
# DEVELOPMENT OF MATCHA SOYMILK USING STEVIA EXTRACT AS SWEETENER

By

JIDAPA KULSAWADPAKDEE
ID 5510973

A Special project submitted to
School of Biotechnology, Assumption University
In partial fulfill of the requirements of the Degree of
Bachelor of Science in Biotechnology
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**TITLE:** Development of matcha soymilk using stevia extract as sweetener

**BY:** Ms. Jidapa Kulsawadpakdee

**ADVISOR:** A. Roungdao Klinjapo

**LEVEL OF STUDY:** Bachelor Degree of Food Science

**DEPARTMENT:** Food technology

**FACULTY:** Biotechnology

**ACADEMIC YEAR:** 2016

(A. Roungdao Klinjapo)

Advisor

# ACKNOWLEDGEMENT

The success and final outcome of this project required a lot of guidance and assistance from many people and I am extremely fortunate to have got this all along the completion of my thesis work. Whatever I have done is only due to such guidance and assistance and I would not forget to thank them

I would like to express my sincere thanks to my thesis advisor, A. Roungdao Klinjapo for her invaluable help and constant encouragement throughout the courses of this project. I am most grateful for her teaching and advice. I would not have achieved this far and this thesis would not have been completed without all the support that I have always received from her.

In addition, I am grateful for the lecturers of school of biotechnology, Assumption University. A. Nootrudee S.,Asst.prof.Dr.Wunwisa Krasaekoopt , and others person for suggestions and all their recommendations and supports. Also, I would like to offer my specially thank to school of biotechnology alumni for helps and supports during this entire project

Finally, I most gratefully acknowledge my parents and my friends for their encouragements and financial support which enable me to complete this thesis.

Ms. Jidapa Kulsawadpakdee

ID: 5510973

**Name:** Ms. Jidapa K. **ID:** 5510973

**Date:** 26 July 2016

**Topic:** Development of Matcha soymilk using Stevia extract as sweetener

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## ABSTRACT

To develop Match soymilk, soy milk was prepared by soaking soybeans with hot water at 80°C for 2 hours, and then soaked with 0.5% $NaHCO_3$ for 15 minutes to reduce beany flavor. Soaked soybeans were blended with hot water at 80°C for 3 minutes at the ratio 1:3. Soymilk was filtered and pasteurized for 15 minutes at 95-98°C. Soymilk was added sugar at 5% (w/v) before varied Matcha powder at 1.1, 1.5, and 1.9% (w/v). Sensory evaluation results showed the highest preference score at 6.63 ± 1.4 for Matcha powder 1.1%. After the evaluation of JAR test, Matcha soymilk was varied the amount of Match powder to 1.2, 1.3, and 1.4% (w/v). The sensory evaluation showed the highest preference score at 6.53 ± 1.1 for 1.4% Matcha powder. Stevia extract was added into Matcha soymilk to reduce the use of sugar. Stevia extract was varied at 0.3, 0.6, and 0.9 (w/v) and the results showed that the best score was 6.97 ± 0.66 for 0.9% stevia extract. Thus, the formula of Matcha soymilk was soymilk 97.7%, Matcha powder 1.4%, and stevia extract 0.9%. Consumer acceptance test showed the 87% of consumer accept Matcha soymilk with price of 20-25 Baht for 59%. The evaluation scores of color, Match aroma, Matcha taste, soymilk flavor, and overall liking were 7.20 ± 0.74, 6.71 ± 0.72, 6.75 ± 0.90, 6.61 ± 1.00, and 6.74 ± 0.87, respectively.

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# INTRODUCTION

Nowadays, the most commonly consumed beverage is green tea and in particular, it has many health benefits. Due to regular green tea has unique aroma and its special taste, the production of green tea is developed as Matcha latte or Matcha milk and this beverage become a popular drink in all gender and ages. In addition, recently, most of people concern about their health and they focus on the product that provide more energy and benefits but less in calories, fat, and sweetness. In particular, normal green tea-flavored milk contains fats from milk and sugar adding for preferable flavored and taste. As the popularity of green tea-flavored milk, the demand from vegetarians and consumers with lactose intolerant disorder increased and they request for non-dairy green tea beverage.

Soymilk is one of the soybean products that vegetarian and lactose intolerant patient can drink. The traditional soymilk is a simple water extract of soaked soybeans and has excellent nutritional value comparable to cow's milk. Interest of food technologists and nutritionists in soymilk has been due not only to the economical and nutritional value of the product but also to the use of soymilk for infants allergic to cow's milk. Accordingly, many improvements were made in the methods of preparation to develop the problem of an undesirable flavor, often described as beany, green or painty, limits the acceptability of soymilk, especially to the population that is not accustomed to soymilk. Therefore, the aim of this study is applied Matcha green tea with the soymilk and used Stevia extract as sweetener instead of sugar.

# OBJECTIVES

1. To find the suitable process to get rid of soy flavor in soymilk
2. To formulate the basic formula of Matcha soymilk
3. To develop formula of Matcha soymilk
4. To study the effect of stevia extract on the sensory of Matcha soymilk
5. To investigate the consumer acceptance

# LITERATURE REVIEW

## I. TEA

Tea (*Camellia sinensis* (L.) O.Kuntze) is one of the most popular beverages worldwide due to its taste, aroma, and health effects (Khokhar and Magnusdottir, 2002). It is the second most consumed beverage in the world, well ahead of coffee, beer, wine, and carbonated soft drinks. Tea is originated from China and it has gained the world's taste in the past 2000 years. The economic and social interest of tea is clear and its consumption is part of many people daily routine, as an everyday drink and as a therapeutic aid in many illnesses. Depending on the manufacturing process, teas are classified into three major types that are non-fermented green tea, semi-fermented' oolong tea, 'fermented' black and red (Pu-Erh) teas. Green tea is produced by drying and steaming the fresh leaves to inactivate the polyphenol oxidase and thus, non-oxidation occurs. Oolong tea is produced when the fresh leaves are subjected to a partial fermentation stage before drying, and black and red teas undergo a post-harvest fermentation stage before drying and steaming, although the fermentation of black tea is due to an oxidation catalyzed by polyphenol oxidase, and that of Pu-Erh tea is attained by using microorganisms.

Young shoots of tea bushes are mainly processed into black tea, green tea, and oolong tea. Although health benefits have been attributed to green tea consumption since the beginning of its history, scientific investigations on this beverage and its constituents have been underway for less than three decades. Recently reported pharmacological properties, e.g., antioxidant, anti-inflammatory, anti-mutagenic, and anti-carcinogenic effects also served to increase the popularity of green tea (Higdon and Frei, 2003; Cabrera et al., 2006; Pharn-Huy et al., 2008; Yuan et al., 2011). In addition, several studies suggest a beneficial impact of green tea intake on bone density, cognitive function, dental caries and kidney stones, among other effects.

## II. GREEN TEA

Green tea is a popular beverage, derived from the tea plant. Its peculiar green color results from the inactivation of polyphenol oxidase by treating fresh tea leaves with hot steam and air. The production of green tea is characterized by an initial heating process, which kills

the enzyme polyphenol oxidase, which is responsible for the conversion of the flavanols in the leaf into the dark polyphenolic compounds that color black tea. The other important process is rolling, in which leaves are cut and twisted. The final form of green tea depends on the particular variant being produced. The rolling stage is very similar to the operation with the same name in black tea production. Green tea production is restricted mainly to China and Japan. Figure 1 shows the principal differences between green and black tea processing.

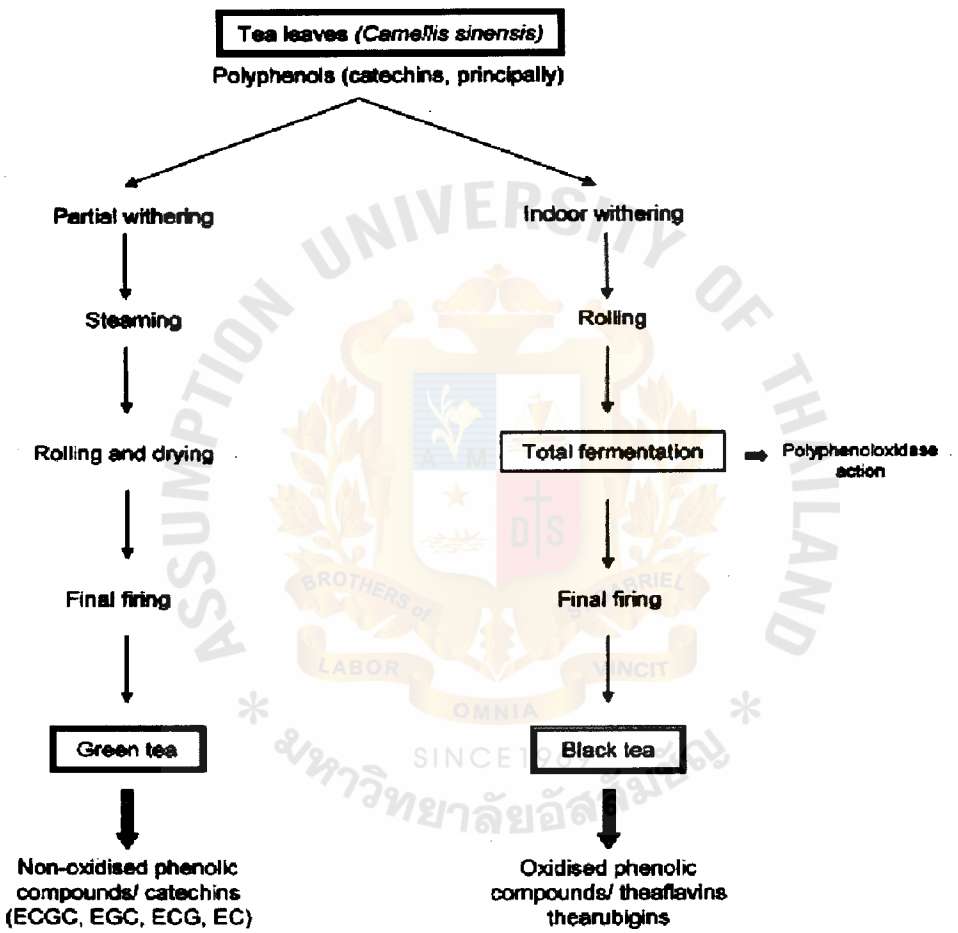


**Figure 1:** Principal differences between green and black tea processing (Cabrera *et al.*, 2006)

## 2.1 Green Tea Composition

Green tea chemical composition is complex: proteins (15– 20% dry weight) whose enzymes constitute an important fraction; amino acids (1–4% dry weight), carbohydrates (5–7% dry weight), lipids, sterols, vitamins (B, C, E), pigments, volatile compounds, minerals

and trace elements (5% dry weight). Due to the great importance of the mineral presence in tea, many studies have been carried out to determine their levels in green tea leaves and their infusions. Polyphenols constitute the most interesting group of green tea leaf components, and in consequence, green tea can be considered an important dietary source of polyphenols, particularly flavonoids. Flavonoids are phenol derivatives synthesized in substantial amounts (0.5–1.5%) and variety (more than 4000 identified), and widely distributed among plants.

The main flavonoids present in green tea include catechins (flavan-3-ols). The four major catechins are epigallocatechin-3-gallate (EGCG) 59% of the total of catechins, epigallocatechin (EGC) 19%, epicatechin-3-gallate (ECG) 13.6%, and epicatechin (EC) 6.4%. Green tea also contains gallic acid (GA) and other phenolic acids such as chlorogenic acid and caffeic acid, and flavonols. The relative catechin content of green tea depends on how the leaves are processed before drying and heating of tea leaves during the manufacturing process can result in polymerization of monopolyphenolic compounds such as the catechins, leading to changes and thus modifying its properties. Other factors influencing catechin content are the geographical location and growing conditions (soil, climate, agricultural practices, and fertilizers), the type of green tea (e.g., blended, decaffeinated, instant, etc.), and the preparation of the infusion (e.g., amount of the product used, brew time, temperature).

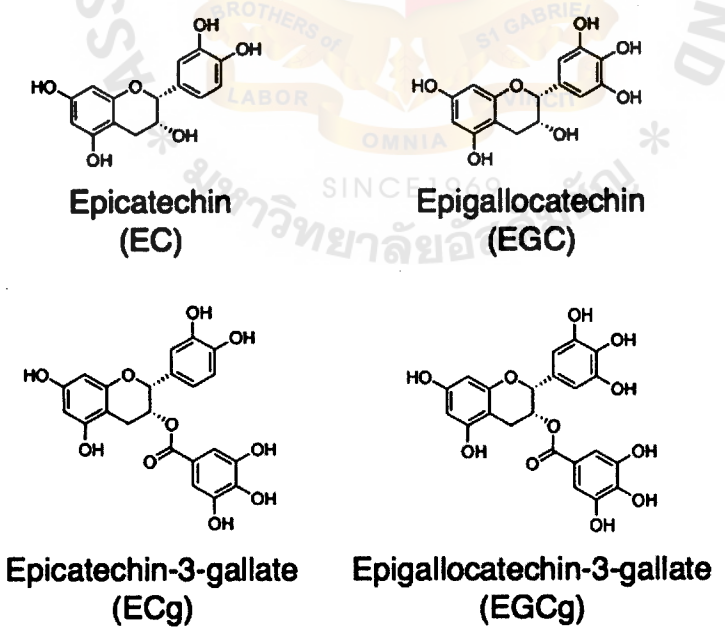


**Figure 2:** Chemical structures of green tea catechins

***Source:*** *https://www.spandidos-publications.com/article_images/etm/8/1/ETM-08-01-0059-g00.jpg*

## 2.2 Matcha green tea

Matcha is premium green tea powder from Japan used for drinking as tea or as an ingredient in recipes. While other green teas are grown throughout the world, Matcha is unique to Japan. Matcha has been used in Zen Buddhist ceremonies for over 800 years. The Buddhist monks honored Matcha tea as the 'health elixir' for its potential to heighten the concentration and enhance the metabolism. In Japan, a nation where green tea is served with every meal and available in every restaurant, Matcha is considered the highest quality and most flavorful of all green teas. It can be instantly recognized by its distinctive, brilliant green hue. It has also become a popular additive in the production of beverages, chocolates, candies, cakes, pastries, cookies, puddings, ice creams, etc. (Tokunaga, 2004).

Matcha is renowned for numerous health benefits. It is rich in nutrients, antioxidants, fiber and chlorophyll. The health benefits of Matcha exceed those of other green teas because Matcha drinkers ingest the whole leaf, not just the brewed water. One glass of Matcha is the equivalent of 10 glasses of green tea in terms of nutritional value and antioxidant content. Table 1 is showed the list of some nutrients found in Matcha green tea.

**Table 1:** Nutrients in 1 gram of Matcha powder

| Nutrients | Content/ 1 g |
|---|---|
| Total catechins | 105 mg |
| EGCg | 61 mg |
| Total amino acids | 34 mg |
| L-theanine | 14.26 mg |
| Caffeine | 35 mg |
| Fiber | 318 mg |
| Carbohydrates | 447 mg |
| Vitamin C | 1.75 mg |
| Vitamin A | 291 units |
| Potassium | 26.6 mg |

Matcha and Green Tea bag Nutritional Comparison

| | Green Tea Bag | Ceremonial Matcha | Comparison |
|---|---|---|---|
| Catechines | 188.8mg | 242mg | x1.3 |
| L-Theanine(Amino Acid) | 9mg | 39mg | x4.3 |
| Protein | 3.35mg | 578mg | x172.5 |
| Total Fiber | less than 0.01g | 0.662g | x66 |
| Calcium | 0.05mg | 6.5mg | x130 |
| Iron | less than 0.01mg | 0.34mg | x34 |
| Caffeine | 31.8mg | 68mg | x2.1 |
| Potassium | 0.45mg | 42.3mg | x94 |
| Vitamin C | 0.1mg | 3.2mg | x32 |

*Comparing one serving of Tea Bag Sencha and Matcha*
- *3g Sencha Tea bag with 240ml (8oz) hot water*
- *2g Matcha with 3oz hot water*

*Source:*
*Standard Tables of Food Composition: Japan Forth and Fifth Revised and Expanded Edition*
*Aiya America Nutritional Analysis: Ceremonial Matcha*
*(Eco Pro research, Brunswick Lab, Covance Lab)*

**Figure 3:** Comparison between Matcha and green tea bag nutrition

Matcha contains L-theanine, an amino acid known to relax the mind. For this reason, Matcha is also known as a mood enhancer. Buddhist monks drank Matcha to assist in meditation, as Matcha's amino acids, combined with caffeine, offer a sustained calm alertness over time. Amino acids are also what gives Matcha is distinctive taste. They contribute to what is known as the fifth taste, or umami, characterized by a rich creamy mouth feel.

Several weeks prior to harvest in the spring, farmers cover the tea plants with bamboo mats or tarp, gradually reducing the amount of sunlight that reaches the plants. This step increases the chlorophyll content and turns the leaves dark green, giving Matcha its distinct green color. Harvesting of Matcha is done by hand to ensure selection of youngest and smallest leaves for the finest quality tea. After harvesting, the leaves are steamed and then air dried. Next, the leaves are sorted for grade, and then destemmed and deveined. Matcha is prepared from a high-quality shade-grown leaf known as tencha, the precursor to Matcha. The tencha is then ground and becomes Matcha.

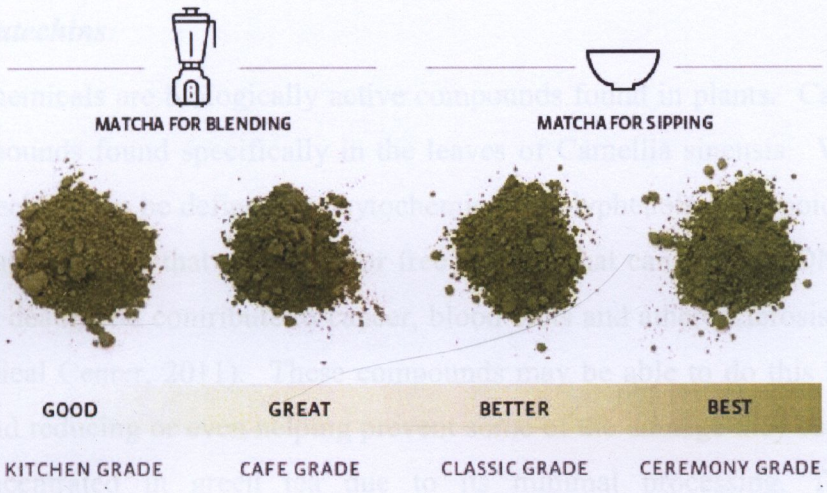


**Figure 4:** Various grades of Matcha

***Source:*** *http://Matchasource.com/wp-content/uploads/2014/10/grades_of_Matcha1.jpg*

Tea grade Matcha is ground on a stone mill to achieve a fine powder texture, unlike industrial grade Matcha which is ground by ultra-fine milling machine. The stone grinding produces a specially shaped powder molecule which impacts the taste and mouth feel of the Matcha. All grades of Matcha Source tea are stone ground. Matcha teas made from young leaves at the top of the plant create fresh grassy sweet tasting bowls of tea. More mature leaves are used for blending, or ingredient grades. These are not as finely de-stemmed and usually have a more astringent flavor profile. After being prized in Japan for scores of years, recently Matcha has been gaining recognition in the western world attributing to its unique flavor and remarkable therapeutic qualities.

## 2.3 Green tea important composition and their health benefits

Green tea has been considered a medicine and a healthful beverage since ancient times. The traditional Chinese medicine has recommended this plant for headaches, body aches and pains, digestion, depression, detoxification, as an energizer and, in general, to prolong life. Green tea leaves contain three main components which act upon human health: xanthic bases (caffeine and theophylline), essential oils and especially, polyphenolic compounds.

### 2.3.1 *Catechins*

Phytochemicals are biologically active compounds found in plants. Catechins are the bioactive compounds found specifically in the leaves of Camellia sinensis. With increasing specificity, catechins can be defined as phytochemicals, polyphenols, flavonoids, and tannins. Catechins are antioxidants that scavenge for free radicals that can damage DNA, change the cell, cause cell death, and contribute to cancer, blood clots and atherosclerosis (University of Maryland Medical Center, 2011). These compounds may be able to do this by neutralizing free radicals and reducing or even helping prevent some of the damage they cause. Catechins are more concentrated in green tea due to its minimal processing. They make up approximately 30% to 40% of the dry weight of green tea leaves (Molinari et al., 2006).

Consumption of catechins has been associated with a variety of beneficial effects including increased plasma antioxidant activity (ability of plasma to scavenge free radicals), brachial artery dilation (blood vessel expansion), fat oxidation, and resistance of LDL to oxidation.

### 2.3.2 *Caffeine*

Caffeine is another important compound found in green tea. It acts mainly upon the central nervous system, stimulating wakefulness, facilitating ideas association and decreasing the sensation of fatigue. Some of the effects caused by caffeine are influenced by theophylline tea content. Theophylline induces psychoactive activity, it also has a slightly inotrope and vasodilator effect, and a much higher diuretic effect than caffeine. However, its most interesting effects can be seen at the bronchopulmonar and respiratory level.

### 2.3.3 *L-Theanine*

L-theanine is also known as Suntheanine. It is an amino acid that is naturally occurring in different types of teas. It is actually found almost exclusively in green tea (Bryan, 2007). L- theanine has been associated with effecting the central nervous system and neurotransmitters. Studies on animals and L theanine have been known to increase levels of dopamine. L- theanine actually has been associated to having the inverse effects of caffeine, such as lowering blood pressure, lowering anxiety, and increasing relaxation. Janet Bryan suggests that based on several studies, a combination of both caffeine and L-theanine (which can be found in green tea) at low doses interact to produce a better ability to focus attention,

while improving speed and accuracy (Bryan, 2007). For this reason, a tea based energy drink is vital for "natural" energy, due to these health benefits when compared to the artificial stimulation associated with caffeine from coffee and other artificial energy beverages.

## 2.4 Health effect of green tea

### 2.4.1 *Stronger immune system*

Matcha contains various antioxidants, polyphenols, EGCG, L-theanine which collectively contribute in boosting the immune defense of the body and helps provide protection against various antigens.

### 2.4.2 *Antioxidant power*

Matcha stores a wealth of natural antioxidants and polyphenols. The antioxidant power of Matcha tea has revealed that as compared to other green teas Matcha has the highest amount of epigallocatechin gallate (EGCG), an extremely healthful component with numerous benefits. These antioxidants seek out for the oxygen free radicals and neutralize their harmful effects thereby, protecting the body from the occurrence of disorders or inflammations associated with the oxidative stress.

### 2.3.3 *Type-2 diabetes*

Matcha tea may prove valuable for maintaining healthy metabolism in diabetic individuals. Antioxidant rich Matcha tea aids in reducing the levels of triglycerides, total cholesterol and hepatic glucose content in the diabetic individuals. An investigative research conducted on diabetic subjects administered with Matcha tea has shown that Matcha exerts inhibitory action against the renal and hepatic damage by restraining the accumulation of advanced glycation end products in the kidneys.

### 2.3.4 Cardiovascular health

Another valuable action exerted by epigallocatechin gallate (EGCG) present in match is the maintenance of cardiovascular health. Richness of this component in Matcha tea makes it a potent potion to keep cholesterol levels low. A research study has suggested that EGCG helps in reducing the accumulation of lipids and promotes autophagy in the vascular endothelial cells.

**2.3.5 *Energy enhancer***

Matcha contains a healthy form of caffeine not to be mistaken with the one present in the regular coffee. This unique form caffeine known as theophylline sustains the energy levels without any adverse effects. The slow release of energy due to theophylline helps in supporting the functionality of adrenal glands and maintains optimum hormonal levels.

**2.3.6 *Detoxication***

Chlorophyll present in Matcha tea accentuates its effectiveness in cleansing process of the body. Chlorophyll is an excellent detoxifier which helps in cleansing the blood. It aids in maintaining the alkalinity of blood and tissues. Chlorophyll also helps in preventing the association of harmful toxins with colon walls and flushes them out of the body.

**2.3.7 *Mental alertness and calming effect***

Matcha tea works wonderfully well in providing a calming effect to the body. L-theanine, a unique amino acid present in Matcha green tea possesses anti-anxiolytic properties and which assists in boosting alpha waves in the brain. These alpha waves encourage relaxation and induce a profound feeling of mental clarity and more alert state of mind just as is imparted by the yoga techniques. A study conducted on theanine suggests that theanine acts as neurotransmitter which exerts calming effect on the brain without causing any drowsiness. This soothing effect provided by Matcha helped the Buddhist monks in maintaining deep concentration during their meditation sessions and was the main reason behind its popularity.

**2.3.8 *Protection from infections***

As stated above, Matcha tea contains epigallocatechin gallate (EGCG) which is also effective in fighting against various bacterial, viral and fungal infections. An investigative research has suggested that EGCG binds to the lipid membrane and exerts inhibitory action against growth of various important human pathogens including influenza A virus, hepatitis B and C virus, herpes virus, adenovirus Staphylococcus aureus bacteria and Candida albicans yeast.

### 2.3.9 *Protection against HIV*

Epigallocatechin present in Matcha is also efficient in the prevention of HIV. Along with this, consumption of Matcha tea may also help in protecting the brain of HIV patients. This defensive act attributes to the penetration power of epigallocatechin through the blood brain barriers which is not feasible for the commercially available anti-retroviral drugs.

### 2.3.10 *Gastrointestinal health*

Match tea is useful for treating gastrointestinal disorders. A research study conducted in this field has revealed that consumption of Matcha stimulates the fecal excretion and helps the body to get rid of harmful chemicals and toxins.

### 2.3.11 *Cancer prevention*

Matcha assists in the prevention of cancer attributing to the presence of epigallocatechin gallate (EGCG) which has chemo-preventive properties. Multiple studies have shown that polyphenols present in Matcha tea prevents the proliferation of malignant cancerous cells, promotes induction of apoptosis and assists in the reducing the risk of developing various cancers including bladder cancer and colorectal cancer. EGCG exerts inhibitory activities and works against the progression of human breast and prostate tumors as well.

## III. SOYMILK

Soy beans are a legume from which many food items are made for regular diet consumption. Soy products are popular with those eating a vegetarian diet because of the high protein content of the soybean. Soymilk and other soy products is traditional staple of Asian cuisine. It can also be used to make tofu which is like a substitute to cheese. Use of soymilk is said to have begun in China in AD 82. It is used extensively in other Asian countries such as Japan and Malaysia. Today is used all over the world and is easily available in various varieties across many countries.

Many choose soymilk because of its versatility and ability to be used as a milk replacement in recipes. It is available in chocolate and vanilla flavours. Some also drink salted soy milk in countries such as China and India. Soy products replace many meat dishes and when milk is extracted from the soybean it is a nutritious replacement for those who do not consume dairy products. With the cost effectiveness of soy and increasing popularity in

diets around the world, research studies are beginning to look at the many other health benefits of consuming this natural plant product.

Soy milk is a white emulsion which resembles cow milk (conventional milk) in both appearance and consistency (Williams and Akiko, 2000). It is made from soybean (Glycine max L) seed and is described as a stable emulsion of oil, water and protein (Wikipedia, 2008). It is an inexpensive source of protein and calories for human consumption which compares favorably with diary milk and can be used as a vital and cheaper substitute for cow milk for solving malnutrition problems in developing countries like Nigeria (Iwe, 2003). Soy milk contains as much as 3.50% protein (about the same as cow milk), 2.00% fat, 0.50% ash and 2.90% carbohydrate (Riaz, 2006). Amongst minerals, soymilk contains calcium, iron, magnesium, phosphorus, potassium, sodium and zinc. Various vitamins such as folate, thiamin, riboflavin, niacin, vitamin B6, B-12, D, E and vitamin K are also found in soymilk. It also contains saturated, monounsaturated and polyunsaturated fatty acids. All these nutrients help in maintaining a good health.

It has therefore been advocated that cow milk production should be substituted with soy milk production, especially where the former is difficult and expensive. It has lower fat content than cow milk and contains no cholesterol (Rehman et al., 2007). This is regarded as one of its positive health benefits. The absence of lactose in soymilk also positions it as a solution to lactose intolerance for some consumers of dairy milk, especially infants with such biochemical challenge. It promotes growth in children who are allergic to cow milk and has been used in solving protein deficiency problems all over the world.

**3.1. Beany flavor in soymilk**

The typical green-beany flavor of soymilk is considered the major deterrent to acceptability of soymilk. When raw legume seeds are ground with water, undesirable odor and flavor similar to drying oil develop very rapidly. Many researchers are dedicated to exploring methods and technologies to eliminate the beany flavor in soymilk to develop for the production of good quality bland tasting, sweet or flavored of soy milk. Among these technologies, hot water blanching and grinding is the most simple and effective. Beany flavor could be reduced by grinding soaked soybean with hot water (Wilkens and others 1967; Kobayashi and others 1995; Endo and others 2004). Blanching with hot water is effective to

eliminate the beany flavors because hot water has been observed to inactivate lipoxygenase, which is the important enzyme to generating soymilk flavor.

Milling soaked soybeans with hot water at temperatures above 80°C is one effective method of reducing beany flavors (Kwok and Niranjan 1995) and result from researchers suggest that treatment by hot water blanching and grinding between 80-100°C significantly influenced the beany flavors. In particular, processing of soybeans using various forms of heat treatment improves texture, palatability as well as nutritional and sensory quality characteristics and that the degree of improvement depends on the temperature, moisture content and duration of heating. This improvement appears to be related to the destruction of trypsin inhibitors and other biologically active components.

Nelson et al. studied various methods of blanching whole soybeans to inactivate lipoxygenase. Blanching fully soaked beans at 99°C for 10 min, blanching dry beans for 20 min, or soaking and blanching in 0.5% sodium bicarbonate for tender beans were suggested depending on the ultimate use of the soybeans.

### 3.2 Lipoxygenase Inactivation

Heating has been the most successful process for the inactivation of undesirable compounds in soymilk including lipoxygenase. Farkas and Goldblith (1962) showed that the inactivation of lipoxygenase by heat follows a first order reaction rate for 90% of the reaction. The decreased heat sensitivity when lipoxygenase is suspended in 20% pea puree led them to conclude that a protective complex is formed. They also found that heat inactivation of lipoxygenase is very sensitive to pH. The rate of inactivation increases below pH 4 or above pH 8.

### 3.3 Bioactive compounds

Functional soy milk can be considered as soy milk that contains extra bioactive components and may help to enhance health or lower risk of diseases. Soybean is a good source of phenolic compounds with antioxidant properties and has an extraordinarily high amount of isoflavones, a group of phytoestrogens that have been reported to possibly lower the risk of hormonal and age-related diseases. However, the presence of natural anti-nutrients, such as trypsin inhibitors (TI), lectins, phytic acids and indigestible oligosaccharides, has limited its consumption. Thus, modifying the processing methods could be an effective way

to improve the health-promoting bioactive components and/or reduce the undesired compounds originally present in soybeans, to support functional soy milk product development (Jiang and Cai, 2013).

## IV. STEVIA

Stevia is a green, leafy plant of *Stevia rebaudiana* Bertoni that is native to South America. Stevia is has more than 240 species of shrubs and small flowering plans in the Asteraceae family, which is the same family as sunflowers. It has been used for medicinal purposes for many centuries. The plant has also been bred for its strong, sweet flavor. It is a natural, sweet-tasting calorie free botanical that may also be used as a sugar substitute or as an alternative to artificial sweeteners. Stevia is 250-450 times as sweet as sugar. It has been found to increase insulin sensitivity in rodent models (Chang *et al.*, 2005) and to have beneficial effects on blood glucose and insulin levels in human studies, which suggests it may have a role in food intake regulation. In safety studies, no negative side effects were reported (Barriocanal, 2008).

**Figure 5:** Stevia (*Stevia rebaudiana* Bertoni)

***Source:*** *http://pollynoble.com/wp-content/uploads/2013/08/stevia3.jpg*

Stevia was recently approved for use as a sweetener by the Joint Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives and has also recently received approval from the Food and Drug Administration. Stevia is inexpensive and available to most consumers; thus, it has the potential to be widely used and may assist

individuals in regulating their weight if it has a positive effect on caloric substitution. Many people may think they have to give up sweets in order to lose or maintain their weight. However, low-calorie sweeteners such as stevia sweeteners offer a way to reduce calories in sweet tasting foods and beverages, which may help to manage weight. They also offer a way for people with diabetes to decrease overall carbohydrate intake. Highly purified stevia sweeteners are a natural, no-calorie source of sweetness.

The two major sweet compounds that are isolated from the leaves are called Stevioside (or steviol glycosides) and Rebaudioside A. These two compounds are hundreds of times sweeter than sugar. In particular , Stevia sweeteners are heat stable to 200°C, are acid stable and do not ferment, making them suitable for use in a wide range of products including baked/cooked foods.

**4.1 Varieties of Stevia**

**4.1.1 *Fresh Stevia Leaves***

This form of stevia is the herb in its most natural, unrefined state. A leaf picked from a stevia plant and chewed will impart an extremely sweet taste sensation reminiscent of licorice that lasts for quite a while. For stevia to have a more practical application as a tea or sweetener, the leaves must be dried or put through an extraction process, which makes the sweet taste even more potent.

**4.1.2 *Dried Leaves***

For more of the flavor and sweet constituents of the stevia leaf to be released, drying and crushing is necessary. A dried leaf is considerably sweeter than a fresh one, and is the form of stevia used in brewing herbal tea. Dried stevia leaf may come in bulk or packaged like tea bags. It has a greenish color and can be used in a wide variety of foods and beverages, including coffee, applesauce and hot cereals.

**4.1.3 *Stevia Extracts***

The form in which stevia is primarily used as a sweetener in Japan is that of a white powdered extract. In this form it is approximately 200 to 300 times sweeter than sugar (by weight). This white powder is an extract of the sweet glycosides (natural sweetening agents) in the stevia leaf. Not all stevia extract powders are the same. The taste, sweetness and cost

of the various white stevia powders will likely depend on their degree of refinement and the quality of the stevia plant used

#### 4.1.4 *Liquid Concentrates*

These come in several forms. There's a syrupy black liquid (that results from boiling the leaves in water), which can enhance the flavor of many foods. Another type is made by steeping stevia leaves in distilled water or a mix of water and grain alcohol.

### 4.2 Health benefits of stevia

Steviol glycosides have zero calories. Stevia-based tabletop sweeteners can have zero or minimal calories per serving, depending upon the other food ingredients with which they are combined. These factors could have a positive effect on those looking to control weight or manage diabetes. Stevia also contains certain vitamins (A, B, C), minerals (iron, zinc, calcium), electrolytes (sodium, potassium), proteins, and other elements.

#### 4.2.1 *Diabetic control*

The most important or widely praised aspect of stevia for human health concerns its ability to regulate blood sugar levels in the body. Opposed to sucrose, which is what normal table sugar consists of, stevia sweetens food in a similar way as sugar, but it contains stevioside, which is a non-carbohydrate glycoside compound. As explained above, when stevioside breaks down, the glucose-containing particles are absorbed by the bacteria in the colon, rather than being absorbed by the bloodstream and affecting glucose levels in the body. This is an ideal replacement for normal sugar for diabetics or people on carbohydrate-controlled diets, because they can eat sweet foods without having to worry about diabetic complications.

#### 4.2.2 *Weight loss*

Stevia is very low in calories and is anywhere from 40-300 times sweeter than sugar, depending on the prevalence of certain extracts in the species variety. This means that people can eat foods like cakes, cookies, and candies made with stevia without worrying about gaining a great deal of calories from sugars, so they won't hurt their chances of successfully losing weight.

### 4.2.3 *Cancer prevention*

The wide range of antioxidant compounds found in stevia make it an ideal dietary supplement for cancer prevention. Quercetin, kaempferol, and the other glycoside compounds in stevia help to eliminate free radicals in the body and preventing them from mutating healthy cells into cancer cells. Antioxidants also help to prevent premature aging, cognitive malfunction, and various other serious conditions like heart disease.

### 4.2.4 *Osteoporosis*

Although this hasn't been extensively tested in humans, certain studies have shown that chickens that have been fed a stevia diet lay significantly thicker shells that contain a much higher content of calcium than average eggs. This has been extrapolated into humans, meaning that it could potentially help build stronger bones and decrease the chances of osteoporosis.

# MATERIALS AND METHODS

## 1. Materials

Soybean, Matcha powder, and stevia extract powder were bought from the supermarket. Sodium hydrogen carbonate (food grade) was available in the laboratory.

## 2. Study the method to eliminate beany flavor in soymilk

### 2.1 Soymilk preparation

#### 2.1.1 *Soymilk formula I*

Soybeans were soaked at room temperature for 10 hours. Soaked soybeans were blended with cold water at the ratio 1:3 for 3 minutes, and then filtered with two-layer sheath cloth. Soymilk was pasteurized for 15 minutes at 95-98°C.

#### 2.2.2 *Soymilk formula II*

Soybean was soaked with hot water at 80°C for 2 hours. After draining, soaked soybeans were blended with hot water (80°C) at the ratio 1:3 for 3 minutes. Soymilk was filtered by two-layer filter cloth and pasteurized for 15 minutes at 95-98°C.

### 2.2 Reducing beany flavor in soymilk by Sodium Bicarbonate

Soybean was soaked with hot water at 80°C for 2 hours. Then $NaHCO_3$ was added 0.5% by total weight (water and soy bean) approximately 15 minutes. After draining, soybeans were blended with hot water (80°C) at the ratio 1:3 for 3 minutes. Soymilk was filtered by two-layer filter cloth and pasteurized for 15 minutes at 95-98°C.

## 3. Formulate the basic formula of Matcha soymilk

Soymilk was prepared and added sugar 5% (w/v). Matcha powder was added at 1.1, 1.5, and 1.9% (w/v). Matcha soymilk was evaluated the preference using 9-points hedonic scale by 30 panelists.

The selected formula was prepare and evaluated color, beany flavor, Matcha aroma, Matcha taste, sweetness and overall liking using Just About Right (JAR) test by 30 panelists.

**4. Develop formula of Matcha soymilk**

Soymilk was prepared and added sugar 5% (w/w). Matcha powder was added at 1.2, 1.3, and 1.4% (w/v). Matcha soymilk was evaluated the preference of color, beany flavor, Matcha aroma, Matcha taste, sweetness and overall liking using 9-points hedonic scale by 30 panelists.

**5. Study the effect of stevia extract on the sensory of Matcha soymilk**

Matcha soymilk with 5% sweetness was prepared using the formula form the previous step. Stevia extract powder was added into Matcha soymilk at 0.3, 0.6, and 0.95 (w/v). Sensory evaluation of color, beany flavor, Matcha aroma, Matcha taste, sweetness, and overall liking was studied using 9-points hedonic scale by 30 panelists.

**6. Consumer acceptance**

Matcha soymilk with stevia adding was prepared and investigated the consumer acceptance by 100 consumers.

# RESULTS AND DISCUSSION

## 1. Preparation less beany flavor soymilk

Traditional method to make soymilk is soaked and ground soybean with water at room temperature. Soymilk is boiled and has strong cooked soy flavor or beany flavor which is undesirable for some consumer. During preliminary experiment, to make Matcha soymilk, the strong cooked soy flavor masks Matcha flavor. To minimize beany flavor, Yuam *et al.* (2008) suggested to soak and to grind soybean with hot water. Thus, two formula of soymilk making was compared. Soymilk formula I was traditional method that soaked soybeans with water overnight before blended with water at room temperature before filtered and pasteurized, while soymilk formula II was soaked soybeans with hot water at about 80°C for 2 hours, and then soaked soybeans were blended with hot water at approximately 80°C before filtered and pasteurized as the same condition with formula I. Soymilk both formulas were observed. It showed that soymilk formula II showed less beany flavor than formula I. The reason for the less of soy flavor was that lipoxygenase enzyme which is caused the beany or soy flavor was inhibited at high temperature.

Referred to Ediriweera (1996) studied, the method to reduce beany flavor in soymilk by using Sodium hydrogen carbonate ($NaHCO_3$) was applied. Soybean was soaked with 80°C water for 2 hours followed by soaked with 0.5% $NaHCO_3$ (w/w) for 15 minutes. Soaked soybeans also blended with hot water (80°C) at the ratio 1:3 for 3 minutes before filtered and pasteurized as the normal process. The result showed that when soybeans were treated with $NaHCO_3$, soymilk and taste showed less beany. Moreover, $NaHCO_3$ affected the increasing of pH from 6.42 as in normal soymilk to 7.46 (as shown in table 2), thus, it affected the lipoxygenase activity. The soymilk treating with and without $NaHCO_3$ showed the different color (as shown in Figure 8). Soymilk with $NaHCO_3$ adding showed more yellowish than soymilk without $NaHCO_3$ adding. The process flow chart of soy milk formula I and II was showed in Figure 7, while flow chart of soy milk using of NaHCO3 was showed in Figure 8.

**Table 2:** The change of pH in soymilk formula II with and without $NaHCO_3$ treat

| Treatment | pH |
|---|---|
| $NaHCO_3$ | 6.42 |
| No $NaHCO_3$ | 7.46 |

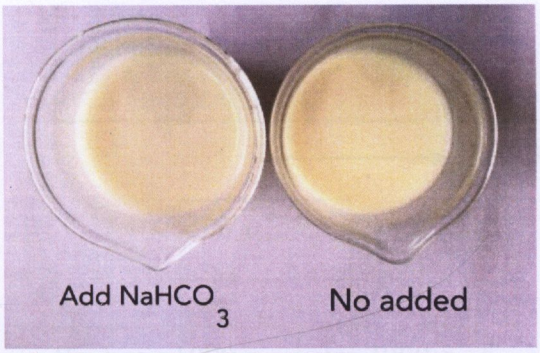


**Figure 6:** Color of soymilk with and without $NaHCO_3$ adding

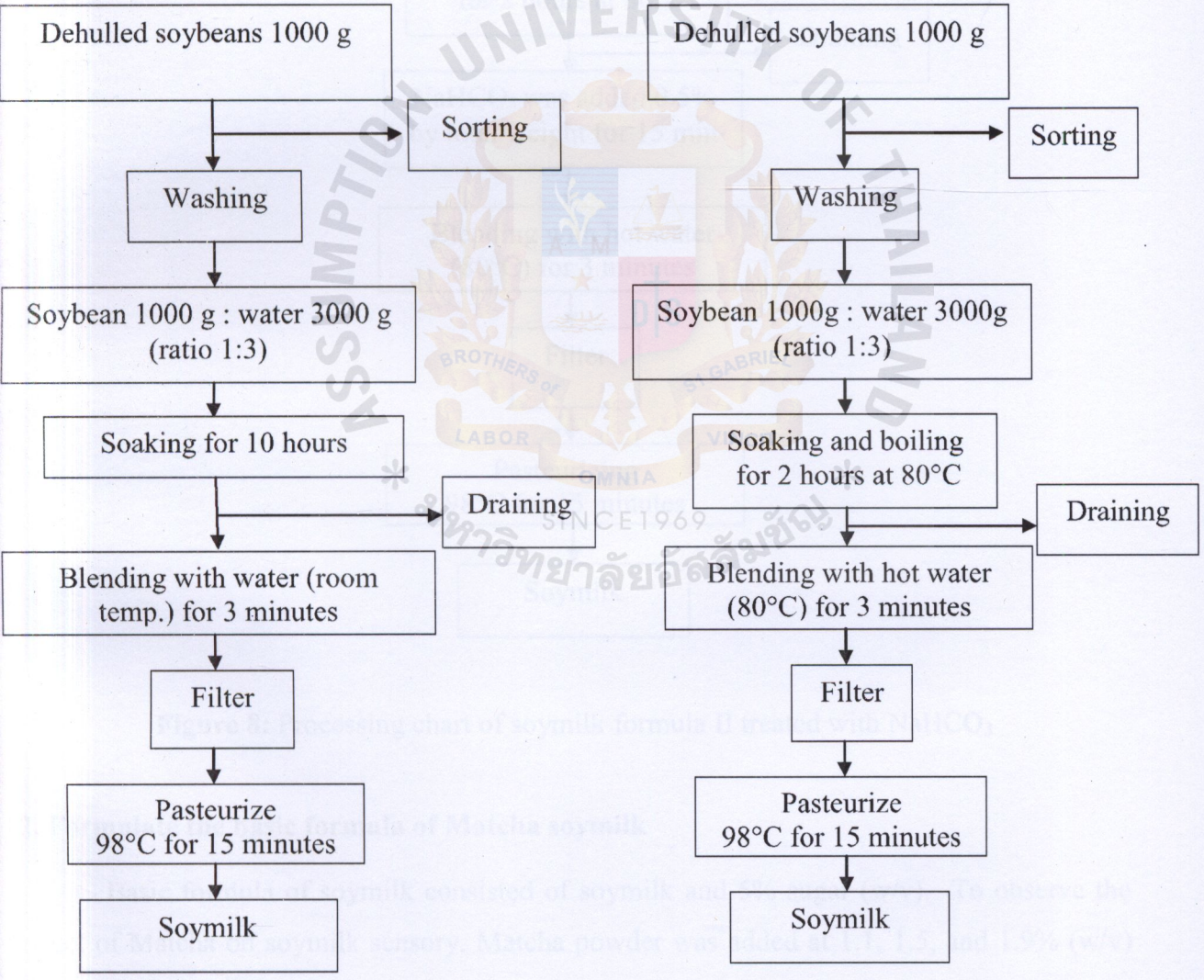


**Figure 7:** Processing chart of soymilk formula I (left) and formula II (right)

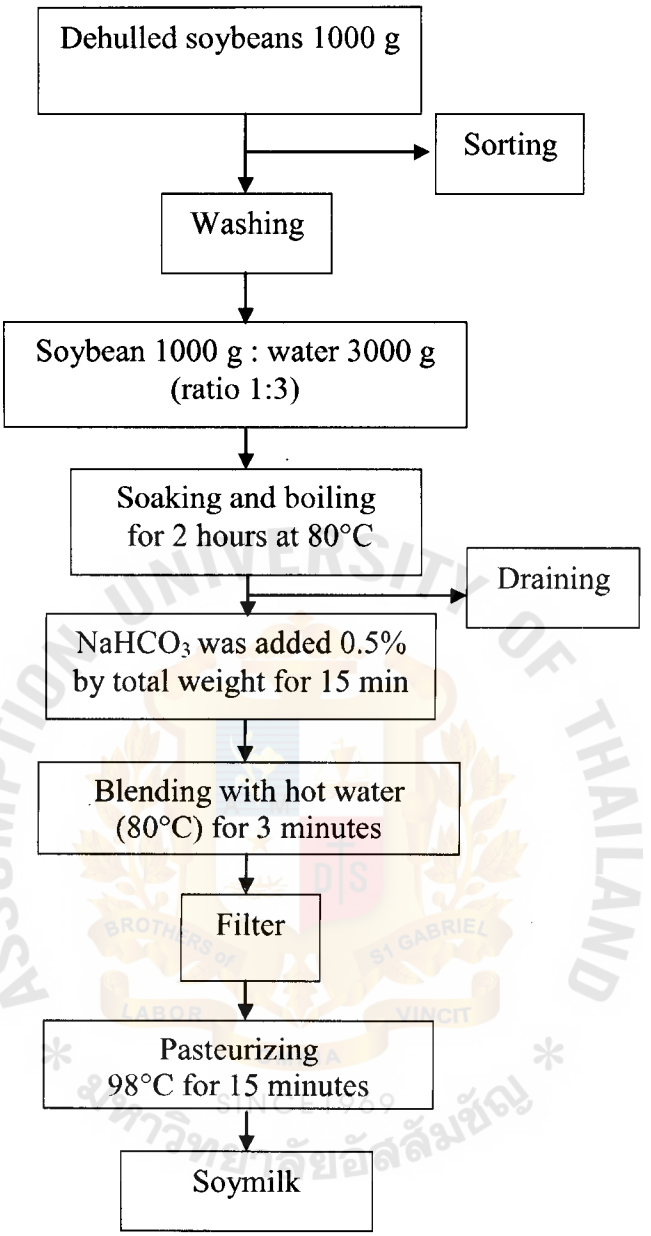


**Figure 8:** Processing chart of soymilk formula II treated with $NaHCO_3$

**2. Formulate the basic formula of Matcha soymilk**

Basic formula of soymilk consisted of soymilk and 5% sugar (w/v). To observe the effect of Matcha on soymilk sensory, Matcha powder was added at 1.1, 1.5, and 1.9% (w/v) during heating soymilk. Samples were evaluated the preference of color, beany flavor,

Matcha aroma, Matcha taste, sweetness and overall liking using 9-point hedonic score. The higher Matcha content showed the more green color intensity (as shown in Figure 9).

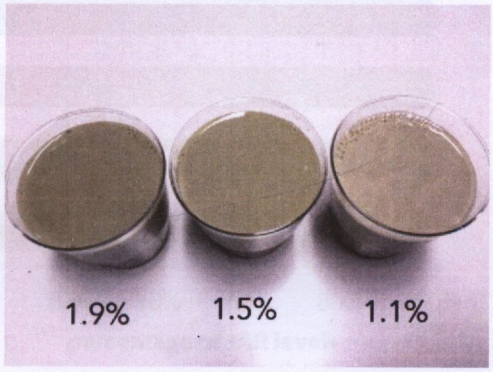


**Figure 9:** Matcha soymilk with Matcha powder at 1.9, 1.5, and 1.1% (w/v)

The average preference test analyzed by RCBD experimental designs of 3 treatments that are 1.1, 1.5, and 1.9% Matcha powder were showed in table 3. Preference score of 1.1% Matcha powder showed the highest score for all attributes except Matcha aroma. Preference score for color, beany flavor, Matcha taste, sweetness, and overall liking of 1.1% Matcha powder that are 6.63 ± 1.54, 6.47 ± 1.14, 6.30 ± 1.15, 6.50 ± 1.33, and 6.63 ± 1.45, respectively, while the highest preference score of Matcha aroma was 6.43 ± 1.38 at 1.9% Matcha powder. However, the preference score for color, Matcha aroma, and Match taste were not significant differences. Thus, Matcha soymilk with 1.1% Matcha powder was used as basic formula and it was prepared to evaluate by JAR test and the results showed in Figure 10 below.

**Table 3:** Preference scores of Matcha soymilk with Matcha powder at 1.1, 1.5, and 1.9%

| Attributes | Matcha powder | | |
|---|---|---|---|
| | **1.1%** | **1.5%** | **1.9%** |
| Color | 6.63 ± 1.54 | 6.77 ± 1.38 | 7.20 ± 1.24 |
| Beany flavor | 6.47 ± 1.14 [a] | 5.43 ± 1.45 [b] | 5.60 ± 1.45 [b] |
| Matcha aroma | 6.37 ± 1.03 | 6.00 ± 1.51 | 6.43 ± 1.38 |
| Matcha taste | 6.30 ± 1.15 | 5.63 ± 1.50 | 6.07 ± 1.26 |
| Sweetness | 6.50 ± 1.33 [a] | 5.37 ± 1.63 [b] | 5.50 ± 1.61 [b] |
| Overall liking | 6.63 ± 1.45 [a] | 5.47 ± 1.56 [b] | 5.70 ± 1.42 [b] |

***Note:*** *Means with same letter are not significantly different at $p \leq 0.05$.*

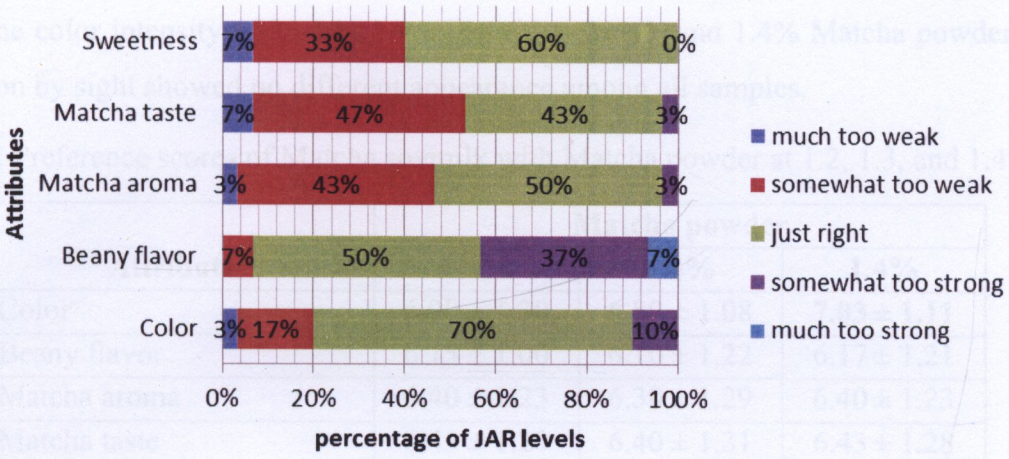


**Figure 10:** Just About Right percentage of Matcha soymilk with 1.1% Matcha powder

From Figure 10, color, beany flavor, Matcha aroma, Matcha taste, and sweetness were obtained just right level at 70, 50, 50, 43, and 60%, respectively. Three attributes that needed to adjust to improve the quality of product were beany flavor, Matcha aroma, and Matcha taste. For the beany flavor, it showed somewhat too strong about 37%, while Matcha taste and Matcha aroma showed somewhat too weak 47% and 43%, respectively. The results implied that beany flavor needed more decreasing, while Matcha taste and Matcha aroma needed more increasing of Matcha powder.

**3. Develop formula of Matcha soymilk**


**Figure 11:** Matcha soymilk with Matcha powder at 1.2, 1.3, and 1.4% (w/v)

In this studied, 5% sugar added soymilk was added Matcha powder at 1.2, 1.3, and 1.4% (w/v). Sensory evaluation was investigated the preference using 9-points hedonic scale

for color, beany flavor, Matcha aroma, Matcha taste, sweetness and overall liking. Figure 10 showed the color intensity of Matcha soymilk with 1.2, 1.3, and 1.4% Matcha powder. The observation by sight showed no different appearance among all samples.

**Table 4:** Preference scores of Matcha soymilk with Matcha powder at 1.2, 1.3, and 1.4% (w/v)

| Attributes | Matcha powder | | |
|---|---|---|---|
| | **1.2%** | **1.3%** | **1.4%** |
| Color | 6.90 ± 1.30 | 6.80 ± 1.08 | **7.03 ± 1.11** |
| Beany flavor | 6.15 ± 1.00 | 6.10 ± 1.22 | 6.17 ± 1.21 |
| Matcha aroma | 6.40 ± 1.23 | 6.30 ± 1.29 | 6.40 ± 1.23 |
| Matcha taste | 6.43 ± 1.20 | 6.40 ± 1.31 | 6.43 ± 1.28 |
| Sweetness | 6.17 ± 1.27 | 6.30 ± 1.07 | **6.37 ± 1.11** |
| Overall liking | 6.20 ± 1.11 | 6.37 ± 1.30 | **6.53 ± 1.06** |

***Note:*** *There were no significantly different at $p \leq 0.05$.*

Table 4 showed the preference score of Matcha soymilk that was adjusted the amount of Matcha powder to 1.2, 1.3, and 1.4% (w/v). All Matcha concentrations showed no significantly different. However, the highest preference score for color, beany flavor, , sweetness and overall liking were 7.03 ± 1.11, 6.17 ± 1.21, 6.37 ± 1.11, and 6.53 ± 1.06, respectively for 1.4% Matcha powder, while Matcha aroma and Matcha taste were not different. Although, there were no significantly different among all samples and attributes, 1.4% Matcha powder was selected for further development according to the highest overall liking scores.

**4. Study the effect of stevia extract on the sensory of Matcha soymilk**

Stevia extract powder was selected to use as sugar substituted according to its sweetness. As claimed in the label that 0.4 g of stevia is equal to 1 teaspoon or 4.2 g of sugar. So, according to the calculation of stevia content and the equal sweetness with 5% sugar added into soymilk, stevia extract powder was added into Matcha soymilk at 0.3, 0.6, and 0.9 (w/v). Sensory evaluation was investigated the preference score for 6 attributes that are color, beany flavor, Matcha aroma, Matcha taste, sweetness and overall liking using 9-points hedonic scale. The evaluation scores showed in table 5 below.

**Table 5:** Preference scores of Matcha soymilk with 0.3, 0.6, and 0.9% stevia extract

| Attributes | Stevia extract powder | | |
|---|---|---|---|
| | **0.3%** | **0.6%** | **0.9%** |
| Color | 7.10 ± 0.65 | 7.07 ± 0.68 | 7.10 ± 0.65 |
| Beany flavor | 6.50 ± 0.85 | 6.60 ± 0.92 | 6.80 ± 0.75 |
| Matcha aroma | 6.77 ± 0.88 | 6.83 ± 0.82 | 6.80 ± 0.79 |
| Matcha taste | 6.23 ± 0.67 $^{b}$ | 6.33 ± 0.83 $^{ab}$ | 6.63 ± 0.71 $^{a}$ |
| Sweetness | 5.87 ± 0.96 $^{b}$ | 6.37 ± 0.75 $^{a}$ | 6.70 ± 0.78 $^{a}$ |
| Overall liking | 6.47 ±0.88 $^{b}$ | 6.63 ± 0.87 $^{ab}$ | 6.97 ± 0.66 $^{a}$ |

***Note:*** *Means with same letter are not significantly different at* $p \leq 0.05$.

As the results showed in Table 5, all percentage of stevia extracts adding had no significantly differences for color, beany flavor, and Matcha aroma. However, Matcha taste, sweetness, and overall liking showed the highest preference score at 0.9% stevia extract ($p \geq 0.05$) that are 6.63 ± 0.71, 6.70 ± 0.78, and 6.97 ± 0.66, respectively. The high score for Matcha taste might be come from the low stevia content. This caused the less sweetness and, thus, Matcha taste was noted. The panelist commented that stevia extract showed little aftertaste. Sweetness of stevia also showed slower onset and longer duration than sugar. Therefore, Matcha soymilk with 0.9% stevia extract was selected and used to study consumer acceptance.

**5. Investigate the consumer acceptance**

Matcha soymilk with 0.9% stevia extract was produced and studied the consumer acceptance test by 100 consumers. The questionnaire was separated to three parts that are consumer behavior, product acceptance, and demographic. From the first part of questionnaire, the results showed as pie chart in Figure 11. The pie charts (Q1) showed that 94% consumer like to drink green tea, while another 6% didn't like to drink. How much consumer like green tea question showed that 49% consumer like, 31% consumer like most. The frequency to drink showed that 56% consumer usually drink green tea 3-4 times a week, while 20 and 13% consumer drink once a week and drink every day. Consumers 44% buy green tea from the convenience stores, 24% consumer buy from Supermarket, and 17% consumer buy green tea from coffee shop.

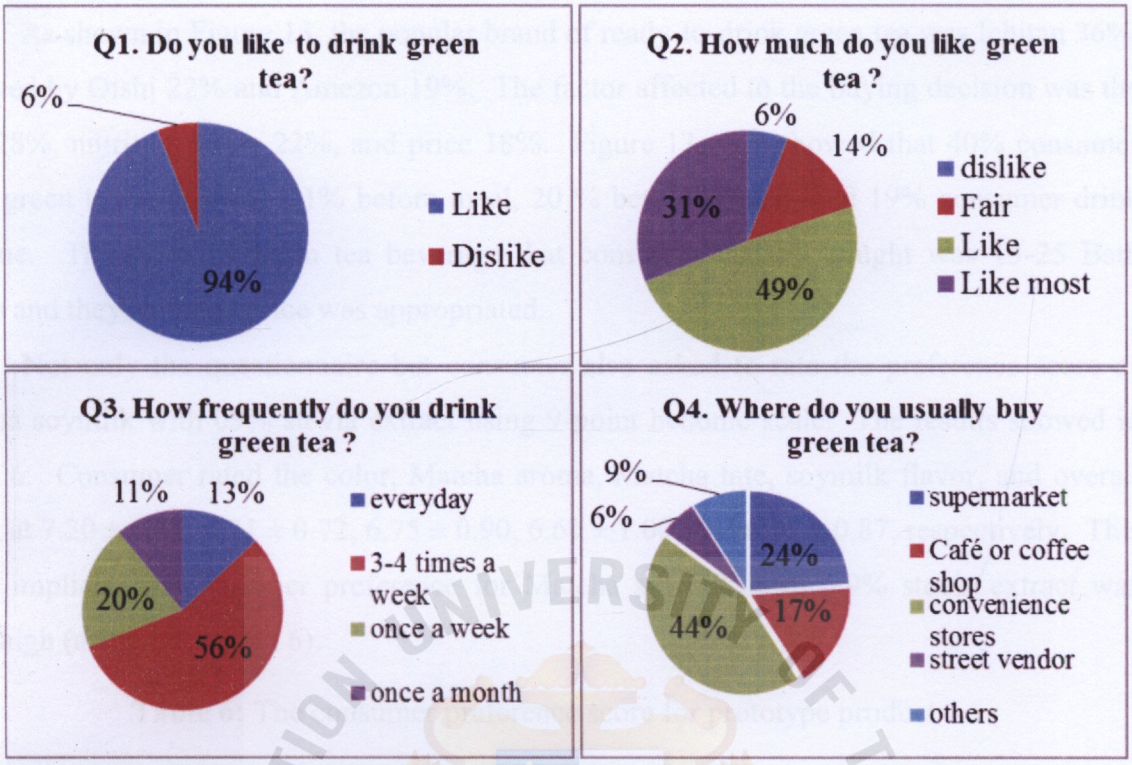


**Figure 12:** Consumer behavior of green tea question 1 to 4

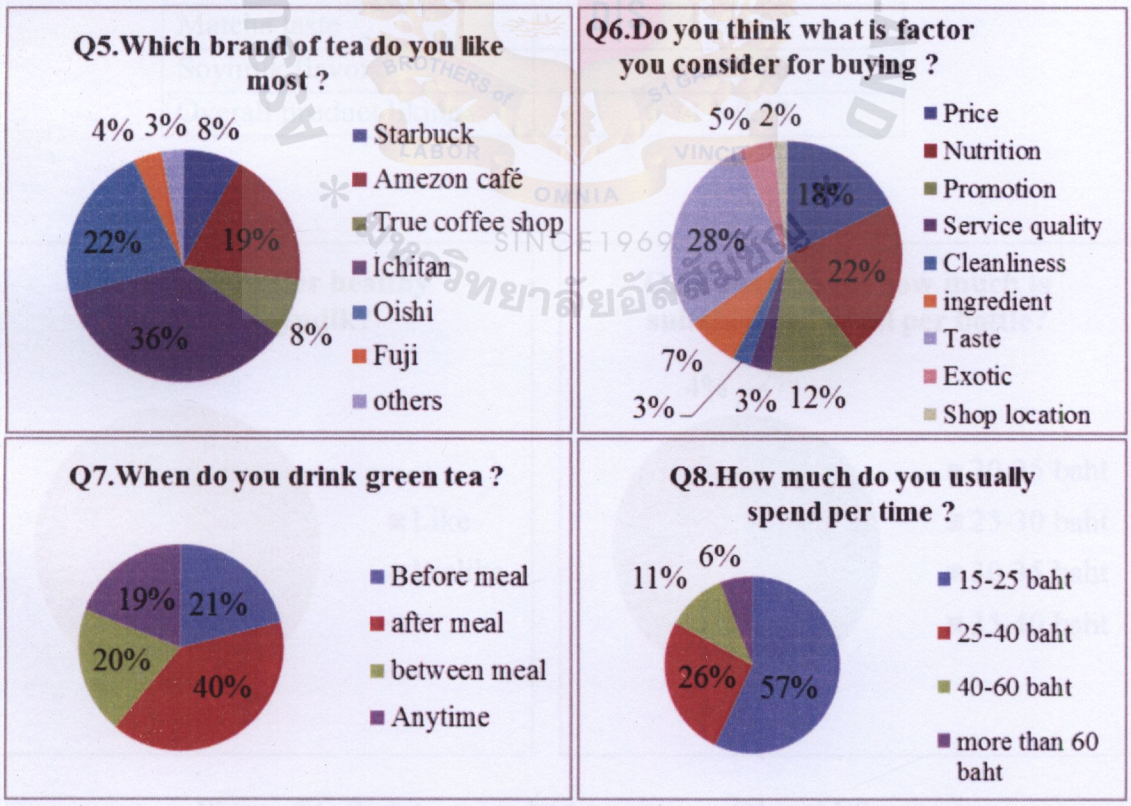


**Figure 13:** Consumer behavior of green tea question 5-8

As shown in Figure 13, the popular brand of ready-to-drink green tea was Ichitan 36%, followed by Oishi 22% and Amezon 19%. The factor affected to the buying decision was the taste 28%, nutrition value 22%, and price 18%. Figure 13 (Q7) showed that 40% consumer drink green tea after meal, 21% before meal, 20 % between meal, and 19% consumer drink anytime. The price of green tea beverage that consumer usually bought was 15-25 Bath (57%) and they said this price was appropriated.

Not only the questionnaire but consumer also asked to rate the preference score of Matcha soymilk with 09% stevia extract using 9-point hedonic scale. The results showed in Table 6. Consumer rated the color, Matcha aroma, Matcha tate, soymilk flavor, and overall liking at 7.20 ± 0.74, 6.71 ± 0.72, 6.75 ± 0.90, 6.61 ± 1.00, and 6.74 ± 0.87, respectively. This result implied that consumer preference for Matcha soymilk with 0.9% stevia extract was quite high (all scores above 6).

**Table 6:** The consumer preference score for prototype product

| Attributes | Preference score |
|---|---|
| Color | 7.20 ± 0.74 |
| Matcha aroma | 6.71 ± 0.72 |
| Matcha taste | 6.75 ± 0.90 |
| Soymilk flavor | 6.61 ± 1.00 |
| Overall product liking | 6.74 ± 0.87 |

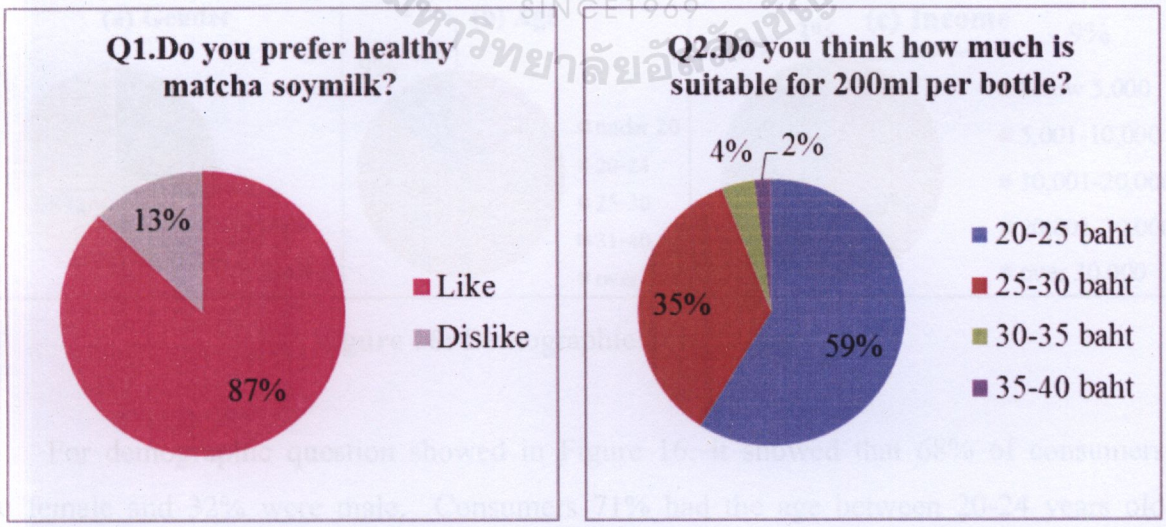


**Figure 14:** Prototype product acceptance Q1 and Q2

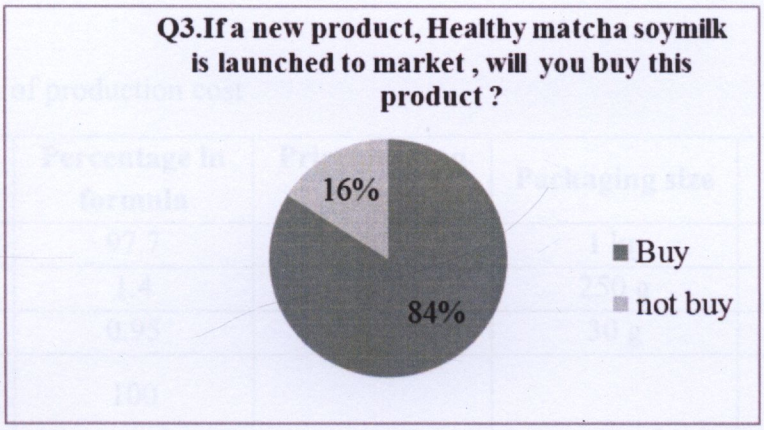


**Figure 15:** Prototype product acceptance Q3

The second part of consumer acceptance study showed in Figure 14 and 15. The percentage of consumer preference for Matcha soymilk with 0.9% stevia extract was 87%, while 13% of consumer doesn't like the product because normally, they don't drink either soymilk or Matcha green tea. The suitable price for 200 ml-size of Matcha soymilk was 20-25 baht at 59% and 25-30 baht at 35%. Finally, for launching new product to the market, the percentage of consumer willing to buy was 84%, while another 16% will not buy because of their behavior that do not drink either prefer drink Matcha green tea or soymilk.

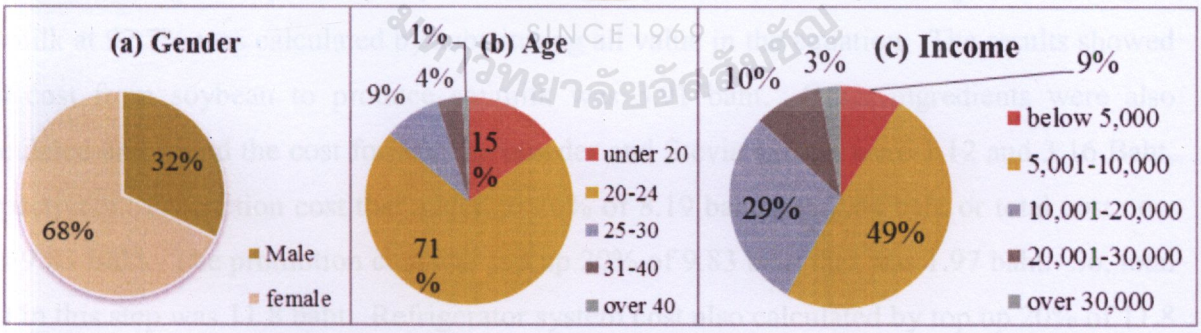


**Figure 16:** Demographic of consumer

For demographic question showed in Figure 16, it showed that 68% of consumers were female and 32% were male. Consumers 71% had the age between 20-24 years old followed by under 20 years old 15% and 25-30 years old 9%. Monthly income of consumers

at 5,001-10,000 Baht, 10,001-20,000 Baht, and 20,001 – 30,000 Baht were 49, 29, and 10%, respectively.

**Table 7:** Calculation of production cost

| Ingredients | Percentage in formula | Price/packing (Baht) | Packaging size | Cost (Baht) |
|---|---|---|---|---|
| Soymilk | 97.7 | 40 | 1 kg | 3.91 |
| Matcha powder | 1.4 | 200 | 250 g | 1.12 |
| Stevia extract | 0.95 | 100 | 30 g | 3.16 |
| Total raw materials cost/batch(200ml) | 100 | | | 8.19 |
| Production cost 20% of total raw material cost | | | | 1.64 |
| Promotion cost 20% of total raw material cost | | | | 1.97 |
| Refrigerator system cost 20% of total raw material cost | | | | 2.36 |
| Total cost of healthy Matcha soymilk (200ml) | | | | 14.16 |
| Profit for selling price at 20-25 | | | | 5.84 – 10.84 |

**Production cost**

To calculate the production cost, firstly, raw materials were calculated per batch (200 ml) by following formula;

packaging size (g) x percentage in formula

Thus, soymilk produced by using 1-kg soybeans (40 Baht) using in the Matcha soymilk at 97.7% was calculated by substituting all value in the equation. The results showed that cost from soybean to produce soymilk was 3.91 baht. Other ingredients were also calculated and found the cost for Matcha powder and Stevia extract were 1.12 and 3.16 Baht, respectively. Production cost that added to 20% of 8.19 baht was 1.64 baht or total cost now was 9.83 Baht. The promotion cost was top up 20% of 9.83 baht that was 1.97 baht. So, total cost in this step was 11.8 baht. Refrigerator system cost also calculated by top up 20% of 11.8 baht and the result was 2.36 baht. Therefore, total cost of stevia-added Matcha soymilk per batch was 14.16 baht. The profit for selling price 20 to 25 baht calculated by subtracting selling price with total cost of product that are 5.84 for 20 Baht and 10.84 for 25 baht.

# CONCLUSION

1. The suitable method to decrease beany flavor in soymilk was treating soybean with $NaHCO_3$.
2. Formula of stevia-added Matcha soymilk was soymilk 97.7%, Matcha powder 1.4%, and stevia extract powder 0.9%.
3. Consumer 87% accepted stevia-added Matcha soymilk and 59% of consumer said that the suitable price was 20-25 Baht for 200 mL beverage.

# REFERENCES

[1] Hae-Ran Lee Ashraf , 1979 , Flavor and composition of soymilk as influenced by ethanolic soaking, heating and pH control , Iowa State University.

[2] Suree Teaw Teing , Soymilk product mixed with carrot juice , 2009, Depertment of foods and Nutrition , Faculty of Home Economis Technology.

[3] J.K. Ikya, D.I. Gernah, H.E.Ojobo and O.K. Oni , Effect of Cooking Temperature on Some Quality Characteristics of Soy Milk ,2013

[4] Yau-Chun, L.V., S. Huan-Lu, L. Xin, W. Liang and G. Shun-Tang, 2011. Influence of blanching and grinding with ahot water on beany and non-beany flavour in soy milk. J. Food Sci

[5] Yuan, S., S.K. Chang, Z. Liu and B. Xu, 2008. Elimination of trypsin inhibitor activity and beany flavor in soy milk by consecutive blanching and Ultra-High Temperature (UHT) processing. J. Agric. Food Chem., 56(17): 7957-7963.

[6] Susu Jiang , Weixi Cai and Baojun Xu , Food Quality Improvement of Soy Milk Made from Short-Time Germinated Soybeans , School of Biological Sciences, The University of Hong Kong, Hong Kong

[7] Samantha Acevedo, Conan Chen, Ethan France, Brian Goldspiel, Antimicrobial properties of various green tea products with and without the addition of sugar

[8] website : https://www.matchasecrets.com/matcha-vs-green-tea-which-is-the-better-tea-for-you/

[9] website : https://en.wikipedia.org/wiki/Stevia

# APPENDIX A

## Appendix A-1 : Sensory evaluation form

Please score the samples base on your preference on a 9-point hedonic scale.

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

| Attribute | Sample code | | |
|---|---|---|---|
| | _____ | _____ | _____ |
| Overall liking | | | |
| Color | | | |
| Beany flavor | | | |
| Matcha aroma | | | |
| Matcha taste | | | |
| Sweetness | | | |

Which sample you prefer _____

Suggestion :

.....

.....

**Appendix A-2 : Just-About-Right form**

PRODUCT : Matcha Soy Milk

Name_____

Instruction : **Please score** the sample base on your preference on a 9-point hedonic scale.

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

**Please mark ' X '** indicate your opinion following the characteristics of the sample of just about right scale.

**COLOR**

Score _____

| much too light | somewhat too light | Just right | somewhat too dark | much too dark |
|---|---|---|---|---|
| | | | | |

**BEANY FLAVOR**

Score _____

| much too weak | somewhat too weak | Just right | somewhat too strong | much too strong |
|---|---|---|---|---|
| | | | | |

**MATCHA AROMA**

Score _____

| much too weak | somewhat too weak | Just right | somewhat too strong | much too strong |
|---|---|---|---|---|
| | | | | |

**MATCHA TASTE**

Score _____

| much too weak | somewhat too weak | Just right | somewhat too strong | much too strong |
|---|---|---|---|---|
| | | | | |

**SWEETNESS**

Score _____

| Not nearly sweet enough | somewhat not sweet enough | Just right | somewhat too sweet | much too sweet |
|---|---|---|---|---|
| | | | | |

Comments/Suggestions :

.....

.....

.....

Appendix A-2 : Consumer acceptance test

# Matcha soy milk (use stevia as sweetener)

I am a student from the faculty of Biotechnology, Assumption University conducting this food development survey as a part of my special project for my Bachelor's degree to learn about your consuming behaviors, attitudes, and need toward the developed product with a goal to determine consumers' acceptance of the developed product. The important information from yours participation will be further used to complete my project.

Please kindly complete the questions below and carefully give mark ✓on the answer(s) based on your opinion. Your personal data will be kept confidential.
Thank you for your kind participation.

## I. Consumer's behavior แบบสอบถามพฤติกรรมของผู้บริโภค

1. Do you like to drink tea? คุณชอบดื่มชาเขียวหรือไม่ ?

❑Yes ชอบ ❑No ไม่ชอบ

2. How much do you like tea ? คุณชอบดื่มชามากน้อยเท่าไร?

❑Dislike most ไม่ชอบมาก ❑Dislike ไม่ชอบ ❑ Fair พอใช้

❑Like ชอบ ❑ Like most ชอบมาก

3. How frequently do you drink tea? คุณดื่มชาบ่อยแค่ไหน?

❑Every day ทุกวัน ❑3-4 times a week 3-4ครั้งต่อสัปดาห์

❑Once a week1ครั้งต่อสัปดาห์ ❑Once a month 1ครั้งต่อเดือน

❑Other อื่นๆ: _____

4. Where do you usually buy tea? คุณซื้อชาดื่มที่ไหน?

❑Supermarket ห้างสรรพสินค้า ❑Convenience stores ร้านสะดวกซื้อ

❑ Cafe or coffee shop ร้านกาแฟ ❑Street vendor ร้านค้าข้างทาง

❑Other อื่นๆ: _____

5. Which brand of green tea do you like most? คุณชอบรับประทานชาเขียวแบรนด์ไหน?

❑Starbuck ❑Amazon cafe ❑True coffee shop

❑Ichitan ❑Oishi ❑Fuji

❑Tea break Other อื่นๆ_____

6. Do you think what is the factor you consider for affecting your buying?
คุณคิดว่าอะไรคือปัจจัยหลักในการเลือกซื้อชา? (able to choose more than 1)

❑Price ราคา ❑Service quality บริการ ❑Taste รสชาติ

❑Nutrition สารอาหาร ❑Cleanliness ความสะอาด ❑ Exotic แปลกใหม่

❑Promotion โปรโมชั่น ❑Ingredient ส่วนผสม ❑Shop location สถานที่

❑Otherอื่นๆ: _____

7. When do you drink tea? คุณดื่มชาตอนไหน?

❑Before meal ก่อนอาหาร ❑After meal หลังอาหาร ❑Anytime ตลอดเวลา

❑Otherอื่นๆ: _____

8. How much do you usually spend per time? คุณใช้จ่ายในการซื้อชากี่บาทต่อครั้ง?

❑15-25 Baht ❑ 25 - 40 Baht ❑ More than 40 baht (บาท)

**II.** Attitude and their needs towards the developed product for matcha soy milk (no sugar added) **แบบสอบถามความคิดเห็นต่อผลิตภัณฑ์ ชาเขียวมัชฉะนมถั่วเหลืองเพื่อสุขภาพ**

Instruction: Rinse your mouth with water and taste sample. Then, rate the sample in each **กรุณาดื่มน้ำและชิมผลิตภัณฑ์ พร้อมให้คะแนนและตอบคำถามดังต่อไปนี้**

1=Dislike extremely ไม่ชอบมากที่สุด 2=Dislike very much ไม่ชอบมาก

3=Dislike moderately ไม่ชอบปานกลาง 4=Dislike slightly ไม่ชอบเล็กน้อย

5=Neither like nor dislike บอกไม่ได้ว่าชอบหรือไม่ชอบ

6=Like slightlymชอบเล็กน้อย 7=Like moderately ชอบปานกลาง

8=like very much ชอบมาก 9=like extremely ชอบมากที่สุด

| Attribute | Rating score คะแนน |
|---|---|
| Color (สี) | |
| Matcha aroma (กลิ่นชามัชฉะ) | |
| Matcha flavor (รสชาติชามัชฉะ) | |
| Soymilk flavor (รสชาตินมถั่วเหลือง) | |
| Overall product liking (ความชอบโดยรวม) | |

1. Do you prefer this product, Healthy matcha soy milk?คุณชอบชาเขียวมัชฉะนมถั่วเหลืองเพื่อสุขภาพ?

❑Yes ชอบ ❑NO, Why ไม่ชอบ,เพราะ_____

2. If a new product, Healthy matcha soy milk, is launched to market, will you buy that product? ถ้าผลิตภัณฑ์วางขายในตลาด คุณจะซื้อหรือไม่

❑Yes ซื้อ ❑NO, Why ไม่ เพราะ_____

3. Do you think what price is the most suitable for 200 ml Healthy matcha soy milk bottle) service? คุณคิดว่าชาเขียวมัชฉะนมถั่วเหลืองเพื่อสุขภาพควรราคาเท่าไร?

❑20-25 ฿ ❑25-30 ฿ ❑30-35 ฿ ❑35-40 ฿

Comments คำแนะนำ:

.....

.....

**III.** General information **ข้อมูลพื้นฐานทั่วไป**

Gender: ❑Male ชาย ❑Female หญิง

Age: ❑Under20 ต่ำกว่า20ปี ❑20-24 year old 20-24ปี

❑25-30 year old 20-24ปี ❑30-35 year old 20-24ปี

❑36-40 year old 20-24ปี ❑Over 40year old มากกว่า40 ปี

Income: ❑below 5,000 ❑5,001-10,000 ❑10,000-20,000

❑20,001-30,000 ❑Over 30,001

Thank you very much for your time

# APPENDIX B

## Appendix B-1 : Formulate the basic formula of Matcha soymilk (table 3)

Overall liking

- summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 22.87 | 11.433 | 7.49 | 0.00127 ** |
| rep | 29 | 92.27 | 3.182 | 2.086 | 0.00869 ** |
| Residuals | 58 | 88.47 | 1.525 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

- LSD

Means with the same letter are not significantly different.

Groups, Treatments and means

| | | |
|---|---|---|
| a | 762 | 6.633 |
| b | 217 | 5.7 |
| b | 369 | 5.467 |

Color

- summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 5.27 | 2.633 | 3.812 | 0.0278 * |
| rep | 29 | 129.07 | 4.451 | 6.443 | 9.87e-10 *** |
| Residuals | 58 | 40.07 | 0.691 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Sweetness

- summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 23.02 | 11.511 | 8.826 | 0.00045 *** |
| rep | 29 | 128.32 | 4.425 | 3.393 | 3.73e-05 *** |
| Residuals | 58 | 75.64 | 1.304 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

- LSD

Means with the same letter are not significantly different.

Groups, Treatments and means

| | | |
|---|---|---|
| a | 762 | 6.5 |
| b | 217 | 5.5 |
| b | 369 | 5.367 |



beany flavor

- summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 18.47 | 9.233 | 13.322 | 1.73e-05 *** |
| rep | 29 | 119.83 | 4.132 | 5.962 | 4.24e-09 *** |
| Residuals | 58 | 40.20 | 0.693 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

- LSD

Means with the same letter are not significantly different.

Groups, Treatments and means

a 762 6.467

b 217 5.6

b 369 5.433

Matcha aroma

- summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 3.27 | 1.633 | 1.819 | 0.171 |
| rep | 29 | 100.27 | 3.457 | 3.851 | 6.19e-06 *** |
| Residuals | 58 | 52.07 | 0.898 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Matcha taste

- summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 6.87 | 3.433 | 3.701 | 0.0307 * |
| rep | 29 | 95.33 | 3.287 | 3.544 | 2.05e-05 *** |
| Residuals | 58 | 53.80 | 0.928 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

**Appendix B-2 : Develop formula of Matcha soymilk (table 4)**

Color

> summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 0.82 | 0.411 | 0.877 | 0.421 |
| rep | 29 | 95.29 | 3.286 | 7.012 | 1.91e-10 *** |
| Residuals | 58 | 27.18 | 0.469 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Beany flavor

> summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 0.09 | 0.0444 | 0.09 | 0.914 |
| rep | 29 | 90.46 | 3.1192 | 6.33 | 1.38e-09 *** |
| Residuals | 58 | 28.58 | 0.4927 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Matcha flavor

> summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 0.29 | 0.144 | 0.282 | 0.755 |
| rep | 29 | 111.16 | 3.833 | 7.482 | 5.23e-11 *** |
| Residuals | 58 | 29.71 | 0.512 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Matcha taste

> summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 0.02 | 0.011 | 0.020 | 0.98 |
| rep | 29 | 111.96 | 3.861 | 7.002 | 1.96e-10 *** |
| Residuals | 58 | 31.98 | 0.551 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Sweetness

> summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 0.62 | 0.3111 | 0.614 | 0.545 |
| rep | 29 | 90.06 | 3.1054 | 6.131 | 2.52e-09 *** |
| Residuals | 58 | 29.38 | 0.5065 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Overall liking

> summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 1.67 | 0.833 | 1.835 | 0.169 |
| rep | 29 | 94.90 | 3.272 | 7.208 | 1.11e-10 *** |
| Residuals | 58 | 26.33 | 0.454 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

**Appendix B-3 : Study the effect of stevia extract on the sensory of Matcha soymilk**

Color

- summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 0.022 | 0.0111 | 0.065 | 0.938 |
| rep | 29 | 29.289 | 1.0100 | 5.871 | 5.63e-09 *** |
| Residuals | 58 | 9.978 | 0.1720 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Beany flavor

> summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 1.40 | 0.7000 | 0.824 | 0.444 |
| rep | 29 | 14.23 | 0.4908 | 0.578 | 0.945 |
| Residuals | 58 | 49.27 | 0.8494 | | |

Matcha aroma

> summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 0.07 | 0.0333 | 0.05 | 0.951 |
| rep | 29 | 23.73 | 0.8184 | 1.23 | 0.248 |
| Residuals | 58 | 38.60 | 0.6655 | | |

Matcha taste

> summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 2.60 | 1.3000 | 2.303 | 0.109 |
| rep | 29 | 16.27 | 0.5609 | 0.994 | 0.493 |
| Residuals | 58 | 32.73 | 0.5644 | | |

- LSD

Means with the same letter are not significantly different.

Groups, Treatments and means

| | | |
|---|---|---|
| a | 930 | 6.633 |
| ab | 524 | 6.333 |
| b | 183 | 6.233 |

Sweetness

> summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 10.56 | 5.278 | 8.175 | 0.000745 *** |
| rep | 29 | 25.29 | 0.872 | 1.351 | 0.163767 |
| Residuals | 58 | 37.44 | 0.646 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

- LSD

Means with the same letter are not significantly different.

Groups, Treatments and means

a 930 6.7

a 524 6.367

b 183 5.867

overall liking

> summary(RCBD)

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|
| trt | 2 | 3.89 | 1.9444 | 3.066 | 0.0542 |
| rep | 29 | 22.62 | 0.7801 | 1.230 | 0.2473 |
| Residuals | 58 | 36.78 | 0.6341 | | |

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

- LSD

Least Significant Difference 0.420587

Means with the same letter are not significantly different.

Groups, Treatments and means

a 930 6.967

ab 524 6.633

b 183 6.467