

**DEVELOPMENT OF TEA COATING  
CASHEW NUT PRETZEL STICKS**

**BY**

**PITCHAYAPA CHAICHUKIAT**

**ID: 5410790**

**A special project submitted to**

**School of Biotechnology, Assumption University**

**In part fulfillment of the requirements of the Degree of**

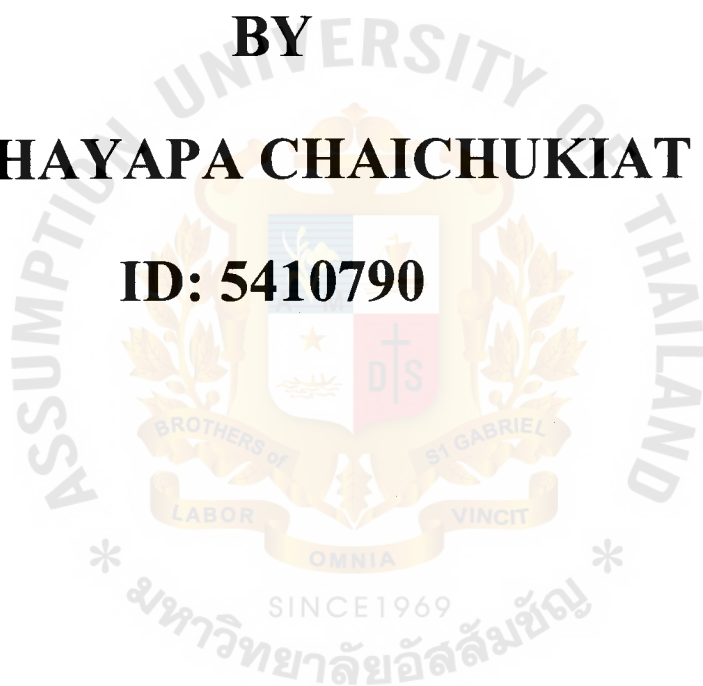
**Bachelor of Science in Biotechnology**

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**TITLE:** Development of tea coating cashew nut pretzel sticks

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(A. ROUNGDAO Klinjapo)

Advisor

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Assumption University



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## ABSTRACT

Tea coating cashew nut pretzel sticks is the new choice of delicious snack with lots of varieties from new pretzel sticks with tea. Basic formula of pretzel sticks consisted of all purpose flour, cake flour, yeast, sugar, salt, and water. Ground raw cashew nut was added into pretzel sticks at 25% and 50% of flour substitution compared with control. Sensory evaluation and texture analysis showed that the suitable ground cashew nut was 25% of flour substitution with the crispiness score at  $7.35 \pm 1.42$ . Cashew nut pretzel sticks were further studied by adding salt at various concentrations (1, 2, and 3%) and 3% salt addition showed the significantly highest score at  $6.95 \pm 0.60$ . For the coating cashew nut pretzel sticks, white chocolate compound and whipping cream was used as ingredients with tea variation; Ceylon and Thai tea. Cashew nut pretzel sticks with tea coating were evaluated the preference and the results showed that Thai tea had higher liking score than Ceylon tea. Therefore, the cashew nut pretzel sticks with tea coating consisted of all-purpose flour 37%, ground cashew nut 12%, water 10%, yeast 2%, sugar 1%, salt 2%, Thai tea powder 4%, whipping cream 14%, and white chocolate compound 18%. Texture analysis of hardness and fracturability of cashew nut pretzel sticks was 1410 g force and color value  $L^*$   $a^*$   $b^*$  of Thai tea was 44.73, 33.51, 51.45, respectively. The result of 100 consumer accepted tea coating cashew nut pretzel sticks with the price 26-30 bath for 12 pieces or 50 grams (1 box).

## List of contents

|                        |     |
|------------------------|-----|
| Acknowledgement        | I   |
| Abstract               | II  |
| List of contents       | III |
| Introduction           | 1   |
| Aim and Objectives     | 2   |
| Literature review      | 3   |
| Methodology            | 21  |
| Results and Discussion | 24  |
| Conclusion             | 36  |
| References             | 37  |
| Appendix A             | 39  |
| Appendix B             | 46  |



## INTRODUCTION

Pretzel sticks are a staple snack becomes commercial snack worldwide which is favorites around the world (Modern Mechanix, 2014). Basic pretzel sticks is a pencil shaped stick of bread that has been rolled and baked to a crispy stick. Pretz is a Japanese snack made by Ezaki Glico. Pretz is stick-shaped and comes with a texture similar to pretzels. Pretz is dusted with seasonings instead of enrobed in flavored fudge (Japanese snack food, 2014). There are many sizes of pretzel sticks to become more variety. This made an ideal source of snack to take along if an individual was traveling for several days.

Recently, pretzel sticks are popular bakery product because of short preparation time including the change of consumer behavior to find something quick and easy to eat such as snack or fast food. However, the growth of easy snack or ready-to-eat food should be served for their tasty and nutritive concern. Thus, a new flavor and taste of the product is important nowadays. Serving pretzel sticks with sweet coating might be compatible. This thing will make the snack get more delicious, increase more flavor, more nutrient, and more varieties.

Cashew nut is one of choices that give a lot of nutrients in bakery product. Delicately sweet, crunchy and delicious cashew nut is packed with energy, antioxidants, minerals and vitamins that are essential for robust health (USDA National Nutrient Database, 2009). Also the coating of breadstick can add some black tea or red tea to get more different varieties. Black tea or red tea made from leaves of the small tree *Camellia sinensis*. Black tea is generally stronger in flavor than the less oxidized teas (Tea's Wonderful History, 2012). All these teas also have caffeine and the anine, which affect the brain and seem to heighten mental alertness.

This study has aim to develop new pretzel sticks product coating by tea and white chocolate compound. This product will be a new choice of delicious snack with lots of varieties from new pretzel sticks with tea.

## **Aim**

To develop the new pretzel sticks product coating by red tea and white chocolate compound

## **Objectives**

1. To formulate the cashew nut pretzel sticks
2. To formulate the white chocolate coating flavored with Thai tea
3. To develop cashew nut pretzel sticks coating with white chocolate flavored and Thai tea
4. To evaluate the consumer acceptance



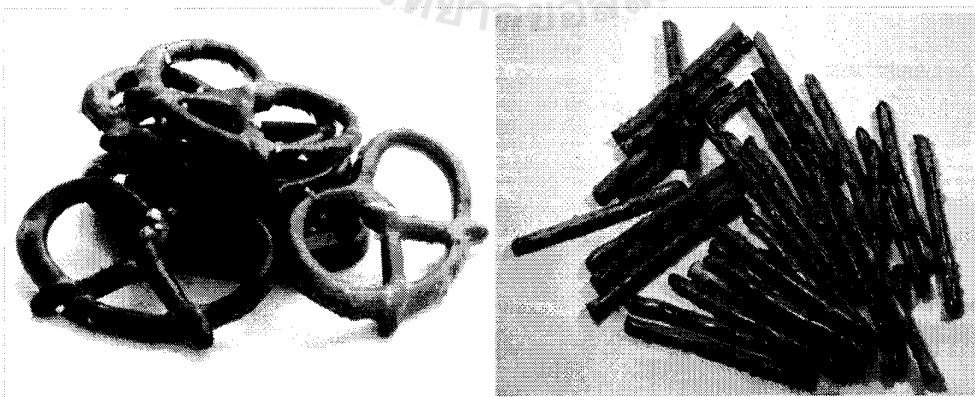


# LITERATURE REVIEW

## I. PRETZEL

Pretzel is a type of baked bread product made from dough most commonly shaped into a unique. Pretzels are a snack food, which have unique shapes and a hard, shiny outer surface. First developed in the seventh century, pretzels have been called one of the world's oldest snack foods [1]. A recent market survey found that the pretzel market in the United States is about \$560 million a year with over 136.2 million kg of pretzels and pretzel products being produced. The pretzel market has grown in recent years because pretzels are considered as a healthy, fat-free snack. Recently, they are mass produced using primarily automated machinery [2].

The originally unique, two looped, knot shape of a pretzel is one of its defining characteristics. The typical pretzel has a pleasant cracker-like flavor, a crisp, brittle texture, and a brown glossy surface color. Salt crystals are often sprinkled on its surface to make them taste more appealing. Pretzels have moisture content from 2 to 4% and therefore have a very long shelf life. While the two-looped knot shaped, hard pretzels may be the most popular kind of pretzel, there are other kinds which are sold. Soft pretzels are also manufactured. These products typically have much higher moisture content than hard pretzels and are usually larger. They also have a shorter shelf life. Other shapes are also produced such as thick and thin rods, pretzel rings, and loops. Additionally, flavored pretzel such as cheese, rye, caraway, kosher, and butter are also available. Finally, salt-free pretzels called baldies are now made [3,4].



**Figure 1:** Unique knot shape pretzels (left) and pretzel sticks (right)

*Source:* [https://c2.staticflickr.com/2/1155/768591540\\_b0147ebf9b.jpg](https://c2.staticflickr.com/2/1155/768591540_b0147ebf9b.jpg)

[http://cdn1.condenast.co.uk/639x426/a\\_c/29Pretzels\\_CNT\\_16nov12\\_rex\\_b.jpg](http://cdn1.condenast.co.uk/639x426/a_c/29Pretzels_CNT_16nov12_rex_b.jpg)

## 1. History

Some historians have said that the pretzel is the oldest snack food ever developed. It is believed that the pretzel was first developed during 610 A.D. by a monk in southern France or northern Italy. Using the dough left over from bread making, he formed the pretzel shape, which was meant to look like a child's arms folded in prayer. He used these creations as treats for children that learned their prayers. He called the snacks pretiola, which means little reward in Latin. The pretiolas eventually found their way into Germany and Austria where they became known as pretzels. The pretzels grew in popularity and are said to have been brought over to America on the Mayflower in 1620. The first pretzels were of the soft variety. Legend has it that one night a baker who was baking a batch of pretzels fell asleep. When he woke up all the moisture was cooked out of them and the hard pretzel was born [5].

## 2. Raw materials

The primary ingredients in pretzel dough include flour, water, yeast, shortening, and sugar. Each of the ingredients has an important effect on the dough during manufacture and the properties of the final product.

### 2.1 Flour

In pretzel dough making, flour is perhaps the most important ingredient. It is primarily made up of starch and protein. When water is added, the flour protein soaks up the water rapidly and reacts with it to form a mass known as gluten. The gluten can be stretched and formed quite a distance without breaking. This allows pretzels to be formed into the desired shapes. Sometimes the flour is enriched with various nutrients such as thiamin, riboflavin, and iron to increase the nutritional value of the product. Nutrient enrichment is highly regulated by the government so preset limits are required for a flour to be called enriched. The flour used for pretzels is called soft wheat flour and has a protein content of about 9%. It is the largest component in the dough making up about 65-70% of the total recipe [3].

#### (1) Bread flour

Bread flour is one type of wheat flours producing from wheat (*Triticum spp.*). It is produced from hard wheat that has five nutrients: fat, minerals, moisture, starches and proteins. Fat and minerals generally account for less than 1% of total flour's content. The moisture content of flour is also relatively low especially when it is packaged. It cannot exceed 15% under government standards but its actual moisture content varies depending on climatic

conditions and storage. In damp areas, flour absorbs moisture from the atmosphere and the moisture content may exceed the standard limit. Starches comprise of 63% to 77% of flour. They are necessary for component absorption of moisture during baking. This process, known as gelatinization, occurs primarily at temperatures above 140°F (60°C). Starches also provide food for yeast during fermentation. Flour proteins are important because of their gluten-forming potential.

In bread flour, it has higher protein (gluten) content (approximately 12 %) than all-purpose bleached or white flour (approximately 10%) and cake flour (approximately 7%). It is smoother in texture and is used to ensure that the dough is elastic and strong so that the bread can have strong and elastic structure. Sometimes it is called strong flour. So, it can be used for general baking [6,7].

## **(2) All-purpose flour**

All-purpose flour is made from a blend of high-gluten hard wheat and low-gluten soft wheat. It is fine-textured flour milled from the inner part of the wheat kernel and contains neither the germ (the sprouting part) nor the bran (the outer coating). All flours not containing wheat germ must have niacin, riboflavin, thiamin and iron added. (Individual millers sometimes also add vitamins A and D). These flours are labeled "enriched". All-purpose flour comes in two basic forms; bleached and unbleached that can be used interchangeably. Flour can be bleached either naturally as it ages or chemically [8].



**Figure 2:** Different characteristic of various flours: all purpose flour, bread flour, white whole wheat flour, and whole wheat flour.

**Source:** [http://blog.kitchenaid.com/wp-content/uploads/bread\\_1\\_text\\_Best-Flours-for-Baking-Bread.jpg](http://blog.kitchenaid.com/wp-content/uploads/bread_1_text_Best-Flours-for-Baking-Bread.jpg)

### **(3) *Cake flour***

Cake flour or pastry flour is fine textured, low gluten soft-wheat flour with high starch content. It makes particularly tender cakes and pastries. Cake flour contains lower protein content than bread flour (7 to 9%). Protein is not important factor in cake structure as in the bread. Weak gluten flour is suitable for mixing condition of cake but cake flour should be strong enough to hold other ingredients and produce delicate structure [9]. Cake flour is a blend of a more finely milled unbleached wheat flour and cornstarch, which makes a better end result than unbleached wheat flour alone (cornstarch blended with all purpose flour commonly substituted for cake flour when the latter is unavailable). The end product, however, is denser than would result from lower-protein, chlorinated cake flour [10].

#### **1.2 Yeast and leavening agent**

Pretzel dough is unusual because it contains both yeast and chemical leavening agents. Yeast is a biological (naturally occurring) raising agent. Yeast is put in the dough and produces carbon dioxide gas as it metabolizes the sugar during fermentation. This gas creates tiny air pockets in the batter, which helps make the pretzels lighter and crispier.

Yeast is typically supplied as a dry, granular product. Dry yeast is desirable because it can be stored for a long time at room temperature. It is one type of leavening agent in bakery product to making the bread. There are many types of yeast. Fresh yeast (compressed), available from some bakeries, needs to be blended with water to form a smooth cream, then added to any remaining liquid and left to foam before being added to the dry ingredients. Dried yeast, available in long-life sachets can be added to liquid or mixed straight into the dry ingredients. For fermentation of the yeast to take place, it needs the right conditions of food (sugar), warmth (26-29°C) and moisture (liquid) [11]. Leavening agents have a similar effect as fermenting yeast; however they have less effect on the final taste. Chemical leavening agents include materials such as sodium bicarbonate and ammonium bicarbonate. These chemical leavening agents will breakdown chemically to produce carbon dioxide gas in the presence of water [4].

#### **1.3 Sugar**

Sugar is the common name for sucrose that is one kind of carbohydrate that is present naturally in fruits and vegetables. All plants use a natural process called photosynthesis to turn sunlight into the nourishment they need for growth. Of all known plants, sugar is most highly concentrated in sugar beets and sugar cane. Sugar is simply separated from the beet or



cane plant, and the result is 99.95% pure sucrose (sugar). The sucrose from sugar beets and sugar cane is not only identical to one another, but each is the same as the sucrose present in fruits and vegetables.

There are many different types of granulated sugar. Some of these are used only by the food industry and professional bakers and are not available in the supermarket. The types of granulated sugars differ in crystal size. Each crystal size provides unique functional characteristics that make the sugar appropriate for a specific food's special need. Regular or white sugar, as it is known to consumers, is the sugar found in every home's sugar bowl, and most commonly used in home food preparation. White sugar is the sugar called for in most cookbook recipes. The food industry stipulates "regular" sugar to be "extra fine" or "fine" because small crystals are ideal for bulk handling and not susceptible to caking. In baking, sugar is important as it adds flavor, taste and moisture and has a tenderizing effect as well as the food for yeast to ferment the bread dough.

#### **1.4 Water**

Water is one of basic ingredient in bakery products. Normally water used in bakery products should be potable free from hazardous materials while most bakeries use municipal water. The types of water are soft water that contains low soluble materials and hard water contains high soluble materials. Intermediate hard water or tap water is suitable for bread making. Yeast ferments and produces gas CO<sub>2</sub> from this water.

The pretzel dough would not be possible without the use of water. While there is less water in pretzel dough than in bread dough, it still makes up about 30-35% of the recipe. Water is important because it lets the dough flow and allows the yeast to contact the sugars for fermentation. It also causes the chemical leavening agents to activate.

#### **1.5 Salt**

Salt is a seasoning, preservative and flavor enhancer. It is a minor ingredient in bread-making and is used to control yeast fermentation. Salt does indeed do something more than loafing around and tasting good. Salt affects dough texture, making it stronger and less sticky. Salt reduces oxidation of the dough during mixing. Oxidation causes the degradation of carotenoid pigments in the flour that contribute to flavor and crumb color. Salt regulates yeast activity, causing fermentation to progress at a more consistent rate. During fermentation, salted doughs rise slowly; an occurrence usually solely attributed to salt's



dehydrating effect on yeast, while unsalted dough mixes has little resistance to extension and feels sticky.

Salt also affects shelf life. Because it attracts water, thus, it can help keep bread from staling too quickly in a dry environment. However, in a humid environment, it can make the crust soggy. Typically the amount of salt in dough is between 1.8 to 2% of the amount of flour, by weight. If there is a large proportion of other ingredient, such as seeds, for which salt also enhances flavor, the percentage of salt could be a little higher.

**1.6 Egg**

Eggs added to dough help with rising. A bread dough rich with egg will rise very high, because eggs are a leavening agent. Eggs also contain the emulsifier lecithin. Lecithin can add to the overall consistency of the loaf. Thus, egg enriches and also adds flavor, moisture, nutritive value and yellow color. They have three main functional properties in cooking; coagulation, emulsification and foaming ability.

As well, the fats from the yolk help to tenderize the crumb and lighten the texture a bit. The fat in egg yolks helps shorten the gluten strands in bread dough, increasing the gluten's elasticity. This results in a more tender crumb and softer crust in the finished bread. Additionally, the coagulating property of eggs due to their protein helps create a more tenderness and even texture. As a leavening agent, the eggs contribute to the bread dough rising higher than non-egg yeast bread. The lipids in egg yolks also give color to the crust of yeast bread. Due to this heavier coloration than egg-less dough, baking temperatures should be reduced slightly to prevent too much coloration. The protein in the eggs also contributes to the Maillard reaction, the chemical change that causes browning of bread's crust, which relies on the presence of heat, moisture, protein and sugars.

**1.7 Vegetable shortening or vegetable oil**

Vegetable shortening is a solid form of vegetable fats and oils. Its main purpose in the dough is to inhibit the formation of the gluten. This helps the dough stay softer, increases the volume and gives it a crumbly texture. Fat also allows the dough to remain more palatable for longer. A typical pretzel recipe may call for about 2-3% vegetable shortening.

***Olive oil***

Olive oil probably is the most widely-used oil in cooking. Olive oil is obtained from the olive fruit (*Olea europaea*; family Oleaceae), a traditional tree crop of the Mediterranean,

primarily in Italy, Spain and Greece (though countries such as America and Australia also produce it). The oil is produced by pressing whole fresh olives. Much like wine-making, climate, soil and the way the olives are harvested and pressed all have an impact on oil's character.

There are many benefits of olive oil such as lowers the levels of total blood cholesterol, LDL-cholesterol and triglycerides. Rich in antioxidants, especially vitamin E, long thought to minimize cancer risk [12]. Olive oil is assessed on three criteria - fruitiness, bitterness and pepperiness – the flavour, smell and colour can vary radically, both according to its origin, as well as whether it's extra virgin (the finest grade) or not. Olive oil has long been recognized for its unusual fat content. This plant oil is one of the few widely used culinary oils that contain about 75% of its fat in the form of oleic acid (a monounsaturated, omega-9 fatty acid). In terms of monounsaturated fat, the closest common culinary oil to olive is canola oil, with about 60% of its fat coming in monounsaturated form.

By contrast, the fat in soybean oil is only 50-55% monounsaturated; in corn oil, it's about 60%; in sunflower oil, about 20%; and in safflower oil, only 15%. When diets low in monounsaturated fat are altered to increase the monounsaturated fat content (by replacing other oils with olive oil), research study participants tend to experience a significant decrease in their total blood cholesterol, LDL cholesterol, and LDL:HDL ratio. Recent research studies have taken these heart-healthy effects of olive oil one step further. Olive oil's monounsaturated fat content (specifically, its high level of oleic acid) has now been determined to be a mechanism linking olive oil intake to decreased blood pressure. Researchers believe that the plentiful amount of oleic acid in olive oil gets absorbed into the body, finds its way into cell membranes, changes signalling patterns at a cell membrane level (specifically, altering G-protein associated cascades) and thereby lowers blood pressure.

### **1.8 Cashew Nut**

Cashew nut is delicately sweet crunchy and delicious. Cashews are not actually nuts but seeds. They are a popular snack and food source. Cashew nut is packed with energy, antioxidants, minerals and vitamins that are essential for robust health. The delicately flavored cashew nut is a favorite between meal snacks that can be readily found in local market all year round. It also makes wonderful nut butter and a special addition to salads and stir-fry dishes.

Cashew, or “caju” in Portuguese, is one of the popular ingredients in sweet as well as savory dishes worldwide. Cashew nuts are actually the kidney-shaped seeds that adhere to the bottom of the cashew apple, the fruit of the cashew tree (*Anacardium occidentale*). The cashew tree is a tropical evergreen native to Brazil’s Amazon rain forest. It spread all over the planet by Portuguese explorers and today, it is cultivated at commercial scale in Brazil, Vietnam, India, and in many African countries [13]. While cashew apples are not appreciated in the United States, they are regarded as delicacies in Brazil and the Caribbean. Cashews are always sold shelled because the interior of the shells contains a caustic resin, known as cashew balm, which must be carefully removed before the nuts are fit for consumption. This caustic resin is actually used in industry to make varnishes and insecticides.



**Figure 3:** Cashew apples and its seeds (left); cross section of cashew fruit (mid); and cashew kernel (right).

**Source:** <http://3.bp.blogspot.com/-BvX6xBQqzGk/Ugi7rAtx9I/AAAAAAAAAXs/1XEPvujmB84/s1600/Cashew-Nut-The-Cholesterol-and-Fat-Busting-Super-Nut.jpg>  
<http://www.hobotraveler.com/2008-1/08-1408-cashew-nut-guatemala.jpg>  
<http://topfoodfacts.com/wp-content/uploads/2013/01/raw-cashew-nuts.jpg>

Cashews, unlike oily tree nuts, contain starch to about 10% of their weight. This makes them more effective than nuts in thickening water-based dishes such as soups, meat stews, and some Indian milk-based desserts. Many Southeast Asian cuisines use cashews for this unusual characteristic, rather than other nuts. Cashew nuts are commonly used in Indian cuisine, whole for garnishing sweets or curries, or ground into a paste that forms a base of sauces for curries, or some sweets. It is also used in powdered form in the preparation of several Indian sweets and desserts. The cashew nut can also be harvested in its tender form, when the shell has not hardened and is green in color. The shell is soft and can be cut with a knife and the kernel extracted, but it is still corrosive at this stage, so gloves are required. The kernel can be soaked in turmeric water to get rid of the corrosive material before use. Cashew nuts are also used in Thai and Chinese cuisine, generally in whole form [14].

1477 e.1

Cashews are high in calories. The 100 g of nuts provide 553 calories. They are packed with soluble dietary fiber, vitamins, minerals and numerous health-promoting phytochemicals that help protect us from diseases and cancers. Cashew nuts also are rich in “heart-friendly” or healthy monounsaturated-fatty acids like oleic and palmitoleic acids that promote good cardiovascular health because monounsaturated fats reduce high triglyceride levels which are associated with increased risk for heart disease. These essential fatty acids help lower harmful LDL-cholesterol while increasing good HDL cholesterol [15].

Cashew is reported about the rich in antioxidants that help in the elimination of free radicals that may cause some cancer. For its minerals, magnesium works with calcium to support healthy muscles and bones in the body. It also helps promote normal sleep patterns in menopausal women. Not only that, cashew's has high copper content is vital in energy production, greater flexibility in blood vessels, bones and joints. Moreover, cashew nuts have a high energy density and high amount of dietary fiber, both have been attributed to a beneficial effect on weight management, but only when eaten in moderation. Therefore, cashew nut consumption helps the body utilize iron, eliminate free radicals, develop bone and connective tissue, and produce the skin and hair pigment melanin.

### 3. Pretzel manufacturing process

Recently, commercial hard pretzels are made in the large scale production. The manufacture of pretzels is a nearly completely automated process, which converts the raw ingredients into a shaped, finished product. It is estimated that 90% of all pretzels are never touched by human hands during the manufacturing process. The following steps outline the procedure used to make typical hard pretzels. Soft pretzels have a slightly different manufacturing procedure.



**Figure 4:** Example of commercial hard pretzels in various styles

*Source:* <http://www.gatewaysupermarket.com>



### **3.1 Mixing Dough**

The pretzel dough is made by factory compounders in large stainless steel tanks. The flour and warm water are stored in bulk and transferred to the tanks automatically. The yeast is added and the three ingredients are blended with high-speed horizontal mixers. When these are adequately blended, the rest of the ingredients such as sugar, sodium bicarbonate, vegetable shortening, salt, and flavorings are added. Compared to many dough products such as bread or crackers, pretzel dough is relatively under mixed. This allows the dough to withstand the punishment of machining without becoming too sticky or misshapen. The dough is then allowed to ferment and rise for about 30 minutes.

### **3.2 Forming pretzel**

The fermented dough is then transferred to the hopper of the shape-making equipment. Traditionally, pretzels were made by rolling the dough and twisting it into the familiar pretzel shape. However, today most companies have extrusion devices in which the dough is forced through an opening and stamped into shape with a wire cutter. The excess dough is recycled to the hopper while the stamped pretzels are transferred to a conveyor. They are passed under rollers to ensure a flat surface and uniformity of size.

### **3.3 Dipping and salting**

The raw pretzels are next conveyed on a wire mesh belt to an alkaline bath. It generally takes several minutes for the pretzels to reach the bath. This slow transport is deliberate as it allows the pretzels to undergo another short fermentation or rest period. The alkaline bath is filled with an aqueous solution of either sodium carbonate or lye. The resulting bath has an overall 1% concentration of sodium hydroxide. It also is held at a temperature of about 93.3°C. The pretzels are dipped in the bath for 10-20 seconds and typically float when they are finished. This process gelatinizes the starch on the pretzel's surface making it gummy and sticky, allowing the salt to adhere more readily.

After the pretzels leave the hot bath, they are passed under a machine which delivers salt crystals to their surface. Modern pretzel making lines use a vibrating salter, which consists of a vibrating plate driven by a series of small motors and magnets. The salt is evenly distributed on each pretzel with the excess falling through the wire mesh belt and being recycled. Generally, the aim is to add about 2% salt to each pretzel.



### 3.4 Cooking

The in-process pretzels are next transported to long convection tunnel ovens. The cooking temperature varies from 350-550°F (176.7-286.1°C) and this baking step takes from about 4-8 minutes. In the front of the oven, the temperature is significantly higher than at the end. The initial high heat caramelizes the gelatinized starch, which produces the characteristic dark brown pretzel color. The temperature is gradually raised at the start because if heated too fast, the structure of the pretzels will be weakened which could cause cracking and breaking during shipping. At the end of the oven the temperature is cooler to allow moisture in the pretzel to be released. During this entire baking cycle, the moisture content is reduced to about 15%. In the next baking phase, the pretzels are kiln dried or oven dried at about 250°F (119.4°C) for anywhere from 20-40 minutes. This further reduces the moisture content to below 4%.

### 3.5 Packaging

From the ovens, the pretzels are passed along various conveyors and allowed to cool. They are then moved along to the packaging machines. Here the pretzels are weighed and the correct amount is placed in the packaging. They can be put in many different types of packages including trays, boxes or bags with cellophane or polyethylene protected coatings. It is important that this packaging be air tight to prevent the uptake of moisture by the product. Excessive moisture would cause them to become soft. The package must also have consumer appealing graphics, which help it stand out on a store's shelves. Most major bakeries distribute products to all of the largest cities in the world. Consequently, there are very few people who are unfamiliar with pretzel snacks.

## II. TEA

### 1. History of tea

Tea is a kind of aromatic beverage that comes from the processed dried leaves, buds, and twigs of the *Camellia sinensis* which originated from China [16-18]. Tea is the most widely consumed beverage in the world next to water. The tea leaves will be harvested and go to the process of tea making. Different kinds of processes give the different types of tea because of the different chemical reaction during the process leading to the different taste and aroma [17,18]. The tea making process is known as a delicate process involving the steeping of the tea plant parts followed by various treatments which are responsible for the distinguishing characteristics of flavor and aroma.

The drinking of tea began in ancient China over 5,000 years ago. According to the legend, the Shen Nong, an early emperor was a skilled ruler, creative scientist, and patron of the arts. His far-sighted edicts required, among other things, that all drinking water be boiled as a hygienic precaution. One summer day while visiting a distant region of his realm, he and the court stopped to rest. In accordance with his ruling, the servants began to boil water for the court to drink. Dried leaves from the nearby bush fell into the boiling water, and a brown liquid was infused into the water. As a scientist, the Emperor was interested in the new liquid, drank some, and found it very refreshing.

In the 1600's, tea became highly popular throughout Europe and the American colonies. In 1662, tea reached English and was fully introduced to the world. England announced tea as their national beverage which lasts for a hundreds of years. Tea also played a dramatic part in the establishment of the United States of America. In 1767 the British Government put a tax on the tea used by American colonists. Protesting this "taxation without representation," the colonists decided to stop buying tea and refused to allow tea ships to be unloaded. One December night in 1773, men dressed as Native Americans boarded British ships in Boston Harbor and threw more than 300 chests of tea into the sea. While not the only instance of teas being thrown overboard in protest of the British tax on tea, this most famous Boston Tea Party was said to be a principle act leading to the Revolutionary War. Anna, Duchess of Bedford, is credited with creating *Afternoon Tea* in 1840, when she began taking tea with a light snack around 4:00 p.m. to ward off "that sinking feeling."

High Tea originated with the rural and working class British, who would return to their homes at about 6:00 p.m. for a meal of potted meats, fish, cheese, salads, sweets, and a pot of strong tea. The U.S. played an important role in the history of tea, inventing the tea bag and iced tea, both in 1904. Recently, the U.S. has led the rest of the world in marketing convenient Ready-To-Drink forms of tea in bottles.

## 2. Type of tea

Different types of teas that are made from *Camellia sinensis* have distinguished flavor and aroma because of the way they are treated during the procedures. The unique flavor of tea beverage depends on the relative compounds being released during the treatments, usually involving heat due to the simple extraction method of applying hot water [18,19]. Nowadays, the various types of tea are classified according to the different process [19].

There are four major tea types that are white tea, green tea, oolong tea and black tea. All four types of tea come from the same raw material of *Camellia sinensis* but what grouped them into different types is the processing methods where the leaves are processed steamed, fermented (oxidized), dried, or bruised in order to provide the tea with their distinctive characteristics [20].

### 2.1 Thai black tea or red tea

Black tea is a type of tea that is more oxidized than oolong, green and white teas. Black tea is generally stronger in flavor than the less oxidized teas. Two principal varieties of the species are used: the small-leaved Chinese variety plant (*C. sinensis* subsp. *sinensis*), used for most other types of teas, and the large-leaved Assamese plant (*C. sinensis* subsp. *assamica*), which was traditionally mainly used for black tea, although in recent years some green and white have been produced [21]. Generally, unblended black teas are named after the region in which they are produced [22]. Often, different regions are known for producing teas with characteristic flavors.

The flavor of black tea varies greatly. Some are flowery, some malty, some spicy, and some nutty. Generally, black teas should be steeped using boiling water for three to five minutes. An exception would be first flush (or 'spring') Darjeeling's. The first flush harvest is made from very delicate leaves and often the finished product looks very much like a green tea (even though it is processed like a black tea). This tea is better with slightly cooler water and a shorter steep. Special attention should be given when preparing black teas, as steeping them too long will quickly result in a bitter taste. Due to their stronger flavor and the use of hotter water, black teas generally cannot handle multiple infusions very well, unlike some other varieties.

### 2.2 Thai tea

Thai tea is also made from strongly brewed Ceylon tea. However, due to Ceylon tea's high price, a locally grown landrace (traditional or semi-wild) version of Assam known as Bai Miang with added food coloring is commonly used. Other ingredients may include added orange blossom water, star anise, crushed tamarind seed or red and yellow food coloring, and sometimes other spices as well. This tea is sweetened with sugar and condensed milk and served chilled [21-22].

## 2.3 Ceylon tea

Ceylon tea comes from Srilanka, a small island in the Indian Ocean named "Ceylon" by British colonists. The history of Ceylon tea was as far back as the year 1824 in which the British brought a tea plant from China to Ceylon (as Sri Lanka was known at the time). At that time, tea was planted in the Royal Botanical Gardens, Peradeniya and is considered to have been the first non-commercial tea plant in Sri Lanka. It is grown on numerous estates which vary in altitude and taste. Ceylon tea is prized for its rich aroma and taste. High-grown tea is honey golden liquor and light and is considered to be among the best tea in terms of its distinct flavor, aroma, and strength. Low-grown teas are a burgundy brown liquor and stronger. Mid-grown teas are strong, rich and full-bodied. [23]

Ceylon black tea is made from the aged stems and leaves of the tea plant. Like green tea, black tea helps with mental alertness and acuity. It may reduce your risk of atherosclerosis, ovarian cancer as it contains theaflavins and thearubigins, which are powerful antioxidants that help to fight free radicals that can damage DNA, and may cause cancer in the body. Moreover, they have also been shown to lower the risks of Parkinson's disease, kidney stones, heart attacks, and reduce the size of tumors. Black tea can also help with orthostatic hypertension or dizziness when standing up. By drinking Ceylon tea chances of catching influenza drastically reduce and it may also increase alpha-wave activity in your brain, allowing you to remain more alert [24].

## III. WHITE COMPOUND CHOCOLATES

Compound chocolates is different from regular chocolates in that cocoa butter that is replaced with vegetable fats, creating a chocolate coating that will melt and turn into a hard shell at room temperature. Compound chocolates have many uses and are available in dark, milk and white varieties. Although white compound chocolate does not contain cocoa solids, it can be just as useful in compound form in baking and confectionery applications.

White compound chocolates are less expensive than regular chocolate, because they do not use cocoa butter, the main expense in regular chocolate. Generally sold in chip or disc form, white compound chocolate is composed of sugar, vegetable fats, milk and whey, in addition to emulsifiers and flavorings. Vegetable fats are hard fats, meaning that they are semisolid at room temperature, allowing them to harden within a few minutes of being removed from a heat source, without tempering. Sugar provides sweetness, texture and body. Full cream or milk powder is the primary ingredient in white compound chocolate, giving it a

smooth, creamy flavor. White compound chocolates melt at 103 to 108 °F, which is higher than regular chocolates, which melt at approximately 98°F. Light and creamy-white in color, white compound chocolates compare in taste to regular white chocolate, differing only in that they do not have the same "melt in your mouth" quality as regular chocolate.

The FDA (Food and Drug Administration, a federal agency) mandates that in order to be called "chocolate", the fat content of the cocoa product is limited to cocoa butter (the naturally-occurring fat of the cocoa bean) and dairy (milk) fat. The cocoa butter in true chocolate melts at human body temperature, giving chocolate a "melt-in-your-mouth" quality, which enhances the cocoa flavor and contributes to the sensory experience of eating chocolate. Only products containing cocoa solids, cocoa butter and dairy fat can be sold as chocolate in the United States. European Union regulations are different and allow up to 5% of other vegetable fats to be present in true chocolate.

Compound Chocolate is a cocoa product containing vegetable fats in the place of cocoa butter. The vegetable fats commonly used are often "hard" fats or fats semi-solid at room temperature, such as coconut oil and palm kernel oil. One of the chief benefits of compound chocolate is that it can deliver cocoa flavor at a greatly reduced cost, due to the fact that vegetable fats are less expensive than cocoa butter.

Compound Chocolate also has the advantage of not having to be tempered. True chocolate must be heated and cooled in a specific way in order to solidify and avoid fat bloom, which is the rising to the surface of the cocoa butter, giving the chocolate a dull, cloudy surface. Because of the texture of the vegetable fat in compound chocolate, the melted compound will harden within a few minutes of removal from a heat source, creating a firm adherent coating on an item dipped in melted compound chocolate.

Compound Chocolate will not produce the shiny surface of tempered true chocolate. According to Archer Daniels Midland, a cloudy surface on items made with compound chocolate may be associated with excessive humidity present when the compound is hardening. Compound Chocolates all follow the same basic recipe: cocoa solids, vegetable fats and sweetener, with milk solids added for milk varieties. Other flavors and colors may be added, and an emulsifier is necessary to keep the product from separating. "White Chocolate" is not a chocolate at all because it contains no cocoa solids. "White Chocolate coating" is a mixture of sugar, vegetable fat, milk and whey, with emulsifiers and flavoring.

The majority of Compound Chocolate is sold in chip, melt or disc form for ease of packaging, merchandising and transportation and consumer use. Compound chocolate may



be formed into any shape, including large bars. A liquid compound chocolate is available for industrial use and can be shipped in tankers.

Compound Chocolate is also known commercially as coating chocolate, compound chocolate coating, chocolate summer coating, decorator's chocolate, confectioners' chocolate, confectionery coating, chocolate flavored coating or confectioners' coating chocolate

### 3.1 Composition

White compound chocolate is composed of sugar, vegetable fats, milk and whey, in addition to emulsifiers and flavorings. Vegetable fats are hard fats, meaning that they are semisolid at room temperature, allowing them to harden within a few minutes of being removed from a heat source, without tempering. Sugar provides sweetness, texture and body. Full cream or milk powder is the primary ingredient in white compound chocolate, giving it a smooth, creamy flavor. [25]

**3.1.1 Sugar** is the sweetener of the compound chocolate. Sugar also adds texture and body to a recipe in which it is an ingredient. "Sugar" implies derivation from cane or beet sources. The ingredient to be concerned about is high fructose corn syrup (HFCS) which has received considerable bad press because of its prevalence in processed "junk" food – HFCS has to be labeled as such so it is not a problem here.

**3.1.2 Vegetable Fat** in compound chocolate replaces the cocoa butter in true chocolate. The substitution of vegetable fat for cocoa butter results in a considerable cost savings. Vegetable fats used may include coconut oil and palm kernel oil.

**3.1.3 Coconut oil** is a fat consisting of about 90% saturated fat. The oil contains predominantly medium chain triglycerides, with roughly 92% saturated fatty acids, 6% monounsaturated fatty acids, and 2% polyunsaturated fatty acids. Of the saturated fatty acids, coconut oil is primarily 44.6% lauric acid, 16.8% myristic acid a 8.2% palmitic acid and 8% caprylic acid, although it contains seven different saturated fatty acids in total. Its only monounsaturated fatty acid is oleic acid while its only polyunsaturated fatty acid is linoleic acid. Coconut oil is often partially or fully hydrogenated to increase its melting point in warmer temperatures. This increases the amount of saturated fat present in the oil, and may produce Trans fats.

**3.1.4 Palm oil and palm kernel oil** are composed of fatty acids, esterified with glycerol just like any ordinary fat. Both are high in saturated fatty acids, about 50% and 80%,

respectively. The oil palm gives its name to the 16 carbon saturated fatty acid palmitic acid found in palm oil; monounsaturated oleic acid is also a constituent of palm oil while palm kernel oil contains mainly lauric acid. Palm oil is the largest natural source of tocotrienol, part of the vitamin E family. Palm oil is also high in vitamin K and dietary magnesium. As they are not derived from animal sources, both coconut oil and palm kernel oil are cholesterol-free.

**3.1.5 Cocoa** is the dried and partially fermented fatty seed of the cacao tree from which chocolate is made. Cocoa powder is the dry powder made by grinding cocoa seeds and removing the cocoa butter from the dark, bitter cocoa solids. Dutch process, “Dutched” or European cocoa is treated with an alkali to make the flavor milder and richer and less bitter. The process also changes the color of the cocoa to a dark, rich, reddish shade.

Natural cocoa, also known as American, regular or non-alkalized cocoa, is lighter and more acidic. The acidity or alkalinity of cocoa is important for bakers, who might change the leavening of baked goods depending on which cocoa is used. Standard cocoa powder has a fat content of approximately 10-12%.

**3.1.6 Full Cream Milk Powder** has 26% minimum butter fat. It is the “milk” component in milk coating chocolate and a primary ingredient in white coating chocolate. This is an animal product with implications for those with milk protein allergies, vegans and vegetarians, and those who keep Kosher.

**3.1.7 Emulsifiers** are compounds that allow two or more unlike and non-blendable substances to be mixed together as a stable whole.

**(1) Lecithin (E322)** is used commercially in substances requiring a natural emulsifier and/or lubricant. Lecithin is the emulsifier that keeps cocoa and cocoa butter in a candy bar from separating. However, one source of lecithin is soy (soya lecithin), which may prevent the product from being Kosher for Passover.

**(2) Polyglycerol Polyricinoleate or PGPR (E476)** is an emulsifier made from castor beans which reduces the viscosity of chocolate and similar coatings and compounds. It works by decreasing the friction between the particles of cocoa, sugar, milk, etc. present so that they can flow more easily when melted. It is used at low levels. It is virtually always paired with lecithin or another plastic viscosity-reducing agent.

**3.1.8 Vanilla** is a generic term describing the flavor essence associated with the pod of certain orchids of the genus vanilla. Vanillin is a specific term referring to the chemical which contributes the vanilla flavor note. Though there are many compounds present in the extracts of vanilla, the compound vanillin (4-hydroxy-3-methoxybenzaldehyde) is primarily responsible for the characteristic flavor and smell of vanilla. Vanillin can be natural, derived from the pods of orchids of the vanilla species, or synthetic, derived from lignin, a by-product of paper processing, or coal tar.

**3.2 Application**

Compound chocolate is most commonly in the chocolate industry for making molded candies. The qualities of compound chocolate, notably its attractive price and the fact that it hardens without tempering, make it ideal for use by the hobbyist chocolatier. Compound chocolate has a reputation for being less “fussy” or hard to work with than true chocolate. The flavor, while not as rich as true chocolate, is very appetizing and desirable.

Compound chocolate is a reliable substitute for couverture chocolate in chocolate fountains, and may be a significant cost-saving tool for large-volume chocolate users such as caterers, restaurants and other commercial enterprises. The procedure for use is identical to that of couverture chocolate.

Compound chocolate is the ingredient of choice in confectionary and bakery applications that involve dipping items in chocolate, such as chocolate-dipped strawberries and cookies. Only compound chocolate will harden to a shell at room temperature without tempering. Compound chocolate may be used in baking; as with couverture chocolate, the chocolate compound pieces will not hold their shape like commercial chocolate chips, which are formulated to hold their shape during baking.

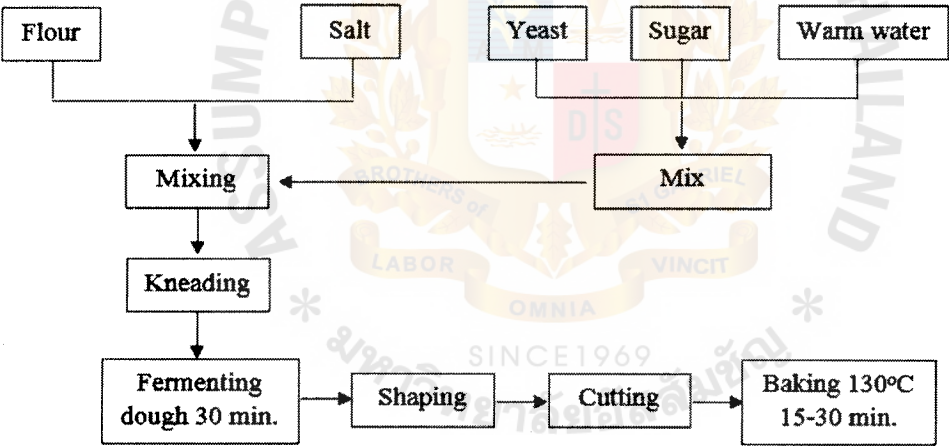
# METHODOLOGY

## 1. Materials

All purpose flour, cake flour, cashew nut, yeast, sugar, salt, Thai tea, Ceylon tea, white chocolate compound, and whipping cream were bought from supermarket.

## 2. Formulate the basic formula of pretzel sticks

Ingredients for pretzel sticks were all purpose flour, cake flour, yeast, sugar, and salt. Pretzel sticks were produced as the formula shown in table 1. To produce pretzel sticks, all purpose flour and cake flour were mixed with salt, while yeast and sugar were separately prepared by mixing with warm water. Then, liquid part was added into dry mixed and kneaded until it formed dough. Dough was left for 30 minutes to 1 hour before shaped and cut to pretzel sticks and heat at 130°C for 30 minutes. The steps of pretzel stick making as flow chart were shown in figure 5.



**Figure 5:** Pretzel sticks making process

**Table 1:** Basic formula of pretzel stick

| Ingredients         | Amount (%) |
|---------------------|------------|
| All – purpose flour | 62         |
| Cake flour          | 15         |
| Water               | 17         |
| Yeast               | 3          |
| Sugar               | 2          |
| Salt                | 1          |



**3. Study the effect of ground cashew nut and salt on the characteristics of pretzel stick**

**3.1 Study the effect of ground cashew nut on the texture of pretzel stick**

Pretzel stick was developed by adding ground cashew nut into flour at various percentages. Raw cashew nuts were ground into powder before added as flour substitution at 0, 25, and 50% (as shown in table 2). Cashew nut pretzel sticks were evaluated the appearance, thickness, crispness, salty, cashew nut flavor, texture, and overall liking by 40 panelists using 9-point hedonic score. Cashew nut pretzel sticks at various percentage of cashew nut were measured the hardness and fracturability by texture analyzer (XTPPlus Texture Analyzer, UK).

**Table 2: Formula of cashew nut as flour substitution in pretzel stick**

| Ingredients             | Cashew nut substituted |     |      |
|-------------------------|------------------------|-----|------|
|                         | 0%                     | 25% | 50%  |
| All – purpose flour (%) | 62                     | 58  | 38.5 |
| Cake flour (%)          | 15                     | –   | –    |
| Water (%)               | 17                     | 17  | 17   |
| Cashew nut (%)          | –                      | 19  | 38.5 |
| Yeast (%)               | 3                      | 3   | 3    |
| Sugar (%)               | 2                      | 2   | 2    |
| Salt (%)                | 1                      | 1   | 1    |

**3.2 Study the effect of salt on the taste of pretzel stick**

Cashew nut pretzel stick was produced using the formula from previous step and varied salt content as 1, 2, and 3%. Saltiness of cashew nut pretzel stick was evaluated by 40 panelists using 9-point hedonic score.

**4. Study the effect of tea addition in white chocolate compound on the characteristics of chocolate coated cashew nut pretzel stick**

Coating compound was prepared by adding tea and whipping cream into melted white chocolate compound according to the formula shown in table 3. Firstly, whipping cream 80 ml was heat for 1 minute then 20 g of tea powder (Thai tea and Ceylon tea) was added and continued heating for 2 minutes. Mixture was filtered before added into melted white chocolate compound which was prepared separately by melting in double boiler for 1 minute and 30 seconds. The mixture was stirred for 1 minute and cooled down for 3 minutes. Coating compound was poured on the cashew nut pretzel stick about 2/3 part of the length.

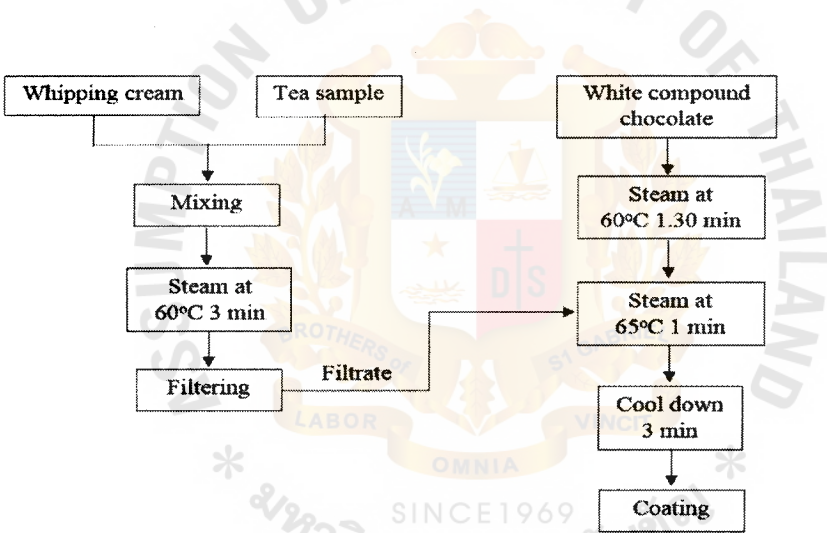
Coated cashew nut pretzel sticks were aged in refrigerator before kept into the airtight plastic box.

Tea coating compound was prepared and let it set before it was measured color using colorimeter (HunterLab<sup>TM</sup>, USA).

**Table 3: Formula of tea sample coating with white compound chocolate**

| Ingredients                         | Percentage (%) |
|-------------------------------------|----------------|
| White chocolate compound            | 50             |
| Whipping cream                      | 40             |
| Tea powder (Thai tea or Ceylon tea) | 10             |

Coating cashew nut pretzel sticks were evaluated the preference of color, tea aroma, tea flavor, sweetness, and overall liking by 40 panelists using 9-point hedonic score. The selected product was re-produced and evaluated by 40 panelists using Just About Right test.



**Figure 6: Coating compound making process**

**4. Investigate consumer acceptance**

Tea coating cashew nut pretzel stick was prepared to investigate the consumer acceptance by 100 consumers.

**5. Statistical analysis**

Experimental design was used Randomized Complete Block Design (RCBD) plan for sensory evaluation and Complete Block design (CRD) for texture analysis, while statistical analysis was used SAS (Statistic Analysis Software).

## **RESULTS AND DISCUSSION**

### **1. Develop basic formulation of pretzel sticks**

Basic ingredients of pretzel dough were all-purpose flour, cake flour, yeast, sugar, salt, and water at 62, 15, 3, 2, 1, and 17%, respectively. All-purpose flour and cake flour were sieved separately before mixed with salt. Yeast was mixed with water, then gradually added into mixed flour and kneaded to form dough. During kneading, pretzel dough became thicker. The kneading was repeated involving pushing and pulling the dough to stretch and strengthen the gluten in the dough. Gluten gives bread structure; it consists of strands of protein that form when water is added to flour. The protein stretches to accommodate the bubbles produced during fermentation, allowing bread to rise.

Pretzel dough was coated its surface by few drops of olive oil and fermented at room temperature around 30 minutes. Dough was covered during proofing to keep its surface soft and moist. Pretzel dough was sufficiently proofed when it had doubled in size. Fermentation produces heat, so the high temperature can result in off flavors. Proofing was an essential way to develop the pretzel's structure and flavor. During proofing, yeast was activated by the liquid and began to feed on the flour, releasing carbon dioxide bubbles. These were trapped by the gluten strands that have been developed during kneading. Also, more alcohol and acids were produced, which flavor the pretzel. Once pretzel dough has risen to double its size, it was punched and kneaded to break up large air pockets and to prevent it from over-proofing. If it is allowed to rise to more than double its size, the gluten will stretch to the point of collapse and will no longer be able to hold the gas bubbles that provide necessary structure for the loaf. Over-proofed dough is usually very dense.

Proofed pretzel dough was kneaded to the actual thickness. It was cut into the stick shape, greased with egg yolk, and baked at 130 °C for 15 – 30 minutes.

### **2. Study the effect of ground cashew nut on the texture of pretzel stick**

To develop cashew pretzel sticks, raw cashew nut was ground and sieved before mixed with flour. Cashew nut pretzel dough was prepared as the previous experiment. As the preliminary experiment, pretzel dough using only all-purpose flour showed the high hardness and toughness, thus the cake flour was added to increase the softness and crispiness. However, when ground cashew nut was added into the pretzel dough, it softens the dough

and the finished pretzel. Therefore, only all-purpose flour was used to make cashew nut pretzel, while both all-purpose and cake flour were used to make normal pretzel as control.

The ratio of ground raw cashew nut to flour was varied at 0, 25, and 50% of flour substitution because the higher amount of ground cashew nut made the pretzel was hard and tough texture. Sensory evaluation was done by 30 panelists using 9-point hedonic score to evaluate cashew nut pretzel stick at various cashew content compared with control. The sensory evaluation results showed in table 4.

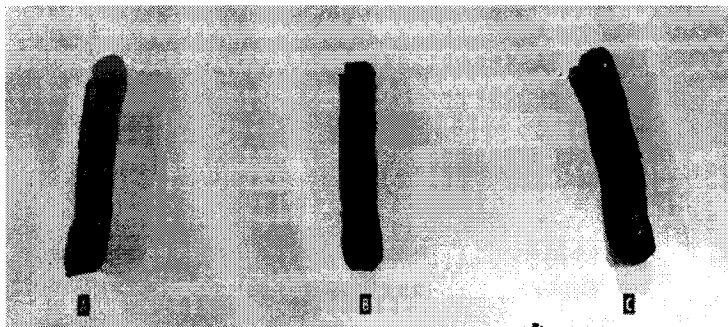
**Table 4: Sensory evaluation of cashew nut as flour substitution in pretzel stick**

| Attributes        | Ground cashew nut substitution |                                |                                |
|-------------------|--------------------------------|--------------------------------|--------------------------------|
|                   | 0%                             | 25%                            | 50%                            |
| Appearance        | 6.63 ± 1.39 <sup>b</sup>       | <b>7.20 ± 1.04<sup>a</sup></b> | 6.80 ± 1.73 <sup>b</sup>       |
| Size              | 5.53 ± 2.32 <sup>b</sup>       | 6.83 ± 1.36 <sup>a</sup>       | <b>7.38 ± 1.55<sup>a</sup></b> |
| Crispness         | 7.85 ± 1.66 <sup>a</sup>       | <b>7.35 ± 1.42<sup>a</sup></b> | 5.85 ± 1.63 <sup>b</sup>       |
| Salty             | 2.30 ± 1.77 <sup>b</sup>       | 2.53 ± 1.81 <sup>b</sup>       | <b>3.10 ± 2.33<sup>a</sup></b> |
| Cashew Nut Flavor | 2.08 ± 2.09 <sup>c</sup>       | 3.88 ± 2.37 <sup>b</sup>       | <b>5.50 ± 2.38<sup>a</sup></b> |
| Texture           | 5.08 ± 1.90 <sup>c</sup>       | 6.08 ± 1.89 <sup>b</sup>       | <b>7.00 ± 1.20<sup>a</sup></b> |
| Overall liking    | 4.75 ± 1.97 <sup>c</sup>       | 6.30 ± 1.86 <sup>b</sup>       | <b>6.98 ± 1.39<sup>a</sup></b> |

As the results showed in table 4, there are 7 attributes that are appearance, size, crispness, salty, cashew nut flavor, texture, and overall liking. It was found that 50% cashew nut pretzel sticks gained the highest score for size, salty, cashew nut flavor, texture, and overall liking at 7.38 ± 1.55, 3.10 ± 2.33, 5.50 ± 2.38, 7.00 ± 1.20, and 6.98 ± 1.39, respectively, while 25% cashew nut pretzel sticks showed the highest score for appearance (7.20 ± 1.04) and crispiness (7.35 ± 1.42).

The overall liking score of 50% cashew nut pretzel sticks was significant different from 25% cashew nut pretzel sticks and control ( $p\leq0.05$ ). When observed each attribute, the results showed that all attributes were significantly different ( $p\leq0.05$ ) for all samples. When observed the crispness in each formula, score of control and 25% cashew nut pretzel sticks showed the no significant different at  $p\leq0.05$ , while 50% cashew nut pretzel sticks showed the lowest score for the crispness. For the cashew nut flavor in each formula, the score was significant different at  $p\leq0.05$  and 50% cashew nut pretzel sticks showed the higher score than 25% cashew nut pretzel sticks and control. The reason that cashew nut pretzel stick showed more saltiness than control because the U.S. Department of Agriculture's Nutrient Database reported that 28-gram serving of raw cashew nuts contains 3 milligrams of sodium [20].





**Figure 7:** Cashew nut pretzel sticks at various cashew nut content; control (A), 25% cashew nut (B), and 50% cashew nut (C)

Cashew nut pretzel sticks at various cashew nut contents were further measured the hardness and fracturability by texture analyzer using 3-Point Bending Rig (HDP/3PB) using 5kg load cell and Heavy Duty Platform (HDP/90). The results obtained from 20 pretzel sticks of each samples. Typical mean maximum force value to measure hardness was  $458.3 \pm 52.6$  g force and mean distance at break fracturability was  $0.38 \pm 0.05$ .

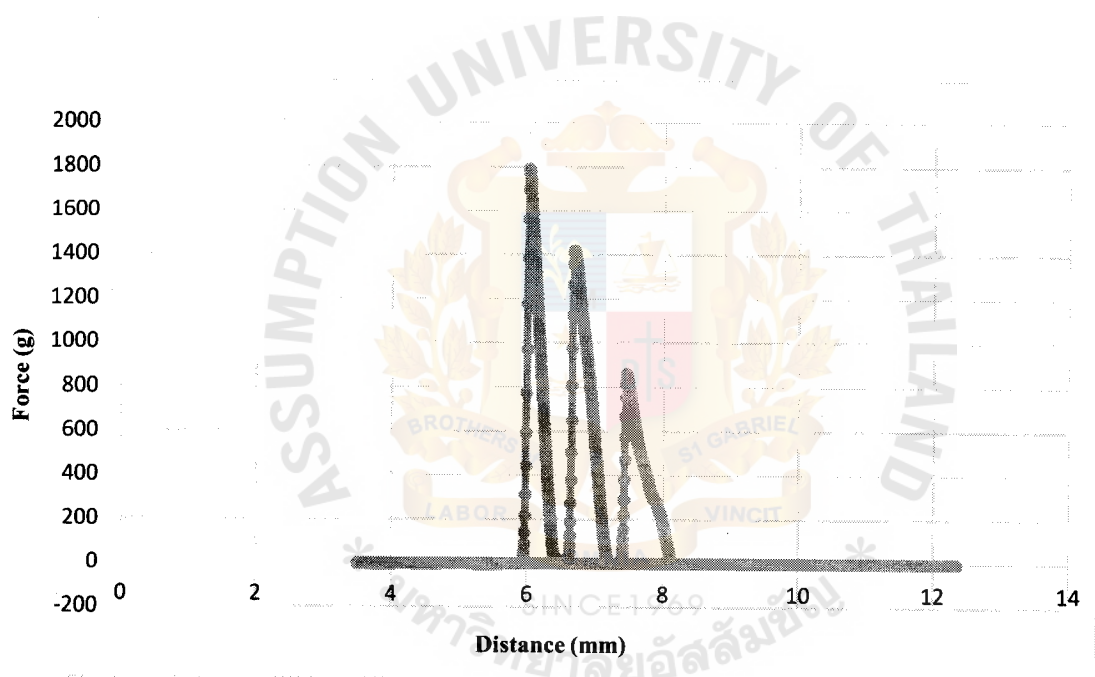


**Figure 8:** Texture analyzer (XTPlus Texture Analyzer, UK)

Crispness is a property manifested by a tendency when subjected to an applied force to yield suddenly with a characteristic sound. It is commonly the textural property possessed by snacks, breakfast cereals, fresh fruit and vegetables and some baked products (biscuits, crackers). These types of products are usually associated with sharp triangular curves

displaying an obvious break point (when tested individually) or produce a 'jagged' multi-peak curve when tested 'in bulk'. The number of peaks that produced is as a result of the fracture events that have occurred during the test. Counting the number of force peaks, the average drop off and measuring linear distance are common calculations applied to such curves. Crispness is usually associated with many small fracture peaks. Whilst a crunchier product may possess the same number of curves the drop from peak to trough will be significantly higher and the linear distance increased accordingly [21].

Fracturability is the tendency of a material to fracture, crumble, crack, shatter or fail upon the application of a relatively small amount of force or impact. It is usually displayed by a product of high degree of hardness and low degree of cohesiveness and is commonly the textural property possessed by baked goods, snacks and generally 'dry' products [21].



**Figure 9:** Measurement of the hardness and fracturability of cashew nut pretzel sticks; 0% (blue line), 25% (orange line), 50% (gray line)

Figure 9 showed the measurement of the hardness and fracturability of cashew nut pretzel sticks at various cashew nut contents. The first curve, blue triangular curve, determined as control (0% cashew nut) and it showed the highest peak at 1805 gram force. The second curve, orange triangular curve, was determined as 25% cashew nut which showed the force peak at 1410 gram force. The last curve, gray triangular curve, was determined as 50% cashew nut showing the force peak was at 880 g. This result implied that the pretzel sticks made from 0% cashew nut was higher crispness than others because of the highest force

peak. Mean force was equal 1365 gram force and standard deviation was 464.39. The coefficient of variation (CV) was defined as the ration of the standard deviation to the mean. Coefficient of variation was equal to 0.34.

Even the 25% cashew nut pretzel sticks showed more attributes at high score than 50% cashew nut pretzel sticks, the most important attribute for hard pretzel was crispiness. Moreover, the further step was coating cashew pretzel stick with chocolate, thus the highest score for crispiness was focus and 25% cashew nut pretzel sticks was selected for further development.

For the saltiness score showed in table 4, the score of saltiness was low in all formulas. Therefore, the selected formula from the previous step was used to produce cashew nut pretzel stick with the increasing of salt content at 1, 2, and 3%. Sensory evaluation was done by 40 panelists using 9-point hedonic score and only saltiness was asked to evaluate.

**Table 5:** Sensory score of salt variation in cashew nut pretzel sticks

| Attributes | Salt content             |                          |                          |
|------------|--------------------------|--------------------------|--------------------------|
|            | 1%                       | 2%                       | 3%                       |
| Saltiness  | 3.43 ± 1.03 <sup>c</sup> | 5.45 ± 0.81 <sup>b</sup> | 6.95 ± 0.60 <sup>a</sup> |

As the results of saltiness showed in table 5, 3% salt showed the significant highest score at 6.95 ± 0.60, while other variation were 5.45 ± 0.81 and 3.43 ± 1.03 for 2 and 1% salt respectively. Thus, the developed formula for cashew nut pretzel consisted of all-purpose flour, water, cashew nut, yeast, sugar, and salt at 57, 16, 19, 3, 2, and 3%, respectively.

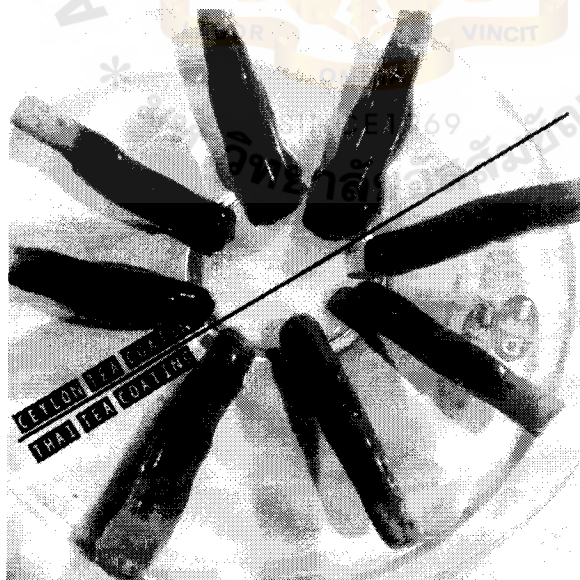
**2. Study the effect of tea addition in white chocolate compound on the characteristics of chocolate coated cashew nut pretzel stick**

To coat cashew nut pretzel sticks, white chocolate compound was selected to use as coating base according to the addition of tea. Dark chocolate or milk chocolate had unique taste and flavor. It should be masked the flavor and color or tea when coated on cashew nut pretzel sticks. For tea type, Thai tea was selected to compare with Ceylon tea. Both Thai tea and Ceylon tea showed the different red color when they were brewed (as shown in figure 8). Thai tea showed the bright red color, while Ceylon tea showed the dark red color. The color of brewed tea was fade to the orange red color and brown orange color for Thai tea and Ceylon tea, respectively, according to the combination with white chocolate compound.



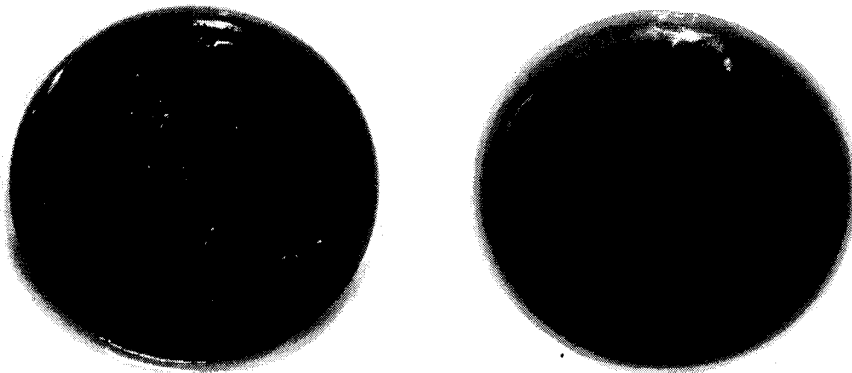
**Figure 10:** Color comparison between brewed Thai tea (A) and brewed Ceylon tea (B)

The ingredients to make coating were white chocolate compound, whipping cream, and tea powder at 50, 40, and 10%, respectively. First of all, whipping cream was used to extract tea color and flavor as it was heated at 60°C for 1 minute before added 20 g of tea powder (Thai tea or Ceylon tea) and continued heating for 2 minutes. After heating, tea was filtered and hot cream was poured on the cashew nut pretzel stick about 2/3 part of the length. Coated cashew nut pretzel sticks were aged in refrigerator before kept into the airtight plastic box. Sensory evaluation was done with cold coated cashew nut pretzel stick because the coating material melted at room temperature. Forty panelists evaluated color lightness, tea aroma, tea flavor, sweetness, and overall liking using 9-point hedonic scores. The sensory scores were showed in table 6.



**Figure 11:** The difference between Ceylon tea coating (darker in color) and Thai tea coating (brighter in color)

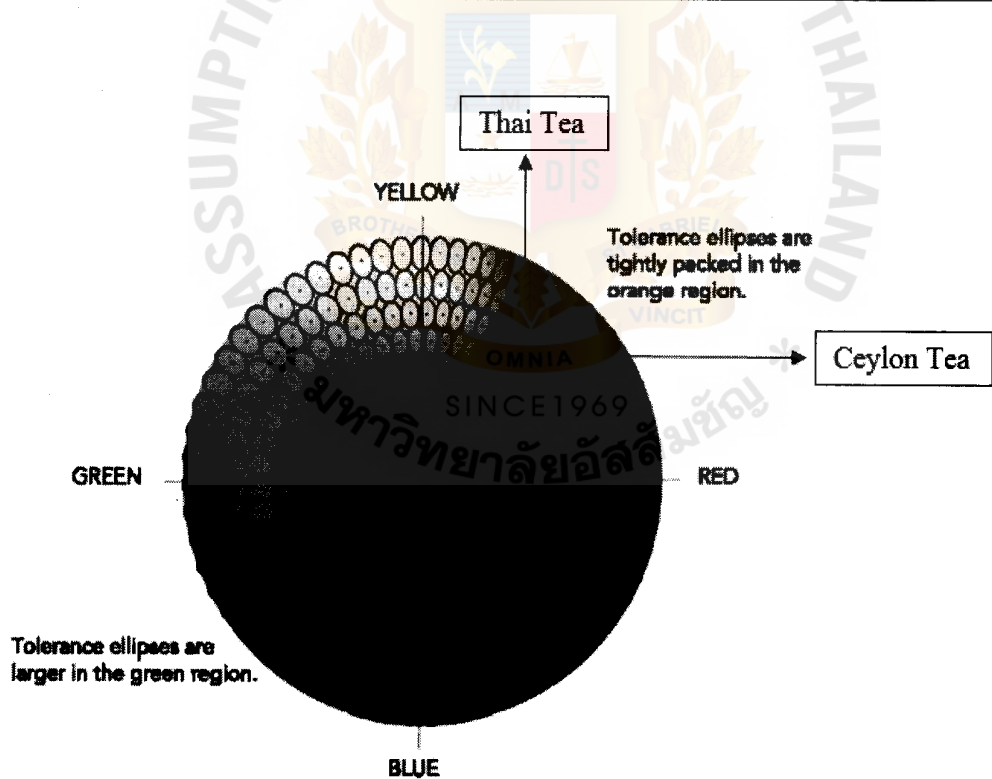




**Figure 12:** Difference color of tea coating compound;  
 Thai tea coating (left) and Ceylon tea coating (right)

**Table 6:** L\*a\*b\* value of Thai tea coating and Ceylon tea coating

| Sample             | L*    | a*    | b*    |
|--------------------|-------|-------|-------|
| Thai tea coating   | 44.73 | 33.51 | 51.45 |
| Ceylon tea coating | 42.42 | 18.89 | 29.07 |



**Figure 13:** Color position of Thai tea coating and Ceylon tea coating on the color chart

Source: [http://www.navy.mi.th/science/BrithDay46/Brithday\\_data/mycolor2.htm](http://www.navy.mi.th/science/BrithDay46/Brithday_data/mycolor2.htm)

Both Thai tea coating and Ceylon tea coating were measured the color value as  $L^*a^*b^*$  using colorimeter.  $L^*a^*b^*$  value of Thai tea coating was 44.73, 33.51, and 51.45, respectively, while  $L^*a^*b^*$  value of Ceylon tea coating was 42.42, 18.89, and 29.07, respectively. The results implied that Thai tea coating showed more brightness and more red color than Ceylon tea coating, while Ceylon tea showed the more yellow and darkness than Thai tea coating. Thus, Thai tea coating showed the orange red color, while Ceylon tea showed dark yellow brown color.

A value of ‘L a b’ color space is a color-opponent space with dimension.  $L$  was stand for lightness, while  $a$  and  $b$  were stand for the color-opponent dimensions, based on nonlinearly compressed coordinates. **CIE  $L^*a^*b^*$**  is the most complete color space specified by the International Commission on Illumination. It describes all the colors visible to the human eye and was created to serve as a device-independent model to be used as a reference [22]. The three coordinates of CIELAB represent the lightness of the color ( $L^* = 0$  yields black and  $L^* = 100$  indicates diffuse white; specular white may be higher), its position between red/magenta and green ( $a^*$ , negative values indicate green while positive values indicate magenta) and its position between yellow and blue ( $b^*$ , negative values indicate blue and positive values indicate yellow).

**Table 7:** Sensory score of salt variation in cashew nut pretzel sticks

| Attributes      | Thai tea                 | Ceylon tea               |
|-----------------|--------------------------|--------------------------|
| Color lightness | 7.43 ± 1.01 <sup>a</sup> | 6.98 ± 0.66 <sup>b</sup> |
| Tea aroma       | 7.90 ± 0.93 <sup>a</sup> | 6.78 ± 0.66 <sup>b</sup> |
| Tea flavor      | 7.40 ± 1.37 <sup>a</sup> | 6.78 ± 0.73 <sup>b</sup> |
| Sweetness       | 7.18 ± 1.20 <sup>a</sup> | 6.93 ± 0.66 <sup>a</sup> |
| Overall liking  | 7.75 ± 0.78 <sup>a</sup> | 7.08 ± 0.62 <sup>b</sup> |

As the results, Thai tea coating showed the significant higher score than Ceylon tea of all attributes, except sweetness that there had no significant difference between Thai tea coating and Ceylon tea coating. However, Thai tea coating on sweetness also showed the higher scores than Ceylon tea coating. The scores of Thai tea coating for color lightness, tea aroma, tea flavor, sweetness, and overall liking were 7.43 ± 1.01, 7.90 ± 0.93, 7.40 ± 1.37, 7.18 ± 1.20, and 7.75 ± 0.78, respectively, while scores of Ceylon tea were 6.98 ± 0.66, 6.78 ± 0.66, 6.78 ± 0.73, 6.93 ± 0.66, and 7.08 ± 0.62, respectively. Hence, Thai tea coating cashew nut pretzel stick was re-produced to evaluate the final formula by 40 panelists using Just About Right test.

**Table 8:** Score of Just about right test of the cashew nut pretzel sticks coating with Thai tea

| Product        |                   | Much too little | Somewhat too little | Just right | Somewhat too much | Much too much |
|----------------|-------------------|-----------------|---------------------|------------|-------------------|---------------|
| Pretzel sticks | Crispness         | 0               | 2.5                 | 82.5       | 17.5              | 0             |
|                | Thickness         | 0               | 0                   | 67.5       | 32.5              | 0             |
|                | Cashew nut flavor | 0               | 5.0                 | 80.0       | 12.5              | 0             |
| Tea coating    | Color lightness   | 0               | 0                   | 92.5       | 7.5               | 0             |
|                | Tea Aroma         | 0               | 15.0                | 80.0       | 5.0               | 0             |
|                | Tea Flavor        | 0               | 12.5                | 77.5       | 10.0              | 0             |
|                | Sweetness         | 0               | 0                   | 70.0       | 20.0              | 0             |

From table 8, all attributes of both pretzel sticks and tea coating showed the just right range with the highest percentage. Just right percentage of crispness, cashew nut flavor, and thickness were 82.5, 80, and 67.5, respectively, while just right percentage of color lightness, Thai tea aroma, Thai tea flavor, and sweetness were 92.5, 80, 77.5, and 70, respectively. For the thickness of pretzel sticks, it was very difficult to get equal size because of manual cutting. For tea coating, even all attributes showed the just right rank, tea aroma and tea flavor were interested to develop in the future.

For the prototype product, marketing value was calculated (as shown in table 9). Thai tea coating cashew nut pretzel sticks 60 pieces cost 62.38 Bath. One pack of Thai tea coating cashew nut pretzel sticks contained 12 pieces or approximately 50 g. This implied that one pack of product cost around 13 Bath.

**Table 9:** Calculate marketing of tea coating cashew nut pretzel sticks

|                 | Weight  | Price (Bath) | Amount/batch | batch/volume | Price/batch (Bath) |
|-----------------|---------|--------------|--------------|--------------|--------------------|
| Flour           | 1 kg    | 43           | 206 g        | 5            | 8.60               |
| Cashew nut      | 1 kg    | 350          | 67 g         | 15           | 23.33              |
| Salt            | 1 kg    | 8            | 9 g          | 111          | 0.07               |
| Sugar           | 1 kg    | 22           | 8 g          | 125          | 0.18               |
| Yeast           | 1 kg    | 30           | 10 g         | 100          | 0.30               |
| Whipping cream  | 1 liter | 155          | 80 g         | 12           | 12.90              |
| White chocolate | 1 kg    | 150          | 100 g        | 10           | 15.00              |
| Thai tea        | 1 kg    | 100          | 20 g         | 50           | 2.00               |
| Total           | –       | 858          | –            | –            | 62.38              |

3. Investigate consumer acceptance

The investigation of consumer acceptance of Thai tea coating cashew nut pretzel sticks as performed by 100 consumers. The questionnaire was separated to three parts that are demographic, consumer behavior, and product acceptance.

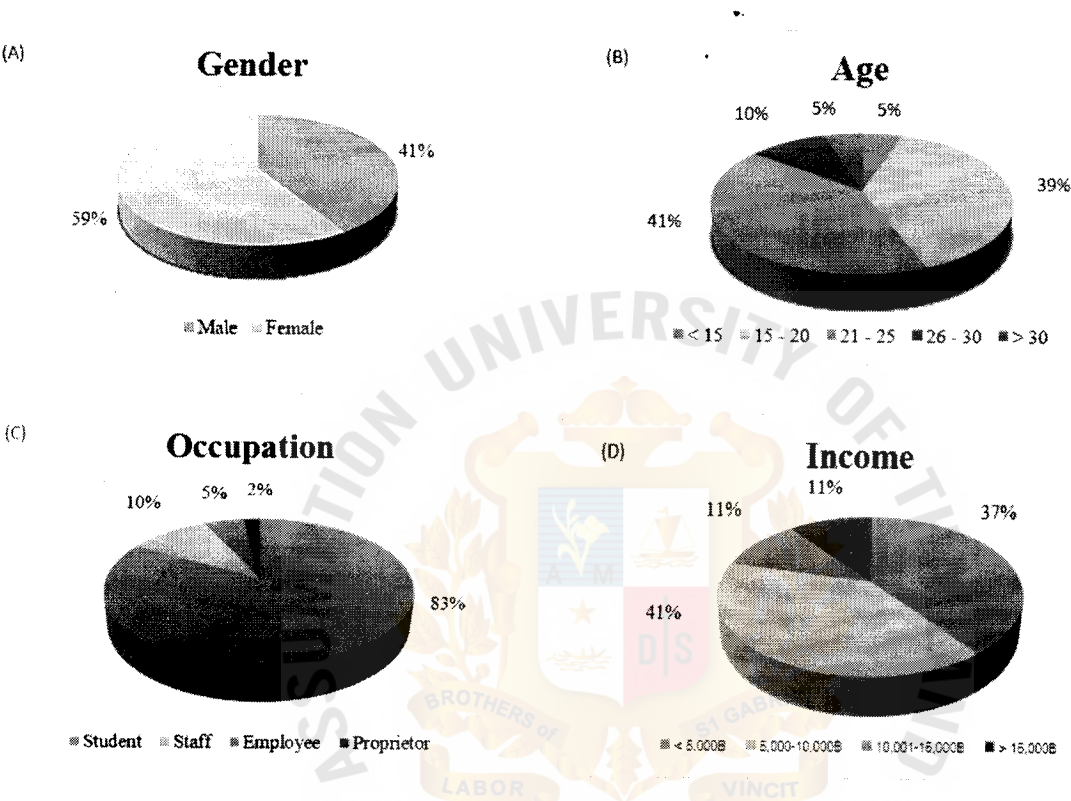
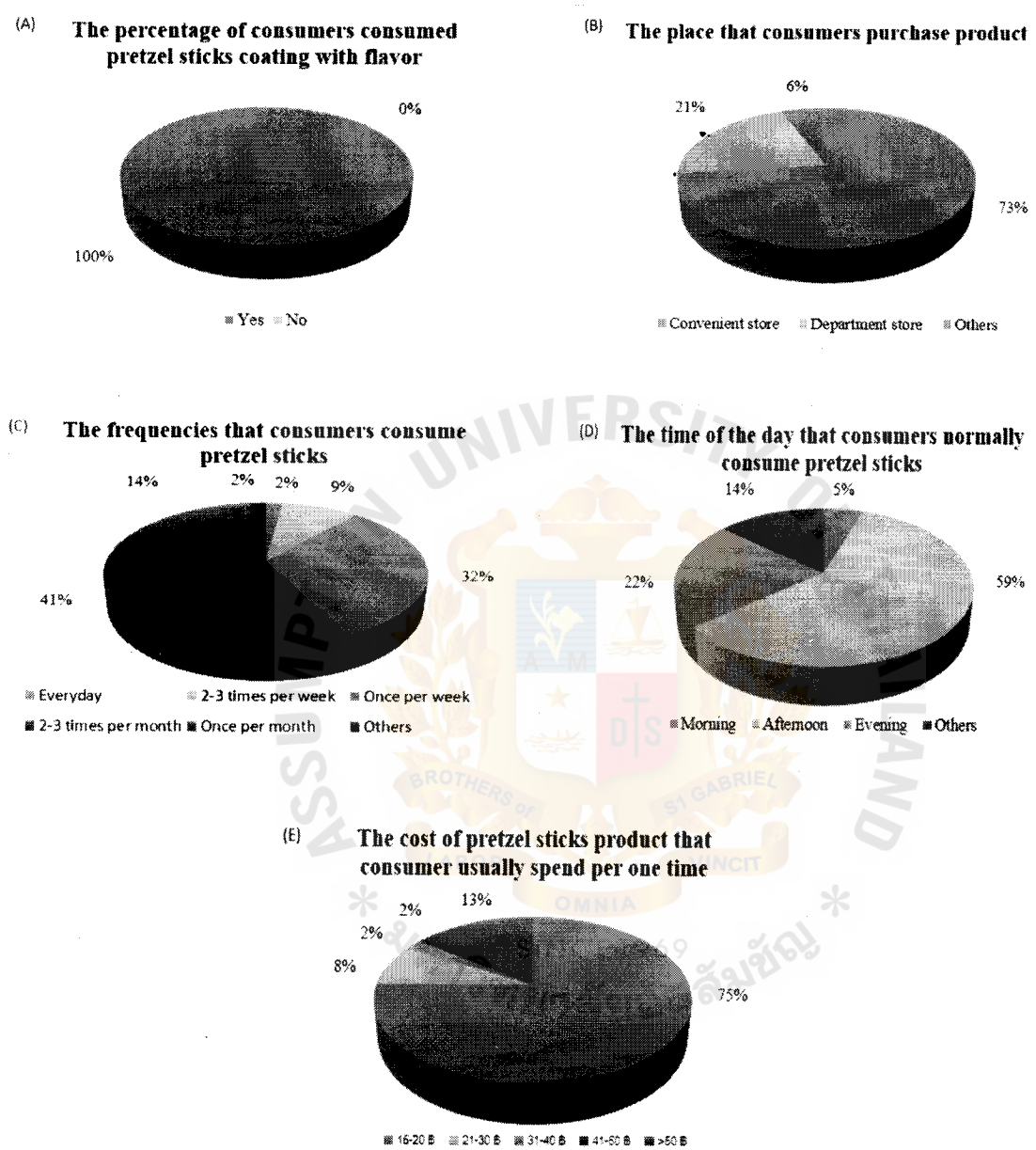


Figure 14: Demographic of consumer; gender (A), age (B), occupation (C), and income (D)

From figure 14A and 12B, 59% of consumers were female and 41% were male. The largest group consumers (41%) had the age between 21-25 years old. The second group was 15-20 years old (39%), while the third group was 26-30 years old (10%). The last two groups were 5% of both under 15 years old and over 30 years old. In figure 14C, the major group of consumer was student (83%). Others occupation were staff, employee, and proprietor in the percentage of 10, 5, and 2% respectively. Focus on monthly income in figure 14D, the demographic showed that consumers income less than 5,000 Bath, 5,001-10,000 Bath, 10,001-15,000 Bath, and more than 15,000 Bath were 37, 41, 11, and 11% respectively. Both occupation and consumer's income implied to the further development of the product to fit the price and package with the major group of consumer.



The second part was investigated the consumer behavior. In this part, the familiar of the product was referred to the pretzel sticks coating with flavor. The place to buy, the size, and how to consume were also asked.



**Figure 15:** Demographic of consumer behavior about pretzel sticks

From figure 15A – 15E, the results showed that all consumers consumed pretzel sticks coating with flavor. Consumers bought product from convenient store (73%), department store (21%), and other place (6%). The frequency to consume pretzel sticks was mostly in 2 to 3 times per month (41%) and once per week (32%). Next group, consumers consumed in once per week (14%) and 2-3 times per week (9%). Last, only 2% of consumers consumed

every day and others. Figure 15D showed that consumers normally consume pretzel sticks in the afternoon (59%), 22% in the evening, 5% in the morning, and 14% for others time. They bought the product around 15 – 20 Bath per one time (75%), more than 50 Bath (13%), and the remaining were 8% of 21-30 Bath and 2% of both 31-40 Bath and 41-50 Bath.

Part three of consumer acceptance test was asked the new pretzel sticks with new coating flavor that preparing to launch in the market.

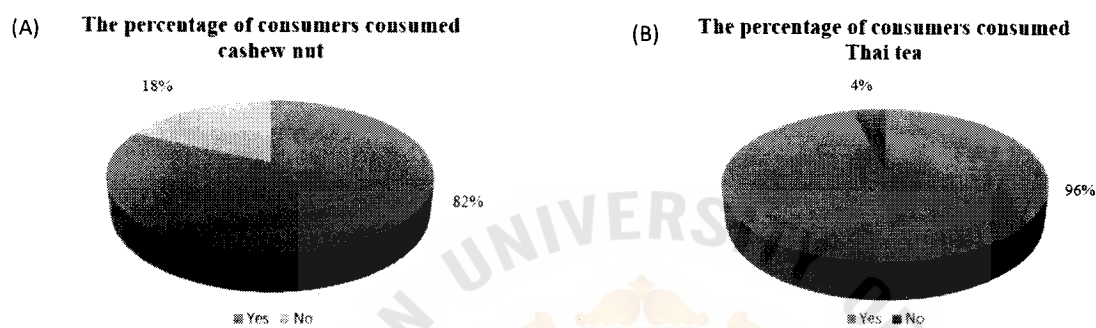


Figure 16: Demographic of consumer behavior about cashew nut and Thai tea

In figure 16A, the percentage of consumers consumed cashew nut is 82%, while the remaining 18% not consumed cashew nut because of allergic, not pleasure, and never consume. In figure 16B, the percentage of consumers consumed Thai tea is 96%, while the remaining 4% did not consume because of the sleepless.

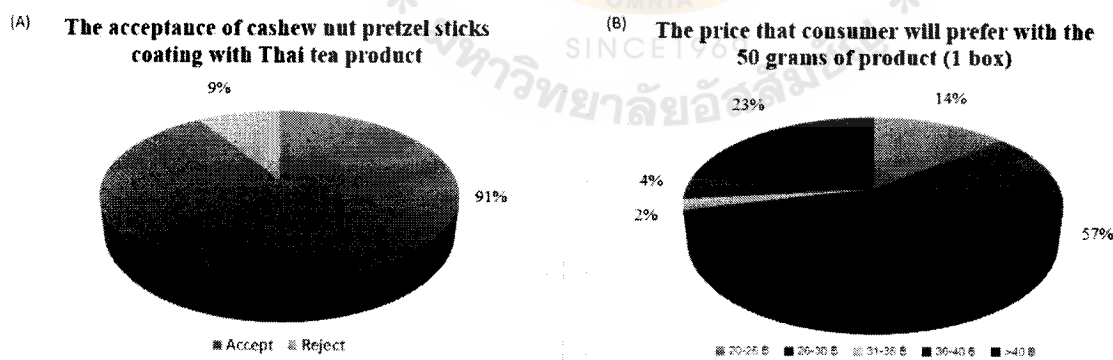


Figure 17: Demographic of consumer acceptance

From figure 17A and 17B, consumers will accept Thai tea coating cashew nut pretzel sticks 91% if the product launch to the market and they were willing to buy with the price around 26-30 Bath for 50 grams (1 box).

## CONCLUSION

1. The ingredients for tea coating cashew nut pretzel sticks were all-purpose flour 37%, ground cashew nut 12%, water 10%, yeast 2%, sugar 1%, salt 2%, Thai tea powder 4%, whipping cream 14%, and white chocolate compound 18%.
2. Texture analysis of hardness and fracturability of cashew nut pretzel sticks was 1410 g force and color value L\* a\* b\* of Thai tea was 44.73, 33.51, 51.45, respectively.
3. All consumer accepted tea coating cashew nut pretzel sticks with the price 26-30 bath for 12 pieces or 50 grams (1 box).



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APPENDIX A

Questionnaires

Preference test

Please test the samples and give the preference score according to 9-point hedonic scale.

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

| Attribute          | Sample 1 | Sample 2 | Sample 3 |
|--------------------|----------|----------|----------|
| Appearance         |          |          |          |
| Size               |          |          |          |
| Crispiness         |          |          |          |
| Salty              |          |          |          |
| Cashew nut         |          |          |          |
| Texture            |          |          |          |
| Overall Acceptance |          |          |          |

Comments



Preference test

Please test the samples and give the preference score according to 9-point hedonic scale.

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

| Attribute | Sample 1 | Sample 2 | Sample 3 |
|-----------|----------|----------|----------|
| Salty     |          |          |          |

Comments

Thank you

Preference test

Please test the samples and give the preference score according to 9-point hedonic scale.

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

| Attribute      | Sample 1 | Sample 2 |
|----------------|----------|----------|
| Lightness      |          |          |
| Tea Aroma      |          |          |
| Tea Flavor     |          |          |
| Sweetness      |          |          |
| Overall liking |          |          |

Comments

Thank you

## Just About Right Test

Date: ..... 10 April 2015 .....

**Instruction:** Please rinse your mouth with water before testing.  
Please test the sample in front of you and evaluate in based on the Just About Right scale by marking ✓ in the box below.

### Preference test

Please test the samples and give the preference score according to 9-point hedonic scale.

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

Sample Number \_\_\_\_\_175\_\_\_\_\_

| Attribute         | Just About Right Test |                     |            |                     |               | Preference test<br>9-point hedonic scale |
|-------------------|-----------------------|---------------------|------------|---------------------|---------------|--|
|                   | Much too little       | Somewhat too little | Just right | Moderately too much | Much too much |  |
| Breadstick        |                       |                     |            |                     |               |  |
| Crispness         |                       |                     |            |                     |               |  |
| Thickness         |                       |                     |            |                     |               |  |
| Cashew Nut Flavor |                       |                     |            |                     |               |  |
| Coating           |                       |                     |            |                     |               |  |
| Lightness (Color) |                       |                     |            |                     |               |  |
| Thai Tea Aroma    |                       |                     |            |                     |               |  |
| Thai Tea Flavor   |                       |                     |            |                     |               |  |
| Sweetness         |                       |                     |            |                     |               |  |
| Overall liking    |                       |                     |            |                     |               |  |

Comments

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Thank you

## แบบสอบถาม

เรื่อง: การสำรวจพฤติกรรมการบริโภคขนมปังแท่งชนิดเคลือบ

คำแนะนำ: แบบสอบถามชุดนี้จัดทำเพื่อต้องการศึกษาพฤติกรรมการบริโภค และเพื่อศึกษาถึงลักษณะของขนมปังแท่งชนิดเคลือบ ที่เป็นที่ต้องการของตลาด เช่น รสชาติ กลิ่น และสี ที่เป็นที่ยอมรับของผู้บริโภค เป็นต้น

ตอนที่ 1: ลักษณะทั่วไปของผู้ทดสอบ

1. เพศ

- ☐ ชาย
- ☐ หญิง

2. อายุ

- ☐ ต่ำกว่า 15 ปี
- ☐ 15 – 20
- ☐ 21 – 25
- ☐ 26 – 30
- ☐ มากกว่า 30

3. อาชีพ

- ☐ นักเรียน/นักศึกษา
- ☐ แม่บ้าน
- ☐ รับจ้าง
- ☐ เจ้าของกิจการ
- ☐ อื่นๆ

4. รายได้ต่อเดือน

- ☐ น้อยกว่า 5,000 บาท
- ☐ 5,000 – 10,000 บาท
- ☐ 10,000 – 15,000 บาท
- ☐ มากกว่า 15,000 บาท

ตอนที่ 2: ลักษณะการบริโภคขนมปังแท่งชนิดเค็มนุ่ม

5. คุณเคยบริโภคขนมปังแท่งเค็มนุ่มรสชาติต่างๆหรือไม่
- ☐ เคย
  - ☐ ไม่เคย
6. ปกติแล้วคุณมักจะซื้อที่ไหนเป็นประจำ
- ☐ ร้านสะดวกซื้อ (seven-eleven)
  - ☐ ห้างสรรพสินค้า
  - ☐ อื่นๆ \_\_\_\_\_
7. คุณบริโภคบ่อยแค่ไหน
- ☐ ทุกวัน
  - ☐ 2-3 ครั้งต่อสัปดาห์
  - ☐ 1 ครั้งต่อสัปดาห์
  - ☐ 2-3 ครั้งต่อเดือน
  - ☐ 1 ครั้งต่อเดือน
  - ☐ อื่นๆ \_\_\_\_\_
8. คุณเคยบริโภคขนมปังแท่งชนิดเค็มนุ่มในราคาเท่าไรต่อครั้ง
- ☐ 15-20 บาท
  - ☐ 21-30 บาท
  - ☐ 31-40 บาท
  - ☐ 41-50 บาท
  - ☐ 51 – 100 บาท
  - ☐ มากกว่า 100
9. คุณมักจะบริโภคเวลาใด
- ☐ เช้า
  - ☐ กลางวัน
  - ☐ เย็น
  - ☐ อื่นๆ \_\_\_\_\_
10. คุณเคยบริโภคเม็คมะม่วงหิมพานต์หรือไม่
- ☐ เคย
  - ☐ ไม่เคย
11. ถ้าหากนำเม็คมะม่วงหิมพานต์มาเป็นส่วนประกอบของตัวขนมปังแท่ง คุณจะยอมรับสินค้านี้หรือไม่
- ☐ ยอมรับ
  - ☐ ไม่ยอมรับ



12. คุณเคยบริโภคชาไทย (ชาเย็น) หรือไม่
- ☐ เคย
  - ☐ ไม่เคย
13. ถ้าหากนำชาไทยมาเป็นส่วนประกอบของตัวเคลือบขนมปังแท่ง คุณจะยอมรับสินค้านี้หรือไม่
- ☐ ยอมรับ
  - ☐ ไม่ยอมรับ
14. คุณจะยอมรับขนมปังแท่งเคลือบชาไทยปริมาณ 50 กรัม (1กล่อง) ในราคาเท่าไร
- ☐ 20 - 25 บาท
  - ☐ 26 - 30 บาท
  - ☐ 31 - 35 บาท
  - ☐ 36 - 40 บาท
  - ☐ มากกว่า 40 บาท



**แบบสอบถาม**

โปรดทำแบบทดสอบ และ ให้คะแนนความชอบในแต่ละลักษณะ ตามคะแนนด้านล่าง

**คะแนนความชอบ 9 จุดของการทดสอบ**

- 9 = ชอบมากที่สุด

4 = ไม่ชอบเล็กน้อย
- 8 = ชอบมาก

3 = ไม่ชอบปานกลาง
- 7 = ชอบปานกลาง

2 = ไม่ชอบมาก
- 6 = ชอบเล็กน้อย

1 = ไม่ชอบมากที่สุด
- 5 = เฉยๆ

โปรดกรอกคะแนนลงในช่องด้านล่าง

| ลักษณะ                      | ตัวอย่าง |
|-----------------------------|----------|
| ตัวขนมปังแ่ง                |          |
| ความกรอบ                    |          |
| ความหนา                     |          |
| รสชาติของเมืงมะม่วงหิมพานต์ |          |
| ตัวเกลือบ                   |          |
| สี                          |          |
| กลิ่นของชาไทย               |          |
| รสชาติของชาไทย              |          |
| ความหวาน                    |          |
| การยอมรับโดยรวม             |          |

ข้อเสนอแนะ

\*\*\*\*\* 😊 THANK YOU 😊 \*\*\*\*\*

APPENDIX B

Statistic Results

I. Pretzel Sticks

|                     |
|---------------------|
| Flour Questionnaire |
|---------------------|

The ANOVA Procedure  
Class Level Information

|        |        |   |
|--------|--------|---|
| Class  | Levels | Values  |
| Sample | 3      | 172 386 419   |
| Panel  | 40     | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28<br>29 30 31 32 33 34 35 36 37 38 39 40 |

Number of Observations Read 120

Number of Observations Used 120

Dependent Variable: App

| Source          | DF  | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|-----|----------------|-------------|---------|--------|
| Model           | 41  | 119.4083333    | 2.9123984   | 1.87    | 0.0091 |
| Error           | 78  | 121.7166667    | 1.5604701   |         |        |
| Corrected Total | 119 | 241.1250000    |             |         |        |

| R-Square | Coeff Var | Root MSE | App Mean |
|----------|-----------|----------|----------|
| 0.495213 | 18.17000  | 1.249188 | 6.875000 |

| Source | DF | Anova SS    | Mean Square | F Value | Pr > F |
|--------|----|-------------|-------------|---------|--------|
| Sample | 2  | 6.9500000   | 3.4750000   | 2.23    | 0.1147 |
| Panel  | 39 | 112.4583333 | 2.8835470   | 1.85    | 0.0109 |

Dependent Variable: Size

| Source          | DF  | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|-----|----------------|-------------|---------|--------|
| Model           | 41  | 246.8583333    | 6.0209350   | 2.34    | 0.0006 |
| Error           | 78  | 200.4666667    | 2.5700855   |         |        |
| Corrected Total | 119 | 447.3250000    |             |         |        |

| R-Square | Coeff Var | Root MSE | Size Mean |
|----------|-----------|----------|-----------|
| 0.551855 | 24.38249  | 1.603149 | 6.575000  |

| Source | DF | Anova SS    | Mean Square | F Value | Pr > F |
|--------|----|-------------|-------------|---------|--------|
| Sample | 2  | 72.2000000  | 36.1000000  | 14.05   | <.0001 |
| Panel  | 39 | 174.6583333 | 4.4784188   | 1.74    | 0.0190 |

Dependent Variable: Crisp

| Source          | DF  | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|-----|----------------|-------------|---------|--------|
| Model           | 41  | 253.3000000    | 6.1780488   | 3.93    | <.0001 |
| Error           | 78  | 122.6666667    | 1.5726496   |         |        |
| Corrected Total | 119 | 375.9666667    |             |         |        |

| R-Square | Coeff Var | Root MSE | Crisp Mean |
|----------|-----------|----------|------------|
| 0.673730 | 17.87249  | 1.254053 | 7.016667   |

| Source | DF | Anova SS    | Mean Square | F Value | Pr > F |
|--------|----|-------------|-------------|---------|--------|
| Sample | 2  | 86.6666667  | 43.3333333  | 27.55   | <.0001 |
| Panel  | 39 | 166.6333333 | 4.2726496   | 2.72    | <.0001 |

Dependent Variable: Salty

| Source          | DF  | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|-----|----------------|-------------|---------|--------|
| Model           | 41  | 421.8750000    | 10.2896341  | 14.94   | <.0001 |
| Error           | 78  | 53.7166667     | 0.6886752   |         |        |
| Corrected Total | 119 | 475.5916667    |             |         |        |

| R-Square | Coeff Var | Root MSE | Salty Mean |
|----------|-----------|----------|------------|
| 0.887053 | 31.41443  | 0.829865 | 2.641667   |

| Source | DF | Anova SS    | Mean Square | F Value | Pr > F |
|--------|----|-------------|-------------|---------|--------|
| Sample | 2  | 13.6166667  | 6.8083333   | 9.89    | 0.0001 |
| Panel  | 39 | 408.2583333 | 10.4681624  | 15.20   | <.0001 |

Dependent Variable: CF

| Source          | DF  | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|-----|----------------|-------------|---------|--------|
| Model           | 41  | 606.7833333    | 14.7995935  | 4.87    | <.0001 |
| Error           | 78  | 237.1833333    | 3.0408120   |         |        |
| Corrected Total | 119 | 843.9666667    |             |         |        |

| R-Square | Coeff Var | Root MSE | CF Mean  |
|----------|-----------|----------|----------|
| 0.718966 | 45.68888  | 1.743792 | 3.816667 |

| Source | DF | Anova SS    | Mean Square | F Value | Pr > F |
|--------|----|-------------|-------------|---------|--------|
| Sample | 2  | 234.8166667 | 117.4083333 | 38.61   | <.0001 |
| Panel  | 39 | 371.9666667 | 9.5376068   | 3.14    | <.0001 |



|                    | Flour 100%               | Flour 75%<br>Cashew nut 25% | Flour 50%<br>Cashew nut 50% |
|--------------------|--------------------------|-----------------------------|-----------------------------|
| Appearance         | 6.63 ± 1.39 <sup>b</sup> | 7.20 ± 1.04 <sup>a</sup>    | 6.80 ± 1.73 <sup>b</sup>    |
| Size               | 5.53 ± 2.32 <sup>b</sup> | 6.83 ± 1.36 <sup>a</sup>    | 7.38 ± 1.55 <sup>a</sup>    |
| Crispness          | 7.85 ± 1.66 <sup>a</sup> | 7.35 ± 1.42 <sup>a</sup>    | 5.85 ± 1.63 <sup>b</sup>    |
| Salty              | 2.30 ± 1.77 <sup>b</sup> | 2.53 ± 1.81 <sup>b</sup>    | 3.10 ± 2.33 <sup>a</sup>    |
| Cashew Nut Flavor  | 2.08 ± 2.09 <sup>c</sup> | 3.88 ± 2.37 <sup>b</sup>    | 5.50 ± 2.38 <sup>a</sup>    |
| Texture            | 5.08 ± 1.90 <sup>c</sup> | 6.08 ± 1.89 <sup>b</sup>    | 7.00 ± 1.20 <sup>a</sup>    |
| Overall Acceptance | 4.75 ± 1.97 <sup>c</sup> | 6.30 ± 1.86 <sup>b</sup>    | 6.98 ± 1.39 <sup>a</sup>    |

Dependent Variable: Texture

| Source          | DF  | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|-----|----------------|-------------|---------|--------|
| Model           | 41  | 257.1833333    | 6.2727642   | 3.21    | <.0001 |
| Error           | 78  | 152.5166667    | 1.9553419   |         |        |
| Corrected Total | 119 | 409.7000000    |             |         |        |

| R-Square | Coeff Var | Root MSE | Texture Mean |
|----------|-----------|----------|--------------|
| 0.627736 | 23.11298  | 1.398335 | 6.050000     |

| Source | DF | Anova SS    | Mean Square | F Value | Pr > F |
|--------|----|-------------|-------------|---------|--------|
| Sample | 2  | 74.1500000  | 37.0750000  | 18.96   | <.0001 |
| Panel  | 39 | 183.0333333 | 4.6931624   | 2.40    | 0.0005 |

Dependent Variable: OL

| Source          | DF  | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|-----|----------------|-------------|---------|--------|
| Model           | 41  | 350.4416667    | 8.5473577   | 5.82    | <.0001 |
| Error           | 78  | 114.5500000    | 1.4685897   |         |        |
| Corrected Total | 119 | 464.9916667    |             |         |        |

| R-Square | Coeff Var | Root MSE | OL Mean  |
|----------|-----------|----------|----------|
| 0.753651 | 20.16955  | 1.211854 | 6.008333 |

| Source | DF | Anova SS    | Mean Square | F Value | Pr > F |
|--------|----|-------------|-------------|---------|--------|
| Sample | 2  | 104.1166667 | 52.0583333  | 35.45   | <.0001 |
| Panel  | 39 | 246.3250000 | 6.3160256   | 4.30    | <.0001 |

The ANOVA Procedure

Duncan's Multiple Range Test for App

|                          |         |
|--------------------------|---------|
| Alpha                    | 0.05    |
| Error Degrees of Freedom | 78      |
| Error Mean Square        | 1.56047 |

|                 |       |       |
|-----------------|-------|-------|
| Number of Means | 2     | 3     |
| Critical Range  | .5561 | .5851 |

Means with the same letter  
are not significantly different.

| Duncan Grouping | Mean   | N  | Sample |
|-----------------|--------|----|--------|
| A               | 7.2000 | 40 | 386    |
| A               | 6.8000 | 40 | 419    |
| A               | 6.6250 | 40 | 172    |

Duncan's Multiple Range Test for Size

|                          |          |
|--------------------------|----------|
| Alpha                    | 0.05     |
| Error Degrees of Freedom | 78       |
| Error Mean Square        | 2.570085 |

|                 |       |       |
|-----------------|-------|-------|
| Number of Means | 2     | 3     |
| Critical Range  | .7137 | .7509 |

**Means with the same letter  
are not significantly different.**

| Duncan Grouping | Mean   | N  | Sample |
|-----------------|--------|----|--------|
| A               | 7.3750 | 40 | 419    |
| A               | 6.8250 | 40 | 386    |
| B               | 5.5250 | 40 | 172    |

Duncan's Multiple Range Test for Crisp

|                          |         |
|--------------------------|---------|
| Alpha                    | 0.05    |
| Error Degrees of Freedom | 78      |
| Error Mean Square        | 1.57265 |

|                 |       |       |
|-----------------|-------|-------|
| Number of Means | 2     | 3     |
| Critical Range  | .5583 | .5874 |

**Means with the same letter  
are not significantly different.**

| Duncan Grouping | Mean   | N  | Sample |
|-----------------|--------|----|--------|
| A               | 7.8500 | 40 | 172    |
| A               | 7.3500 | 40 | 386    |
| B               | 5.8500 | 40 | 419    |

Duncan's Multiple Range Test for Salty

|                          |          |
|--------------------------|----------|
| Alpha                    | 0.05     |
| Error Degrees of Freedom | 78       |
| Error Mean Square        | 0.688675 |

|                 |       |       |
|-----------------|-------|-------|
| Number of Means | 2     | 3     |
| Critical Range  | .3694 | .3887 |

**Means with the same letter  
are not significantly different.**

| <b>Duncan Grouping</b> | <b>Mean</b> | <b>N</b> | <b>Sample</b> |
|------------------------|-------------|----------|---------------|
| A                      | 3.1000      | 40       | 419           |
| B                      | 2.5250      | 40       | 386           |
| B                      | 2.3000      | 40       | 172           |

Duncan's Multiple Range Test for CF

|                                 |          |
|---------------------------------|----------|
| <b>Alpha</b>                    | 0.05     |
| <b>Error Degrees of Freedom</b> | 78       |
| <b>Error Mean Square</b>        | 3.040812 |

|                        |          |          |
|------------------------|----------|----------|
| <b>Number of Means</b> | <b>2</b> | <b>3</b> |
| <b>Critical Range</b>  | .7763    | .8168    |

**Means with the same letter  
are not significantly different.**

| <b>Duncan Grouping</b> | <b>Mean</b> | <b>N</b> | <b>Sample</b> |
|------------------------|-------------|----------|---------------|
| A                      | 5.5000      | 40       | 419           |
| B                      | 3.8750      | 40       | 386           |
| C                      | 2.0750      | 40       | 172           |

Duncan's Multiple Range Test for Texture

|                                 |          |
|---------------------------------|----------|
| <b>Alpha</b>                    | 0.05     |
| <b>Error Degrees of Freedom</b> | 78       |
| <b>Error Mean Square</b>        | 1.955342 |

|                        |          |          |
|------------------------|----------|----------|
| <b>Number of Means</b> | <b>2</b> | <b>3</b> |
| <b>Critical Range</b>  | .6225    | .6550    |

**Means with the same letter  
are not significantly different.**

| Duncan Grouping | Mean   | N  | Sample |
|-----------------|--------|----|--------|
| A               | 7.0000 | 40 | 419    |
| B               | 6.0750 | 40 | 386    |
| C               | 5.0750 | 40 | 172    |

Duncan's Multiple Range Test for OL

|                          |         |
|--------------------------|---------|
| Alpha                    | 0.05    |
| Error Degrees of Freedom | 78      |
| Error Mean Square        | 1.46859 |

|                 |       |       |
|-----------------|-------|-------|
| Number of Means | 2     | 3     |
| Critical Range  | .5395 | .5676 |

**Means with the same letter  
are not significantly different.**

| Duncan Grouping | Mean   | N  | Sample |
|-----------------|--------|----|--------|
| A               | 6.9750 | 40 | 419    |
| B               | 6.3000 | 40 | 386    |
| C               | 4.7500 | 40 | 172    |

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**Salty**



|           | Df | Sum Sq  | Mean Sq | F value  | Pr(>F)     |
|-----------|----|---------|---------|----------|------------|
| trt       | 2  | 250.350 | 125.175 | 167.4247 | <2e-16 *** |
| rep       | 39 | 23.258  | 0.596   | 0.7977   | 0.7793     |
| Residuals | 78 | 58.317  | 0.748   |          |            |

LSD

Mean Square Error: 0.6972222

trt, means and individual ( 95 %) CI

| y | std.err | replication | LCL         | UCL      |
|---|---------|-------------|-------------|----------|
| 1 | 3.425   | 0.16364243  | 40 3.100915 | 3.749085 |
| 2 | 5.450   | 0.12885094  | 40 5.194817 | 5.705183 |
| 3 | 6.950   | 0.09439415  | 40 6.763057 | 7.136943 |

alpha: 0.05 ; Df Error: 117

Critical Value of t: 2.428889

Least Significant Difference 0.4535009

Means with the same letter are not significantly different.

Groups, Treatments and means

|   |   |       |
|---|---|-------|
| a | 3 | 6.95  |
| b | 2 | 5.45  |
| c | 1 | 3.425 |

## II. Thai tea with white compound chocolate

Lightness

|     | Df | Sum Sq | Mean Sq | F value | Pr(>F)    |
|-----|----|--------|---------|---------|-----------|
| trt | 1  | 4.05   | 4.0500  | 6.5950  | 0.01417 * |

rep 39 32.80 0.8410 1.3695 0.16512

Residuals 39 23.95 0.6141

Mean Square Error: 0.7275641

trt, means and individual ( 95 %) CI

|     | y     | std.err   | replication | LCL      | UCL      |
|-----|-------|-----------|-------------|----------|----------|
| 482 | 6.975 | 0.1043140 | 40          | 6.767327 | 7.182673 |
| 605 | 7.425 | 0.1596772 | 40          | 7.107107 | 7.742893 |

alpha: 0.05 ; Df Error: 78

Critical Value of t: 1.990847

Least Significant Difference 0.3797157

Means with the same letter are not significantly different.

Groups, Treatments and means

|   |     |       |
|---|-----|-------|
| a | 605 | 7.425 |
| b | 482 | 6.975 |

### Tea aroma

|           | Df | Sum Sq | Mean Sq | F value | Pr(>F)        |
|-----------|----|--------|---------|---------|---------------|
| trt       | 1  | 25.312 | 25.3125 | 48.9009 | 2.192e-08 *** |
| rep       | 39 | 30.387 | 0.7792  | 1.5053  | 0.103         |
| Residuals | 39 | 20.188 | 0.5176  |         |               |

Mean Square Error: 0.6483974

trt, means and individual ( 95 %) CI

| y   | std.err | replication | LCL         | UCL      |
|-----|---------|-------------|-------------|----------|
| 482 | 6.775   | 0.1043140   | 40 6.567327 | 6.982673 |
| 605 | 7.900   | 0.1467599   | 40 7.607824 | 8.192176 |

alpha: 0.05 ; Df Error: 78

Critical Value of t: 1.990847

Least Significant Difference 0.3584623

Means with the same letter are not significantly different.

Groups, Treatments and means

|   |     |       |
|---|-----|-------|
| a | 605 | 7.9   |
| b | 482 | 6.775 |

### Tea flavor

|           | Df | Sum Sq | Mean Sq | F value | Pr(>F)    |
|-----------|----|--------|---------|---------|-----------|
| trt       | 1  | 7.812  | 7.8125  | 7.3088  | 0.01011 * |
| rep       | 39 | 52.888 | 1.3561  | 1.2687  | 0.23043   |
| Residuals | 39 | 41.688 | 1.0689  |         |           |

### LSD

Mean Square Error: 1.2125

trt, means and individual ( 95 %) CI

| y   | std.err | replication | LCL         | UCL      |
|-----|---------|-------------|-------------|----------|
| 482 | 6.775   | 0.1159548   | 40 6.544152 | 7.005848 |
| 605 | 7.400   | 0.2172084   | 40 6.967571 | 7.832429 |

alpha: 0.05 ; Df Error: 78

Critical Value of t: 1.990847

Least Significant Difference 0.4901892

Means with the same letter are not significantly different.

Groups, Treatments and means

|   |     |       |
|---|-----|-------|
| a | 605 | 7.4   |
| b | 482 | 6.775 |

### Sweetness

|           | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|-----------|----|--------|---------|---------|--------|
| trt       | 1  | 1.25   | 1.25000 | 1.2264  | 0.2749 |
| rep       | 39 | 32.80  | 0.84103 | 0.8252  | 0.7243 |
| Residuals | 39 | 39.75  | 1.01923 |         |        |

### Overall

|           | Df | Sum Sq  | Mean Sq | F value | Pr(>F)        |
|-----------|----|---------|---------|---------|---------------|
| trt       | 1  | 9.1125  | 9.1125  | 17.4316 | 0.0001617 *** |
| rep       | 39 | 17.8875 | 0.4587  | 0.8774  | 0.6575300     |
| Residuals | 39 | 20.3875 | 0.5228  |         |               |

## LSD

Mean Square Error: 0.4907051

trt, means and individual ( 95 %) CI

| y   | std.err | replication | LCL         | UCL      |
|-----|---------|-------------|-------------|----------|
| 482 | 7.075   | 0.09731985  | 40 6.881251 | 7.268749 |
| 605 | 7.750   | 0.12273591  | 40 7.505652 | 7.994348 |

alpha: 0.05 ; Df Error: 78

Critical Value of t: 1.990847

Least Significant Difference 0.311841

Means with the same letter are not significantly different.

Groups, Treatments and means

|   |     |       |
|---|-----|-------|
| a | 605 | 7.75  |
| b | 482 | 7.075 |