Development of Fruit Leather using Japanese pumpkin (Cucurbita maxima) and Black plum(Prunus salicina) from The Royal Project

By
Mr. Buntoon Thaosatien
ID. 441-8881

special project submitted to the Faculty of Biotechnology, Assumption University
in part fulfillment of the requirements for the degree of Bachelor of Science
in Biotechnology
2008

Development of Fruit Leather using Japanese pumpkin (*Cucurbita maxima)* and Black plum *(Prunus Salicina)* from The Royal Project

By

Mr. Buntoon Thaosatien

ID: 441-8881

A special project submitted to the Faculty of biotechnology, Assumption University in part of fulfillment of the requirements for the degree of Bachelor of Science

2008

SPECIAL PROJECT

Development of Fruit Leather using Japanese pumpkin (*Cucurbita maxima)* and Black plum *(Prunus salicina)* from The Royal Project

By

Mr. Buntoon Thaosatien

ID: 441-8881

2008

Title	: Development of Fruit Leather using Japanese pumpkin (*Cucurbita maxima*) and Black plum (*Prunus salicina*) from The Royal Project
By	: Mr. Buntoon Thaosatien
Advisor	: A. Roungdao Klinjapo
Level of study	: Bachelor of Sciences
Department	: Food Technology
Faculty	: Biotechnology
Academic Year	: 2008

_____ Advisor

(A. Roungdao Klinjapo)

ABSTRACT

This project was concerned about the development of fruit leather by using the Japanese pumpkin (*Cucurbita maxima*) and black plum (*Prunus salicina*) from the Royal Project. The basic formula was performed by varying the species of plum (red plum and black plum). Black plum was selected to adjust the basic formula. The ratios of Japanese pumpkin to black plum were varied as 3:2, 1:1, and 2:3. The preference test was performed to get the best result which was the ratio of 50:50. Then, the percentage of sugar was studied at 10, 15, and 20% by using Hedonic scoring. As the results, 20% of sugar was selected according to the score and the appearance of leather. The Hedonic score for the color, sweetness, flavor, texture, and overall liking were 7.1, 7.0, 7.0, 7.1, and 7.1, respectively. Therefore, the prototype formula contained Japanese pumpkin 50%, black plum 50%, and sugar 20% (base on weight of the mixture between Japanese pumpkin and black plum). Finally, the consumer acceptance test showed that 82% of panelists accepted the fruit leather using Japanese pumpkin (50%) and black plum (50%) with the overall liking scores of 7.4, indicating moderately like to very much like. The acceptance price was 16 – 20 Baht per 30 pieces (diameter of each piece is about 2 inches). The color of the Japanese pumpkin and black plum leather was measured by using CR-400 Konica colorimeter. The results showed that the red color of 20% sugar had more intensity than 15% and 10% sugar, respectively.

ACKNOWLEDGEMENT

I would like to express my deep appreciation and sincere gratitude towards to my advisor, A. Roungdao Klinjapo for her kind encouragement, guidance, suggestion, and motivation, which enable me to attain this special project successfully. It was a great opportunity to be experienced and gain knowledge in this research area

I am equally grateful and appreciation to the members of advisory committee, A. Nootrudee Siriboon and Dr. Wunwisa Krasaekoopt for their constructive comments and suggestion to complete of this study. Furthermore, I would like to express my special thanks to A. Wallop Imachai for all raw materials, both Japanese pumpkin and black plum from the Royal Project at Monngoe, Chiangmai.

Special thanks for Ms. Worrawalan Poonsawat from the Mahidol University for her assistance during the colorimeter analysis including Ms. Siriwan Panprivech and Ms. Kamolnate Kitsawad for her assistant during my data analysis.

I would like to thank all of student from the Faculty of Biotechnology and officers from Maxway Co. Ltd. for their help and comment in sensory evaluation and consumer acceptance survey.

Finally, my sincere and deepest gratitude is extended to my parents for their infinite love, understanding, and support.

Mr. Buntoon Thaosatien

CONTENTS

LIST OF TABLES

LISTS OF FIGURES

INTRODUCTION

In 1969, His Majesty the King desired to establish the Royal Hill-Tribes Development Program, at present called The Royal Project, for initiating the benefits of sedentary agricultural practice to the Hill-Tribes community by introduction of substituted cash crops that may fetch higher prices than opium. During the early stages of the project, His Majesty encouraged the grafting of temperate climate peach scions to the stocks of local species of peach trees. The grafted trees bore fruits that were improved in texture and taste and were hardy enough to withstand long transportation journey to the markets. Other temperate climate fruit scions were also experimented with at different elevations at the Royal Project's Highland Agricultural Research Stations in various villages in Chiang Mai Province.

Monngoe is one of the villages in Chiangmai province that cultivated the opium for many years ago. The Royal Project made this village changing from cultivar the opium to agricultural crops. The vegetables and fruits are planted including Japanese pumpkin, plum, Japanese apricot, peach, kiwi, and garlic. Recently, the villagers successfully developed their area and increased the yield up. Thus, the yields are over supplied in some year. Not only the over supply crops but also the low-quality crops caused the excess crops retain in the market.

Both Japanese pumpkin and Black plums are the excess crops that are discarded and become rotten. Black plum is fruit which has sweet and sour taste while pumpkin has only sweet taste. The producers want to develop the new products from those fruits with longer shelf life. For this reason, the fruit leather is a good choice according to the easy procedure and requires less apparatus. The basic procedure is mixed the fully ripe Japanese pumpkin and Black plum with sugar, spread on tray and dried.

The aim of this project is to increase the value added of the excess Japanese pumpkins and Black plums from the Royal Project's crops and to develop the longer shelf life product that the villagers able to do it at home.

OBJECTIVES

1. To increase the value of excess crops from the Royal Project by developing a new product.
2. To formulate basic formula of fruit leather using Japanese pumpkin and black plum.
3. To study the ratio of Japanese pumpkin and black plum in the product.
4. To study the sugar content in the product.
5. To determine the consumer preference.

LITERATURE REVIEW

1. PUMPKIN

Pumpkin is a useful plant yielding, both in the ripe and unripe condition. When ripe, the pumpkin is boiled or baked, or made into various kinds of pie, alone or mixed with other fruit; while small and green it may be eaten like the vegetable marrow.

Pumpkin is a gourd-like squash of the genus *Cucurbita* and the family *Cucurbitaceae* (which also includes gourds). It is a common name of or can refer to cultivars of any one of the following species: *Cucurbita pepo*, *Cucurbita mixta*, *Cucurbita maxima*, and *Cucurbita moschata*. However, the most common genus and species name for pumpkin is *Cucurbita maxima*.

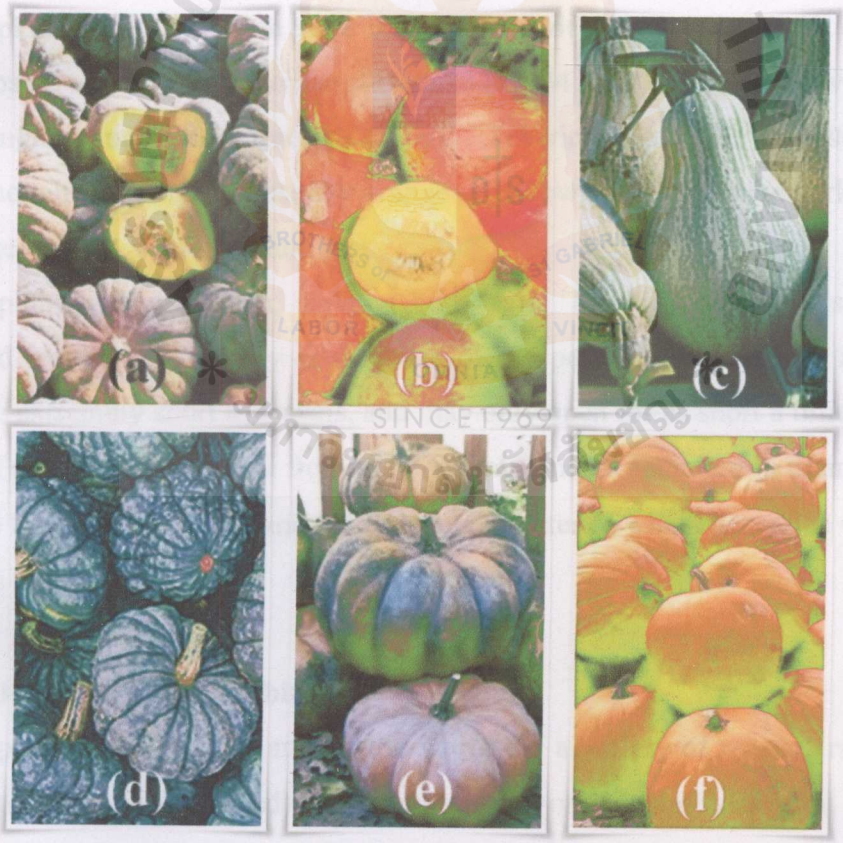

Figure 1: The variation of pumpkin species; (a) Chirimen (*Cucurbita moschata*), (b) Potimarron (*Cucurbita maxima*), (c) Tennessee Sweet Potato (*Cucurbita mixta*), (d) Queensland Blue (*Cucurbita maxima*), (e) Muscade de Provence (*Cucurbita moschata*), and (f) Kürbisse (*Cucurbita maxima*).

The word ***pumpkin*** originates from the word "pepon" which is Greek for "large melon." The French adapted this word to "pompon," which the English changed to "pompion" and later American colonists changed that to the word we use today, "pumpkin". The origin of pumpkins is not known, although pumpkins are thought to have originated in North America. The oldest evidence, pumpkin-related seeds dating between 7000 and 5500 B.C., were found in Mexico. Pumpkins are a squash-like fruit that range in size (less than 1 pound to over 1000 pounds), shape, color, and appearance (smooth or ribbed).

Since some squash share the same botanical classifications as pumpkins, the names are frequently used interchangeably. In general, pumpkins have stems which are firmer, more rigid, pricklier, have a +/- 5 degree angle, and are squarer in shape than squash stems which are generally softer, more rounded, and more flared where joined to the fruit.

Pumpkins generally weigh 9–18 lbs (4–8 kg) with the largest (of the species *C. maxima*) capable of reaching a weight of over 75 lbs (34 kg). The pumpkin varies greatly in shape, ranging from oblate through oblong. The rind is smooth and usually lightly ribbed. Although pumpkins are usually orange or yellow, some fruits are dark green, pale green, orange-yellow, white, red and gray.

Pumpkins are monocots, having both male and female flowers; the latter distinguished by the small ovary at the base of the petals. These bright and colorful flowers have extremely short life spans, and may only open for as short a time as one day. The color of pumpkins is derived from the orange pigments abundant in them. The main nutrients are lutein, and both ∝- and β-carotene, the latter of which generates vitamin A in the body.

1.1 Distribution and Habitation

Pumpkins are grown all around the world for a variety of reasons ranging from agricultural purposes (animal feed) to commercial and ornamental sales. Out of the seven continents only Antarctica is unable to produce pumpkins, the biggest international producers of pumpkins include the United States, Mexico, India, and China. The pumpkin capital of the world is Morton, IL. The traditional American pumpkin is the Connecticut Field variety.

Although native to the Western hemisphere, pumpkins are cultivated in North America, continental Europe, Australia, New Zealand, India and some other countries. The pumpkin is the state fruit of New Hampshire.

1.2 Uses

Pumpkin was among the fruits of the first Thanksgiving celebration of the Pilgrims; it has been a favorite pie filling for autumn festivities ever since, and its shell is carved into the Halloween jack-o'-lantern. The summer squashes include the pattypan, acorn, scallop, and summer crookneck squashes. Other squashes are varieties of *C. moschata*, including the crookneck squashes and the cheese pumpkin, and *C. maxima*, the winter squashes (e.g., the Hubbard and turban squashes), called pumpkins in Europe.

1.2.1 Cooking

Pumpkins are very versatile in their uses for cooking, from the fleshy shell, to the seeds, to even the flowers; most parts of the pumpkin are edible. Traditionally, pumpkin is a very popular Halloween and Thanksgiving staple. Although most people use store bought canned pumpkin, home-made pumpkin puree can serve the same purpose.

When ripe, the pumpkin can be boiled, baked, steamed, or roasted. Often, it is made into various kinds of pie which is a traditional staple of the Canadian and American Thanksgiving holiday. Pumpkins that are still small and green may be eaten in the same way as the vegetable marrow/zucchini. Pumpkins can also be eaten mashed or incorporated into soup.

In the Middle East, pumpkin is used for sweet dishes; a well-known sweet delicacy is called *halawa yaqtin*. In South Asian countries like India, pumpkin is cooked with butter, sugar, and spices; this dish is called *kadu ka halwa*. In Guangxi province, China, the leaves of the pumpkin plant are consumed as a cooked vegetable or in soups. In Australia, pumpkin is often roasted in conjunction with other vegetables. In Japan, small pumpkins are served in savory dishes, including tempura.

In Thailand, small pumpkins are steamed with custard inside and served as a dessert. In Italy it can be used, with cheeses, as a savory stuffing for ravioli. And also, pumpkin can be used to flavor both alcoholic and nonalcoholic beverages.

1.2.2 Pumpkin Extract

East China Normal University research on type-1 diabetic rats, published in July 2007, suggests that chemical compounds found in pumpkin promote regeneration of

damaged pancreatic cells in, resulting in increased bloodstream insulin levels. According to the research team leader, pumpkin extract may be "a very good product for pre-diabetic people, as well as those who already have diabetes", possibly reducing or eliminating the need for insulin injections for some type-1 diabetics. It is unknown whether pumpkin extract has any effect on diabetes mellitus type 2, as it was not the subject of the study.

1.2.3 Pumpkin Seed

Pumpkin seeds, also known as pepitas, are small, flat, and dark green seeds. Most pumpkin seeds are covered by a white husk, although some pumpkin varieties produce seeds without them. Pumpkin seeds are a popular snack that can be found hulled or semi-hulled at most grocery stores. However, roasting pumpkin seeds (usually scooped out of jack-o-lanterns) is a popular Halloween treat. Pumpkin seeds have many health benefits, some of which include a good source of protein, zinc and other vitamins, and are even said to lower cholesterol. One gram of pumpkin seed protein contains as much tryptophan as a full glass of milk.

1.2.4 Pumpkin seed oil

Pumpkin seed oil is thick, green oil that is produced from roasted pumpkin seeds. When used for cooking or as a salad dressing, pumpkin seed oil is generally mixed with other oils because of its robust flavor. It is used in cooking in central and Eastern Europe. Furthermore, it has long believed to be a folk remedy for prostate problems that it has in fact been shown to combat benign prostatic hyperplasia.

1.3 Japanese pumpkin (*Cucurbita maxima*)

Kabocha is a Japanese name called the variety of winter squash pumpkin. The word *kabocha* has come to mean a general type of winter squash to many English-speaking growers and buyers. In Australia, New Zealand and Southeast Asia, Kabocha is commonly called **Japanese pumpkin** while in North America called **Kabocha squash**. In Japan, the word *kabocha* may refer to either the squash discussed in this article or to the Western-style pumpkin. Varieties include: Ajihei, Ajehei No. 107, Ajihei No. 331, Ajihei No. 335, Cutie, Ebisu, Emiguri, and Miyako.

Nowadays, many of the Kabocha in the market are of the type called Kuri Kabocha, which was created based on Seiyo Kabocha (buttercup squash). It's popular for its strong yet sweet flavor and moist, fluffy texture, which is like chestnuts. It's found in the market under such brand names as Miyako, Ebisu, Kurokawa, Akazukin, etc.

1.3.1 Characteristic

Kabocha is hard, has knobby-looking skin, shaped like a squatty pumpkin, and has a dull colored deep green skin with some celadon-to white-colored stripes, and an intense yellow-orange color on the inside. In many respects it is similar to the Buttercup squash, but without the characteristic cup on the blossom end. It is a member of the species *Cucurbita maxima*, along with the Hubbard and Buttercup squashes.

Figure 2: Kabocha squash

Source: *http://www.umassvegetable.org/*

An average Kabocha weighs 2-3 pounds, but can weigh as much as 8 pounds. It has an exceptional naturally sweet flavor, even sweeter than butternut squash. It is similar in texture and flavor to a pumpkin and a sweet potato combined. Some can taste like a Russet potato. Like other squash-family members, it is commonly mixed in side dishes and soups, or anywhere pumpkin, potato, or other squash would be. It is a common ingredient in vegetable tempura and makes a wonderful soup by adding a small amount of rice or wheat starch.

Primarily grown in Japan, California, Florida, Tasmania, Hawke's Bay New Zealand, Southwestern Colorado, Mexico, Chile, and South Africa, but is widely adapted for climates that provide a growing season of 100 days or more. Most of the California, Colorado and New Zealand crop are exported to Japan.

1.3.2 History

It is generally believed that all squash originated in Mesoamerica. However, Kabocha was introduced to Japan by Portuguese sailors in 1541. Those sailors brought it with them from Cambodia. The Portuguese named the pumpkin as *Cambodia abóbora* which was shortened by the Japanese to Kabocha. Certain regions of Japan use an alternate abbreviation, shortening the second half of the name instead to "bobora". Another name for kabocha is 南瓜 or 南京瓜 (Nanking melon), which suggest that the vegetable arrived in Japan by way of China.

According to a different source, the squash was grown in North America in the past two decades and almost the entire crop was imported to Japan. Approximately 10-15% of the crop is made available for American consumers.

1.3.3 Nutrition

Kabocha is rich in beta carotene, iron, vitamin C, potassium, and trace amount of calcium, folic acid, and minute amounts of B vitamins.

1.3.4 Ripening

When Kabocha is just harvested, it is still growing. Unlike other vegetables and fruits, the freshness of Kabocha isn't important. It should be fully matured first, in order to become flavorful. First, Kabocha is ripened in a warm place (77°F) for 13 days, during which some of the starch converts to carbohydrate content. Then it's transferred to a cool place (50°F) and stored for about a month in order to increase its carbohydrate content. In this way the just-harvested, dry, bland-tasting kabocha is transformed into smooth, sweet kabocha. Fully ripened, succulent kabocha will have reddish-yellow flesh and a hard skin with a dry, corky stem. It is heavier than it looks. It reaches the peak of ripeness about 1.5 to 3 months after its harvested.

2. PLUM (*Prunus salicina*)

Plum (*Prunus salicina* syn. *Prunus triflora* or *Prunus thibetica*) also called Chinese plum or Japanese plum. Plum is a stone fruit tree in the genus *Prunus*, subgenus *Prunus*. The subgenus is distinguished from other subgenera (peaches, cherries, bird cherries, etc) in the shoots having a terminal bud and the side buds solitary (not clustered),

the flowers being grouped 1-5 together on short stems, and the fruit having a groove running down one side, and a smooth stone.

Plum is a smooth, shiny-skinned fruit. Firstly, it had been grown in Asia centuries ago. However, it had been grown in all regions of the world. Plums are referred to as a stone-fruit because they contain a stone (pit) in the center of the flesh which may be either a free-stone or a clingstone. If the stone clings to the flesh of the fruit, the plum is a clingstone fruit; otherwise it is a free-stone. Skin colors of plums may range from yellow, orange, green, red, purple, to dark blue or almost black, while the range of flavors from the flesh can be from tart to very sweet and juicy. The lighter colored skins are typically the sweeter skins while the darker skins are bitter and tarter tasting.

There are thousands of varieties of plums, the most commonly available falling into either the European or the Japanese species. European plums are smaller, oval-shaped fruits with darker purple skins covering a golden-colored, dense, drier flesh that holds together well for cooking. A free-stone variety of plum used for snacking, canning, stewing, or drying, it is the European plum that is often dried and made into prunes, which is why it may be referred to as a "prune plum" or a "fresh prune".

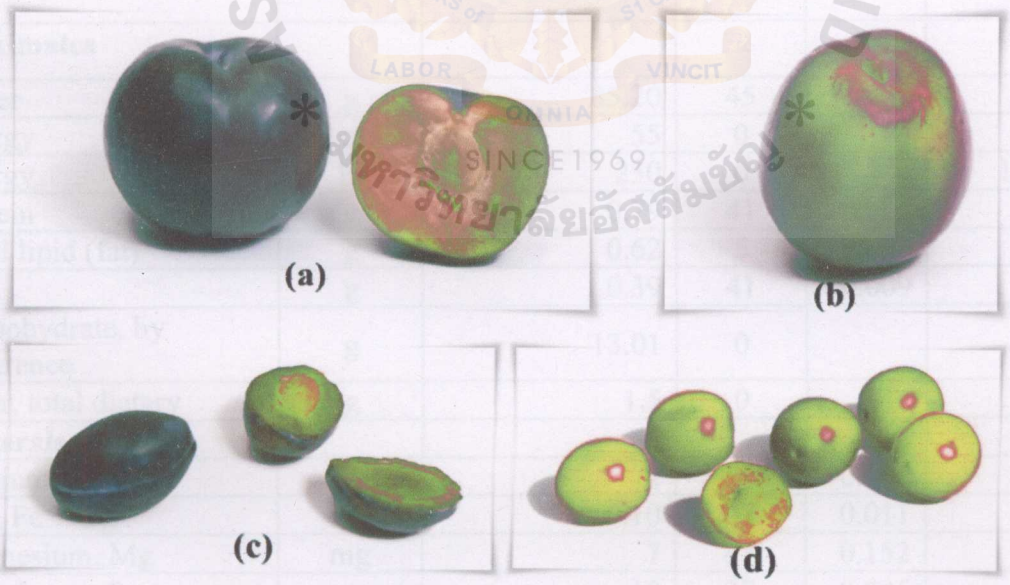

Figure 3: The different morphology of various plum species; (a) black plums, (b) red plums, (c) European plums, and (d) wild plums.

Source: *http://www.recipetips.com*

The Japanese plums, which are clingstone fruits, are grown from a species originating in Asia centuries ago that have brought into many different countries to be raised for commercial production. Often used for snacking, cooking, pickling, and canning, the Japanese plum is round or heart-shaped. On the outside, this variety of plum has a skin that is deep red to blackish-red in color, covering a flesh that is golden tan to red toned. Food stores will often label the common Japanese plums used for eating as "Red" or "Black" plums. However, there are also Japanese plums that will be labeled as "greengage" or "yellowgage" plums, which have a green or golden yellow outer skin covering a rich, sweet inner flesh. Kelsey and Wickson are two common varieties from the green and yellowgage species.

The black plum is the sweetest. It also has the advantage of having a very small pit, thus providing more edible flesh. Choose black plums that are firm to just beginning to soften but not hard or mushy.

Table 1: The nutrition information of black plums

Nutrient	Units	Value per 100 g of edible portion	Sample Count	Std. Error	1 fruit (2⅛" dia) ------- 66 g
Proximates					
Water	g	85.20	45	0.369	56.232
Energy	kcal	55	0		36.300
Energy	kj	230	0		151.800
Protein	g	0.79	41	0.024	0.521
Total lipid (fat)	g	0.62	5	0.020	0.409
Ash	g	0.39	41	0.009	0.257
Carbohydrate, by difference	g	13.01	0		8.587
Fiber, total dietary	g	1.5	0		0.990
Minerals					
Calcium, Ca	mg	4	5	0.166	2.640
Iron, Fe	mg	0.10	37	0.011	0.066
Magnesium, Mg	mg	7	37	0.152	4.620
Phosphorus, P	mg	10	37	0.845	6.600
Potassium, K	mg	172	21	4.254	113.520
Sodium, Na	mg	0	21	0.059	0.000
Zinc, Zn	mg	0.10	5	0.012	0.066
Copper, Cu	mg	0.043	37	0.004	0.028
Manganese, Mn	mg	0.049	37	0.004	0.032
Selenium, Se	mcg	0.5	0		0.330

Table 1: The nutrition information of black plums (continued)

Nutrient	Units	Value per 100 g of edible portion	Sample Count	Std. Error	1 fruit (2⅛" dia) ------- 66 g
Vitamins					
Vitamin C, total ascorbic acid	mg	9.5	5	0.847	6.270
Thiamin	mg	0.043	1		0.028
Riboflavin	mg	0.096	1		0.063
Niacin	mg	0.500	0		0.330
Pantothenic acid	mg	0.182	5	0.006	0.120
Vitamin B-6	mg	0.081	10	0.008	0.053
Folate, total	mcg	2	23	0.282	1.320
Folic acid	mcg	0	0		0.000
Folate, food	mcg	2	23	0.282	1.320
Folate, DFE	mcg_ DFE	2	0		1.320
Vitamin B-12	mcg	0.00	0		0.000
Vitamin A, IU	IU	323	5	80.587	213.180
Retinol	mcg	0	0		0.000
Vitamin A, RAE	mcg_ RAE	16	5	4.029	10.560
Vitamin E	mg_A TE	0.600	0		0.396
Lipids					
Fatty acids, total saturated	g	0.049	0		0.032
4:0	g	0.000	0		0.000
6:0	g	0.000	0		0.000
8:0	g	0.000	0		0.000
10:0	g	0.000	0		0.000
12:0	g	0.000	0		0.000
14:0	g	0.000	0		0.000
16:0	g	0.041	0		0.027
18:0	g	0.009	0		0.006
Fatty acids, total monounsaturated	g	0.406	0		0.268
16:1 undifferentiated	g	0.005	0		0.003
18:1 undifferentiated	g	0.400	0		0.264
20:1	g	0.000	0		0.000
22:1 undifferentiated	g	0.000	0		0.000
Fatty acids, total polyunsaturated	g	0.134	0		0.088
18:2 undifferentiated	g	0.134	0		0.088
18:3 undifferentiated	g	0.000	0		0.000
18:4	g	0.000	0		0.000

Table 1: The nutrition information of black plums (continued)

Nutrient	Units	Value per 100 g of edible portion	Sample Count	Std. Error	1 fruit (2⅛" dia) ------- 66 g
20:4 undifferentiated	g	0.000	0		0.000
20:5 n-3	g	0.000	0		0.000
22:5 n-3	g	0.000	0		0.000
22:6 n-3	g	0.000	0		0.000
Cholesterol	mg	0	0		0.000
Phytosterols	mg	7	0		4.620
Amino acids					
Threonine	g	0.016	6		0.011
Isoleucine	g	0.016	6		0.011
Leucine	g	0.021	6		0.014
Lysine	g	0.017	6		0.011
Methionine	g	0.006	6		0.004
Cystine	g	0.004	6		0.003
Phenylalanine	g	0.017	6		0.011
Tyrosine	g	0.006	6		0.004
Valine	g	0.019	6		0.013
Arginine	g	0.013	6		0.009
Histidine	g	0.013	6		0.009
Alanine	g	0.029	6		0.019
Aspartic acid	g	0.249	6		0.164
Glutamic acid	g	0.037	6		0.024
Glycine	g	0.012	6		0.008
Proline	g	0.034	6		0.022
Serine	g	0.020	6		0.013

Source: *USDA Nutrient Database for Standard Reference, Release 15 (August 2002).*

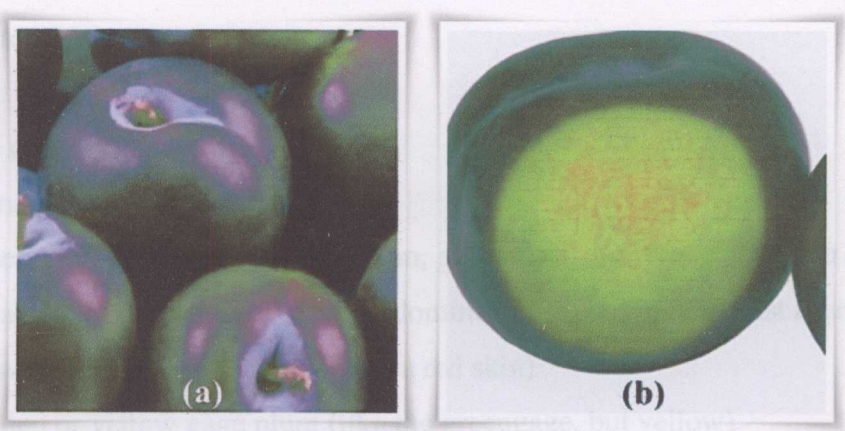

Figure 4: The appearance of black plum (a) and the section of fully-ripe black plums showed the red flesh (b).

2.1 Cultivation and uses

Plum is sweet and juicy fruit. It can be eaten fresh or used in jam-making or other recipes. Plum juice can be fermented into plum wine; when distilled, this produces a brandy known in Eastern Europe as Slivovitz, Rakia, Tzuica or Palinka. Dried plums are known as prunes. Prunes are also sweet and juicy and contain several antioxidants.

In recent years, prune marketers in the United States have begun marketing their product as "dried plums", because "prune" has negative connotations connected with elderly people suffering from constipation.

Various flavors of dried plum are available at Chinese grocers and specialty stores worldwide. They tend to be much drier than the standard prune. Cream, ginseng, spicy, and salty are among the common variety flavors. Licoricē is generally used to intensify the flavor of these plums and is used to make salty plum drinks and toppings for shaved ice or *baobing*.

Pickled plums are another type of preserve available in Asia and international specialty stores. The Japanese variety, called *umeboshi*, is often used for rice balls, called "Onigiri" or "Omusubi". The *ume*, from which umeboshi are made, is however more closely related to the apricot than to the plum.

Prune kernel oil is made from the fleshy inner part of the pit of the plum. Plums come in a wide variety of colors and sizes. Some are much firmer-fleshed than others and some have yellow, white, green or red flesh, with equally varying skin color.

Both plums and prunes are known for their laxative effect. This effect has been attributed to various compounds present in the fruits, such as dietary fiber, sorbitol, and isatin. Prunes and prune juice are often used to help regulate the functioning of the digestive system.

Plum cultivars in use today include:

- Damson, or Damask Plum
- Greengage, or greengage plum (firm, green flesh and skin even when ripe)
- Mirabelle (a dark yellow plum predominantly grown in northeast France)
- Satsuma plum (firm red flesh with a red skin)
- Golden or yellow gage plum (like the greengage, but yellow)

When it flowers in the early spring, a plum tree will be covered in blossom, and in a good year approximately 50% of the flowers will be pollinated and become plums. Flowering starts after 80 growing degree days. When it flowers in the early spring, a plum tree will be covered in blossom, and in a good year approximately 50% of the flowers will be pollinated and become plums. Flowering starts after 80 growing degree days.

If the weather is too dry, the plums will not develop past a certain stage. However the plums will fall from the tree while still tiny green buds. If the plum is unseasonably wet or if the plums are not harvested as soon as they are ripe, the fruit may develop a fungal condition called brown rot. Brown rot is not toxic, and very small affected areas can be cut out of the fruit, but unless the rot is caught immēdiately the fruit will no longer be edible. Plum is used as a food plant by the larvae of some Lepidoptera including November Moth, Willow Beauty and Short-cloaked Moth.

The Serbian plum is the third most produced in the world and the alcoholic drink slivovitz (*Plum brandy*) (Serbian: шљивовица / šljivovica) is the national drink of Serbia. According to FAO report, the plum production is averages 424,300 tones per year during 1991–2001.

A large number of plums are also grown in Hungary where they are called *szilva* and are used to make *lekvar* (a plum paste jam), *palinka* (a slivovitz-type liquor), plum dumplings, and other foods. The region which produces the best and most plums is Szabolcs-Szatmár in the northeastern part of the country near the borders with Ukraine and Romania.

The *mei* blossom (*Prunus mume*), along with the peony, are considered traditional floral emblems of China. On June 21, 1964, the Executive Yuan of the Republic of China officially designated the *mei* blossom to be its national flower, with the triple grouping of stamens (one long and two short) representing the Three Principles of the People and the five petals symbolizing the five branches of the ROC government. The designation repeats a previous statement by the ROC government in 1929.

The *mei* blossom is also the floral symbol of the ancient Chinese city Nanjing, which served as the former capital (and remained designated as the official capital) of the Republic of China.

3. FRUIT LEATHER

Fruit leather is a nutritious treat for young and old alike. The leathery sheets of dried fruit purée are easy to make using either fresh or canned fruits. Many fruits are suitable for fruit leather, including apples, apricots, bananas, berries, cherries, grapes, oranges, pears, pineapples, plums, strawberries, tangerines, and tomatoes. Fruit combinations make a variety of flavors possible. For example, tart rhubarb blends well with sweet strawberries. Other excellent combinations are pears with apricots and bananas with strawberries.

Not only that, the seasoning can be added by blending them with the purée or sprinkling before drying, such as apple pie seasoning is in applesauce leather. The toppings such as coconut, slivered almonds, or chopped filberts may be added before leathers are dry. Furthermore, yogurt is another interest ingredient to make new taste of fruit leather. Either plain or flavored yogurt is blended with berries to make sour fruit leather. Recently, the vegetable leather was developed. One of the vegetable leathers used stewed tomatoes and tomato sauce to make a dried-leather, and then sprinkle on top with leaf basil, leaf oregano, salt, and garlic.

Figure 5: Example of the fruit leather making from apple and berries.

3.1 Selecting and preparing fresh fruit

The selection and preparation of raw materials or fresh fruits are very important because the good product quality comes from the good raw material quality. The appropriate fruit should be fully ripe without spoilage. The fruits with minor blemishes and bruises that are not suitable for canning or freezing also can be used if the

imperfections are removed. After washing, the stems of fruits are removed and the blemishes are cut away.

If necessary, the fruit are pared, peeled, pit, cored, or removed seeds depending on the types of fruit. Apples, peaches, pears, and pine apples are pared while bananas, tomatoes, oranges, and tangerines are peeled. Apricots, cherries, peaches, and plums are pit. Apples, pears, and pineapples are pears. Oranges, Concord and Tokay grapes are removed seeds.

The fruits are cut into slices or chunks that can be puréed or ground easily. However, the fruit purée had to avoid the excessive browning during the preparation process. Because the enzymatic browning led to the flavor and color change in the products.

3.2 Making fresh fruit purée

The fresh fruit purée are prepared by either the cooked or the uncooked method. The color of light fruits may be better if preserved by the cooked method. This method also is more satisfactory for hard fruits that must be softened before being puréed. However, the uncooked method is faster than cooked method.

3.2.1 Cooked method

Fruit can be puréed when hot (hot break method) or when cold (cold break method). The results will be different. The hot break method retains more of the natural fruit flavor and preserves the light colors of fruit while the cold break method is faster.

Hot break method

The pieces of fruit are placed in the top of a double boiler to avoid scorching. Then, the fruits are covered and cooked over boiling water 15 minutes. After that, the fruits are removed from heat and let them cooled. Purée fruits are blended in a blender by using an appropriate speed, or grind in a food mill, using the finest blade.

Cold break method

The pieces of fruit are puréed in a blender with an appropriate speed, or grind in a food mill, using the finest blade. When the fruits are completely puréed, immediately place them in the top of a double boiler and cover before they are cooked over boiling water for 10 minutes.

Concentrating the purée

The juicy purée are concentrated to shorten the drying time by placing the ground or puréed fruit in a heavy, deep saucepan. Then, the purée are cooked over low heat and

stirred constantly until the mixture thickens. Finally, the purée are removed from heat and cooled to room temperature. However, the sugar may be added approximately 1 tablespoon to each 1¼ cups of purée during cooking period to decrease cooking time.

3.2.2 Uncooked method

The pieces of raw fruit are purée in blender with the appropriate speed, or grind in a food mill by using the finest blade. Alternatively, the berry purée are run through a strainer to remove seeds. The juicy purée may be concentrated by following the instructions above for concentrating the purée.

3.3 Making canned fruit purée

Canned fruit, including baby food without tapioca, is suitable for making fruit leather. Whole fruits are drained and purée in a blender with the appropriate speed, or grind in a food mill by using the finest blade. Alternatively, the juicy purée are concentrated as the instructions method above for concentrating the purée.

3.4 Preserving fruit color

Light-color fruit leather (such as apple, peach, apricot, pear, and banana) tends to darken during drying. Thus the colors can preserve by adding fruit juices or ascorbic acid. For fruit juice, both pineapple juice and lemon juice may help to prevent browning while orange juice tends to cause browning. The flavor of the dried fruit will depend on the type of juice used. For ascorbic acid (vitamin C), there are three methods for its application as follows:

(i) *Crystals*

The crystal form is available from some pharmacies. They are added ¼ teaspoon to 2 cups of purée.

(ii) *Tablets*

Approximately 750 mg tablets are crushed before added into 2 cups of purée.

(iii) *Commercial mixtures containing ascorbic acid*

These mixtures are often used to prepare fruits for freezing. Normally, they are not as effective as pure ascorbic acid. The specific application should follow the label instructions.

3.5 Flavoring the purée

The purée are sweetened by adding sugar or honey but the fruit leather becomes stickier when the honey is added. Not only that, any of a variety of spices such as nutmeg, cinnamon, and allspice may be added to get more variety of tastes. For variation in texture, fruit leathers might be added finely chopped nuts or coconut.

3.6 Drying the purée

The prepared purée are poured onto the tray which lining with plastic wrap, then spread to approximately ⅛ to ¼-inches thickness. The purée is then dried in an oven, dehydrator, or even under the sunlight. The plastic wrap should not melt at the drying stage.

3.6.1 Oven drying

Electric and gas ovens with automatic shutoffs for temperature regulation are more suitable for drying the fruit leather. In this method, the fruit purée are placed in the oven with racking 2 inches apart and 3-inch clearance from the top and bottom of the oven. The oven is set on the lowest setting, and prop the door open with a potholder or a stick to let moisture escape. The opening will vary from a ½-inch crack for electric ovens up to 8 inches for gas ovens. Temperature should be maintained at 140°F during drying, thus it's best to use an oven thermometer. The pans are turned and rotated each one or two hours. Drying time will vary from 4 to 8 hours depending on the temperature, humidity, and type and amount of purée.

3.6.2 Sun drying

The cheesecloth is put over, but not touching, the purée to protect from insects. The trays are placed in direct sunlight and take them indoors at night if there is a possibility of moisture. Drying time will vary from 8 hours to 2 days depending on temperature and humidity.

3.6.3 Dehydrator

The temperature is maintained at 135 to 140°F. Drying time in dehydrator will vary from 4 to 8 hours.

3.7 Test for doneness

The leather should feel tacky but should not contain any moisture.

3.8 Storing the leather

To store whole sheets of fruit leather, they should be rolled like a scroll within plastic wrap or cut into 1-inch slices from rolled leather for bit-size pieces. Then, the fruit leathers are stored in plastic freezer bags or tightly sealed containers in a cool, dry place. Check periodically and discard any moldy leather. However, for long-term storage, the fruit leathers are refrigerated or freeze.

3.9 Using fruit leather

Fruit leather is easy to eat and convenient to pack. It makes ideal snacks at home, on the trail, or on the ski slopes. Use fruit leather in place of raisins for cooking.

4. COLOR MEASUREMENT

4.1 Hunter L*a*b* Color model

The Hunter L*a*b* instruments duplicate how our eyes see color. They measure the product color and give numerical value. These objective measurements optimize the confidence of your quality decisions. Hunter L*a*b* expertise and experience ensure that the research get the right instrument for its application.

Hunter L*a*b* systems measure reflected and transmitted color of food products. They give numerical values that correlate to what you see and are ideal for measuring raw materials through final product. These include liquids such as sauces and juices, solids such as spices and meats, as well as non-uniform products such as cereals and snack foods. Portable, bench and on-line systems are available.

They are ideal for measuring color during all phases of food production from raw materials to the final product. This includes liquids (sauces and juices), solids (spices and meats), and non-uniform products (cereals and snack foods).

Background

The Hunter L*a*b* color scale evolved during the 1950s and 1960s. At that time, many of the scientists involved with color measurement were working on uniform color scales. The X,Y,Z system was being used, but it did not give a good indication of sample color based solely on the numbers. The uniform color scales being investigated gave better indications of the color of a sample based solely on the numbers. There were

several permutations of the Hunter L*a*b* color scale before the current formulas were released in 1966.

The Hunter L*a*b* color scale is more visually uniform than the X,Y,Z color scale. In a uniform color scale, the differences between points plotted in the color space correspond to visual differences between the colors plotted. The Hunter L, a, b color space is organized in a cube form similar to the CIE 1976 L*a*b* color model.

The L* axis runs from top to bottom. The maximum for L* is 100, which would be a perfect reflecting diffuser. The minimum for L* would be zero, which would be black. The a* and b* axes have no specific numerical limits. Positive a* is red. Negative a* is green. Positive b* is yellow. Negative b* is blue.

Hunter L*a*b* color algorithm

The quantities L*, a*, and b* are obtained from the tristimulus values according to the following transformations:

$$L = 100\sqrt{\frac{Y}{Y_n}}$$

$$a = K_a\left(\frac{X/X_n - Y/Y_n}{\sqrt{Y/Y_n}}\right)$$

$$b = K_b\left(\frac{Y/Y_n - Z/Z_n}{\sqrt{Y/Y_n}}\right)$$

where

X, Y, and Z are the CIE tristimulus values.

X_n, Y_n, and Z_n are the tristimulus values for the illuminant.

Y_n is 100.

K_a and K_b are chromaticity coefficients for the illuminant.

Hunter L*a*b* color difference

There are delta values ΔL*, Δa*, and Δb* associated with the Hunter L*a*b* color model. These values indicate how much a standard and sample differ from one another in L*, a*, and b*. The ΔL*, Δa*, and Δb* are calculated from the following equations:

$$\Delta L^* = L^*_{sample} - L^*_{standard}$$

The positive ΔL means that the sample is lighter than the standard while the negative ΔL means that the sample is darker than the standard.

$$\Delta a^* = a^*_{sample} - a^*_{standard}$$

The positive Δa* means that the sample is redder than the standard while the negative Δa* means that the sample is greener than the standard.

$$\Delta b^* = b^*_{sample} - b^*_{standard}$$

The positive Δb* means that the sample is yellower than the standard while the negative Δb* means that the sample is bluer than the standard.

4.2 CIE XYZ Color model

As mentioned in the preceding page, CIE considered the tristimulus values for red, green, and blue to be undesirable for creating a standardized color model. Instead, they used a mathematical formula to convert the RGB data to a system that uses only positive integers as values. The reformulated tristimulus values were indicated as *XYZ*. These values do not directly correspond to red, green, and blue, but are approximately so. The curve for the *Y* tristimulus value is equal to the curve that indicates the human eye's response to the total power of a light source. For this reason, the value Y is called the luminance factor and the *XYZ* values have been normalized so that *Y* always has a value of 100.

The CIE XYZ color space was deliberately designed so that the Y parameter was a measure of the brightness or luminance of a color. The chromaticity of a color was then specified by the two derived parameters x and y, two of the three normalized values which are functions of all three tristimulus values X, Y, and Z:

$$x = \frac{X}{X + Y + Z}$$

$$y = \frac{Y}{X + Y + Z}$$

$$z = \frac{Z}{X+Y+Z} = 1 - x - y$$

The X and Z tristimulus values can be calculated back from the chromaticity values x and y and the Y tristimulus value:

$$X = \frac{Y}{y}x$$

$$Z = \frac{Y}{y}(1 - x - y)$$

Obtaining the *XYZ* tristimulus values is only part of defining the color. The color itself is more readily understood in terms of hue and chroma. To make this possible, CIE used the *XYZ* tristimulus values to formulate a new set of chromaticity coordinates that are denoted *xyz*.

The chromaticity coordinates are used in conjunction with a chromaticity diagram, the most familiar one being CIE's 1931 *xyY* Chromaticity Diagram:

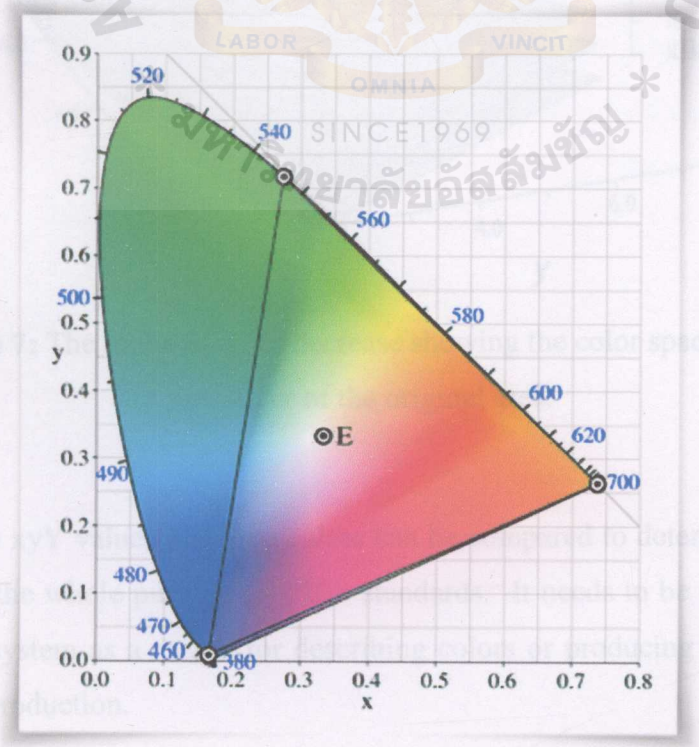

Figure 6: The CIE color space chromaticity diagram.

The horseshoe-shaped color space is set in a grid using the chromaticity coordinates x and y as a locator for any value of hue and chroma. These correspond to the color itself (e.g., reddish-orange) and the fullness of the color or saturation. The coordinate z is not used, but can be inferred from the other two since the sum of the coordinates x + y + z is always 1.

The white spot in the following diagram represents the location of the illuminant. The third dimension is indicated by the tristimulus value Y. As previously mentioned, this value indicates the lightness or luminance of the color. The scale for Y extends from the white spot in a line perpendicular to the plane formed by x and y using a scale that runs from 0 to 100. The fullest range of color exists at 0 where the white point is equal to CIE Illuminant C. As the Y value increases and the color becomes lighter, the range of color, or gamut, decreases so that the color space at 100 is just a sliver of the original area.

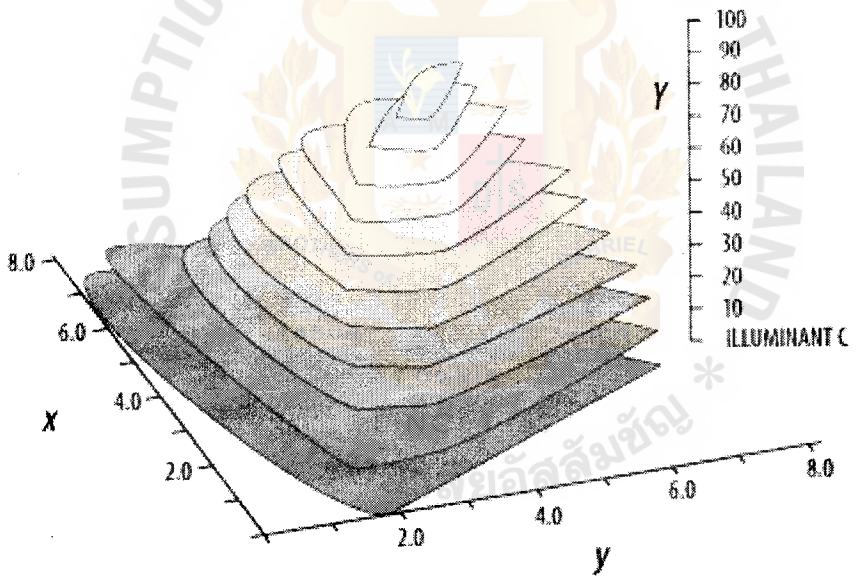

Figure 7: The range of color decrease showing the color space at 100 as a sliver of the original area.

Using the xyY values, any two colors can be compared to determine whether they match–which is the whole purpose of CIE's standards. It needs to be noted that CIE did not create their system as a means for describing colors or producing a line of swatches for use in color production.

It is not possible to use the xyY chromaticity diagram as a map for showing the relationships between colors. The diagram is a flat representation of what is really a curved surface. Therefore, like a Mercator projection map of the world, parts of it are visibly distorted in relationship to others. Colors of equal amounts of difference appear farther apart in the green part of the diagram than they do in the red or violet part.

MATERIALS AND METHODS

1. Raw materials and ingredients

- Japanese pumpkin (*Cucurbita maxima*)
- Black plum (*Prunus salicina*)
- Sugar
- Blender
- Tray
- Shortening
- Air dry oven
- pH meter
- Colorimeter

2. Selection and preparation of Japanese pumpkin and black plum

Both Japanese pumpkin and black plum are over supplied and not suitable size for sale from the Royal Project, Monngoe, Chiangmai. For Japanese pumpkins, the fully matures and no spoilage are selected and cut into smaller pieces. The seeds were removed before steamed for 10 minutes. The flesh was taken out from the skin by using spoon.

For black plums, they are selected the fully ripening because of its sweetness and sour taste. Then, they were washed and wait until dry. The dried black plum were packed in the plastic bags and kept them in the freezer while Japanese pumpkins are kept in the cold room at 4°C. The freeze black plums were thawed before peeling the skin and removing seeds.

3. Formulation and production of Japanese pumpkin and black plum leather

Table 2: The basic formula for Japanese pumpkin – black plum leather

Raw materials	**%**
Japanese pumpkin	50
Black plum	50
Sugar	10 (base on the % of Japanese pumpkin and black plum)

The cooked flesh of Japanese pumpkin and the peeled black plum were blended in the blender at the ratio of 1:1 (50% Japanese pumpkin and 50% black plum). Sugar was added after all the fruits mixed well. Trays were greased with the shortening and set a side. The mixture of Japanese pumpkin and black plum was dropped 1 table spoon on tray and spread it into a round shape (approximately 1-inch radius) by using spoon. Then, the fruit leathers were dried at 50°C for 5 hours in air dry oven.

4. Variation the ratio of Japanese pumpkin and black plum

In this step, the ratio of Japanese pumpkin and black plum was varied as 3:2, 1:1 and 2:3. The preference test was done to test the product by 30 untrained panelists.

5. Variation the amount of sugar

The amount of sugar added into the leather was varied to 10, 15 and 20% base on the weight of Japanese pumpkin and black plum. The products were tested for the sweetness and texture using 9-point hedonic score test with 30 untrained panelists.

6. Consumer acceptance test

The prototype formula was prepared for testing with 30 untrained panelists using Just-about-right test.

7. Physical and chemical analysis.

Both Japanese pumpkin and black plum were determined the pH before cooking (HANNA pH211 Instruments Microprocessor pH Meter) and the products were investigated the color intensity by (Konica colorimeter CR400/410). The products were kept in plastic bag at 4°C for 1 month to test the physical change (color, appearance, and texture).

RESULTS AND DISCUSSION

1. Selection and preparation of Japanese pumpkin and black plum

Japanese pumpkins are used to check the quality by using nail picking on the pumpkin's skin. The fully mature Japanese pumpkin should be picked the skin easily. The good quality has orange-yellow flesh and more sweetness. Some of Japanese pumpkins have soggy flesh inside according to the inappropriate storage condition and immature harvest.

After sorting, Japanese pumpkins were cut into a small piece and stream with hot water approximate 10 minutes. After steaming, the flesh of Japanese pumpkin soften and broken. The orange-yellow of the fresh flesh changed to darken yellow color (Fig. 8). The soften flesh of Japanese pumpkin was removed from the skin using spoon.

Figure 8: Japanese pumpkin after streaming process.

The black plums are selected after thawing. The ripe black plum has dark-red skin and it should not be too soft. The imperfect parts are cut and the whole fruit is used without peeling according to the fewer raw materials in the market.

The freeze black plums were thawed and cut to remove the seed inside (as shown in Fig. 9 and 10). Both dark-red skin and juicy flesh were used. Prepared black plums were put into the bowl and cover with the white cloth before used.

The pH of fresh Japanese pumpkin and black plum was shown in table 3. As the result, the flesh of Japanese pumpkin is mild acid while the flesh of black plum is high acid and high sour taste.

Figure 9: The freeze black plums are thawed.

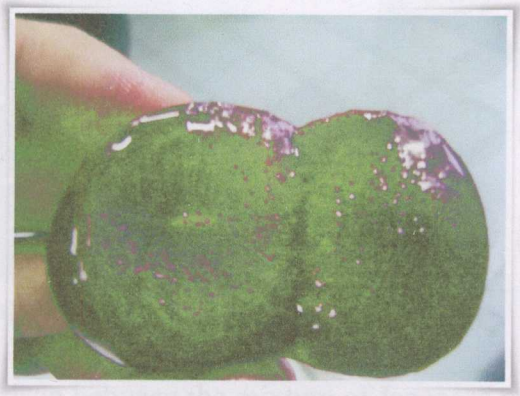

Figure 10: Black plum remove seed

Table 3: The pH value of fresh Japanese pumpkin and black plum

Sample	pH
Japanese pumpkin	6.4
Black plum	3.3

2. Formulation and production of Japanese pumpkin and black plum leather

The production of Japanese pumpkin and black plum leather is developed to the easier process and used less equipment, so that, the farmer able to be done. The cooked flesh of Japanese pumpkins and juicy flesh of black plums were blended together in the blender at the ratio of 1:1. The mixture was smooth texture and very sticky and has intense red color because of the dark-red color of black plum. The big pieces of fruit will be effect on the texture of the leather during the drying process. In this step, sugar was added about 10% based on the weight of Japanese pumpkin and black plum. The mixture was blended until sugar was completely melted.

Thus, one spoon of the mixture was dropped on the greased tray and spread into the round shape (approximately 1-inch diameter) using spoon. During the spreading, the mixture should be spread with continuous sheet and equal thickness of each. Then, the trays of round-wet leathers were dried in the air-dry oven at 50°C for 5 hours. The bigger size and uncontrolled thickness made the crack of leather during the drying process. Not only that, the higher temperature than 50°C and the longer period of drying will burned the thin leathers and crack the thick leathers.

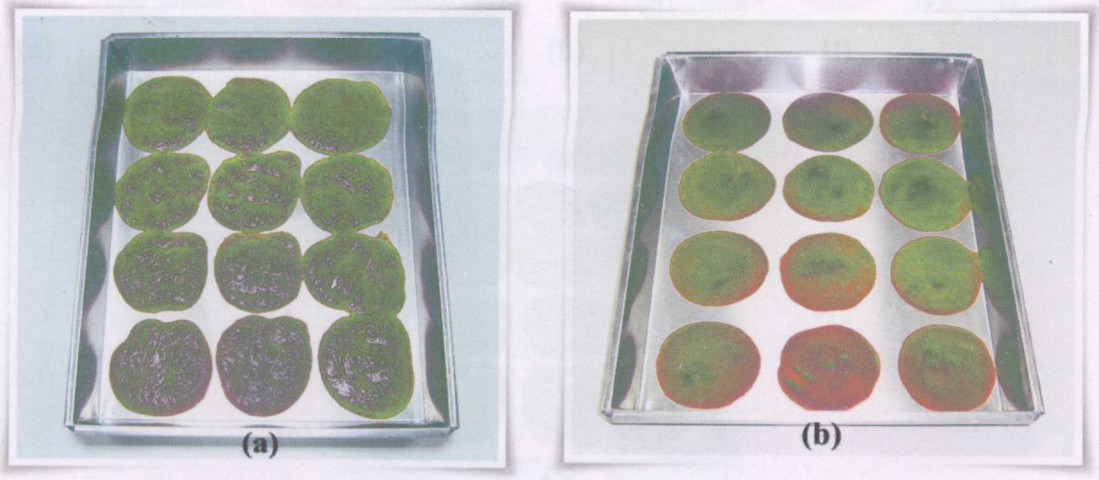

Figure 11: The comparison between the mixture of Japanese pumpkin and black plum before (a) and after (b) drying process.

3. Variation the ratio of Japanese pumpkin and black plum

The percentage of Japanese pumpkin and black plum was studied by varying the ratio of Japanese pumpkin and black plum to 2:3, 1:1, and 3:2. The leather texture of the ratio 2:3 was the best according to smoothness and no crack while the ratio of 1:1 and 3:2 result the more breaking area in the dried leather. The increasing proportion of black plum is responsible for the smoothness of dried leather because of the pectin content in black plum. Not only that, the intensity of red color also increased according the high portion of black plum because the red color of the product resulted from the dark-red flesh of black plum. The different color shade of each ratio of Japanese pumpkin and plum are shown in figure 12.

As the results, the amount of 30 untrained panelists selected their preference product at the ratio of 2:3, 1:1, and 3:2 as 6, 15, and 9, respectively. For sour taste, the high proportion of black plum also showed the more sour taste than the lower proportion of black plum. By the way, the ratio of 1:1 was selected for further experiment according to the highest score of preference test.

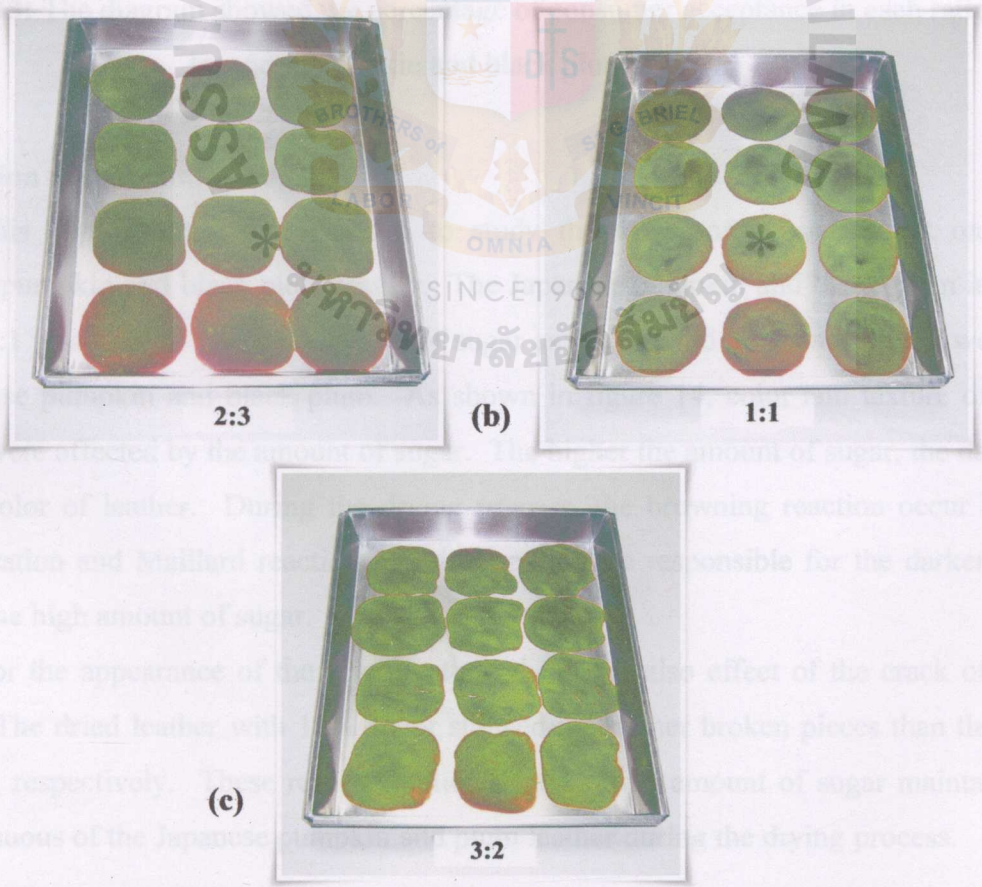

Figure 12: The different color and appearance of the leather at various ratio of Japanese pumpkin and black plum; 2:3 (a), 1:1 (b), and 3:2 (c).

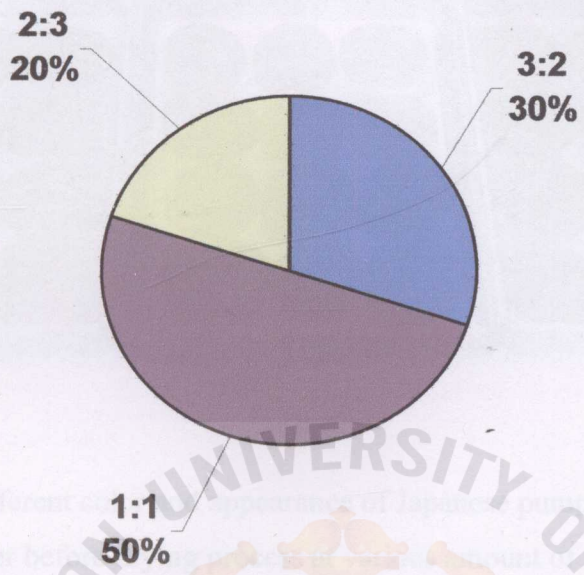

Figure 13: The diagram showed the percentage of consumer acceptance in each ratio of Japanese pumpkin and black plum leather.

4. Variation the amount of sugar

This experiment was performed to study the effect of sugar amount on the Japanese pumpkin and black plum leather. The Japanese pumpkin and black plum in the ratio of 1:1 was used to vary the amount of sugar as 10, 15, and 20% base on the weight of Japanese pumpkin and black plum. As shown in figure 14, color and texture of the mixture were affected by the amount of sugar. The higher the amount of sugar, the darker the red color of leather. During the drying process, the browning reaction occur both caramelization and Maillard reaction. Both reactions are responsible for the darker red color in the high amount of sugar.

For the appearance of the dried leather, the sugar also effect of the crack of the leather. The dried leather with 10% sugar showed the higher broken pieces than the 15 and 20%, respectively. These results implied that the high amount of sugar maintained the continuous of the Japanese pumpkin and plum leather during the drying process.

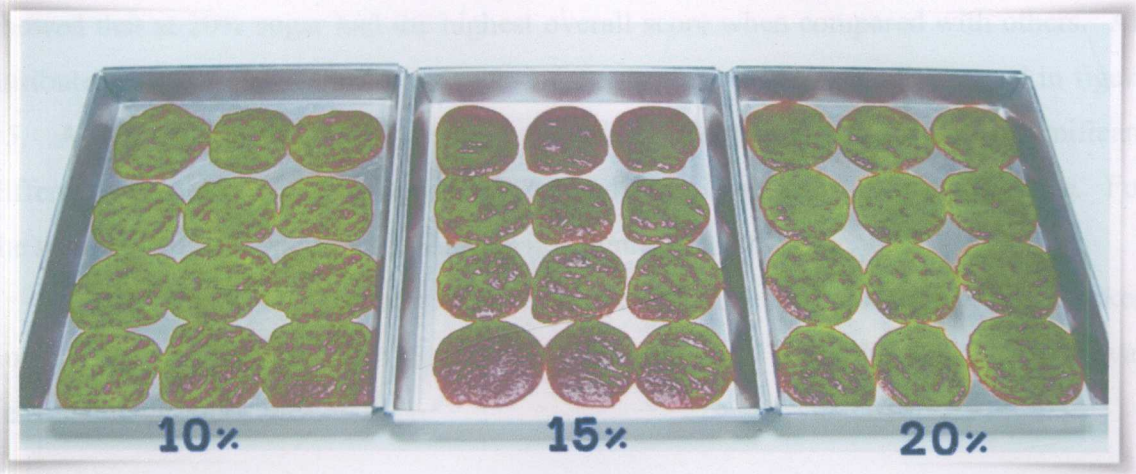

Figure 14: The different color and appearance of Japanese pumpkin and black plum leather before drying process at various amount of sugar; (from left to right is 10, 15, and 20%).

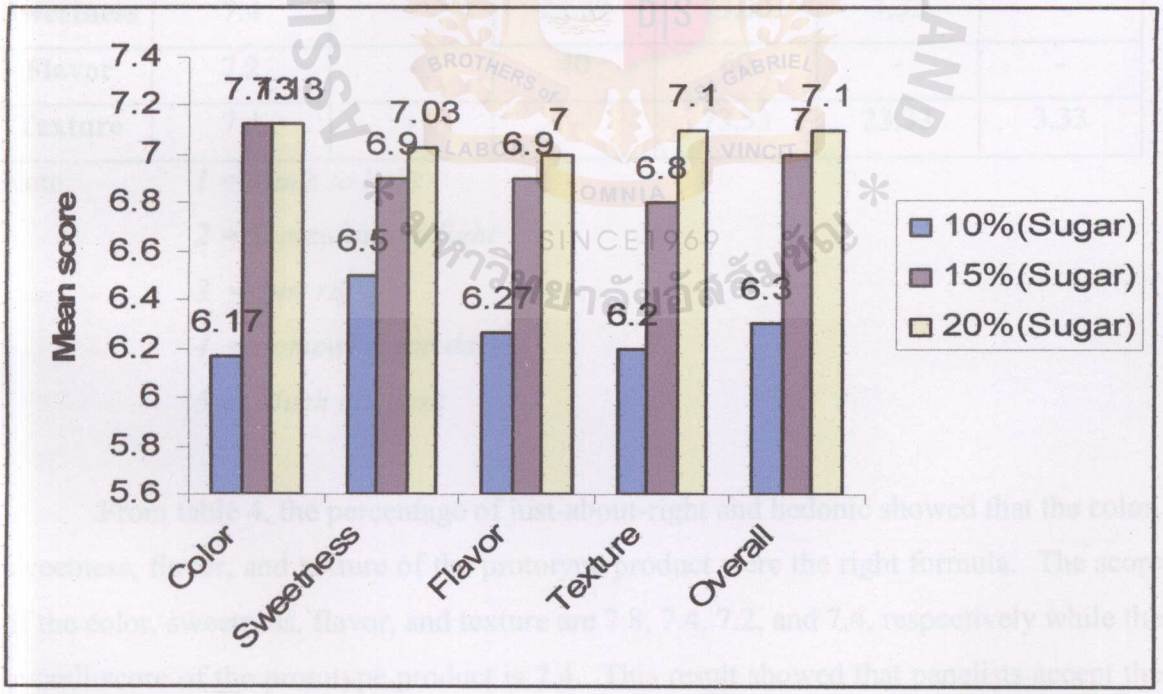

Figure 15: The mean score of various amount of sugar in Japanese pumpkin and black plum leather.

The consumer test using 9-points hedonic score test with 30 untrained panelists showed that at 20% sugar had the highest overall score when compared with others. All attribute scores, which are, color, sweetness, flavor, texture and overall, showed in figure 15. As the results, the color, texture, flavor and overall of 10% sugar is significant difference with 15 and 20% sugar while 15 and 20% is no significantly difference. For the sweetness, all the sugar variations are not significant difference.

However, Japanese pumpkin and black plum leather with 20% of sugar was taken out from the tray easier than 15 and 10%, respectively. Thus, the 20% of sugar was selected for further study.

5. Consumer acceptance test

Table 4: The result from Just-about-right and preference test of the ratio 1:1 of Japanese pumpkin and black plum with 20% of sugar

Attribute	Preference	1	2	3	4	5
Color	7.8	-	6.67	83.33	10	-
Sweetness	7.4	-	23.33	73.33	3.33	-
Flavor	7.2	-	40	60	-	-
Texture	7.4	-	-	73.33	23.33	3.33

Note: *1 = Much to light*
2 = Somewhat too light
3 = Just right
4 = Somewhat too dark
5 = Much too dark

From table 4, the percentage of just-about-right and hedonic showed that the color, sweetness, flavor, and texture of the prototype product were the right formula. The score of the color, sweetness, flavor, and texture are 7.8, 7.4, 7.2, and 7.4, respectively while the overall score of the prototype product is 7.4. This result showed that panelists accept the Japanese pumpkin and black plum leather more than 50%.

6. Consumer acceptance

Market survey was conducted about information and customer preference on Japanese pumpkin and black plum leather. The questionnaires were done by 50 untrained panelists at ABAC University and Maxway Co., Ltd. According to table 5, the gender was equal in male and female as 36% and 64%, respectively. The age of panelists were varying from 16 – 25 year, 26 – 35 year, and 36 – 45 year as 36, 56, and 8%, respectively. The largest group of income is 15,001 – 20,000.

The educations of panelists were varying from 70% of Bachelor's degree and 30% of Master's degree. The biggest group of career is private employee as 64% and the remaining portion is student. The preference test of 50 untrained panelists to Japanese pumpkin and black plum leather is like and dislike 82 and 18%,respectively.

Table 5: The demographic data of 50 untrained panelists

Demographic Data	Amount in percentage (%)
Gender:	
Male	36
Female	64
Age:	
16 – 25	36
26 – 35	56
36 - 45	8
Income:	
5,000 – 10,000	28
10,001 – 15,000	16
15,001 – 20,000	30
More than 20,000	26
Education:	
A Bachelor's Degree	70
A Master's Degree	30
Career:	
Student:	36
Private Employee	64

Table 5: The demographic data of 50 untrained panelists (continued)

Demographic Data	Amount in percentage (%)
Preference:	
Dislike Japanese pumpkin and black plum leather	18
Like Japanese pumpkin and black plum leather	82
Ever eat fruit leather:	
Ever	88
Never	12
Where you buy fruit leather:	
Fresh market	38
Supermarket	26
Superstore	10
Stall	26
How often do you eat:	
1 time / month	82
other	18
Suitable price for fruit leather:	
5 – 10 B	20
11 – 15 B	10
16 – 20 B	38
21 – 2 5B	8
More than 25	16
Japanese pumpkin and black plum leather suitable size:	
Smallest	18
Suitable	66
Biggest	16

Table 5: The demographic data of 50 untrained panelists (continued)

Demographic Data	Amount in percentage (%)
Suitable price for Japanese pumpkin & black plum leather:	
5 – 10 B	10
11 – 15 B	32
16 – 20 B	58
Consumer interest to by product:	
Interest	68
Not interest	32

From table 5, the demographic data showed that the panelist ever eats fruit leather at 88% and never eat is 12%. The panelist bought fruit leather from fresh market (38%) with high frequency than from the supermarket (26%), superstore (10%) and stall (26%). The frequency of buying (per month) is 82% percent for 1 time / month and other is 18%. For suitable price for fruit leather (30 pieces per box), the most suitable price is 16 – 20 baths per box (38%). As the result, consumer bought a fruit leather is quit small group. Thus, the product development will used to increase the demand of consumer to buy a fruit leather product.

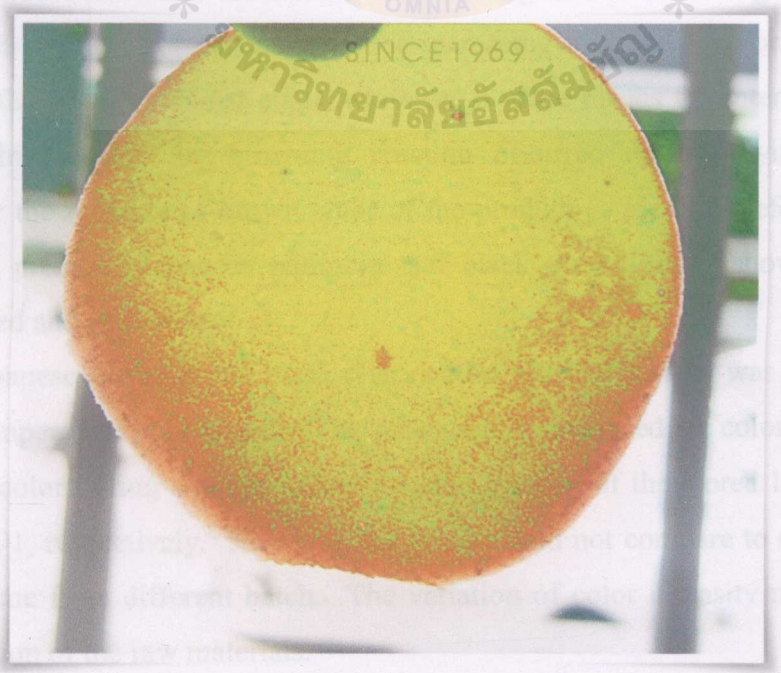

Figure 16: Final product of Japanese pumpkin and black plum leather.

The panelist scored that the size of product (round shape with 1-inch diameter) is suitable at 66% while 18% is scored as too small and 16% is scored too big. The 58% of panelists said that the suitable price for Japanese pumpkin and black plum leather is 16 – 20 baths, 10% panelists selected 5 – 10 baths, and 32% panelists selected for 11 – 15 baths. The 68% of panelists are interested to buy product. Finally, the panelists commented that Japanese pumpkin and black plum leather is different from another fruit leathers in market and this made them want to test and buy the product if it launch to market.

7. Color measurement of Japanese pumpkin and black plum by Konica colorimeter CR400/410

Table 6: The value of Hunter L*a*b color measurement

Sample	L	a	b
10% sugar	29.56	9.65	50.98
15% sugar	30.46	11.12	52.52
20% sugar	30.65	13.79	52.86

The L, a, b value showed that the L value is closed to 100; the color is more white while the -100 value replied to the black color. The higher amount of sugar increases the intensity of red-yellow color according to the increasing of a and b color. The a value indicated that the intensity of red color, while the b value means the intensity of yellow color. For this results, the browning reaction occurred during drying process is responsible for the increase of brown color of the product as mention before. From the figure 16, the piece of Japanese pumpkin and black plum leather showed the equal dispersion of red and yellow spot.

The Japanese pumpkin and black plum leather with 20% sugar was kept in plastic bag at room temperature for 1 month. This product also measured the color to investigate the change of color during storage. The L, a, and b value of the stored leather is 31.9, 17.72, and 55.01, respectively. However, the result could not compare to others because the product came from different batch. The variation of color intensity might be come from the variation of the raw materials.

CONCLUSION

The prototype formula use the ratio of Japanese pumpkin and black plum is 1:1 with 20% sugar base on weight of Japanese pumpkin and black plum. The process starting from blending of steamed Japanese pumpkin and pit black plum together, then the sugar was added. The finely blended mixtures were poured into round shape on tray before dried at 50°C for 5 hours. The high amount of sugar is affected on the less stickiness and less crack of the dried leather on tray. The intensity of red-yellow color of Japanese pumpkin and black plum with 20% sugar has higher than Japanese pumpkin and black plum with 10 and 15% sugar, respectively. The higher intensity of red-yellow color is responsible for the browning reaction occurred during drying process.

REFERENCES

Anonymous (2008) Pumpkin

http://en.wikipedia.org/wiki/Pumpkin

Anonymous (2008) Kabocha (Japanese pumpkin)

http://en.wikipedia.org/wiki/Kabocha

Kabocha squash

http://www.umassvegetable.org/

Kabocha squash, Barron's Educational Services, Inc. 1995 based on THE FOOD LOVER'S COMPANION, 2nd edition, by Sharon Tyler Herbst.

http://www.epicurious.com/tools/fooddictionary/entry?id=3123

Japanese Kabocha - Japanese Pumpkin - Kabocha Squash

http://japanesefood.about.com/od/vegetable/p/japanesekabocha.htm

Vegetarians in Paradise/Kabocha History, Kabocha Nutrition

http://www.vegparadise.com/highestperch10.html

Anonymous (2008) Plum (Prun)

http://en.wikipedia.org/wiki/Plum

The different morphology of various plum species

http://www.recipetips.com

The nutrition information of black plums

USDA Nutrient Database for Standard Reference, Release 15 (August 2002).

Turning Over a New Leaf Change from 'Prune' to 'Dried Plum' Proving Fruitful

http://www.failuremag.com/arch_business_dried_plums.html

Making dried fruit leather , Revised July 1999, C. Raab and N. Oehler

http://extension.oregonstate.edu/catalog/html/fs/fs232/

Preparation Leathers and Jerkies no. 9.311 by P. Kendall and J. Sofos

http://www.uga.edu/nchfp/how/dry/csu_leathers_jerkies.pdf

Hunter L*a*b Color Model

http://www.labcognition.com/panoramaonlinehelp/englisch/colorimetric_analysis/color_models/hunter_l_a_b__color_model.html

Color model CIE-XYZ

http://dba.med.sc.edu/price/irf/Adobe_tg/models/ciexyz.html

Appendix A

Appendix 1

Appendix A-1: The percentage from ranking test ratio between Japanese pumpkin and black plum.

Attribute (ratio of Japanese pumpkin and black plum)	Score
3:2	9
1:1	15
2:3	6

- Attribute percent between Japanese pumpkin and black plum
- Score is number of panelist

Appendix A-2: Score of color in variation percentage of sugar

NO.	Percentage of sugar contain in product		
	10%	15%	20%
1	5	7	7
2	6	7	8
3	6	7	8
4	6	5	7
5	6	7	7
6	7	8	7
7	7	7	7
8	6	7	7
9	7	7	7
10	5	6	8
11	5	8	8
12	5	8	6
13	4	9	6
14	8	8	8
15	8	8	8
16	7	6	8
17	7	7	7
18	8	8	8
19	4	7	5
20	5	5	7
21	6	7	7
22	8	8	8
23	8	9	7
24	5	5	6
25	4	7	6
26	4	8	7
27	7	7	7
28	8	7	7
29	6	8	7
30	7	6	8
Total	185	214	214
Average	6.17	7.13	7.13
S.D.	1.34	1.04	0.78

Appendix A-3: Score of sweetness in variation percentage of sugar.

NO.	Percentage of sugar contain in product		
	10%	15%	20%
1	6	7	8
2	8	6	8
3	8	8	8
4	6	6	7
5	8	7	6
6	5	7	6
7	6	8	8
8	6	8	7
9	6	7	7
10	7	7	6
11	7	7	6
12	6	7	7
13	7	6	5
14	6	7	8
15	6	7	8
16	6	7	8
17	7	6	8
18	7	8	7
19	5	7	6
20	4	6	7
21	7	8	8
22	8	8	8
23	8	7	8
24	7	6	8
25	3	5	8
26	7	7	6
27	6	7	4
28	7	7	6
29	7	6	7
30	8	7	7
Total	195	207	211
Average	6.5	6.9	7.03
S.D.	1.20	0.76	1.07

Appendix A-4: Score of flavor in variation percentage of sugar.

NO.	Percentage of sugar contain in product		
	10%	15%	20%
1	6	7	9
2	7	7	6
3	6	7	7
4	6	5	7
5	8	6	6
6	7	7	7
7	6	7	7
8	6	7	7
9	6	7	7
10	6	7	7
11	7	8	6
12	7	8	7
13	5	7	7
14	6	7	8
15	6	7	8
16	6	7	8
17	7	6	7
18	7	8	7
19	4	7	6
20	5	5	8
21	6	8	8
22	8	8	8
23	8	8	6
24	6	5	8
25	5	7	6
26	4	7	6
27	6	7	4
28	7	7	6
29	6	6	8
30	8	7	8
total	188	207	210
average	6.27	6.9	7
S.D.	1.05	0.84	1.02

Appendix A-5: Score of texture in variation percentage of sugar.

NO.	Percentage of sugar contain in product		
	10%	15%	20%
1	5	8	7
2	7	7	6
3	7	7	7
4	5	6	7
5	7	6	7
6	7	8	7
7	4	8	7
8	5	7	6
9	6	7	8
10	6	8	7
11	6	6	8
12	6	8	7
13	6	8	7
14	6	7	8
15	5	7	8
16	8	6	7
17	8	6	7
18	8	8	8
19	4	6	7
20	5	6	7
21	5	5	7
22	8	8	8
23	8	7	7
24	5	7	8
25	6	7	8
26	6	4	4
27	7	8	7
28	7	7	6
29	7	6	8
30	6	5	7
Total	186	204	213
Average	6.2	6.8	7.1
S.D.	1.19	1.06	0.84

Appendix A-6: Score of overall in variation percentage of sugar.

NO.	Percentage of sugar contain in product		
	10%	15%	20%
1	6	8	8
2	8	6	5
3	5	7	7
4	6	5	7
5	7	6	7
6	6	7	7
7	6	8	7
8	6	7	7
9	6	7	8
10	6	8	7
11	5	8	6
12	7	8	7
13	5	8	7
14	6	7	8
15	6	7	8
16	7	7	8
17	7	6	7
18	7	8	7
19	5	7	6
20	5	6	8
21	6	7	8
22	8	8	8
23	8	8	7
24	7	6	8
25	4	6	8
26	6	7	6
27	6	7	4
28	7	7	6
29	7	6	8
30	8	7	8
Total	189	210	213
Average	6.3	7	7.1
S.D.	1.02	0.83	0.99

Appendix A-7: percentage of just-about- right in 20% sugar add in product

	Much too light	Somewhat too light	Just right	Somewhat too dark	Much too dark
Color		2	25	3	
%		6.67	83.33	10	

	Much too tasteless	Somewhat too tasteless	Just right	Somewhat too sweetly	Much too sweetly
Sweetness		7	22	1	
%		23.33	73.33	3.33	

	Much too weak	Somewhat too weak	Just right	Somewhat too strong	Much too strong
Flavor		12	18		
%		40	60		

	Much too coarse	Somewhat too coarse	Just right	Somewhat too fine	Much too fine
Texture			22	7	1
%			73.33	23.33	3.33

Appendix A-8: Score of hedonic test in 20% of sugar add in product.

Attribute	Overall	Color	Sweetness	Flavor	Texture
1	8	8	8	7	8
2	7	8	8	7	6
3	7	8	7	7	8
4	7	7	8	6	7
5	7	7	6	7	7
6	8	9	8	7	8
7	8	7	8	8	7
8	7	8	6	7	7
9	7	8	7	7	8
10	8	8	8	8	7
11	7	8	7	7	7
12	8	8	8	7	8
13	8	7	8	8	8
14	7	8	7	6	7
15	7	8	5	7	7
16	8	7	7	8	8
17	9	9	9	9	8
18	6	8	7	6	7
19	8	8	7	6	8
20	7	8	7	8	7
21	9	9	9	9	9
22	6	6	7	5	6
23	8	7	9	8	7
24	7	9	7	6	8
25	7	7	7	7	7
26	6	9	6	6	7
27	7	8	7	8	7
28	8	8	8	8	9
29	7	7	7	7	7
30	8	8	8	8	7
Average	7.4	7.83	7.37	7.17	7.4
S.D.	0.77	0.75	0.93	0.95	0.72

Appendix A-9: Result L.a.b color measurement of 10% of sugar.

10%	L	a	b
Sheet 1 (1)	29.74	8.71	51.28
(2)	29.81	9.57	51.40
(3)	29.81	9.59	51.40
Sheet2(1)	29.26	9.34	50.45
(2)	29.85	13.10	51.48
(3)	29.21	8.69	50.37
Sheet3(1)	29.83	9.37	51.43
(2)	29.52	9.30	50.91
(3)	29.98	12.33	51.70
Sheet4(1)	29.79	10.05	51.37
(2)	29.16	8.50	50.29
(3)	29.43	8.80	50.76
Sheet5(1)	29.22	7.68	50.38
(2)	29.30	10.28	50.53
(3)	29.50	9.50	50.88
Average	29.56	9.65	50.98
S.D.	0.28	1.41	0.49

Appendix A-10: Result L.a.b color measurement of 15% of sugar.

15%	L	a	b
Sheet 1 (1)	30.37	10.29	52.37
(2)	30.43	11.31	52.47
(3)	30.56	10.63	52.70
Sheet2(1)	31.04	11.46	53.52
(2)	30.52	10.27	52.62
(3)	30.64	12.39	52.84
Sheet3(1)	30.44	12.66	52.49
(2)	30.21	10.46	52.10
(3)	30.43	12.19	52.47
Sheet4(1)	30.81	13.47	53.14
(2)	30.43	10.36	52.48
(3)	30.01	9.73	51.75
Sheet5(1)	30.29	11.75	52.23
(2)	30.39	10.14	52.40
(3)	30.31	9.73	52.27
Average	30.46	11.12	52.52
S.D.	0.24	1.16	0.42

Appendix A-11: Result L.a.b color measurement of 20% of sugar.

20%	L	a	b
Sheet 1 (1)	31.39	17.10	54.13
(2)	30.92	15.48	53.32
(3)	31.08	16.10	53.60
Sheet2(1)	29.94	10.68	51.64
(2)	30.45	12.65	52.51
(3)	29.99	10.34	51.72
Sheet3(1)	31.69	17.49	54.65
(2)	31.07	16.18	53.58
(3)	31.26	16.89	53.91
Sheet4(1)	30.68	13.73	52.91
(2)	30.27	11.38	52.20
(3)	30.26	12.95	52.17
Sheet5(1)	30.16	12.28	52.02
(2)	30.45	12.49	52.51
(3)	30.16	11.15	52.02
Average	30.65	13.79	52.86
S.D.	0.55	2.51	0.95

Appendix A-12: Result L.a.b color measurement of 20% of sugar (Shelf life).

20%(Old)	L	A	B
Sheet 1 (1)	33.68	20.25	58.09
(2)	32.83	18.6	56.62
(3)	32.21	16.86	55.55
Sheet2(1)	32.17	18.73	55.48
(2)	32.38	19.19	55.83
(3)	31.8	18.42	54.83
Sheet3(1)	31.87	16.3	54.96
(2)	31.4	16.79	54.15
(3)	31.23	16.05	53.85
Sheet4(1)	31.21	15.81	53.83
(2)	31.7	17.44	54.67
(3)	32.35	18.8	55.79
Sheet5(1)	31.45	17.21	54.23
(2)	30.76	17	53.05
(3)	31.45	18.35	54.24
Average	31.89933	17.72	55.01133
S.D.	0.735124	1.290747	1.268936

Appendix A-13: Result XYZ color measurement of 10% of sugar.

10%	Y	X	Z
Sheet 1 (1)	8.84	10.12	-15.28
(2)	8.89	10.31	-15.35
(3)	8.89	10.31	-15.35
Sheet2(1)	8.56	9.92	-14.79
(2)	8.91	10.93	-15.40
(3)	8.53	9.79	-14.74
Sheet3(1)	8.90	10.29	-15.37
(2)	8.71	10.08	-15.06
(3)	8.99	10.88	-15.53
Sheet4(1)	8.87	10.38	-15.33
(2)	8.50	9.72	-14.69
(3)	8.66	9.94	-14.97
Sheet5(1)	8.54	9.63	-14.75
(2)	8.58	10.10	-14.84
(3)	8.70	10.10	-15.04
Average	8.74	10.17	-15.10
S.D.	0.17	0.37	0.29

Appendix A-14: Result XYZ color measurement of 15% of sugar.

15%	Y	X	Z
Sheet 1 (1)	9.22	10.79	-15.94
(2)	9.26	11.01	-16.00
(3)	9.34	10.98	-16.14
Sheet2(1)	9.63	11.44	-16.64
(2)	9.31	10.89	-16.09
(3)	9.39	11.33	-16.22
Sheet3(1)	9.27	11.24	-16.01
(2)	9.13	10.72	-15.77
(3)	9.26	11.16	-16.00
Sheet4(1)	9.49	11.63	-16.41
(2)	9.26	10.84	-16.00
(3)	9.01	10.47	-15.56
Sheet5(1)	9.17	10.99	-15.85
(2)	9.24	10.78	-15.95
(3)	9.19	10.66	-15.87
Average	9.28	10.99	-16.03
S.D.	0.15	0.32	0.26

Appendix A-15: Result XYZ color measurement of 20% of sugar.

20%	Y	X	Z
Sheet 1 (1)	9.85	12.67	-17.02
(2)	9.56	12.05	-16.52
(3)	9.66	12.27	-16.69
Sheet2(1)	8.96	10.58	-15.49
(2)	9.27	11.25	-16.02
(3)	8.99	10.55	-15.54
Sheet3(1)	10.04	12.95	-17.35
(2)	9.65	12.28	-16.68
(3)	9.77	12.54	-16.89
Sheet4(1)	9.41	11.59	-16.27
(2)	9.16	10.91	-15.83
(3)	9.16	11.17	-15.82
Sheet5(1)	9.10	10.99	-15.72
(2)	9.27	11.22	-16.02
(3)	9.10	10.80	-15.72
Average	9.40	11.59	-16.24
S.D.	0.34	0.80	0.58

Appendix A-16: Result XYZ color measurement of 20% of sugar (Shelf life).

20%(Old)	Y	X	Z
Sheet 1 (1)	11.34	14.94	-19.61
(2)	10.78	13.99	-18.63
(3)	10.37	13.21	-17.93
Sheet2(1)	10.35	13.52	-17.88
(2)	10.48	13.76	-18.11
(3)	10.11	13.20	-17.47
Sheet3(1)	10.16	12.87	-17.55
(2)	9.86	12.62	-17.04
(3)	9.75	12.37	-16.85
Sheet4(1)	9.74	12.31	-16.84
(2)	10.05	12.95	-17.37
(3)	10.47	13.67	-18.08
Sheet5(1)	9.89	12.73	-17.09
(2)	9.46	12.21	-16.35
(3)	9.89	12.93	-17.09
Average	10.18	13.15	-17.59
S.D.	0.47	0.73	0.82

Appendix B

Appendix B

SPSS Data

Analysis variation percentage of sugar add in product.

Between-Subjects Factors

		N
trt	1.00	30
	2.00	30
	3.00	30

Descriptive Statistics

Dependent Variable: color

trt	Mean	Std. Deviation	N
1.00	6.1667	1.34121	30
2.00	7.1333	1.04166	30
3.00	7.1333	.77608	30
Total	6.8111	1.16015	90

Tests of Between-Subjects Effects

Dependent Variable: color

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	18.689(a)	2	9.344	8.041	.001
Intercept	4175.211	1	4175.211	3592.912	.000
trt	18.689	2	9.344	8.041	.001
Error	101.100	87	1.162		
Total	4295.000	90			
Corrected Total	119.789	89			

a R Squared = .156 (Adjusted R Squared = .137)

Grand Mean

Dependent Variable: color

Mean	Std. Error	95% Confidence Interval	
		Lower Bound	Upper Bound
6.811	.114	6.585	7.037

Multiple Comparisons

Dependent Variable: color

	(I) trt	(J) trt	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	1.00	2.00	-.9667(*)	.27834	.001	-1.5199	-.4134
		3.00	-.9667(*)	.27834	.001	-1.5199	-.4134
	2.00	1.00	.9667(*)	.27834	.001	.4134	1.5199
		3.00	.0000	.27834	1.000	-.5532	.5532
	3.00	1.00	.9667(*)	.27834	.001	.4134	1.5199
		2.00	.0000	.27834	1.000	-.5532	.5532

Based on observed means.
* The mean difference is significant at the .05 level.

color

	trt	N	Subset 1	Subset 2
Duncan(a,b)	1.00	30	6.1667	
	2.00	30		7.1333
	3.00	30		7.1333
	Sig.		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) = 1.162.
a Uses Harmonic Mean Sample Size = 30.000.
b Alpha = .05.

Between-Subjects Factors

		N
trt	1.00	30
	2.00	30
	3.00	30

Descriptive Statistics

Dependent Variable: sweetness

trt	Mean	Std. Deviation	N
1.00	6.5000	1.19626	30
2.00	6.9000	.75886	30
3.00	7.0333	1.06620	30
Total	6.8111	1.03744	90

Tests of Between-Subjects Effects

Dependent Variable: sweetness

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4.622(a)	2	2.311	2.205	.116
Intercept	4175.211	1	4175.211	3984.388	.000
trt	4.622	2	2.311	2.205	.116
Error	91.167	87	1.048		
Total	4271.000	90			
Corrected Total	95.789	89			

a R Squared = .048 (Adjusted R Squared = .026)

Grand Mean

Dependent Variable: sweetness

Mean	Std. Error	95% Confidence Interval	
		Lower Bound	Upper Bound
6.811	.108	6.597	7.026

Multiple Comparisons

Dependent Variable: sweetness

	(I) trt	(J) trt	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	1.00	2.00	-.4000	.26431	.134	-.9253	.1253
		3.00	-.5333(*)	.26431	.047	-1.0587	-.0080
	2.00	1.00	.4000	.26431	.134	-.1253	.9253
		3.00	-.1333	.26431	.615	-.6587	.3920
	3.00	1.00	.5333(*)	.26431	.047	.0080	1.0587
		2.00	.1333	.26431	.615	-.3920	.6587

Based on observed means.

* The mean difference is significant at the .05 level.

sweetness

	trt	N	Subset 1
Duncan(a,b)	1.00	30	6.5000
	2.00	30	6.9000
	3.00	30	7.0333
	Sig.		.059

Means for groups in homogeneous subsets are displayed.

Based on Type III Sum of Squares

The error term is Mean Square(Error) = 1.048.

a Uses Harmonic Mean Sample Size = 30.000.

b Alpha = .05.

Between-Subjects Factors

		N
trt	1.00	30
	2.00	30
	3.00	30

Descriptive Statistics

Dependent Variable: texture

trt	Mean	Std. Deviation	N
1.00	6.2000	1.18613	30
2.00	6.8000	1.06350	30
3.00	7.1000	.84486	30
Total	6.7000	1.09596	90

Tests of Between-Subjects Effects

Dependent Variable: texture

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	12.600(a)	2	6.300	5.812	.004
Intercept	4040.100	1	4040.100	3727.346	.000
trt	12.600	2	6.300	5.812	.004
Error	94.300	87	1.084		
Total	4147.000	90			
Corrected Total	106.900	89			

a R Squared = .118 (Adjusted R Squared = .098)

Grand Mean

Dependent Variable: texture

Mean	Std. Error	95% Confidence Interval	
		Lower Bound	Upper Bound
6.700	.110	6.482	6.918

Multiple Comparisons

Dependent Variable: texture

	(I) trt	(J) trt	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	1.00	2.00	-.6000(*)	.26881	.028	-1.1343	-.0657
		3.00	-.9000(*)	.26881	.001	-1.4343	-.3657
	2.00	1.00	.6000(*)	.26881	.028	.0657	1.1343
		3.00	-.3000	.26881	.267	-.8343	.2343
	3.00	1.00	.9000(*)	.26881	.001	.3657	1.4343
		2.00	.3000	.26881	.267	-.2343	.8343

Based on observed means.
* The mean difference is significant at the .05 level.

texture

	trt	N	Subset 1	Subset 2
Duncan(a,b)	1.00	30	6.2000	
	2.00	30		6.8000
	3.00	30		7.1000
	Sig.		1.000	.267

Means for groups in homogeneous subsets are displayed.
Based on Type III Sum of Squares
The error term is Mean Square(Error) = 1.084.
a Uses Harmonic Mean Sample Size = 30.000.
b Alpha = .05.

Between-Subjects Factors

		N
trt	1.00	30
	2.00	30
	3.00	30

Descriptive Statistics

Dependent Variable: flavor

trt	Mean	Std. Deviation	N
1.00	6.2667	1.04826	30
2.00	6.9000	.84486	30
3.00	7.0000	1.01710	30
Total	6.7222	1.01702	90

Tests of Between-Subjects Effects

Dependent Variable: flavor

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	9.489(a)	2	4.744	4.999	.009
Intercept	4066.944	1	4066.944	4285.315	.000
trt	9.489	2	4.744	4.999	.009
Error	82.567	87	.949		
Total	4159.000	90			
Corrected Total	92.056	89			

a R Squared = .103 (Adjusted R Squared = .082)

Grand Mean

Dependent Variable: flavor

Mean	Std. Error	95% Confidence Interval	
		Lower Bound	Upper Bound
6.722	.103	6.518	6.926

Multiple Comparisons

Dependent Variable: flavor

	(I) trt	(J) trt	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	1.00	2.00	-.6333(*)	.25153	.014	-1.1333	-.1334
		3.00	-.7333(*)	.25153	.005	-1.2333	-.2334
	2.00	1.00	.6333(*)	.25153	.014	.1334	1.1333
		3.00	-.1000	.25153	.692	-.6000	.4000
	3.00	1.00	.7333(*)	.25153	.005	.2334	1.2333
		2.00	.1000	.25153	.692	-.4000	.6000

Based on observed means.

* The mean difference is significant at the .05 level.

flavor

	trt	N	Subset	
			1	2
Duncan(a,b)	1.00	30	6.2667	
	2.00	30		6.9000
	3.00	30		7.0000
	Sig.		1.000	.692

Means for groups in homogeneous subsets are displayed.

Based on Type III Sum of Squares

The error term is Mean Square(Error) = .949.

a Uses Harmonic Mean Sample Size = 30.000.

b Alpha = .05.

Between-Subjects Factors

		N
trt	1.00	30
	2.00	30
	3.00	30

Descriptive Statistics

Dependent Variable: overall

trt	Mean	Std. Deviation	N
1.00	6.3000	1.02217	30
2.00	7.0000	.83045	30
3.00	7.1000	.99481	30
Total	6.8000	1.00783	90

Tests of Between-Subjects Effects

Dependent Variable: overall

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	11.400(a)	2	5.700	6.277	.003
Intercept	4161.600	1	4161.600	4583.028	.000
trt	11.400	2	5.700	6.277	.003
Error	79.000	87	.908		
Total	4252.000	90			
Corrected Total	90.400	89			

a R Squared = .126 (Adjusted R Squared = .106)

Grand Mean

Dependent Variable: overall

Mean	Std. Error	95% Confidence Interval	
		Lower Bound	Upper Bound
6.800	.100	6.600	7.000

Multiple Comparisons

Dependent Variable: overall

	(I) trt	(J) trt	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	1.00	2.00	-.7000(*)	.24604	.006	-1.1890	-.2110
		3.00	-.8000(*)	.24604	.002	-1.2890	-.3110
	2.00	1.00	.7000(*)	.24604	.006	.2110	1.1890
		3.00	-.1000	.24604	.685	-.5890	.3890
	3.00	1.00	.8000(*)	.24604	.002	.3110	1.2890
		2.00	.1000	.24604	.685	-.3890	.5890

Based on observed means.
* The mean difference is significant at the .05 level.

overall

	trt	N	Subset 1	Subset 2
Duncan(a,b)	1.00	30	6.3000	
	2.00	30		7.0000
	3.00	30		7.1000
	Sig.		1.000	.685

Means for groups in homogeneous subsets are displayed.
Based on Type III Sum of Squares
The error term is Mean Square(Error) = .908.
a Uses Harmonic Mean Sample Size = 30.000.
b Alpha = .05.

Appendix C

Appendix C

Questionnaire

Appendix C-1

Questionnaire

Japanese pumpkin & black plum sheet

Name. _____ Date. _____

Instructions

- You have received 3 samples labeled with 3-digit number.
- Taste sample from left to right.
- Rinse with water between each sample as needed to clear your palate.
- Write "1" in the box of the sample which you find "most overall liking", write "2" for the next and "3" for "least overall liking".
- If two samples appear the same, make the "best guess" as to their rank order.

Code			
Rank Order			

Comment :

_____

_____

_____

_____

_____

Thank You

Appendix C-2

Japanese pumpkin and black plum sheet

Name: Date:

Instructions:

1. Please rinse your mouth with water before starting. You may rinse again at anytime during the test you need to.
2. please taste the three samples in the ordered presented, from the left to the right. Then evaluate hedonic scale in each attribute of sample by using the following numbers:

1 = dislike extremely	6 = like slightly
2 = dislike very much	7 = like moderately
3 = dislike moderately	8 = like very much
4 = dislike slightly	9 = like extremely
5 = neither like nor dislike	

Attribute			
Color			
Sweetness			
Flavor			
Overall			

Comment:.....

.....

Appendix C-3 Hedonic Test and Just About Right Test

Product: Japanese pumpkin and black plum sheet
Name:
Date:

Instruction:

3. Please rinse your mouth with water before starting. You may rinse again at anytime during the test you need to.
4. Please rate whether the level of a sensory attribute of the sample is "too high", "just right" or "too low" and rate the sample from most preferred to least preferred using the following number:

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

Hedonic Rating

1. Overall liking _____

Taste

2. Color _____

Much too light	Somewhat too light	Just right	Somewhat too dark	Much too dark

3. Sweetness _____

Much too tasteless	Somewhat too tasteless	Just right	Somewhat too sweetly	Much too sweetly

4. flavor _____

Much too weak	Somewhat too weak	Just right	Somewhat too strong	Much too strong

5. Texture _____

Much too coarse	Somewhat too coarse	Just right	Somewhat too fine	Much too fine

Appendix C-4 แบบสอบถาม

การสำรวจพฤติกรรม ทัศนคติ และความต้องการผลิตภัณฑ์

ฝักทองผสมลูกไหน(พลัม)แผ่น (Japanese pumpkin-Black pump sheet)

<u>คำชี้แจง</u> กรุณาเติมเครื่องหมาย (√) ใน ☐ ที่ท่านคิดว่าเหมาะสมและตรงกับความคิดเห็นของท่านมากที่สุด

1) เพศ

☐ ชาย ☐ หญิง

2) อายุ

☐ ต่ำกว่า 15 ปี ☐ 16 – 25 ปี

☐ 26 – 35 ปี ☐ 36 – 45 ปี

☐ 46 – 55 ปี ☐ มากกว่า 55 ปี ขึ้นไป

3) การศึกษาปัจจุบัน

☐ ต่ำกว่ามัธยมศึกษา ☐ มัธยมศึกษา หรือ เทียบเท่า

☐ อนุปริญญา หรือ เทียบเท่า ☐ ปริญญาตรี

☐ สูงกว่าปริญญาตรี

4) อาชีพ

☐ นักเรียน / นักศึกษา ☐ ข้าราชการ / รัฐวิสาหกิจ

☐ ธุรกิจส่วนตัว ☐ พนักงานบริษัทเอกชน

☐ อื่นๆ โปรดระบุ _____

5) รายได้ต่อเดือน

☐ น้อยกว่า 5,000 บาท ☐ 5,001 – 10,000 บาท

☐ 10,001 – 15,000 บาท ☐ 15,001 – 20ม000 บาท

☐ มากกว่า 20,000 บาท

6) คุณเคยทานผลไม้แผ่นหรือไม่

☐ เคย ☐ ไม่เคย

7) คุณเคยซื้อผลไม้แผ่นจากที่ใดบ้าง (เลือกได้มากกว่า 1 ข้อ)

☐ ตลาดสด ☐ แผงลอย ☐ ร้านสะดวกซื้อ

☐ ซุปเปอร์มาเก็ต ☐ ห้างสรรพสินค้า ☐ อื่นๆโปรดระบุ_____

8) คุณรับประทานผลไม้แผ่นบ่อยแค่ไหน

☐ ทุกวัน ☐ 3 – 4 ครั้ง / สัปดาห์ ☐ 1 ครั้ง / สัปดาห์

☐ 3 – 4 ครั้ง / เดือน ☐ 1 ครั้ง / เดือน

9) คุณคิดว่าผลไม้แผ่น 1 กล่อง (30 ชิ้น) ควรมีราคาประมาณเท่าไหร่

☐ 5 – 10 บาท ☐ 11 – 15 บาท ☐ 16 – 20 บาท

☐ 21 – 25 บาท ☐ มากกว่า 25 บาท

10) คุณชอบทานผลไม้แผ่นแบบใด

☐ แบบแผ่น (เหนียว) ☐ แบบแผ่นค่อนข้างแห้ง(ไม่เหนียว)

☐ อื่นๆ โปรดระบุ _____

11) คุณรู้จักฟักทองญี่ปุ่น หรือไม่

☐ รู้จัก ☐ ไม่รู้จัก

12) คุณรู้จักลูกไหน(พลัม) หรือไม่

☐ รู้จัก ☐ ไม่รู้จัก

13) หากมีผลไม้แผ่นในรสชาติของฟักทองผสมลูกไหน(พลัม)ท่านจะสนใจหรือไม่

☐ สนใจ เพราะ _____

☐ ไม่สนใจ เพราะ _____

15) หลังจากรับประทานฟักทองผสมลูกไหน(พลัม)แผ่นแล้วคุณคิดว่า คุณให้ความชอบต่อคุณลักษณะใดของผลิตภัณฑ์ต่อไปนี้

กรุณาเติมเครื่องหมาย(√) ใน ☐ ที่ท่านคิดว่าเหมาะสม (กรุณาตอบครบทุกข้อและสามารถให้คะแนนซ้ำกันได้) โดย

1 = ไม่ชอบมากที่สุด 6 = ชอบนิดหน่อย

2 = ไม่ชอบมาก 7 = ชอบปานกลาง

3 = ไม่ชอบปานกลาง 8 = ชอบมาก

4 = ไม่ชอบนิดหน่อย 9 = ชอบมากที่สุด

5 =

คุณลักษณะ	1	2	3	4	5	6	7	8	9
รสชาด									
กลิ่น									
ลักษณะที่ปรากฏภายนอก (เช่น สี ขนาดหรือรูปร่าง)									
คุณค่าทางโภชนาการ									
ความแปลกใหม่									

16) คุณชอบผลิตภัณฑ์นี้หรือไม่ เพราะเหตุใด

☐ ชอบ เพราะ _____

☐ ไม่ชอบ เพราะ _____

17) คุณคิดว่าขนาดของผลิตภัณฑ์ชิ้นนี้เหมาะสมหรือไม่

☐ เล็กเกินไป ☐ พอดี

☐ ใหญ่เกินไป ☐ อื่นๆ โปรดระบุ _____

19) คุณคิดว่า ฟักทองผสมลูกไหน(พลัม)แผ่น (Japanese pumpkin-black plum fruit sheet) ควรตั้งราคาประมาณเท่าไหร่ ต่อ 1 กล่อง (30 ชิ้นต่อ 1 กล่อง)

☐ 5 – 10 บาท ☐ 11 – 15 บาท

☐ 16 – 20 บาท ☐ อื่นๆ โปรดระบุ _____

20) หากมี ฟักทองผสมลูกไหนแผ่น วางขายในตลาด ท่านจะสนใจทดลอง หรือไม่ เพราะเหตุใด

☐ สนใจ เพราะ _____

☐ ไม่สนใจ เพราะ _____

0846562666