce the greatest leavening action. In addition to their effects on leavening, fats also serve to tenderize the breads they are used in and also help to keep the bread fresh longer after baking.

Water

Water is used to form the flour into a phase or dough and for hydrating the flour protein to be partially absorbed. By the flour, starch partially damaged starch fractions of the flour and the form water phase in the dough in which soluble solids such as sugar, salt, soluble protein are dissolved and in which the yeast cells are dispersed. In addition to the water in each of these they also bring additional sweeteners, fats, and/or leavening

components. The volume of liquid required varies between recipes, but a ratio of 1 part liquid to 3 parts flour is common for yeast breads. In addition to water, other types of liquids that may be used include dairy products, fruit juices, or beer.

Red dragon fruit extract

Freshly red dragon fruit are selected to use in the bread making processed. Fruits are extracted and then pasteurized before being processed which contain no artificial colors, flavors or preservatives. That is ready-to-drink 100% natural red dragon fruit extract.

Materials and methods

Materials and Apparatus

1) Red dragon fruit
2) All-purpose flour, Kite
3) Instant active dry yeast for white bread, Fermipan
4) Sugar
5) Salt
6) Shortening, Olympus
7) Bread-maker, Severin, Model BM 3983
8) pH meter, HANNA Instruments
9) Refractometer, TAMCO
10) Digital balance, ZEPPER, Model no. ES-3000H

Methods

I. Determination properties of red dragon fruit extract

a. Color of the red dragon fruit extract using Munsell Book of Color
b. pH of the red dragon fruit extract - Measure pH of the red dragon fruit extract after one day processing using pH meter.
c. Solid content – Measure °Brix of the red dragon fruit extract after one day processing using a hand refractometer.
d. Effect of temperature on color of the red dragon fruit by heat from 30° – 100°C, observe and record the color every 10-minute interval.

II. Preliminary test to study a possible condition for using the red dragon fruit in bread

a. **Comparison of yeast fermentation activity in dough using water (as control) and the red dragon fruit extract:** Using a basic formula of white pan bread with white bread yeast to prepare dough containing (a) water, and (b) replacing 25% of water in the formula with the red dragon fruit extract. Observe volume increased after 60 min fermentation.
b. **Determination of a type of yeast used in production of red dragon fruit bread:** Varying two types of yeast - white bread yeast and sweet bun yeast -

in the basic formula for white pan bread containing replacement of 25% red dragon fruit extract and observe a change in volume after 60 min fermentation Basic formula for white pan bread:

Table 2: Basic formula of white pan bread from bread makers Severin, Model BM 3983

Ingredients	Amount (grams)*
Flour	100
Water	59
Yeast	2
Sugar	6.5
Salt	2
Shortening	4

* On a flour weight base or fwb

III. Formulation of red dragon fruit bread using bread maker

a. Preliminary test with the bread maker Severin, Model BM 3983

Use the basic formula of white pan bread to prepare bread using the bread maker Severin, Model BM 3938 with water and observe appearance and volume of the bread

b. Formulate the red dragon fruit bread

i. **Determine the amount of red dragon fruit extract use in red dragon fruit bread** Replacing 25 to 70% of water in the formula in Table 2 with the red dragon fruit extract and prepare the bread sample using bread makers. Observe the highest amount of the red dragon fruit extract to replace in the formula that could possibly make pan bread.

ii. Measure volume of red dragon fruit bread

Volume of bread was determined by replacement method of a known dimension containers containing rice grain and/or bread sample and grain.

iii. Evaluate bread samples using the scoring system of bread, Pyler (1973) to determine the characteristics of the red dragon fruit bread.

A group of students who had taken FT 4114, Bakery Technology who had familiar with bread scoring system was used to evaluate the bread samples. The samples were evaluated on 9 attributes base on Pyler criteria of bread. The total score from 9 attributes were combined as evaluation value to select bread sample for further study.

iv. Preference test

Two selected bread samples from (iii) were used in preference test using test panelists to evaluate 7 attributes on preference scale of 1 to 9. The most preferred bread sample was selected for further study.

v. Flavor profile of red dragon fruit bread

Trained test panelists were used to assess flavor intensity of the red dragon fruit on a non-structural scale. The result was analyzed and used to construct a flavor profile of the product.

vi. Cost

Cost of production was determined for the selected bread sample from (iii). Raw material cost was estimated from the amount of raw material used in the product. Production cost and promotion cost were estimated from the total cost of raw materials.

vii. Consumer test

Consumer acceptance test was conducted with the selected bread sample from (iii) using 100 consumers.

IV. Sensory evaluation of the red dragon fruit bread

a. **Use the scoring system of bread, Pyler (1973) to determine the characteristics of the red dragon fruit bread.** 8 test panelists were Biotechnology students who had take FT 4114 and had experience in bread scoring from the class. Bread scoring system includes volume, crust characteristics, crumb characteristics, and flavor of the product(Appendix C-1)

b. **Use preference test from 30 consumers**. They were asked to determine their preference on appearance, color, texture, yeast aroma, taste and moisture attributes of the red dragon bread.

c. **Flavor profile of the red dragon fruit bread**. 8 test panelists from (a.) were asked to rate intensity compared with the ideal bread which is normal white bread with five attributes including saltiness, sweetness, sourness, red dragon flavor and yeast odor selected attributes of the bread sample for flavor profile.

Fermentation power of yeast with the red dragon fruit extract

1. **Fermentation power in 1 hour**

To measure the fermented power of yeast by using 'water' and 'the pasteurized red dragon fruit extract' to substitute the water in the normal white bread formula with the white bread yeast for normal white bread. Dough samples obtained from this method were placed in the volumetric cylinders to measure the increased volume in milliliters from 0-60 minutes during yeast fermentation to observe the effect of using red dragon fruit juice.

2. **Type of yeast**

To measure the fermented power of two types of yeast by which are 'white bread yeast for normal white bread' and 'sweet bun yeast' on the pasteurized red dragon fruit extract. Dough samples obtained from two different types of yeast were placed in the volumetric cylinders to measure the increased volume in milliliters from 0-60 minutes during yeast fermentation to select the suitable yeast to use in the red dragon bread.

V. Statistical analysis

The screening on the percentage of fruit juice from 8 trained panelists was analyzed using Complete Randomized Design. Mean were compared using uni-variate test from SPSS version 17.

VI. Experimental location

1. Pilot plant and E8 laboratory, Assumption University

2. Testing for consumer acceptance in Assumption University, Huamak Campus.

VII. Time planning and research place

Table 3: Job description timeline

Job	Description
1	Discuss with advisor and searching for the special project topic
2	Research information on the related research
3	Discover material and method
4	Implement special project, collect the data and analyze the data
5	Consumer survey test
6	Preparation of report and presentation
7	Last approval of special project by advisor
8	Special project Presentation

The following Grant chart shows the schedule of each task and its planned completion period. The plan is constructed in order to complete the job description follow the time line.

Table 4: Product Development Time Line in 2010

	May				June				July				August				September				October			
Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1																								
2																								
3																								
4																								
5																								
6																								
7																								
8																								

Result and Discussion

I. Determination properties of red dragon fruit extract

a. Determine color of the red dragon fruit extracted using Munsell Book of Color.

Color of pasteurized red dragon fruit juice extract kept in the freezer overnight was measured by using Munsell book. The Munsell notation was read as 10RP 4/11 as shown in Figure3. The hue 'RP' falls between two principal hues, 'Red' and 'Purple', represents purplish red of pigment betalain. Value '4' scales brightness of the color reflects that red dragon fruit color is rather dull but with Chroma '11' telling that this color has high intensity or concentration.

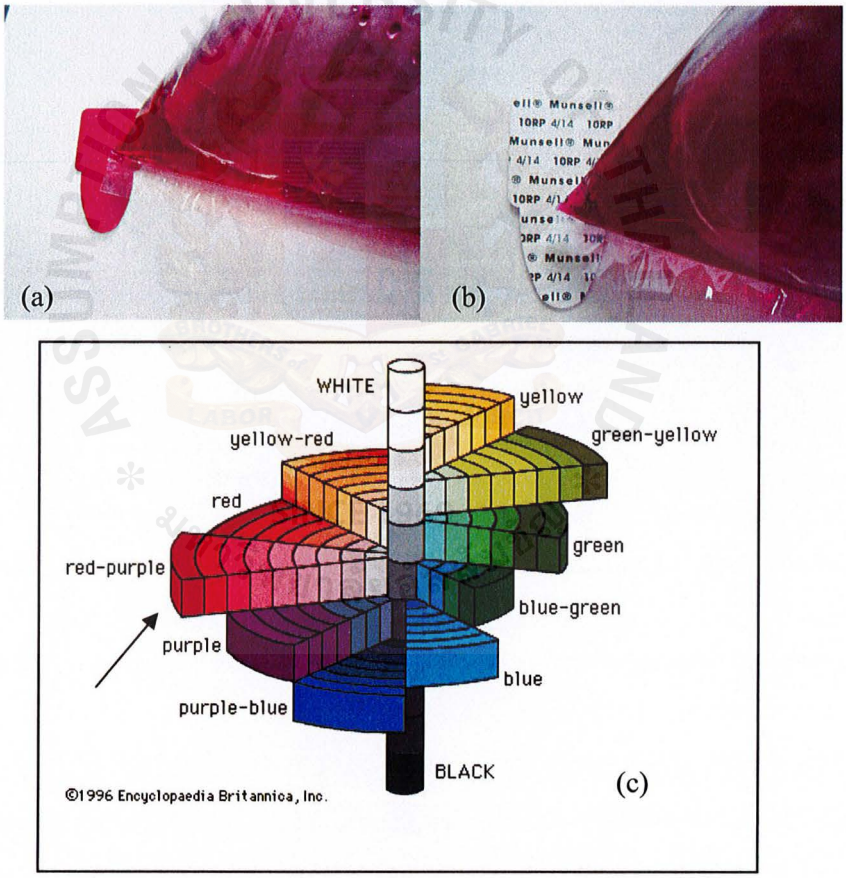


Figure3: Color of the red dragon fruit extracted using Munsell Book of Color (a) color comparison with standard strip, (b) close-up comparison, and (c) Munsell notation
Source: http://laimagenfija.files.wordpress.com/2008/03/carta-de-colores-de-munsell.gif

b. pH of the red dragon fruit extract

Red dragon fruit extract, pasteurized and kept in the freezer overnight was measured its pH by pH meter. The pH of red dragon fruit juice extracted was 4.6 as shown in Figure 4. This pH indicates that the red dragon fruit extract is acidic but does not reach 4.5 for an acid food. Therefore, pasteurization might not be enough to kill spoilage microorganism in the sample. However the sample was kept frozen during a period of the experiment without any sign of spoilage It could be that the freezing storage of the sample could have helped delaying microbial spoilage or some component in the red dragon fruit could have antimicrobial property that prevented microorganism from spoiling the extract since red dragon fruit is known to contain many phenolic compounds.

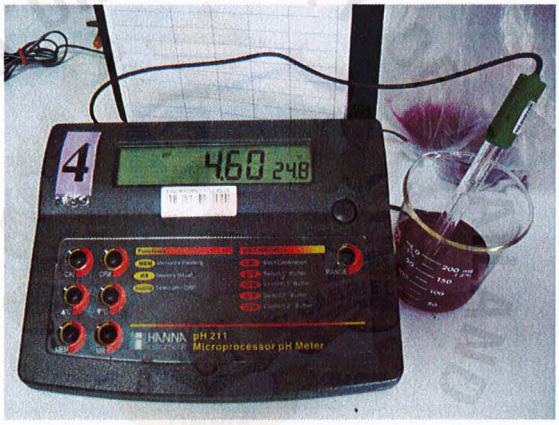


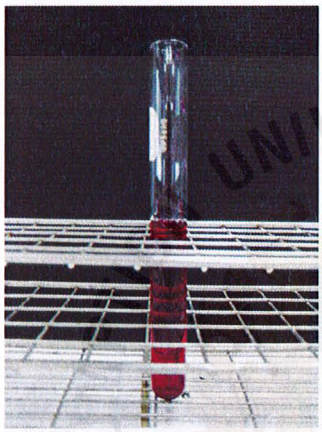
Figure4: pH of the red dragon fruit extracted using pH meter

c. Solid content

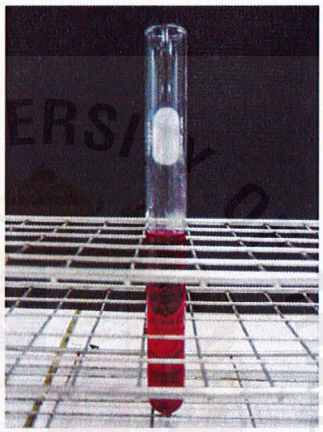
After one day storage in the freezer, the red dragon fruit extract was measured its solid content using hand refractometer. The solid content of the sample was 7° Brix, indicating that the extract contained low amount of soluble material, possible sugar, acid, some soluble compounds. As sugar and acid are two main components in many fruit juice and both contribute to the taste of the juice. The red dragon fruit juice which has low soluble solid taste is rather brand.

d. Effect of temperature on color change of red dragon fruit extract

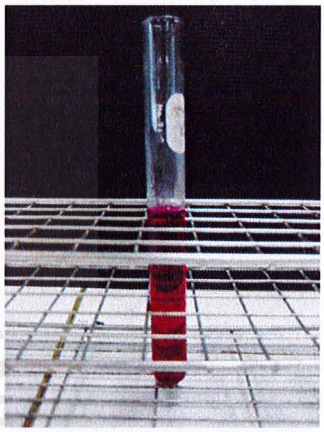
The effect of temperature on color of the red dragon fruit extract was observed by heating the sample from 30°C – 100°C in a water bath and recorded the color changed every 10 minutes interval. As temperature increased, the color of red dragon fruit extract was photographed and shown in figure 5 and 6. Slight color change was observed after heating to 90°C and 100°C, indicated the pigment in Red dragon fruit could withstand high heating temperature. The color became less purplish but still remained bright red.



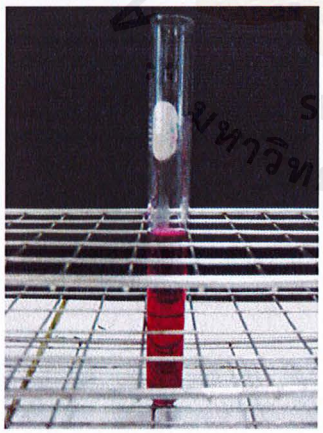
(a) 30°C



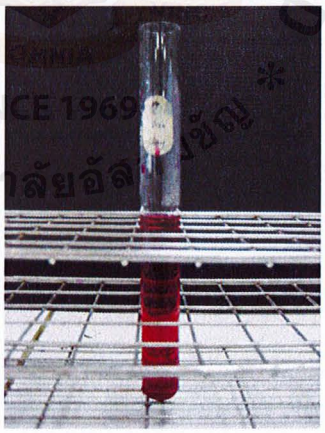
(b) 40°C



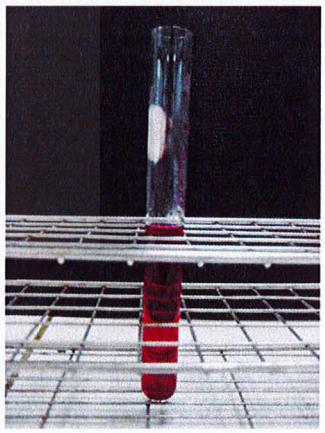
(c) 50°C



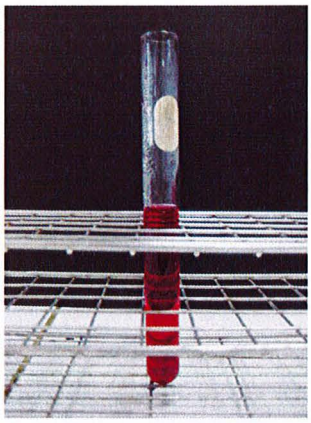
(d) 60°C



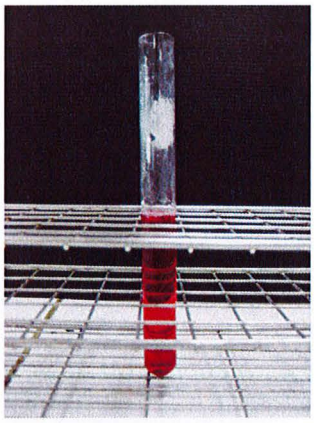
(e) 70°C



(f) 80°C



(g) 90°C



(h) 100°C

Figure 5: Color of Red dragon fruit juice at temperature 30°C to 100°C

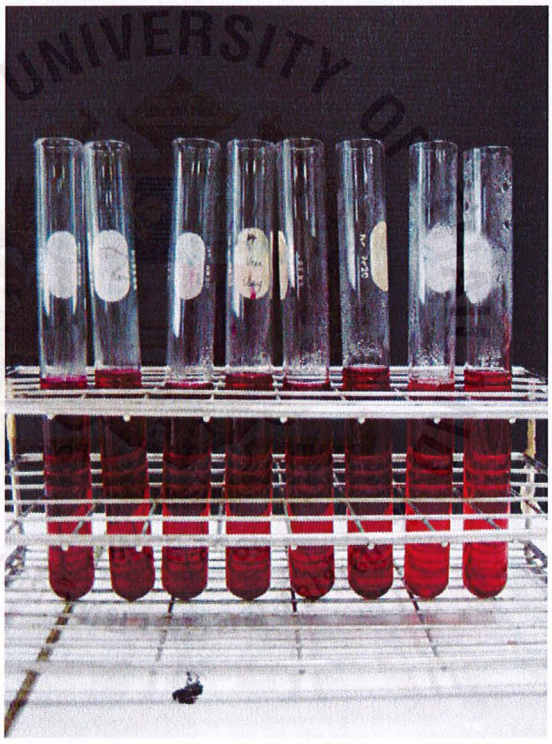


Figure 6: Red dragon fruit extract heated from 30°C to 100°C from left to right

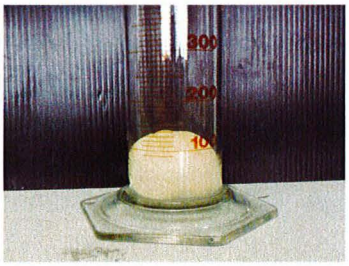
II. Preliminary test to study a possible condition for using red dragon fruit in bread

a. Comparison of yeast activity in dough samples containing water as control and red dragon fruit extract

To compare activity of active dry yeast for normal white bread when red dragon fruit was added, two dough samples were made using the basic recipe in Table 2. One contained water as a control. The other used 25% red dragon fruit extract substituted water in the recipe. The dough samples were prepared by bread maker, Severin Model BM 3983 to provide consistent dough development. The dough was left to ferment for one hour. The results were shown in Figure 7. It was observed that dough from the bread maker had light pink color, 7.5RP 8/6. For percent expansion, control dough and red dragon fruit dough had 107% and 90%, respectively. The results were shown in Table 5. When comparing yeast activity with water and red dragon fruit, though percent expansions were 20% different, yeast could ferment the dough containing red dragon fruit close to control.

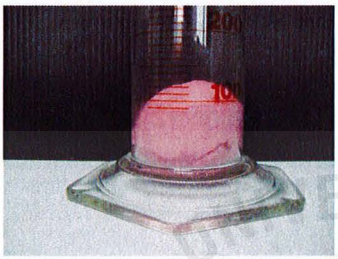
Table 5: Show the yeast fermentation power (%) of dough samples with water and red dragon fruit extract after 60 minute fermentation

Liquid used	Time of fermentation		Yeast fermentation power (%)
	0 min	60 min	
Water	147	304	107
25% Red dragon fruit extract	132	250	90

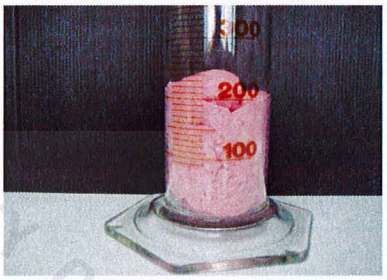


0-minute fermentation of control

60-minute fermentation of control



0-minute fermentation of red dragon fruit dough



60-minute fermentation of red dragon fruit dough

Figure 7: 0-minute and 60-minute fermentation dough prepared by water as control and 25% substitution with red dragon fruit extract.

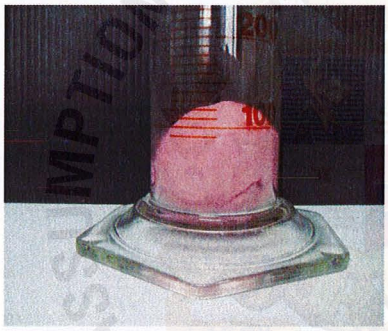
b. Determination of a type of yeast used in production of red dragon fruit bread

Though the active dry yeast for normal white pan bread could ferment the dough sample containing red dragon fruit at the same rate as the control dough (containing water), it was suspected that another baker's yeast for sweet bun might provide better fermentation than the yeast for normal white pan bread. The sweet bun yeast was suitable for making bread containing high concentration of sugar (another word, or high soluble solid). The study was conducted to determine fermentation of two types of yeast when red dragon fruit was used to substitute water for making bread. Bread maker, Severin Model BM 3983, was used to control mixing and kneading process of the dough. Red dragon fruit dough samples were made from two different types of active dry yeast - for normal white bread and for sweet bun. After 60 minutes fermentation, the dough made from normal white bread yeast had higher

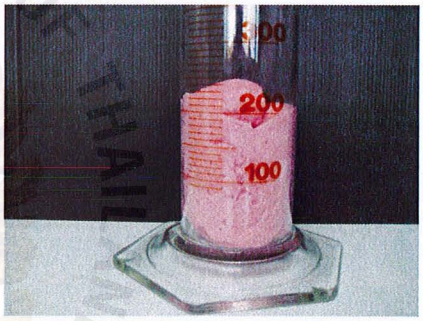
percent of expansion, 91%, while the dough with the sweet bun yeast expanded by 52% as shown in Figure 8. As a result active dry yeast for normal white bread was more suitable to use for further study using bread maker.

Table 6: Show the yeast fermentation power (%) of dough samples with different type of yeast after 60 minute fermentation

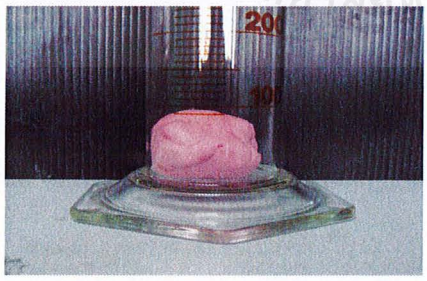
Type of yeast	Time of fermentation		Yeast fermentation power (%)
	0 min	60 min	
White bread yeast	131	250	91
Sweet bun yeast	97	147	52



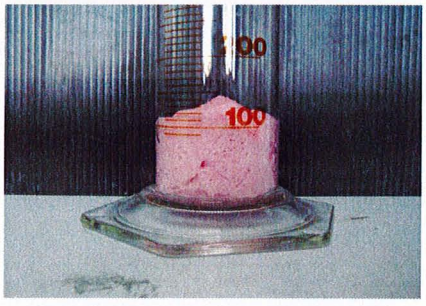
0-minute fermentation of red dragon fruit with normal white pan bread yeast



60-minute fermentation of red dragon fruit with normal white pan bread yeast



0-minute fermentation of red dragon fruit with sweet bun yeast



0-minute fermentation of red dragon fruit with sweet bun yeast

Figure 8: 0 and 60- minutes fermentation of red dragon fruit dough with active dry yeast for sweet bun (above pictures) and with active dry yeast for normal white bread (below pictures)

III. Formulation of red dragon fruit bread using bread maker

a. Preliminary test with the bread maker

Bread samples were prepared using the basic formula of white pan bread from Table 2 with short term process (short time fermentation) and long term process (long time fermentation) of bread maker to study the machine performance by observing appearance and volume of the bread. The bread from short term process was small, dense and moist, with air cells that did not open while the bread from long term process was larger, more open air cells, and drier than the bread from short term process. Therefore, the long term process was selected from further study.

b. Formulate the red dragon fruit bread

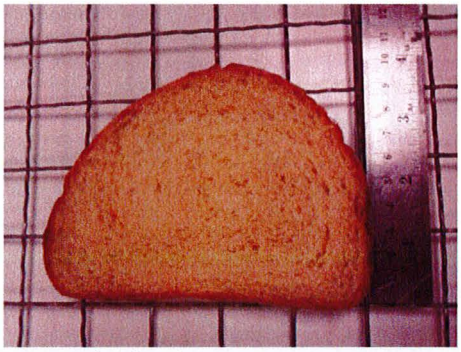
i Determine the amount of red dragon fruit extract use in red dragon fruit bread

Bread samples were prepared by using bread makers, Severin Model BM 3983. The amount of red dragon fruit extract was varied from 25 to 70% for substituting with water in the formula to estimate the highest amount of red dragon fruit extract to substitute in water in the basic formula that could possibly be made pan bread. The results were shown in the figure 9 and Table 7 and 8.

It was observed that increasing percentage of red dragon fruit substituted in the formula up to 40% also increased volume of the obtained bread. Above 40% substitution bread had decreased its volume. It could be that at low percentage red dragon fruit might, in somehow, strengthen gluten network so that it could hold more gas and increased volume was resulted. Since water is one factor in gluten formation. At higher percentage, red dragon fruit extract might interfere with gluten formation by competing in binding with water. For red dragon fruit contained mucous substances that could absorb water. At concentration these substances would hold water to their molecule and less water was available for gluten formation.

Crust of the bread was thicker and redder as more percent substitution of red dragon fruit was added. The color changed from golden brown of regular pan bread to orange red and pink with high percentage of red dragon fruit (50% to 70%), implied that the pigments were concentrated at the crust while little color change was observed in the crumb, except at 70% substitution.

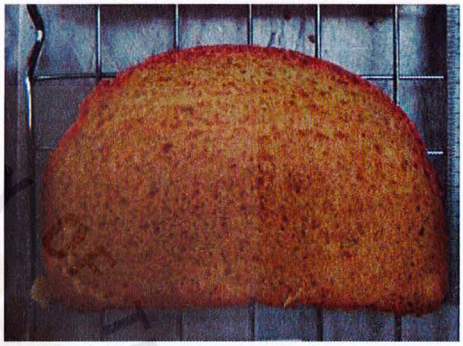
At low substitution percentage red dragon fruit bread crumb contained uniform air cells until reaching 50% substitution that the crumb started to have irregular air cell size with more large air cells presented. Crumb color also affected by the present of red dragon fruit. At low percent substitution, crumb had even color while at high percent substitution crumb color appeared uneven, as shown at 50 and 60% substation. The color also changed from creamy white to dark yellowish orange. Moreover, it was observed that the dark color was located at all edges of the slice while in the middle the crumb had lighter color. This could indicate, first, mixing and kneading of the dough at high percent substitution could not be accomplished, and lastly, pigments must have move away from the center of the slice. Moreover with opened structure in the crumb caused more light to reflect on the surface could lead to lighter color of the crumb.



25% Substitution

30% Substitution

40% Substitution



50% Substitution

60% Substitution

70% Substitution

Figure 9: Red dragon bread prepared by substitution of water with red dragon extract from 25-70%

ii. Measure volume of red dragon fruit bread

Bread was measured its volume by replacing method. A box of known volume was first, filled with rice and measured the weight (as equivalent the volume of the box). Then, it was empty and placed the bread sample in the middle before filling the remaining space with rice. The amount of the rice used was determined. The difference between the weights of rice filled in the empty box and the box containing bread sample is used to determine the volume of the bread.

Table 7: Volume of control bread and bread sample containing 25% to 60% red dragon fruit extracts substituted with water in bread formula.

Bread Sample	Volume in ml
Control (0% red dragon fruit)	1,555.0[a]
25% Red dragon fruit substitution	1,383.5[a]
30% Red dragon fruit substitution	1,968.8[b]
40% Red dragon fruit substitution	1,969.3[b]
50% Red dragon fruit substitution	1,594.2[a]
60% Red dragon fruit substitution	1,552.8[a]

From Table 6 it was observed that there was a significant difference in volume of bread prepared with different amount of red dragon fruit. 30% and 40% red dragon fruit substitution bread had higher volume than control, 25%, 50% and 60%. The result correlated with the characteristics of bread samples. At 30-40% substitution present of red dragon fruit helped strengthening gluten structure and allowed dough to maintain gas produced from yeast fermentation. As a result, volumes of these breads were higher than other bread.

iii. Evaluate bread samples using the scoring system of bread, Pyler (1973) to determine the characteristics of the red dragon fruit bread.

Bread samples from (i) were evaluated the bread characteristics according to Pyler's criteria (Appendix C-1). Eight taste panelists were Biotechnology students who had taken FT4114 (Baker Technology) and were familiar with bread and how to score it. The obtain data were analyzed and the results were shown in Table 8.

Table8: The average bread score from bread scoring system (Pyler, 1973) on 9 attributes, of the red dragon fruit bread containing different amounts of red dragon fruit extract.

Characteristics	Mean score* of bread containing different amount of red dragon fruit extract (total liquid base)					
	0%	25%	30%	40%	50%	60%
Volume (15)	13.3^{c}	12.6^{a}	15^{d}	15^{d}	12.8^{b}	12.5^{b}
Color of crust (5)	4.2	3.8	4	3.9	4	3.6
Symmetry of bread (5)	4.4	4.6	4.3	4.4	4.2	4.4
Uniform of bread (5)	4.3	4.5	4.2	4.4	4.3	4.2
Texture (15)	12.8	12.9	13.2	13.2	13.1	12.1
Color of crumb (10)	8.3	8.0	7.9	8.0	8.2	7.2
Grain (10)	8.2^{ab}	8.6^{b}	8.1^{ab}	8.1^{ab}	8.7^{b}	7.2^{a}
Aroma (15)	12.7	11.8	12.0	12.9	12.6	13.1
Taste (20)	16.1^{ab}	17^{ab}	15.2^{a}	15.9^{ab}	17.6^{b}	16.3^{ab}
Total (100)	84.8	82	83.2	85.4	85.5	80.6

* Non significance at $p \leq 0.05$, $t < 0.05$

There was no significant different of the average of the total score from all bread samples. Volume, grain, and taste scores were significantly different ($p<0.05$) while color of crust, symmetry of bread, uniform of bread, texture, color of crumb, and aroma were not significant difference. 50% substitution gained the highest scores in grain, taste and total and significant different from 60% substitution in grain and 30% substitution in taste. The highest volume

scores were found in 30% and 40% substitution which were significant different from the remaining bread samples, correlated with (i) and (iii).

iv. Preference test

From the result of scoring system in (iii) there was no significant difference among bread prepared with different % substitution of red dragon fruit. 30% and 40% substitution were selected to find the most preferred formula from 30 taste panelists. These ranges were selected for economic cost of production and their observation result together with the bread scores. The taste panelists were asked to determine their preference on appearance, color, texture, yeast aroma, taste and moistness of the sample on 9-point hedonic score. Table 8 demonstrated that there was no significant difference in the preference scores for all attributes. Each bread sample was rated as moderately like, around 7.

Table 9: Preference scoring test of 30% and 40% substitution red dragon fruit bread samples

Attributes	**Average preference score***	
	30% red dragon extract	**40% red dragon extract**
Appearance	7.1	7.4
Color	7.2	7.2
Texture	7.3	7.2
Yeast aroma	7.0	7.0
Taste	7.3	7.2
Moistness	7.3	7.1
Overall liking	7.3	7.2

* Non significant difference ($p<0.05$)

For economic purpose 30% substitution could save more money that 40% substitution. As a result, 30% red dragon fruit substituted bread was selected for further study.

v. **Flavor profile of the red dragon fruit bread**

Bread contained 30% red dragon fruit substitution with water was used to measure flavor intensity from 8 test panelists in order to construct a flavor profile of the product. After discussion on flavor characteristics of the product, five consensus flavor attributes were agreed. They were saltiness, sweetness, sourness, red dragon flavor and yeast odor. The test panelists were asked to determine flavor intensity on a 10-cm non-structural scale (Appendix C-3). The result was analyzed and shown in the Table 10. Flavor profile was constructed from the average scores for all attribute and demonstrated in Figure 10.

Table 10: Mean intensity scores of red dragon fruit bread

Attributes	Mean scores
Saltiness	6.69
Sweetness	6.55
Sourness	6.77
Red dragon flavor	7.57
Yeast odor	7.37

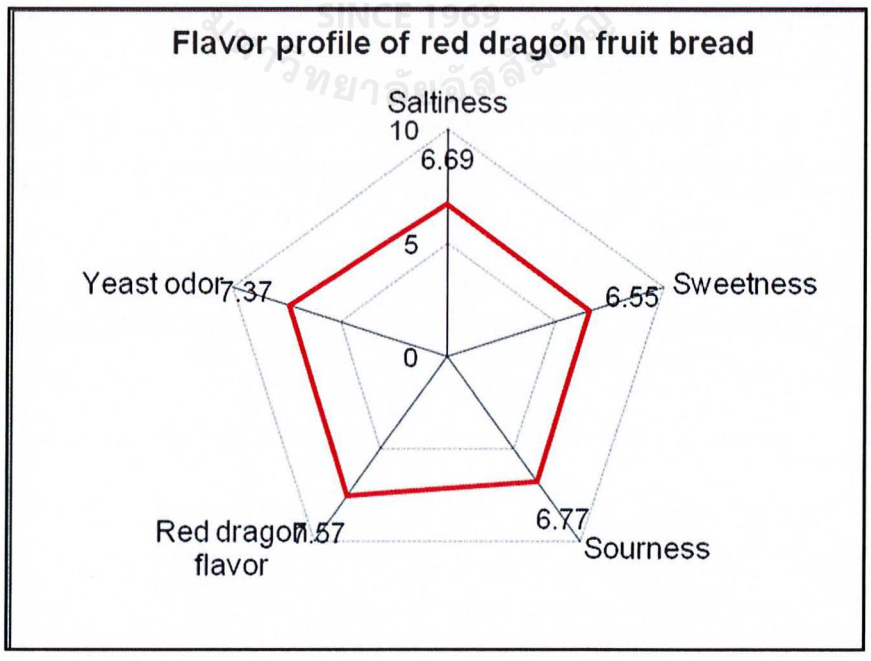


Figure10: Flavor profile of red dragon fruit bread contained 30% substitution

From the flavor profile it was observed that the bread had moderate saltiness, sweetness, and sourness scored about 5.5 to 6.5 out of 10. It had quite strong yeast odor, 7 which is typical for fresh bread, and red dragon fruit flavor. The intensity of salt, sweet, and sour was also normal in normal white pan bread which has not strong flavor. There was quite strong red dragon fruit flavor intensity in the bread with 7.57, correlated to the amount of red dragon fruit added in the bread. It was expected that high red dragon fruit flavor would be observed if percent substitution increased in the product.

vi. Cost

Cost of production was estimated for 30% substitution red dragon fruit bread and compared with 40% substitution and shown in Table 11 and 12. It was found that the total cost of product 30% and 40% substitution red dragon fruit bread were 31 and 35.43 Baht per a loaf of 440 gm. 40% substitution red dragon fruit bread cost 14.3% more than 30% substitution bread. Among the costs of ingredients in the bread, the highest was in the cost of red dragon fruit. Thus, the difference mainly came from the different amount of red dragon fruit in the formula. The result confirmed that selection including economic purpose was a right decision in the project. As a result red dragon fruit bread substituted with 30% red dragon fruit extract was the most suitable formula of the product.

Table11: Amount of ingredients per one batch of prototype formula

Ingredients	Amount (grams) for 30%	Amount (grams) for 40%
Flour	288.18	288.18
Red dragon fruit extract	51	68
Yeast	5.77	5.77
Sugar	18.73	18.73
Salt	5.77	5.77
Shortening	11.53	11.53

Table12: Cost per serving size (1 loaf ≈ 440 grams) of Red dragon fruit bread

Ingredients	**Cost/gram (Baht)**	**Grams**	**Cost (Baht) 30%**	**Cost (Baht) 40%**
Flour	0.034	288.18	9.79	9.79
Red dragon fruit extract	0.19	51	9.79	-
	0.19	68	-	12.92
Yeast	0.294	5.77	1.69	1.69
Sugar	0.0235	18.73	0.44	0.44
Salt	0.012	5.77	0.07	0.07
Shortening	0.104	11.53	1.19	1.19
Total			22.97	26.24
Product 20%			4.59	5.25
Marketing 15%			3.44	3.94
Total cost per batch (serving size 1 loaf ≈ 440 grams)			31.00	35.43

vii. Consumer test

30% substituted red dragon fruit bread was selected from (iv) and (vi) to test for consumer acceptance with 100 consumers who were general people from house wife, government officer to students.

Demographic survey resulted in almost equal amount of male and female were in the survey. 44% were in the age of 20-25 years old, 70% bachelor degree, and 51% students with income less than 10,000.- Baht 34%, as shown in Figure 11.

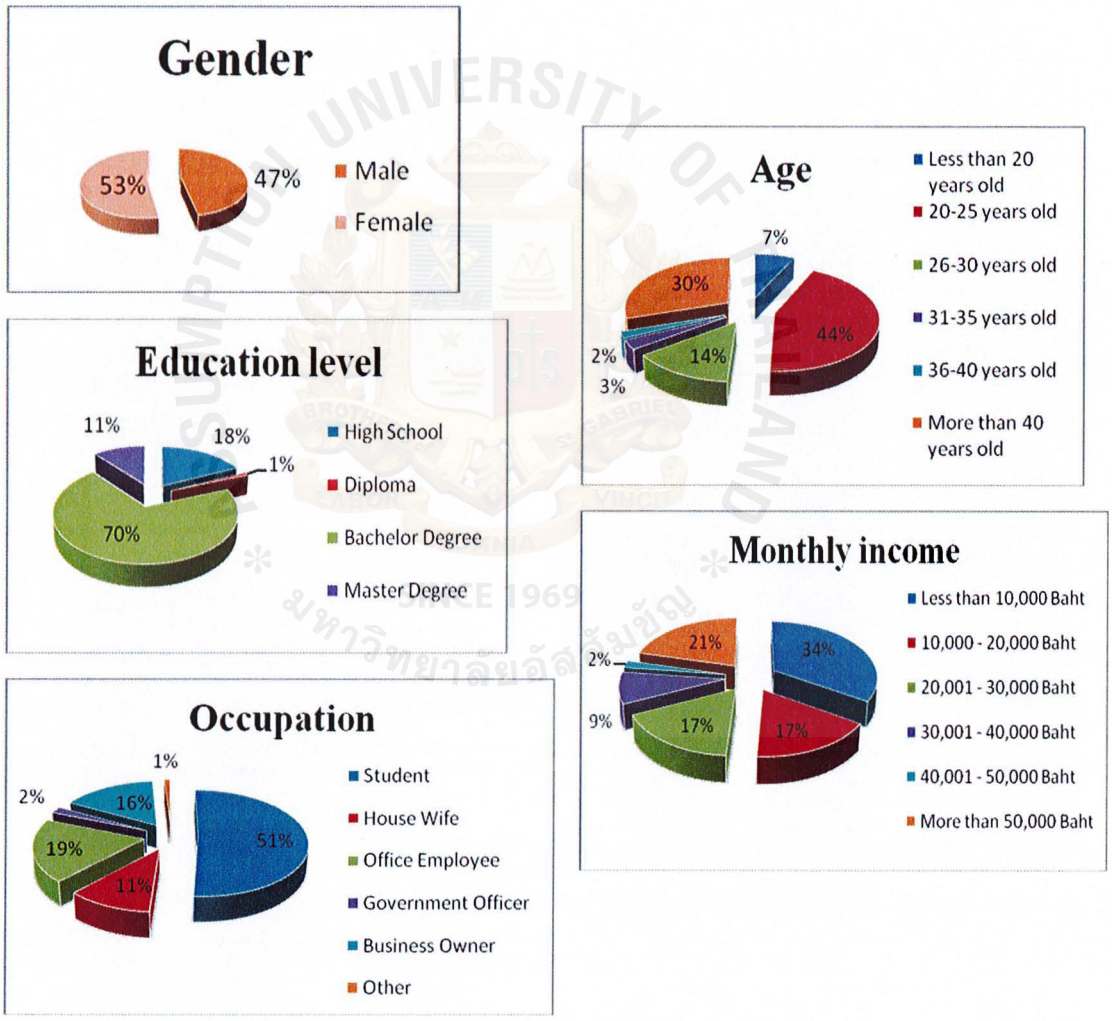
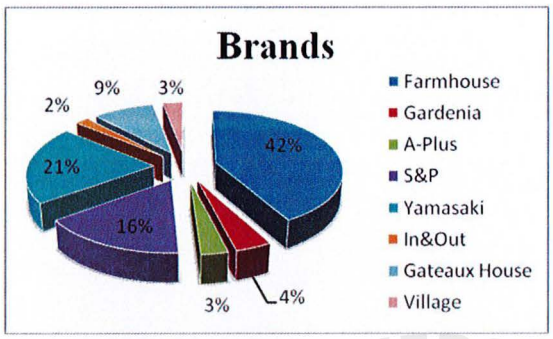
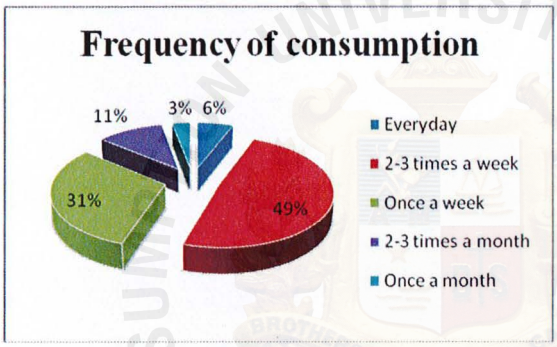
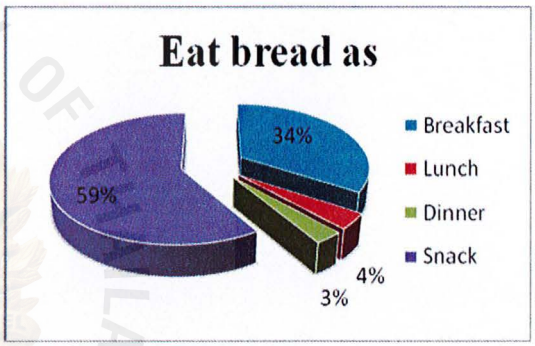


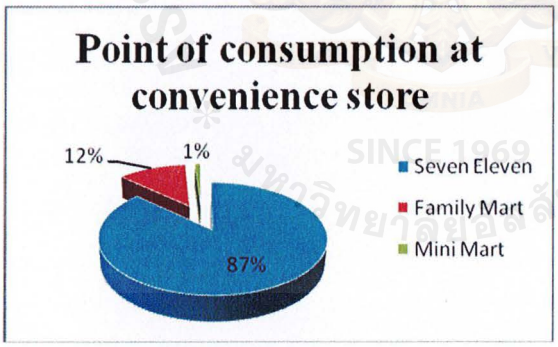
Figure11: Demographic result from consumer acceptance test

In Figure 12, buying behavior of consumer indicated that more than 40% bought Farmhouse than other brands. 49% consumed bread 2-3 times a week and 59% consumed as snack. When asked where to buy, for convenience store 87% bought at Seven Eleven and for supermarket, 21% bought at Tesco Lotus.









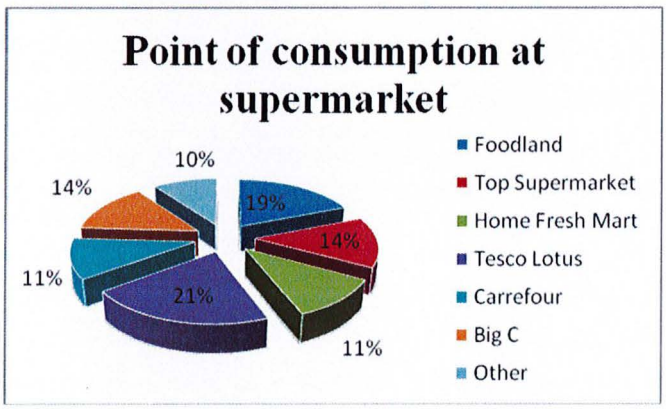


Figure12: Information of consumer's behavior on bread from consumer acceptance test

Table 13 shows average score and its standard deviation from preference test of 100 people participated in the consumer acceptance test. The product received moderately like scores in color, texture including crumb softness and crispness and overall acceptance. Flavor and aroma were rated in slightly like to moderately like range, almost agreed with the results from test panelists (v).

Table13: Average score and standard deviation of 7 attributes from consumer acceptance test

Attributes	Mean ± Standard deviation
Color	7.1 ± 0.8
Appearance	6.9 ± 0.1
Aroma	6.6 ± 0.9
Flavor	6.8 ± 0.9
Crumb softness	7.3 ± 0.9
Crust crispiness	7.3 ± 0.9
Overall liking	7.1 ± 0.7

Purchasing intention this product was accepted by 99% with 85% intended to buy and the suitable price should be 45 Baht per loaf of 440 gm.

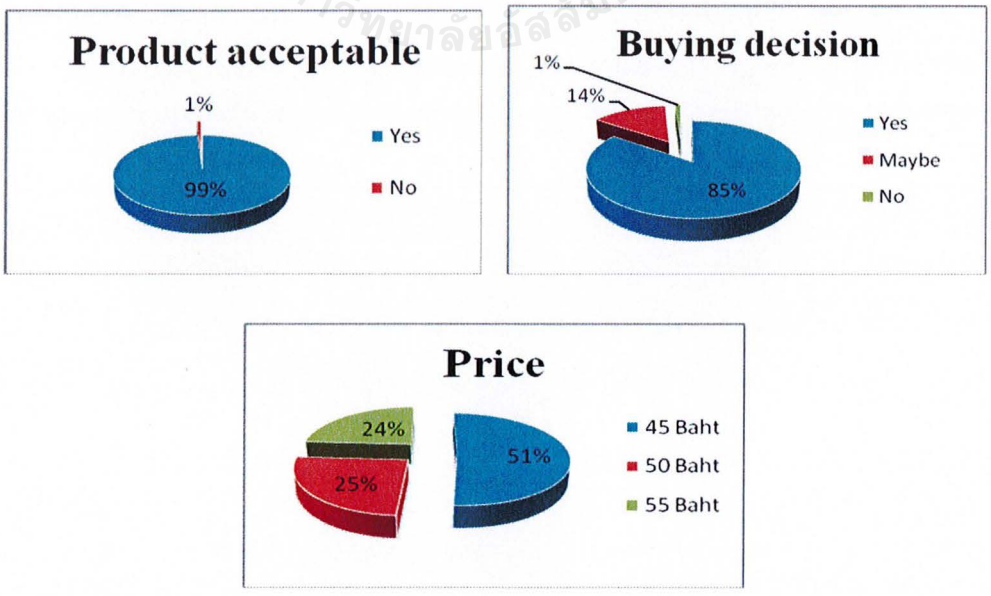


Figure13: Purchase intention from consumer acceptance test

Conclusion

1. Red dragon fruit bread formula includes 100% flour, 13.4% red dragon fruit extract, 1.5% yeast, 4.9% sugar, 1.5% salt, and 3.0% shortening on a flour base weight.
2. It was obtained 83.2 out of 100 from Bread scoring system (Pyler, 1973).
3. The bread had high volume, orange brown crust, light cream crumb, and uniform air cells.
4. It received moderately liking score, 7, in appearance, color, texture, yeast aroma, taste, moistness, and overall acceptance from 30 test panelists.
5. Its flavor profile was characterized as moderately saltiness, sweetness, and sourness, and strong yeast odor and dragon fruit flavor on a scale of 0-10.
6. Production cost for the red dragon fruit bread was 31 Baht per 440-gram loaf.
7. Consumer acceptance test demonstrated that 99% of consumer accepted the product with 85% intended to buy it. The suitable price was 45 Baht per loaf which would produce benefit of 45%.

Recommendation

For further study on red dragon fruit bread, it is recommended to

1. Determine the texture profile to estimate texture intensity for the bread product.
2. Determine crumb texture by using instrument as a texture analyzer to measure crumb softness for better understanding of the change of product when more red-dragon fruit extracted was substituted in the formula.
3. Improve crumb color by using natural color or food colorant to attract more consumer attention.
4. Proximate analysis of the product to differentiate chemical composition of each treatment.

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Appendix A

Preliminary test to study a possible condition for using the red dragon fruit in bread

(A-1) Measurement dough volume (ml) from 0-60 minute's fermentation

Liquid used	Time of fermentation		Yeast fermentation power (%)
	0 min	60 min	
Water	147	304	106.8
25% Red dragon fruit extract	132	250	89.4

(A-2) Measurement dough volume (ml) from 0-60 minute's fermentation

Type of yeast	Time of fermentation		Yeast fermentation power (%)
	0 min	60 min	
White bread yeast	131	250	90.8
Sweet bun yeast	97	147	51.5

Appendix B

Preliminary experiment

(B-1) Preliminary test with the bread maker to observe volume of bread

Sample	Weigh of bread with rice (g.)	Weigh of bread (g.)	Volume (ml)
Normal white bread (control)	1372.0	1211.2	1555.0
25% Red dragon fruit bread	1505.6	1077.6	1383.5
30% Red dragon fruit bread	1049.7	1533.5	1968.8
40% Red dragon fruit bread	1049.3	1533.9	1969.3
50% Red dragon fruit bread	1341.5	1241.7	1594.2
60% Red dragon fruit bread	1373.7	1209.5	1552.8

Weight of full box of rice = 2583.2 g.

Volume of box = 3316.4 ml

Appendix C

Product development

(C-1) Questionnaire: scoring test of normal white bread yeast with normal white bread and red dragon fruit bread.

Scoring test

Product: Red dragon fruit bread and normal white bread

Name: _____ Date: _____

Instruction

1. Please rinse your mouth with water before starting
2. Please taste the sample and rate the sample in each attribute according to the quality bread scoring

Scoring of Bread Quality

Quality Attribute	Score	Sample
Volume	15	
Color and nature of crust	5	
Symmetry of form	5	
Uniform of bake	5	
Texture	15	
Color of crumb	10	
Grain	10	
Aroma	15	
Taste	20	
Total	100	

(C-2) Result from scoring test varying amount of red dragon fruit extract

Volume

Duncan

sample	N	Subset			
	1	2	3	4	1
25% red dragon fruit juice	10	10.8000			
60% red dragon fruit juice	10		12.5000		
50% red dragon fruit juice	10		12.8000		
0% red dragon fruit juice	10			13.3000	
30% red dragon fruit juice	10				15.0000
40% red dragon fruit juice	10				15.0000
Sig.		1.000	.083	1.000	1.000

Means for groups in homogeneous subsets are displayed.
Based on Type III Sum of Squares
The error term is Mean Square(Error) = .144.
a Uses Harmonic Mean Sample Size = 10.000.
b Alpha = .05.

crust

Duncan

sample	N	Subset
	1	1
60% red dragon fruit juice	10	3.6000
20% red dragon fruit juice	10	3.8000
40% red dragon fruit juice	10	3.9000
30% red dragon fruit juice	10	4.0000
50% red dragon fruit juice	10	4.0000
0% red dragon fruit juice	10	4.2000
Sig.		.111

Means for groups in homogeneous subsets are displayed.
Based on Type III Sum of Squares
The error term is Mean Square(Error) = .528.
a Uses Harmonic Mean Sample Size = 10.000.
b Alpha = .05.

Symmetry

Duncan

sample	N	Subset
	1	1
50% red dragon fruit juice	10	4.2000
30% red dragon fruit juice	10	4.3000
40% red dragon fruit juice	10	4.4000
60% red dragon fruit juice	10	4.4000
0% red dragon fruit juice	10	4.4000
20% red dragon fruit juice	10	4.6000
Sig.		.328

Means for groups in homogeneous subsets are displayed.
Based on Type III Sum of Squares
The error term is Mean Square(Error) = .617.
a Uses Harmonic Mean Sample Size = 10.000.
b Alpha = .05.

Uniform

Duncan

sample	N	Subset
	1	1
30% red dragon fruit juice	10	4.2000
60% red dragon fruit juice	10	4.2000
50% red dragon fruit juice	10	4.3000
0% red dragon fruit juice	10	4.4000
40% red dragon fruit juice	10	4.4000
20% red dragon fruit juice	10	4.5000
Sig.		.429

Means for groups in homogeneous subsets are displayed.
Based on Type III Sum of Squares
The error term is Mean Square(Error) = .530.
a Uses Harmonic Mean Sample Size = 10.000.
b Alpha = .05.

Texture

Duncan

sample	N	Subset
	1	1
60% red dragon fruit juice	10	12.1000
20% red dragon fruit juice	10	12.9000
50% red dragon fruit juice	10	13.1000
0% red dragon fruit juice	10	13.2000
40% red dragon fruit juice	10	13.2000
30% red dragon fruit juice	10	13.2000
Sig.		.061

Means for groups in homogeneous subsets are displayed.
Based on Type III Sum of Squares
The error term is Mean Square(Error) = 1.287.
a Uses Harmonic Mean Sample Size = 10.000.
b Alpha = .05.

Crumb

Duncan

sample	N	Subset
	1	1
60% red dragon fruit juice	10	7.2000
30% red dragon fruit juice	10	7.2000
40% red dragon fruit juice	10	8.0000
20% red dragon fruit juice	10	8.0000
50% red dragon fruit juice	10	8.2000
0% red dragon fruit juice	10	8.3000
Sig.		.102

Means for groups in homogeneous subsets are displayed.
Based on Type III Sum of Squares
The error term is Mean Square(Error) = 1.683.
a Uses Harmonic Mean Sample Size = 10.000.
b Alpha = .05.

Grain

Duncan

sample	N	Subset	
	1	2	1
60% red dragon fruit juice	10	7.2000	
30% red dragon fruit juice	10	8.1000	8.1000
40% red dragon fruit juice	10	8.1000	8.1000
0% red dragon fruit juice	10	8.2000	8.2000
20% red dragon fruit juice	10		8.6000
50% red dragon fruit juice	10		8.7000
Sig.		.098	.334

Means for groups in homogeneous subsets are displayed.
Based on Type III Sum of Squares
The error term is Mean Square(Error) = 1.472.
a Uses Harmonic Mean Sample Size = 10.000.
b Alpha = .05.

Aroma

Duncan

sample	N	Subset
	1	1
20% red dragon fruit juice	10	11.8000
30% red dragon fruit juice	10	12.0000
50% red dragon fruit juice	10	12.6000
0% red dragon fruit juice	10	12.7000
40% red dragon fruit juice	10	12.9000
60% red dragon fruit juice	10	13.1000
Sig.		.117

Means for groups in homogeneous subsets are displayed.
Based on Type III Sum of Squares
The error term is Mean Square(Error) = 2.554.
a Uses Harmonic Mean Sample Size = 10.000.
b Alpha = .05.

Taste

Duncan

sample	N	Subset 2	Subset 1
30% red dragon fruit juice	10	15.2000	
40% red dragon fruit juice	10	15.9000	15.9000
0% red dragon fruit juice	10	16.1000	16.1000
60% red dragon fruit juice	10	16.3000	16.3000
20% red dragon fruit juice	10	17.0000	17.0000
50% red dragon fruit juice	10		17.6000
Sig.		.107	.128

Means for groups in homogeneous subsets are displayed.
Based on Type III Sum of Squares
The error term is Mean Square(Error) = 4.813.
a Uses Harmonic Mean Sample Size = 10.000.
b Alpha = .05.

Total

Duncan[a,b]

Sample	N	Subset 1
60% red dragon fruit juice	10	80.5000
30% red dragon fruit juice	10	82.1000
20% red dragon fruit juice	10	83.1000
40% red dragon fruit juice	10	84.1000
0% red dragon fruit juice	10	85.6000
50% red dragon fruit juice	10	85.8000
Sig.		.113

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 41.504.
a. Uses Harmonic Mean Sample Size = 10.000.
b. Alpha = .05.

(C-3) Questionnaire: preference test of red dragon fruit bread varying amount of fruit extract.

Preference Test

Product: Red dragon fruit bread

Name: Date:

Instruction

1. Please rinse your mouth with water before starting
2. Please taste the sample and rate the sample in each attribute from most preferred to least preferred using the following number

9	Like extremely	4	Dislike slightly
8	Like very much	3	Dislike moderately
7	Like moderately	2	Dislike very much
6	Like slightly	1	Dislike extremely
5	Neither like nor dislike		

Attribute	Sample no.	Sample no.
Appearance		
Color		
Texture		
Yeast aroma		
Taste		
Moistness		
Overall liking		

(C-4) Result from preference test varying amount of red dragon fruit extract

Between-Subjects Factors

		Value Label	N
Sample	1.00	30% red dragon fruit juice	30
	2.00	40% red dragon fruit juice	30

Descriptives statistic

		N	Mean	Std. Deviation
Appearance	30% red dragon fruit juice	30	7.1000	.71197
	40% red dragon fruit juice	30	7.3000	.74971
	Total	60	7.2000	.73184
Color	30% red dragon fruit juice	30	7.2333	.67891
	40% red dragon fruit juice	30	7.2333	.77385
	Total	60	7.2333	.72174
Texture	30% red dragon fruit juice	30	7.3000	.74971
	40% red dragon fruit juice	30	7.2333	.89763
	Total	60	7.2667	.82064
YeastAroma	30% red dragon fruit juice	30	7.0333	1.06620
	40% red dragon fruit juice	30	7.0667	.94443
	Total	60	7.0500	.99873
Taste	30% red dragon fruit juice	30	7.2667	1.01483
	40% red dragon fruit juice	30	7.2333	.85836
	Total	60	7.2500	.93201
Moistness	30% red dragon fruit juice	30	7.2667	.82768
	40% red dragon fruit juice	30	7.1333	1.07425
	Total	60	7.2000	.95314
OverallLiking	30% red dragon fruit juice	30	7.3000	.74971
	40% red dragon fruit juice	30	7.2000	.84690
	Total	60	7.2500	.79458

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Appearance	Between Groups	.600	1	.600	1.123	.294
	Within Groups	31.000	58	.534		
	Total	31.600	59			
Color	Between Groups	.000	1	.000	.000	1.000
	Within Groups	30.733	58	.530		
	Total	30.733	59			
Texture	Between Groups	.067	1	.067	.097	.756
	Within Groups	39.667	58	.684		
	Total	39.733	59			
Yeast Aroma	Between Groups	.017	1	.017	.016	.898
	Within Groups	58.833	58	1.014		
	Total	58.850	59			
Taste	Between Groups	.017	1	.017	.019	.891
	Within Groups	51.233	58	.883		
	Total	51.250	59			
Moistness	Between Groups	.267	1	.267	.290	.592
	Within Groups	53.333	58	.920		
	Total	53.600	59			
Overall Liking	Between Groups	.150	1	.150	.235	.630
	Within Groups	37.100	58	.640		
	Total	37.250	59			

Appearance

Tests of Between-Subjects Effects

Dependent Variable: Appearance

Source	Type II Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.600[a]	1	.600	1.123	.294
Intercept	3110.400	1	3110.400	5819.458	.000
Sample	.600	1	.600	1.123	.294
Error	31.000	58	.534		
Total	3142.000	60			
Corrected Total	31.600	59			

a. R Squared = .019 (Adjusted R Squared = .002)

Color

Tests of Between-Subjects Effects

Dependent Variable:Color

Source	Type II Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.000[a]	1	.000	.000	1.000
Intercept	3139.267	1	3139.267	5924.430	.000
Sample	.000	1	.000	.000	1.000
Error	30.733	58	.530		
Total	3170.000	60			
Corrected Total	30.733	59			

a. R Squared = .000 (Adjusted R Squared = -.017)

Texture

Tests of Between-Subjects Effects

Dependent Variable: Texture

Source	Type II Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.067[a]	1	.067	.097	.756
Intercept	3168.267	1	3168.267	4632.592	.000
Sample	.067	1	.067	.097	.756
Error	39.667	58	.684		
Total	3208.000	60			
Corrected Total	39.733	59			

a. R Squared = .002 (Adjusted R Squared = -.016)

Yeast aroma

Tests of Between-Subjects Effects

Dependent Variable:YeastAroma

Source	Type II Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.017[a]	1	.017	.016	.898
Intercept	2982.150	1	2982.150	2939.910	.000
Sample	.017	1	.017	.016	.898
Error	58.833	58	1.014		
Total	3041.000	60			
Corrected Total	58.850	59			

a. R Squared = .000 (Adjusted R Squared = -.017)

Taste

Tests of Between-Subjects Effects

Dependent Variable:Taste

Source	Type II Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.017[a]	1	.017	.019	.891
Intercept	3153.750	1	3153.750	3570.283	.000
Sample	.017	1	.017	.019	.891
Error	51.233	58	.883		
Total	3205.000	60			
Corrected Total	51.250	59			

a. R Squared = .000 (Adjusted R Squared = -.017)

Moistness

Tests of Between-Subjects Effects

Dependent Variable:Moistness

Source	Type II Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.267[a]	1	.267	.290	.592
Intercept	3110.400	1	3110.400	3382.560	.000
Sample	.267	1	.267	.290	.592
Error	53.333	58	.920		
Total	3164.000	60			
Corrected Total	53.600	59			

a. R Squared = .005 (Adjusted R Squared = -.012)

Overall liking

Tests of Between-Subjects Effects

Dependent Variable:OverallLiking

Source	Type II Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.150[a]	1	.150	.235	.630
Intercept	3153.750	1	3153.750	4930.391	.000
Sample	.150	1	.150	.235	.630
Error	37.100	58	.640		
Total	3191.000	60			
Corrected Total	37.250	59			

a. R Squared = .004 (Adjusted R Squared = -.013)

(C-5) Questionnaire: flavor analysis of red dragon fruit bread

Flavor analysis

Product: **Red dragon bread**

Name: _____ Date: _____

Instruction

1. Please rinse your mount before testing the sample.
2. Evaluate the sample based on intensity of the attribute by ticking and write sample number on the line representing attribute of product.

Flavor of the sample

1. Saltiness

Ideal

2. Sweetness

Ideal

3. Sourness

Ideal

4. Red dragon flavor

Ideal

5. Yeasty odor

Ideal

Comment.....

.....

.....

Thank You for your cooperation

Appendix D

Consumer acceptance

(D-1) Questionnaire: Consumer survey of the Prototype

"Red dragon fruit bread"

This is a part of FT 4190 special project, which would like to survey the consumer's behavior and acceptance on a new product – "Red dragon fruit bread". Please kindly answer the questions by checking in the provided space.

Part 1: Demographic Data

Gender: ☐ Male ☐ Female

Age: ☐ Less than 20 years old ☐ 20-25 years old ☐ 26-30 years old
☐ 31-35 years old ☐ 36-40 years old ☐ More than 40 years old

Education level: ☐ Primary School ☐ High School ☐ Diploma
☐ Bachelor Degree ☐ Master Degree ☐ Doctorial Degree

Occupation: ☐ Student ☐ House-Wife
☐ Office Employee ☐ Government Officer
☐ Business Owner ☐ Others .....

Monthly income: ☐ Less than 10,000 Baht ☐ 10,001-20,000 Baht
☐ 20,001-30,000 Baht ☐ 30,001-40,000 Baht
☐ 40,001-50,000 Baht ☐ More than 50,000 Baht

Part 2: Information of consumer's behavior on bread

Do you usually consume bread? ☐ Yes ☐ No

What brands of bread do you familiar the most? (Choose three brands)

☐ Farmhouse ☐ Gardenia ☐ A-Plus
☐ S&P ☐ Yamazaki ☐ In & Out
☐ Gateaux House ☐ Village ☐ Other (.....)

How often do you eat bread?

☐ Everyday ☐ 2-3 times a week ☐ Once a month
☐ Once a week ☐ 2-3 times a month ☐ Other (.....)

You usually eat bread as:

☐ Breakfast ☐ Lunch ☐ Dinner

☐ Snack ☐ Other (.....)

If you buy in a convenience store, where do you usually buy bread? (Answer more than one)

☐ Seven Eleven ☐ Family Mart

☐ Mini Mart at gas station ☐ Other (.....)

If you buy in a supermarket, where do you usually buy bread?

☐ Foodland ☐ Top Supermarket ☐ Home Fresh Mart

☐ Tesco Lotus ☐ Carrefour ☐ Big C

☐ Other (.....)

Instruction:

Please taste the sample and rate the sample in each attribute from most preferred to least preferred by ticking in these following table.

Attributes	Dislike extremely	Dislike very much	Dislike moderately	Dislike slightly	Neither like nor dislike	Like slightly	Like moderately	Like very much	Like very extremely
Color									
Appearance									
Aroma									
Flavor									
Crumb Softness									
Crust Crispiness									
Overall liking									

Is this product acceptable? ☐ Yes ☐ No

Part 3: Purchase intention

Would you buy this product if is commercially available?

☐ Yes, because.....

☐ Maybe, because.....

☐ No, because.....

How much do you prefer for loaf of 440 grams?

☐ 45 baht ☐ 50 baht ☐ 55 baht

Suggestion

.....
.....
.....

Thank you for your cooperation

(D-2) Result from consumer acceptance test

Frequencies

Part1: Demographic Data

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	47	47.0	47.0	47.0
	Female	53	53.0	53.0	100.0
	Total	100	100.0	100.0	

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 20 years old	7	7.0	7.0	7.0
	20-25 years old	44	44.0	44.0	51.0
	26-30 years old	14	14.0	14.0	65.0
	31-35 years old	3	3.0	3.0	68.0
	36-40 years old	2	2.0	2.0	70.0
	More than 40 years old	30	30.0	30.0	100.0
	Total	100	100.0	100.0	

Education level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High School	18	18.0	18.0	18.0
	Diploma	1	1.0	1.0	19.0
	Bachelor Degree	70	70.0	70.0	89.0
	Master Degree	11	11.0	11.0	100.0
	Total	100	100.0	100.0	

Occupation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Student	51	51.0	51.0	51.0
	House Wife	11	11.0	11.0	62.0
	Office Employee	19	19.0	19.0	81.0
	Government Officer	2	2.0	2.0	83.0
	Business Owner	16	16.0	16.0	99.0
	Other	1	1.0	1.0	100.0
	Total	100	100.0	100.0	

Monthly income

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 10,000 Baht	34	34.0	34.0	34.0
	10,000 - 20,000 Baht	17	17.0	17.0	51.0
	20,001 - 30,000 Baht	17	17.0	17.0	68.0
	30,001 - 40,000 Baht	9	9.0	9.0	77.0
	40,001 - 50,000 Baht	2	2.0	2.0	79.0
	More than 50,000 Baht	21	21.0	21.0	100.0
	Total	100	100.0	100.0	

Part2: Information of consumer's behavior on bread

Brands

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Farmhouse	42	42.0	42.0	42.0
	Gardenia	4	4.0	4.0	46.0
	A-Plus	3	3.0	3.0	49.0
	S&P	16	16.0	16.0	65.0
	Yamasaki	21	21.0	21.0	86.0
	In&Out	2	2.0	2.0	88.0
	Gateaux House	9	9.0	9.0	97.0
	Village	3	3.0	3.0	100.0
	Total	100	100.0	100.0	

Frequency of consumption

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Everyday	6	6.0	6.0	6.0
	2-3 times a week	49	49.0	49.0	55.0
	Once a week	31	31.0	31.0	86.0
	2-3 times a month	11	11.0	11.0	97.0
	Once a month	3	3.0	3.0	100.0
	Total	100	100.0	100.0	

Eat bread as

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Breakfast	34	34.0	34.0	34.0
	Lunch	4	4.0	4.0	38.0
	Dinner	3	3.0	3.0	41.0
	Snack	59	59.0	59.0	100.0
	Total	100	100.0	100.0	

Point of consumption at convenience store

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Seven Eleven	87	87.0	87.0	87.0
	Family Mart	12	12.0	12.0	99.0
	Mini Mart	1	1.0	1.0	100.0
	Total	100	100.0	100.0	

Point of consumption at supermarket

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Foodland	19	19.0	19.0	19.0
	Top Supermarket	14	14.0	14.0	33.0
	Home Fresh Mart	11	11.0	11.0	44.0
	Tesco Lotus	21	21.0	21.0	65.0
	Carrefour	11	11.0	11.0	76.0
	Big C	14	14.0	14.0	90.0
	Other	10	10.0	10.0	100.0
	Total	100	100.0	100.0	

Product acceptable

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	99	99.0	99.0	99.0
	No	1	1.0	1.0	100.0
	Total	100	100.0	100.0	

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Color	100	7.0500	.80873	.08087

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Color	87.174	99	.000	7.05000	6.8895	7.2105

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Appearance	100	6.9900	.79766	.07977

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Appearance	87.631	99	.000	6.99000	6.8317	7.1483

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Aroma	100	6.6000	.98473	.09847

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Aroma	67.023	99	.000	6.60000	6.4046	6.7954

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Flavor	100	6.8100	.90671	.09067

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Flavor	75.107	99	.000	6.81000	6.6301	6.9899

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Crumb softness	100	7.3300	.96457	.09646

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Crumb softness	75.992	99	.000	7.33000	7.1386	7.5214

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Crust crispiness	100	7.2800	.93290	.09329

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Crust crispiness	78.036	99	.000	7.28000	7.0949	7.4651

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Overall liking	100	7.1100	.70918	.07092

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Overall liking	100.257	99	.000	7.11000	6.9693	7.2507

Part3: Purchase intention

Buying decision

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	85	85.0	85.0	85.0
	Maybe	14	14.0	14.0	99.0
	No	1	1.0	1.0	100.0
	Total	100	100.0	100.0	

Price

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	45 Baht	51	51.0	51.0	51.0
	50 Baht	25	25.0	25.0	76.0
	55 Baht	24	24.0	24.0	100.0
	Total	100	100.0	100.0	