DEVELOPMENT AND PHYSICOCHEMICAL ANALYSIS OF CHINESE STEAMED BUNS INCORPORATED WITH SUGARCANE BAGASSE POWDER

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Development and physichochemical analysis of chinese steamed buns incorporated with sugarcane bagasse powder / Ten Chee Shan.

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By

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Research Report submitted in partial fulfillment of
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ENDORSEMENT

The project report entitled **DEVELOPMENT AND PHYSICOCHEMICAL ANALYSIS OF CHINESE STEAMED BUNS INCORPORATED WITH SUGARCANE BAGASSE POWDER** by Ten Chee Shan, Matric No. UK 17174 has been reviewed and corrections have been made according to the recommendations by examiners. This report is submitted to the Department of Food Science in partial fulfillment of the requirement of the degree of Bachelor of Food Science (Food Technology), Faculty of Agrotechnology and Food Science, Universiti Malaysia Terengganu.

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DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

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ABSTRACT

The objectives of this study were to compare the chemical, physical, microstructure and sensory properties of steamed buns supplemented with sugarcane bagasse powder. In this study, sugarcane bagasse powder was used to substitute with 0%, 2%, 4%, 6% and 8% of Hong Kong flour for making sugarcane bagasse steamed buns. 100% of Hong Kong flour formulation was used as a control. The differences of composition between sugarcane bagasse powder and Hong Kong flour were studied. Proximate composition, physical quality and sensory evaluation of steamed buns containing sugarcane bagasse were analyzed and compared with those control steamed buns. Their microstructure (pore characteristics) was evaluated by Tabletop microscope. Control Chinese steamed buns contained more moisture and fat content, whereas fiber, protein and ash content were higher in sugarcane bagasse steamed buns and total carbohydrate content do not showed its trends. Sugarcane bagasse steamed buns showed lower lightness and became darker with more sugarcane bagasse powder added and showed significant differences. Hardness, colour a* and b* values of steamed buns significantly increased with the addition of sugarcane bagasse powder. Specific volume and colour L* value of steamed buns decreased with the addition of sugarcane bagasse powder. Sugarcane bagasse steamed buns had lower specific volumes than the control steamed buns. Steamed buns were subjected to sensory evaluation for colour, aroma, tenderness, pore size, taste, moistness and overall acceptance. Increasing levels of sugarcane bagasse powder caused slightly decreases in total sensory scores. All the steamed buns samples except steamed buns produced from 8 % sugarcane bagasse were considered acceptable and 4% score the highest acceptance score. From the ranking preference test, panel prefer 4% sugarcane bagasse steamed buns than control and least preferred showed to 8% sugarcane bagasse steamed buns. Overall, sugarcane bagasse powder could be added into steamed buns formula and thus be developed as a health-promoting functional food.

ABSTRAK

Objektif dalam kajian ini adalah untuk membandingkan kimia, fizikal, saiz liang dan penilaian sensori untuk roti kukus cina yang telah ditambah dengan hampas tebu. Dalam kajian ini, hampas tebu telah digunakan untuk penggantian dengan 0%, 2%, 4%, 6% dan 8% dengan tepung Hong Kong untuk menghasilkan roti kukus hampas tebu. 100% tepung Hong Kong formula dijadikan sebagai roti kukus kawalan. Perbezaan komposisi antara tepung Hong Kong dengan serbuk hampas tebu telahpun dikaji. Analisis proksimat, analisis fizikal dan penilaian sensori untuk roti kukus yang mempunyai hampas tebu telahpun dikaji dan telah dibandingkan dengan roti kukus kawalan. Saiz liang untuk roti kukus telah diperhatikan dengan menggunakan Tabletop mikroskop. Roti kukus kawalan mempunyai kandungan lembapan dan lemak yang tinggi manakala gentian kasar, protein, dan kandungan abu didapati lebih tinggi di roti kukus hampas tebu dan jumlah karbohidrat tidak menunjukkan trend. Roti kukus hampas tebu menunjukkan kecerahan yang rendah dan menjadi semakin gelap warnnaya apabila semakin banyak serbuk hampas tebu ditambah dan menunjukkan adanya perbezaan beerti. Kekerasan, a* dan b* nilai warna untuk roti kukus meningkat secara perbezaan bererti dengannya penambahan serbuk hampas tebu. Isipadu dan L* warna nilai untuk roti kukus menurun dengannya penambahan serbuk hampas tebu. Roti kukus hampas tebu mempunyai isipadu yang lebih rendah daripada roti kukus kawalan. Roti kukus telah dinilai untuk penilaian sensori untuk atribut-atribut warna, bau, kelembutan, size liang, rasa, kelembapan dan penerimaan keseluruhan. Peningkatan kandungan serbuk hampas tebu menyebabkan sedikit penurunan dalam penerimaan keseluruhan. Semua sampel roti kukus kecuali roti kukus yang dihasilkan daripada 8% hampas tebu telah dianggap boleh diterima dan skor 4% roti kukus hampas tebu mendapat skor yang paling tinggi penerimaan. Dari ujian keutamaman, panel paling suka 4% roti kukus hampas tebu berbanding dengan roti kukus kawalan dan 8% hampas tebu menunjukkan kesukaan yang paling rendah. Scara keseluruhan, tepung hampas tebu bolah ditambah ke dalam roti kukus formula dan dengan itu akan dianggap sebagai makanan berkhiasat kesihatan.

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LIST OF ABBREVIATIONS

%	Percent
g	Gram
kg	Kilogram
°C	Degree celcius
m	Meter
cm	Centimeter
mm	Millimeter
ml	Milliliter
s	Seconds
L*	Indication for lightness
a*	Indication for redness/ greenness
b*	Indication for yellowness/ blueness
h	Hour
=	Equal to
$>$	More than
$<$	Less than
$\geq$	Equal or more than
$\leq$	Equal or less than
&	And

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The Chinese steamed buns is a popular traditional wheat product which is originated from China and also widely consumed in others South-eastern Asian (Luangsakul et al., 2009). It is also a type of steamed, filled bun or bread-like item in Chinese cuisine. In general, Chinese steamed buns had a round shape, typically 5-10 cm in diameter and sometimes this Chinese steamed bun may contain several kinds of stuffing including savoury or sweet taste to improve the flavour of the plain steamed bun (Luangsakul et al., 2009).

Comparing with others buns and bread, steaming and not baking Chinese steamed buns used to cook the dough can gives a product with a thin smooth white skin rather than the thicker brown crust of western oven-baked breads (Luangsakul et al., 2009). In addition, the quality and the composition of these Chinese steamed buns are mainly depending on manual labour and the worker's skills.

There are many researchers have been studying the dietary fiber content of food and industrial residues in order to improve technological knowledge of the production of concentrates as well as the development and testing of enriched products originating from regional foods (Verdalet et al., 2010).

Bagasse, is the crushed remnants of sugarcane stalks left after the extraction of juice, it is a by-product of sugar milling. Throughout the world, there are about 54 million of dry tons of sugarcane bagasse is produced annually (Rodrigues et al., 2003; Rodrigues et al., 2010). Therefore, bagasse is widely used in health foods for its dietary fiber (Fernandez et al., 1996) because the chemical constituents of bagasse are variable with cellulose, hemicelluloses and lignin (Maede and Chen, 1977). So, the beneficial effects of consuming dietary fiber due to human health have been widely reported by researchers (Schneeman, 1998).

An adequate used of this sugarcane bagasse can gives and add value in other material and act as a solution from removal of this abundant waste, and can solve a problem of the sugar industry and increasing the economical yield of the process. Therefore, a double effect is obtained from economic and ecologic (Gamez et al., 2006).

From this reasons, this had prompted efforts where adding dietary fiber into food products is being more and more important.

1.2 Problem Statement

Much of the research done on incorporating sugarcane bagasse in bread, noodles, cookies and pasta but no research done by using this sugarcane bagasse powder incorporation in steaming product, such as Chinese steamed buns in this study. Besides, this, sugarcane bagasse is a waste products and it is necessary to find another alternative to more utilize this waste product. Chinese steamed buns choose to be the main subject to incorporating with sugarcane bagasse powder because Chinese steamed buns are easily make, and can be stored and freeze for several months. When concerning to health problem patients especially to diabetes patients, this enriched fiber steamed buns can be an alternative food product compare to wheat flour Chinese steamed buns.

1.3 Significance of Study

This study can provide some knowledge on effect of sugarcane bagasse powder of dietary fiber content on Chinese steamed buns. Chinese steamed buns by incorporating with sugarcane bagasse powder bring a lot of advantages to consumer and environment where it is a healthier alternative ways to food product with added dietary fiber content. For the environment, it can optimize or increase the usage of waste (sugarcane bagasse) from sugar-making factories or from production sugarcane juice, where this bagasse is said to be recyclable. With the usage of sugarcane bagasse, we can reduce adding oat or wheat flour in order to increase the dietary fiber in food products. In this study, sugarcane bagasse powder can be a good source for the improvement of the nutritional value of Chinese steamed buns for its fiber content.

1.4 Objectives

1.4.1 General Objective

To study the effect in characteristics of using sugarcane bagasse powder incorporated into Chinese steamed buns.

1.4.2 Specific Objective

I. To develop of Chinese steamed buns incorporated with sugarcane bagasse powder.

II. To determine chemical properties of Chinese steamed buns with different percentage of sugarcane bagasse powder in terms of moisture, fiber, protein, fat, ash and total carbohydrate content.

III. To investigate the effect of incorporating sugarcane bagasse powder into Chinese steamed buns for colour, specific volume, microstructure and textural analysis.

IV. To determine the sensory acceptability and preference of Chinese steamed buns incorporated with different percentage of sugarcane bagasse powder.

CHAPTER 2

LITERATURE REVIEW

2.1 Wheat flour

Gluten is the major protein in wheat flour dough, responsible for their unique viscoelastic behavior during deformation. It is now widely accepted that gluten proteins are responsible for variations in baking quality, and in particular it is the insoluble fraction of the high-molecular- weight (HMW) glutenin polymer which is the best related to difference in dough strength the baking quality among different wheat varieties (Cauvain, 2003).

White wheat flour is milled from the wheat karnels after the outer covering, called bran, and the germ are removed. Wheat flour contains 63-70 percent starch and 7 to 15 percent protein. The rest is moisture content, fat, sugar and minerals (Gisslen, 2011). There are two important purposes on milling process. One is to remove the bran and one other is to reduce the endosperm to small and fine particles (Sun et al., 2007).

The different milling methods on flour quality have proved to effects the performance of the steamed bread making quality. From the researched found by Sun et al. (2007), the results showed that debranning affected both the quality of the flour and the steamed bread. Debraning lower the gluten index, maximum resistance and starch damage, but on the same ways, it increased pericarp content, ash content, L* value, falling number and particle size distribution.

2.1.1 Types of wheat flour

The gluten-forming properties of wheat make it the most commonly milled grain and the major source of flour for bread making (Amy, 2008). Wheat flours are classified according to their protein or mineral content. Table below shows some common types of wheat flour that are usually used in baking product.

Table 2.1: Common types of wheat flours

Types of flours	Descriptions
Whole wheat flour	Is made from the entire wheat kernel, including bran, germ, and endosperm. Whole wheat flour contains fat from the germ, so it requires refrigeration to prevent rancidity.
White flour	Is made from only the endosperm of wheat grain.
Bread flour	Is a long patent white flour made primarily from hard, winter wheat. The higher gluten content of this flour makes it ideal for making product that requires elastic gluten for multiple rising periods.
Durum flour	Is made from hard winter durum wheat. It has the highest protein content.
All purpose flour	The protein contents flour averages about 11%. Blending hard and soft wheat flours yields flour that can be used for all purpose.
Pastry flour	Also called as cookie or cracker flour. A lower content of about 9 %.
Cake flour	The higher gluten content of regular flour. It is pure white and has a very fine, silky, soft texture.
Gluten flour	Is made from wheat flour that has been milled in such way to retain the gluten
Graham flour	Made with whole wheat graham flour that was made by combining a finely ground endosperm with a coarsely ground germ and bran.

Amy (2008)

2.1.2 Proximate content of wheat flour

Table 2.2: Proximate chemical composition of wheat flour (All purpose flour)

Constitutes	Percentage (%)
Carbohydrate	83.50 ± 0.38
Crude Protein	10.62 ± 0.51
Moisture	12.68 ± 0.02
Crude Fiber	2.03 ± 0.45
Crude Fat	2.63 ± 0.88
Crude Ash	1.22 ± 0.44

Lin et al. (2009)

2.2 Chinese steamed bread

Chinese steamed bread is a fermented product made by using wheat flour, which is cooking by using steaming technique with a steamer. The most popular wheat product in China is Chinese steamed bread and around 40% of the wheat flour consumption is from making of Chinese steamed bread, particularly in northern China (He et al., 2003).

The studied from Su et al. (2005) said that, this Chinese steamed bread has been consumed for at least 2000 years in china and it is a staple food product of the China people. From the food culture intercommunication among different countries, the Chinese steamed bread originated from China has been gaining to Korea, Japan, and some Southeast Asian countries. Nowadays, the industrialization trend of this steamed bread has followed the trend of baking bread production in western countries (Su et al., 2005).

2.2.1 Types of steamed bread

There are three major types of steamed bread consumed in China, namely Northern style, Southern style and Cantonese style.

Table 2.3: Characteristics differences between the three types of steamed bread

	Northern	Southern	Cantonese
Shape	Round or pillow like	Pillow-like	Pillow –like
Weight	100-120g	25-30g	100-120g
Grain structure	Dense	Open	Open
Textural characteristics	Firm texture, very chew, very cohesive	Soft bite, elastic, cohesive	Firm bite, elastic, chewy
Purpose	Staple food	Dessert	Dessert
Region	Northern China	Southern China	Mainland China, Taiwan, Southeast Asia

(Crosbie et al., 1998; Sim et al., 2010)

2.2.2 Formulation of Chinese steamed bread

The formula of Chinese steamed bread is simply the flour, water, salt, and yeast, and may sometimes include sugar and/ or shortening. In the traditional method, the starter "mother dough" is produced in place of yeast, the final product is sour-type bread. Sponge-dough system, commonly used in making of steamed bread with the fermentation time of 3 to 4 hours. It formed a variety of shape and filled with meats, vegetables or a sweet bean paste prior to steaming (Rubenthaler et al., 1990).

From the research, Rubenthaler et al. (1990) provided an optimum formula was 8% sugar and either 1.0% instant active dry yeast or 1.5% fresh yeast with a 3.5 hours fermentation, 58 min proofing, and 10min steaming. Protein quality as well as quantity had a significant effect on the quality of steamed bread produced. Weak soft wheat benefited from increases in protein content. Wheat cultivars, class, and years or location were found to influence steamed bread quality.

2.2.3 Analysis on quality of Chinese steamed bread

Zhu et al. (2001) found that, the Chinese steamed bread quality properties had a significant impact with the flour protein contain, where it gives effect on dough properties. An increasing the protein could significantly improve the dough properties. Addo et al. (1991) also reported that in order to produce acceptance steamed bread, the protein content was so important especially use from low protein soft wheat flour.

2.3 Chinese steamed buns

Chinese steamed buns is the same with the Chinese steamed bread in term of formulation production and also it is steamed at the final stage. However, the differences between Chinese steamed buns and steamed bread in that the shape and filled. Chinese steamed buns is a small and a round shape with the filled inside. So, the filled steamed bread is now called as steamed buns. The fillings for the steamed buns can be sweet or savoury. Typical sweet fillings include various bean pastes mixed with sugar. Savoury includes chopped vegetables, minced meat and seafood, or combination of these ingredients (Rubenthaler et al., 1990).

The quality requirement for Chinese steamed buns is different from normally baked breads, in term of distinct attributes of elasticity, stickiness and smooth appearance associated with the traditional product (He et al., 2003). There are conflicting reports on the effect of flour protein quality and for gluten quality upon Chinese steamed buns quality. Zhang and Wang (1987) found that, there is no correlation between the protein qualities upon Chinese steamed bun, positive effect shown with increasing the protein quality could even improve the quality of the dough (Addo et al., 1991) and negative effect for the protein quality to the volume properties of the steamed buns (Rubenthaler et al., 1992).

2.3.1 Ingredient and formulation

The formulation is almost the same with the making of Chinese steamed bread. The production of Chinese steamed buns from starter dough requires several steps. Firstly, wheat flour and water are added to the starter dough and left to ferment at 30 ^{o}C for 16-20h. Then, this activated dough is mixed with other ingredients (flour, water, sugar and chemical leavening agents), shaped as a bun, stuffed and then steamed.

2.3.2 Physicochemical Analysis

Chinese steamed buns made from starter dough have different texture than made from yeast. From the starter dough, the texture is more like cake-like texture and are sticky chewed, while made yeast steamed buns have something taste like bread taste and texture. Therefore, in the study if Luangsakul et al. (2009) was investigated the microflora functions towards steamed buns. Chinese steamed buns with the starter dough is mainly focusing on the lactic acid bacteria and yeasts as the former provide the sour flavour and expected provide carbon dioxide in the later stage for fermentation leaving agents. Finally they found that, there is low density found in the starter dough of Chinese steamed buns compare to yeast in sourdough.

Other than that, the amount of humectants and lactic acid has some effects to the steamed bun. After the researched done, the water activity of the steamed buns was found to decrease while the sensory qualities were not significantly changed with the increasing of glycerol at level $p > 0.05$. In addition, adding more lactic acid reduced pH of the Chinese steamed buns, decreased flavour and overall acceptability. However, water activity, appearance and texture were not affected (Poonnakasem, unknown).

2.3.3 Steamed buns ingredients and their function

The fundamental ingredients of steamed buns are flour, water, yeast, sugar, shortening and baking powder. The table below shown the ingredients and functions used in the making Chinese steamed buns.

Table 2.4: Typical steamed buns ingredient and functions

Ingredients	Functions
Flour	Wheat flour is most common flour used in yeast bread and steamed bun because of its highest amount of gluten. Gluten is the protein that provides a firm, elastic structure to steamed buns. It also can form viscoelastic dough.
Water	Hydrates the flour protein to form a gluten
Yeast	Reacts with sugar to produce carbon dioxide, alcohol from the process of fermentation and cause the leavening of the steamed

	buns. Yeast also provides some flavour the product.
Sugar	Serves as a source of fermentable carbohydrate to feed the yeast that grow and cause the buns to rise. The added sugars also bring out the flavour of sweet taste to the product.
Shortening	Shortening retard gluten development, so steamed buns prepared with shortening has a softer and smoother texture. The fat in steamed buns also slows down the moisture loss.
Baking powder	Softness the texture and also helps to break up the top skin.

Amy (2008)

2.4 Sugarcane

Since the 19th century, sugarcane (*Saccharum officinarum*) has been grown in Malaysia as mainly function for the sugar production (Tan, 1989). Around 17,000 ha are planted with sugarcane and confined mainly to areas in Kedah and Perlis where the climate was most suitable.

2.4.1 Sugarcane juice

According to Brown (1999), sugarcane is the most agriculturally important monocots in terms of the production. With this reasons, up to 70% of the whole sugar production is provided by sugarcane as well (De Souza et al., 2008).

Fresh sugarcane juice is being popular in many countries because of its cheap and sweet beverages. It is becoming a fashion juice served at roadside stalls, cafeterias and restaurants throughout the world during harvest season (Mao et al., 2007). However, the sugarcane juice is rapid deterioration, and this problem caused it is limited in the processing and marketing of sugarcane juice (Prasas and Nath, 2002; Yusof et al., 2000). So, the most widely used method for delaying this deterioration problem is by using blanching the sugarcane before juice extraction (Rossi et al., 2003) and addition of antioxidant agents (Ozoglu and Bayindirli, 2002).

In Malaysia, fresh sugarcane juice is popular in because of its pleasing, sweet and thirst-quenching beverage. It is also served in fresh at many eateries from roadside stalls to high class hotel restaurants (Yusof et al., 2000).

2.4.1.1 Sugarcane juice composition

Sugarcane juice contains 0.85 % - 1.45 % of soluble solids in the form of organic non-sugars such as protein, starch, gums and waxes (Chen and Chou, 1999).

Table 2.5: Composition of sugarcane and juice solid

Millable cane	**Cane (%)**
Water	73-76
Solids	24-27
Soluble solids	10-16
Fiber (dry)	11-16
Juice Constituents	**Soluble Solids (%)**
Sugars	75-92
Sucrose	70-88
Glucose	2-4
Fructose	2-4
Salts	3.0-4.5
Inorganic acids	1.5-4.5
Organic acids	1.0-3.0
Organic acids	1.5-5.5
Carboxylic acids	1.1-3.0
Amino acids	0.5-2.5
Other organic non sugars	
Protein	0.5-0.6
Starch	0.001-0.100
Gums	0.30-0.60
Waxes, fats, phosphatides	0.05-0.15
Other	3.0-5.0

Chen and Chou (1999)

2.4.2 Sugarcane Bagasse

Sugarcane bagasse is one of the largest agro-industrial by-products. Sugarcane bagasse is a fibrous residue of cane stalks left after the crushing and extraction of the juice from the sugarcane. It is a lignocelluloses residue, type of by-product of the sugar industry and is almost completely used by the sugar factories back as fuel for the broiler process (Pandey et al., 2000).

2.4.2.1 Composition in sugarcane bagasse

Cellulose, hemicelluloses and lignin, these three main fractions can be found in sugarcane bagasse constituents. Approximately 25-33% of sugarcane bagasse is hemicelluloses (Du Toit et al., 1984; Rodriguez-Chong et al., 2004; Sasaki et al., 2003). From the other researches, sugarcane bagasse consists of approximately 50% cellulose and 25% hemicelluloses and also 25% lignin. In chemically, sugarcane bagasse also contains about 50% α-cellulose, 30% pentosans, and 2.4% ash (Pandey et al., 2000). Vilay et al. (2008) also figure out the main chemical composition of bagasse fiber obtained from chemical analysis are cellulose (36.32%), hemicelluloses (24.7%), and lignin (18.14%). From this researched, it can be conclude that, sugarcane bagasse is a main source of insoluble fiber.

2.4.2.2 The usage of sugarcane bagasse in other field

Other than incorporating sugarcane bagasse in to food products as to enrich the food with fiber, some researcher has been increasing interest in the biodegradable plastic composites using natural fiber reinforcement (Vilay et al., 2008) where natural fiber have the advantages of biodegradability of low cost and low density. This studied used sugarcane bagasse fiber as reinforcing components for unsaturated polyester resin to open up further possibilities in waste management (Vilay et al., 2008).

2.5 Dietary fiber

2.5.1 Definition of Dietary fiber

According to AOAC (2000), the consensus definition of dietary fiber is the edible parts of plants or analogous carbohydrate that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. Dietary fiber includes polysaccharides, oligosaccharides, lignin, and associated plant substances. Dietary fibers promote beneficial physiological effect including laxation, and/or blood cholesterol attenuation, and/ or blood glucose attenuation.

2.5.2 Types of dietary fiber

Among the constituents of dietary fiber, there can be distinguished into soluble and insoluble components. For soluble components included pectin, gums, mucilage, while for the insoluble included celluloses, lignin, and hemicelluloses. Thus final distinction governs their physicochemical properties and their nutritional effects.

Soluble fiber form a gel network with alginates, carrageenans and pectin or a thickened network with xanthan gum, some hemicelluloses in some physicochemical conditions where in this ways they are bind to water. Insoluble fibers have a strong hygroscopic property as they swell and can absorb up to 20 times their weight in the water. Cereals are generally insoluble in water, whereas vegetable, fruits and nuts contain a higher proportion of soluble fiber (Thebaudin et al., 1997).

2.5.2.1 Soluble fibers

Soluble fiber includes gums, mucilages, pectin, and hydrocolloid. Soluble fiber dissolves in water and form a gel-like consistency. This type of fiber has been shown to help in lower cholesterol levels by pulling cholesterol from the bloodstream. Soluble fiber also slows digestion which allow human to lasting energy (Douglas, 2011).

Pectin, an important property of pectin is the ability to form a gel in the presence of Ca^{2+} or in the presence of sugar and acid. Gelling agent in many different industrial applications also used these types of pectin (Voragen et al., 2003).

Gum, consists of a number of water-soluble polysaccharides come from different chemical structures and provide diverse functional properties (Rosell et al., 2007). From the previous studied, the gum has been used to retard the baked goods from staling and can improve the quality of the fresh produce (Barcenas and Rosell, 2005) and to enhance frozen dough for its shelf life (Asghar et al., 2007).

Hydrocolloids have been used in baked goods for retarding the staling and for improving the quality of the fresh products (Barcenas and Resell, 2005).

2.5.2.2 Insoluble fibers

Cellulose, lignin, and the hemicelluloses, are all insoluble fibers, these fibers provided structure to plants. So, the skin of most fruits and vegetables are also good source of insoluble fiber.

Insoluble fiber act rapidly travels through the body, and it go through plumbing system. Insoluble fibers pick up miscellaneous fats and whatever else is lingering around. Fiber is not digested, it simply passes through the body and fiber does not get absorbed into the bloodstream, but it does have a positive impact in blood chemistry. It works like a flushing action and ushers all the unfavorable things in body system (Douglas, 2011).

2.6 Health effects of Fibers

Fibers have important benefits for health, especially because of its effect on the digestive system. A various studied have demonstrated the beneficial effect of consumption of dietary fiber in protection against heart disease and cancer, normalization of blood lipids, regulation of glucose absorption and insulin secretion and prevention of constipation and diverticular disease (Stollman and Raskin, 2004; Jenkins et al., 1998; Kritchevsky and Bonfield, 1997).

2.6.1 Fiber and diabetes

Fiber can helps in control or reduce type 2 diabetes disease. Soluble fibers trap the carbohydrate and slow down the rate of carbohydrate digestion and absorption. The slower adsorption of glucose levels helps prevent side swings in blood sugar level throughout the day (Kendall et al., 2010).

2.6.2 Fiber and coronary heart disease

Clinical studied found that, the increasing intake of high fiber fruits and vegetables has show in lower the risk of blood cholesterol and thus lower the risk of heart disease. Soluble fiber will binds to dietary cholesterol, helping the body eliminate the cholesterol. This can reduce the blood cholesterol where this is the main factor that bring to heart disease (Kendall et al., 2010).

2.6.3 Fiber and colon cancer

Previous studied has generally shown as association between low total fat intake, high fiber intake, and a reduced incidence of colon cancer where insoluble fibers adds bulk to stool, which in turn dilutes carcinogens and speeds their transit through the intestine and out of the body (Kendall et al., 2010).

2.6.4 Fiber and weight Management

Fiber can help in weight management, because most of the fiber food contains fewer calories and low in fat and sugar. Since fiber-containing foods slow the digestion and provide bulk, it can prolong the feel fullness and thus eat less. It is important to add fiber gradually to diet and the drink more fluids as well (Kendall et al., 2010).

2.7 Recommended Intake for dietary fiber

Recommendations for increasing the amount of fiber in US diet have come from several governmental and private organizations, each with a concern for improving the health of the US public. In 2002, the National Academy of Science Food and Nutrition Board established Dietary Reference Intakes, specifically adequate intakes (AI) for fiber. Adequate intakes of total fiber, representing the sum of dietary fiber and functional fiber, were established based on amounts of fiber shown to protect against heart disease (Food and Nutrition Board, 2002). The recommendations for fiber intake for adults and children are shown in Table below.

Table 2.6: Recommended intake of dietary fiber

Population Group	Age (years)	Total Fiber (g)
Men	19 to 50	38
	≥51	31
Women	19 to 50	25
	≥51	21
Children	1 to 3	19
	4 to 8	25
Girls	9 to 18	26
Boys	9 to 13	31
	14 to 18	38

Sareen, Jack and James (2009)

2.8 Potential source of dietary fiber supplement

In traditionally, the fiber supplement is only focused on the use of milling byproduct of cereal grains. Now, there are many others source of dietary fiber can be found in underutilized sources either from fruits and vegetables (apples, date, sugarcane bagasse), legumes and seeds (peas, peanut hull) and in cereal grains (rice, corn) (Mckee and Latner, 2000).

2.9 Microscopic evaluation

SEM technique has been done by Pomeranz et al. (1984) on the wheat, wheat-rye and rye dough and bread. In white bread, the dough structure which is formed by a protein matrix that becomes thinner, finer and better distribution by fermentation and formation of small vacuoles.

Examination of microstructure of wheat flour dough and bread has been helpful in determining the changes that occur in physical structure during the various stages of bread preparation (Fleming and Sosulski, 1978). Previous studies showed that the supplemented breads showed decreased loaf volumes, compact or coarse crumb grains, and firm textures that were resistant to compression.

Samples of these breads were observed by Fleming and Sosulski (1978) by using light microscopy and scanning electron microscopy. The supplemental proteins were shown to disrupt the well-defined protein-starch complex observed in the wheat flour bread. In addition, small pores were observed in the thick cell walls of the supplemented breads, and these pores may allow gases to escape from the structure during baking.

CHAPTER 3

MATERIALS AND METHODS

3.1 Raw Materials

3.1.1 Preparation of sugarcane bagasse powder

Sugarcane bagasse used in this study was collected from Kampung Keson at Terengganu. The natural fresh sugarcane bagasse was firstly washed thoroughly by using water and then was washed with distilled water to remove access soluble solid content. The ^{o}Brix reading was taken to ensure that there are no access soluble solid remain in the sugarcane bagasse.

Then the sugarcane bagasse were dried in oven at 70 ^{o}C for two days or the moisture content was reached about 10- 12 %. The dried sugarcane bagasse was blended into smaller pieces by hand blender and was grounded using a laboratory sample mill and 0.2 mm powder in size was obtained. The sugarcane bagasse powder produced was then packaged in air-tight plastic packaging and sealed properly and was stored in room temperature for future incorporated into steamed buns for analysis. Figure 3.1 showed the flow on the procedure of sugarcane bagasse powder preparation.

Natural fresh sugarcane bagasse was collected from Kampung Keson, Terengganu.

↓

Washed thoroughly using water and then distilled water

↓

dried in oven-drying at 70 °C or reached 10-12 % moisture content

↓

blended and milled of dried sugarcane bagasse and reached around 0.2 mm size particle

↓

Packed and sealed well and stored in room temperature.

Figure 3.1 Procedure of sugarcane bagasse powder preparation

3.1.2 Ingredients used for Chinese steamed buns

The ingredients used in the making of Chinese steamed buns were mainly from Hong Kong flour, castor sugar, shortening, dry yeast, baking powder, warm water and greaseproof paper. All this ingredients were purchased from a local market at Mee Soya Trading, Kuala Terengganu and the same trade products were used in all experiments.

3.1.3 Preparation of Chinese steamed buns

The Chinese steamed buns were made in Food Service Laboratory and Food Technology Laboratory in University Malaysia Terengganu (UMT) by using the equipments like dough mixer, mixing bowl, weight scale, steamer, large bowl, small bowl, and others related equipments. Before started, all the equipments were washed first to avoid any contamination from the equipments to Chinese steamed buns.

To make eight pieces of Chinese steamed buns, 200g of Hong Kong flour was needed with 130 g warm water, 22 g castor sugar, 17 g shortening, 2 g dry instant yeast, 1.5 g baking powder and 1 pieces of greaseproof paper.

Firstly, all the ingredients used were prepared and weighted follow the formulation. The Chinese steamed buns was made by mixed all the dry ingredients such as Hong Kong flour, castor sugar and baking powder at first stage by using laboratory dough mixer and were mixed thoroughly in mixing bowl. After that, dry instant yeast was added later and lastly the entire remaining ingredients were added. All the ingredients were mixed thoroughly and finally soft dough was formed. The dough was then placed in a bowl covered with wet cloth and allowed undergoes fermentation for 30 min or until it rose up to double its original size. Then dough was taken out and punched for 10 times

By using the weight scale, dough was weighted and divided into eight pieces for each had 45 g. The dough was rounded into round shape and placed the rounded shape dough on a piece of greaseproof paper and then placed on a tray and ready to steam. The ready buns were steamed for 20 minutes. Do not uncover immediately when the steaming is finished, but allow remaining covered for further five minutes and cooling slightly.

3.1.4 Displacement of sugarcane bagasse powder in Hong Kong flour

The Chinese steamed buns were prepared from the Hong Kong flour and were substituted with different amounts of sugarcane bagasse powder produced from the previous stage. Subsequently, different Chinese steamed buns formulations were tested by changing the amount of an ingredient at a time to get an optimum amount of each ingredient. The Chinese steamed buns were carried out by substituted 2 %, 4 %, 6 % and 8 % of sugarcane bagasse powder and a control. The steamed buns were evaluated for chemical, physical and sensorial properties.

The formulations of reformulated steamed buns were shown in table below.

Table 3.1: Amount of displacement of sugarcane bagasse powder in steamed buns

Ingredients	Control	2 %	4 %	6 %	8 %
Hong Kong flour	200 g	196 g	192 g	188 g	184 g
Sugarcane bagasse powder	0	4 g	8 g	12 g	16 g
Warm water	130 g	130 g	130 g	130 g	130 g
Castor sugar	22 g	22 g	22 g	22 g	22 g
Shortening	17 g	17 g	17 g	17 g	17 g
Instant dry yeast	2 g	2 g	2 g	2 g	2 g
Baking powder	1.5 g	1.5 g	1.5 g	1.5 g	1.5 g

3.1.5 Comparison of bagasse powder with Hong Kong flour buns

Chinese steamed buns and sugarcane bagasse steamed buns made in this study were compared by analyzing proximate analysis, colour measurement, specific volume, microstructure and texture analysis. Steamed buns were submitted to sensory evaluation for colour, aroma, tenderness, pore size, taste, moistness and overall acceptability by level of acceptability and preference test.

3.2 Methodology

Figure in below shown the experimental design will be use in this study.

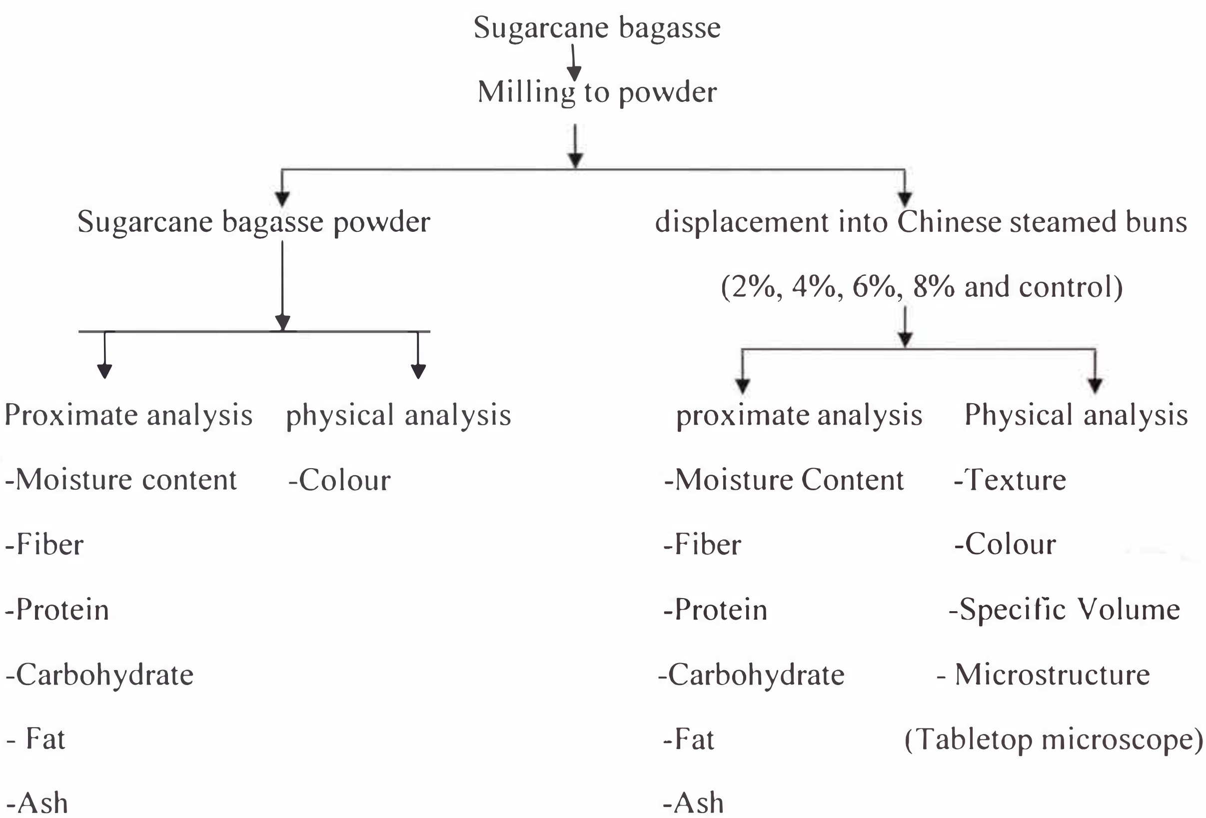


Figure 3.2: Research experimental design

3.2.1 Experimental Design

In this research, totally there were five formulations, which included control Chinese steamed buns and 2 %, 4 %, 6 % and 8 % sugarcane bagasse steamed buns. All these samples were undergoing several analyses which included proximate analysis, physical analysis and sensory evaluation. All analysis was done in duplicate and average readings were calculated.

3.3 Chemical analysis

Chemical analysis was conducted at "Makmal Sains Makanan" in University Malaysia Terengganu (UMT). The chemical analysis of Hong Kong flour, sugarcane bagasse powder and steamed buns were determined by using AOAC method (AOAC, 2000). There were six types of basic proximate analysis were determined, included Moisture content, Fiber content, Protein content, Fat content, Fiber content, Ash content and Total Carbohydrate content.

3.3.1 Moisture Content

The moisture content of Hong Kong flour, sugarcane bagasse powder and steamed buns were carried out in this study by using air-oven method (AOAC Official Method 925.10). First, the crucibles were dried in air-oven at 105 °C for 30 minutes. Then the crucibles were cooled in desiccators for 1 hour and the weights of crucibles were recorded. After that, the samples with 2 g were weighted and placed into the crucibles. The samples were put into air-oven in 105 °C for 6 hours or until the constant weight was obtained. After dried, the samples were then cooled again in desiccators. Finally, the dried samples were weighted together with the crucible. Lastly, the moisture content of samples was calculated by using the following formula.

Formulation:

Weight of dry sample = weight of crucible and sample

– weight of crucible and sample after drying

$$\% \text{ dry sample} = \frac{weight\ of\ dry\ sample}{original\ sample\ weight\ (5g)}\ x\ 100\%$$

% moisture of sample = 100% - % of dry sample

3.3.2 Protein Content

The protein content of the Hong Kong flour, Sugarcane bagasse powder and steamed buns were determined by using Kjeldhi System method with Tecator Kjeltec System (Foss Tecator Sweden). 1 g of steamed buns samples and 2 g of Hong Kong flour and sugarcane bagasse powder were weighted and placed inside the digestion tube. Then, two tablets of Kjeltabs Cu 3.5 and 12 ml H_2SO_4 were added into the tube. Next, the tube was shaked gently in order mixed the samples with the acid for digestion. The exhaust system was connected to the digestion tubes in the rack and the water aspirator was operated at full flow. Then the rack and the exhaust system were placed on the preheated Digester heater lock D_{36} at 420 °C and started the process. The samples were heated continuous to digest until the blank sample was clear in colour with blue or green solution for 30 minutes. The rack was removed with exhaust still in the place and cooled for 10-20 minutes in the stand.

After that, around 75 ml of distilled water were added into each Kjeldhi digestion flask. The receiver solution (25 ml boric acid with 10 drops of bromocresol green indicator solution) was prepared in a conical flask for the distillation process. Then, the digestion tube was placed in the distillation unit and the safety door was closed. 50 ml of 40 % NaOH was dispensed into the tube and the distillation process was carried out using 0.1 ml HCL (0.1000 N) to the collecting solution to determine the amount of nitrogen present. The volume of acid used was recorded. Lastly, the protein content of the sample was calculated by using the formula in below.

Formulation:

Percentage of nitrogen (%)= $\frac{(T-B) X N X 14.007 X 100}{\text{weight of the sample (mg)}}$

Percentage of protein (%)= Percentage of nitrogen X F

Where,

T= Titration volume for the sample (ml)

B= Titration sample for the control (ml)

N= Concentration of hydrochloric acid

F= Protein factors for Hong Kong flour (5.7), sugarcane bagasse powder (6.25) and steamed buns (4.38)

3.3.3 Fat content

Fat content of Hong Kong flour, sugarcane bagasse powder and steamed buns were determined by the Soxhlet method according to AOAC (2000). The samples of steamed buns were grinded to a fine particle, and petroleum ether was used as the organic solvent. The pre-dried extraction thimble was weighted to obtain the weight of thimble.

1 g of sugarcane bagasse powder and 2 g of Hong Kong flour and steamed buns were placed in thimbles and were weighed again. The electronic weight was used to weight the samples. Pre-dried extraction beaker was weighed. 75 ml of petroleum ether was placed in the extraction cup and the extraction cup was put on heater of apparatus or manual extraction system (Soxtex Aventi 2055). Extraction done for 1 hour, then the heat was lower and cooled down the samples. Then, the extraction cup was removed and placed in air-dry oven at 103 °C for 2 hours. After that, the extraction cup was cooled in desiccators for 1 hour and the weight was weighed.

Weight of samples' fat content can be calculated by using following equation

Formulation:

$$\% \text{ Fat} = \frac{W3-W2}{W1} X\ 100\%$$

W1= Weight of sample (g)

W2= Weight of extraction cup (g)

W3= Weight of extraction cup + fat (g)

3.3.4 Fiber content

Dietary fiber content of the Hong Kong flour, sugarcane bagasse powder and steamed buns were determined by using Fibertec 2021 System with fibercap capsule according to AOAC (2000) method. First steps, the fibercap capsules were dried in the air-dry oven at 105 °C for 1 hour. Then, the capsules with the lid were weighted.

2 g of Hong Kong flour and steamed buns and 1 g of sugarcane bagasse powder samples were weighed as well and were transferred into fibercap capsule. After that, the capsules were closed with the lid and placed it into capsule holder.

The extraction process was done by treatment of 350 ml of sulphuric acid solution. Firstly, the sulphuric acid solution were placed on the hotplate and heated until boiling. When the reagent was boiled, the heating point was lower to level 5. Then, capsule together with capsule holder was added slowly with carousel into the boiling reagent until the samples were sinking slowly. Next, carousel was added fully into the reagent. Follow on, condenser was placed above the condenser extraction cylinder and tap water was open for reflux system. The solution was heated slowly for 20 minutes.

After the process, the extraction cylinder, carousel and capsules were washed with boiled water with amount 350 ml for three times. Next, capsule was repeated washed by using sodium hydroxide solution (NaOH) 1.25 % followed by three times of distilled water again. Then, the capsule was removed from the carousel and was dried in the oven at 105 °C for 2 hours and continued cooled in the desiccators. Next, the weight of samples and capsule were weighed and recorded. Then, capsule with the samples were put in crucible and dried overnight in the furnace at 550 °C. Finally, the crucibles were transferred to desiccators for cooling process. The weight of crucibles and samples were recorded. Lastly, the fiber content of the samples was calculated by using following formulation.

Formulation:

$$\text{Percentage of fiber content (\%)} = \frac{W3-(W1 \times A)-(W5-W4-D)}{W2} \times 100\%$$

Where,

W1= Weight of capsule (g)

W2= Weight of sample (g)

W3= Weight of capsule with residue (g)

W4= Weight of crucible ash (g)

W5= Weight of total ash (include crucible) (g)

$$A = \frac{W3}{W1}$$

D= W5-W4

3.3.5 Ash Content

The ash content shows the mineral content of the samples for Hong Kong flour, sugarcane bagasse powder and steamed buns. This method was carried out by charring samples in a muffle furnace according to AOAC (2000) method. First, crucibles were dried in the oven at 103 °C for 30 minutes and then transferred to desiccators for cooled in 1 hour. Then the crucible and about 2 g of the samples were weighed. Next, the samples were heated in the muffle furnace at 550 °C for overnight. Finally, the samples were cooled in the desiccators for 1 hour and the weight of crucibles with ash were weighed and recorded. Lastly, the ash content of the steamed buns was calculated using following formula.

Formulation:

$$\text{Percentage of ash content (\%)} = \frac{\text{Ash weight (g)}}{\text{weight of sample (g)}} \times 100\ \%$$

Ash weight (g) = weight of crucible + samples after dried (g) – weight of crucible (g)

3.3.6 Total Carbohydrate content

The carbohydrate content in this study were determined by using difference method using the formula in below.

Percentage of total carbohydrate (%) = 100% - (% Moisture + % of fat + % of protein + % of ash content)

3.4 Physical Analysis

The physical analyses for Hong Kong flour and sugarcane bagasse powder were only done for colour measurement, while physical analysis for steamed buns were colour measurement, specific volume, microstructure and textural analysis.

3.4.1 Colour Measurement

The colour values of Hong Kong flour, sugarcane bagasse powder and steamed buns were determined by using measurement with CR-400 Konica Chroma meter (Konica Minolta Sensing Inc, Osaka, Japan). A standard white plate (X= 91.98, Y= 93.97 and Z= 110.41) were used to standardise the instrument. Each sample was individually measured in triplicate. The determination was measured by determined the L* (brightness or whiteness), a* (redness or greenness) and b* (yellowness or blueness) values.

3.4.2 Specific volume

The steamed bun volume was determined by rapeseed displacement method. The volume was measured after the steamed bun cooled at least one hour in a room temperature. Steamed bun were placed in a contained which is higher than and greater in perimeter than the steamed bun. The void space in the container contained steamed bun were filled with the rapeseeds so that the rapeseeds are level with the top edge of the container. The amount of rapeseeds was measured in whole millilitres using graduated cylinder. The steamed bun from the container was removed and the steamed bun was weighed. The weight of the steamed bun was calculated in terms of whole grams. Next, the empty container was filled again with the rapeseeds so that the rapeseeds are level with the top edge of the container and the amount of the rapeseeds were calculated again as specific above. Weight of the steamed bun was measured using a balance and measured to nearest 0.01 g. Specific volume (ml g^{-1}) was the ratio of volume to weight of steamed bun.

Formulation:

Specific volume (ml g^{-1}) = $\frac{W2-W1}{W3}$

W1 = volume of rapeseeds in the void space in the container containing the steamed bun (ml)

W2 = volume of rapeseeds in the empty container (ml)

W3 = weight of steamed buns (g)

3.4.3 Textural Analysis

Textural analysis was performed using a Textural Analyser TA-XT 2i (Stable Micro System, UK). Steamed buns were sliced by using a knife after steamed buns were cooled down. The central three sliced of 13 mm thickness were used for the test. A probe of P 35 was used for the Texture Profile Analysis (TPA) test, followed the procedure as follow: pre-test speed: 1.0 mm/s; test speed: 1.0 mm/s; post-test speed: 1.0 mm/s; strain: 50.0 %; time: 5.0 s; trigger type: Auto, 5.0 g.

From the TPA test profile, hardness parameters was obtained and used in this study. Two measurements per sample for duplication were recorded. Each time of measurement was taken, the maximum peak force value was recorded and the average was calculated in force unit.

3.4.4 Microstructure

The steamed buns were cut into a thickness of 2-3 mm and the microstructures were determined by using Tabletop Microscope in AKUATROP Laboratory located in UMT.

3.5 Sensory Evaluation

Sensory evaluation of steamed buns was conducted by 30 untrained panellists. The panellist was randomly selected among the students from University Malaysia Terengganu (UMT). A questionnaire was used to collect demographic data on gender, age and others panellists' information. No sensory training was provided prior to the evaluations sessions. Sensory analysis was conducted in the restaurant of Food Service Laboratory.

Steamed buns were prepared freshly for presentation to panellists in kitchen Food Service Laboratory. Each time, subject was presented with 5 samples (control, 2 %, 4 %, 6 %, and 8 % of sugarcane bagasse powder substituted steamed buns) on a single plate with random left to right configuration, identified only by random assigned three digit codes. A glass of warm water provided in order to wash their mouth after tested each samples.

Two types of test were carried out, which are acceptance test and preference test in this study. Degree of acceptance of steamed buns was tested with quantitative affective test.

For the acceptance test, the attribute of colour, aroma, tenderness, pore size, taste, moistness and overall acceptance were evaluated by the panel. For each steamed buns, panellist was instructed to select the number in the scale from 1 to 7, with using 7-points scaling score that best fit their perception of the acceptability of these five samples of steamed buns towards each attribute. The example of the scores are as shown: 1- dislike extremely; 2- dislike moderately; 3- dislike slightly; 4- neither like nor dislike; 5- like slightly; 6- like moderately; 7- like extremely.

For Ranking Preference test, a structural graphic 5 points hedonic scale used for sensory analysis of five formulations of steamed buns which ranked the sample from the most preferred to least preferred. The scale number 1 indicated most preferred and 5 indicated least preferred.

3.6 Statistical Analysis

All the results from the data of the test were analyzed with using Minitab version 14. The data obtained from chemical analysis, physical analysis and sensory analysis were stated as mean value ± standard deviation. One way analysis of variance (ANOVA) followed by Fisher's LSD on the individual rating for each characteristics or attributes to observe the degree of significant different ($p< 0.05$) among the samples and these were performed in Minitab on personal computer.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Chemical Analysis

Hong Kong flour, purchased from the local market (Mee Soya Trading, Kuala Terengganu) and sugarcane bagasse powder, produced from the lab were used in this study, and their physicochemical properties were compared. On the same way, different types of steamed buns incorporated with different percentage of sugarcane bagasse powder were also compared.

Moisture, fiber, protein, fat, ash and total carbohydrate content determination had been done to Hong Kong flour, sugarcane bagasse powder and steamed buns. Figure 4.1 to Figure 4.6 showed the graph result with mean score of the proximate analysis for each moisture, fiber, protein, fat, ash and total carbohydrate respectively. Figure 'a' is the result in between Hong Kong flour and sugarcane bagasse powder, while Figure 'b' is the graph result for steamed buns with different percentage of sugarcane bagasse powder substitution.

4.1.1 Moisture Content

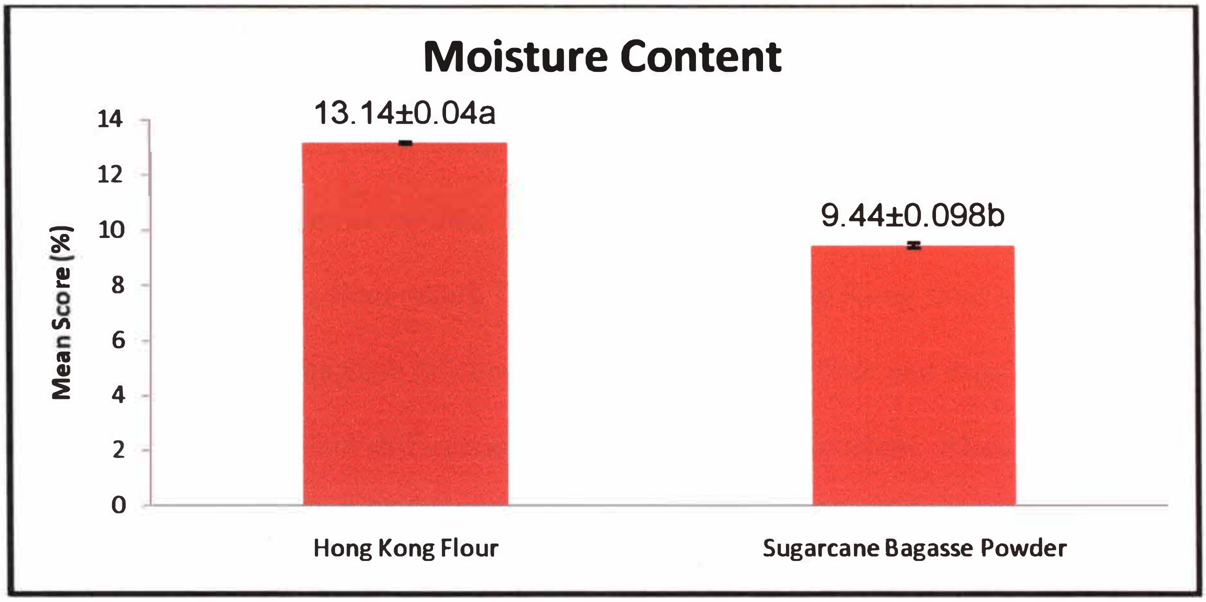


Figure 4.1a: Moisture Content for Hong Kong flour and sugarcane bagasse powder

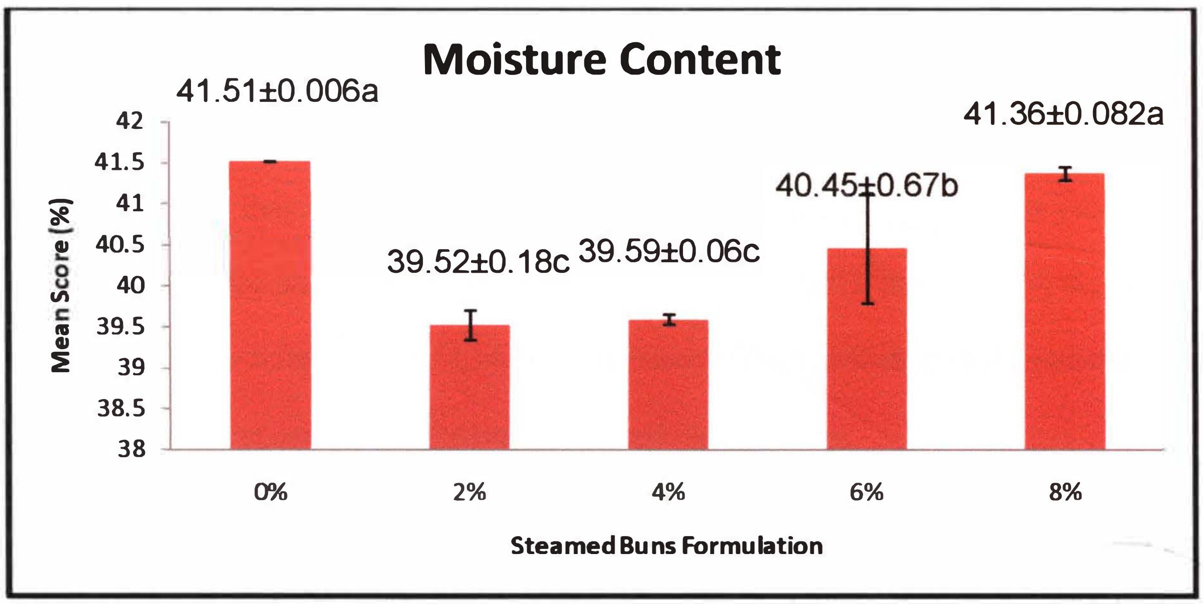


Figure 4.1b: Moisture Content for steamed buns with different formulations

*Mean values with different superscript shows significant differences ($p < 0.05$).

The moisture content of foods usually use as an indicator of food quality. It is very important to measure the amount of moisture content contain in steamed buns because of its potential impact on the sensory and physical properties of the steamed buns. Figure 4.1a showed the mean and standard deviation of the moisture content for both Hong Kong flour with sugarcane bagasse powder. Sugarcane bagasse powder contained less moisture content than Hong Kong flour where 13.14 % ± 0.04[a] for Hong Kong flour and only 9.44 % ± 0.098[b] for sugarcane bagasse powder. Both the Hong Kong flour and sugarcane bagasse powder showed significant differences in terms of moisture content. Also, the moisture content of wheat flour in making steamed buns by Tseng et al. (2011) which contained 12.41 % ± 0.04 were reported a little higher than the Hong Kong flour which used in this study. However, the moisture content of sugarcane bagasse powder in this study is mainly depends on the time and temperature used in the drying process.

Moisture content of the flour in good condition is in the ranges from 11 to 14 %. If it becomes higher than this, spoilage is likely to occur. With this reason, flour should be always stored in dry place with properly covered (Gisslen, 2011). In this study, the Hong Kong flour (wheat flour) was in 13.14 % of moisture content, which is in the range of 11 to 14 % requirement and suitable to use in steamed buns making.

Figure 4.1b showed the result of moisture content of Chinese steamed buns and sugarcane bagasse steamed buns. The higher was the amount of sugarcane bagasse powder added, the higher was the moisture content in sugarcane bagasse steamed buns. The amount of moisture content was increased from 39.52 % ± 0.18[c] in 2 % sugarcane bagasse steamed buns to 41.36 % ± 0.082[a] in 8% sugarcane bagasse steamed buns. There are significant differences between these five formulations of steamed buns. However, the

Chinese steamed buns (control) had the highest moisture content compared to sugarcane bagasse steamed buns with the moisture content of 41.51 % ± 0.006[a]. Also, the moisture content of Chinese steamed buns were higher those from Tseng et al. (2011) who reported value of 38.67 % ± 0.28 in white steamed buns.

Moisture content is related to castor sugar used in steamed buns making too. Sugar had hydroscopic characteristics, where they attract water and hold water (Gisslen, 2011). However, this castor sugar not much effect to the differences content of moisture content for steamed buns since the amount for each steamed buns formulations was fixed. In addition in all the steamed buns experiments, as the concentration of fiber material increased (sugarcane bagasse powder here), the moisture content (water absorption) increased. The increasing of moisture content may be caused by the strong water-binding ability of fibres (Chen et al., 1988), where higher amount of fiber was added subsequently. On the other hand, Cauvein (2003) also stated that, the addition of fiber can also increase the water absorption of dough, as well as the particle size of fiber. Although the size particle of the sugarcane bagasse powder are almost same size with using sample mill equipment with the particle size of 0.12 mm, the amount of sugarcane bagasse powder added are different from 2 % sugarcane bagasse steamed buns to 8 % sugarcane bagasse steamed buns. The moisture content of steamed buns was increased gradually as the percentage of sugarcane bagasse powder was added. Because of these five formulations of sugarcane bagasse steamed buns was drier than the control, this indicating that this product formulation may affect this important parameter, critical for its stability and shelf-life.

4.1.2 Fiber Content

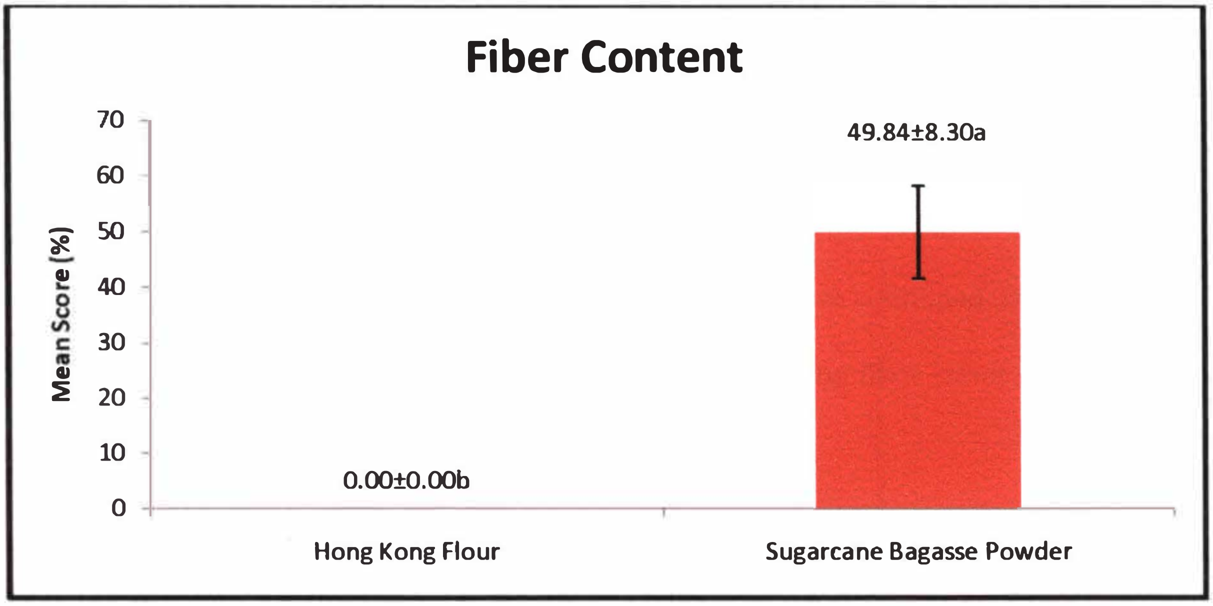


Figure 4.2a: Fiber Content for Hong Kong flour and Sugarcane bagasse powder

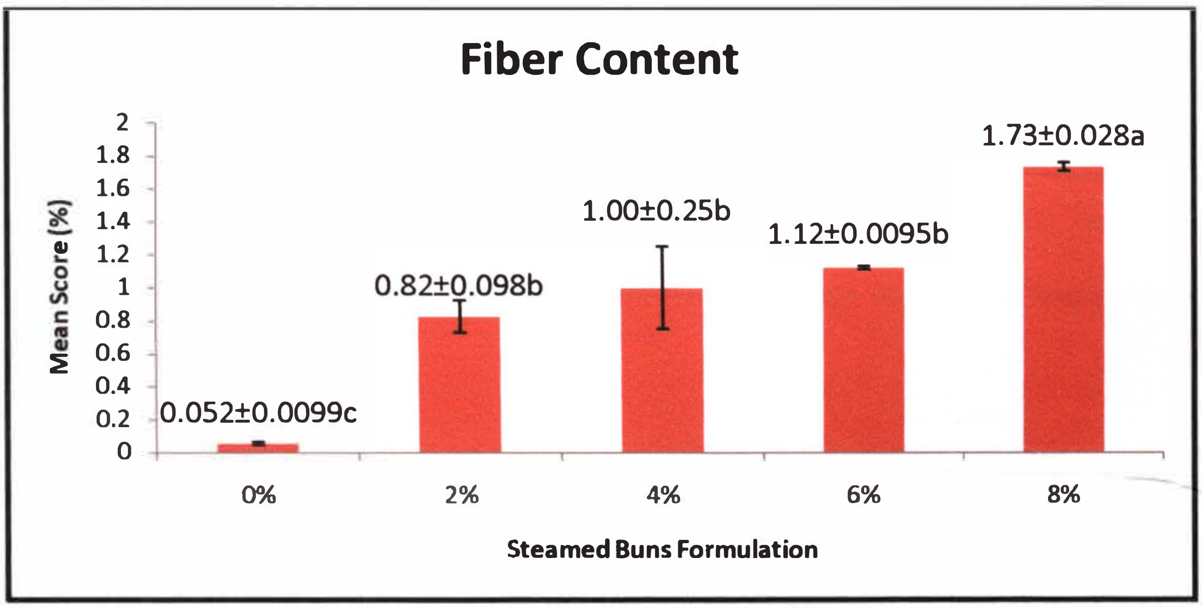


Figure 4.2b: Fiber content for steamed buns with different formulations

*Mean values with different superscript shows significant differences ($p < 0.05$).

Figure 4.2a in above, the fiber content of sugarcane bagasse powder was greatly higher than those of Hong Kong flour with 49.84 % ± 8.30[a] for sugarcane bagasse powder and 0.00 % ± 0.00[b] for Hong Kong flour, respectively. Pandey et al. (2000) stated that bagasse consists of approximately 50 % cellulose, and 25 % each of hemicelluloses and lignin. While the wheat flour from Tseng et al. (2011) contained only 3.20 % ± 0.92 of fiber content and none in Hong Kong flour in this study and bagasse contained 38.89 % ± 1.07 of fiber (Gaonkar and Kulkarni, 1989). So, it is show why the fiber result for sugarcane bagasse powder was higher than Hong Kong flour.

As can seen in the result of Figure 4.2b above, the crude fiber content of the fiber-enriched steamed buns was higher than the content of the control steamed buns (no added fiber). The content of fiber significantly increased with the increasing levels of sugarcane bagasse powder in steamed buns as compared to the control Chinese steamed buns. From the previous study of Hong Kong flour and sugarcane bagasse powder (Figure 4.2a), it is found that there are 0 % of fiber content in Hong Kong flour, but when added into Chinese steamed buns, a little amount of fiber content was detected which was only 0.052 % ± 0.01[c]. This is due to the fiber content from dry yeast used in the fermentation of steamed buns.

From one way ANOVA test, it is found that Chinese steamed buns (control) contained least fiber content while 8 % sugarcane bagasse steamed buns contained highest amount of fiber content. However, control steamed buns with 8 % steamed buns showed significant differences ($p< 0.05$) among them and with the rest of the sugarcane bagasse added steamed buns, while 2 %, 4 % and 6 % shows no significant differences ($p>0.05$) in terms of fiber content analysis.

4.1.3 Protein Content

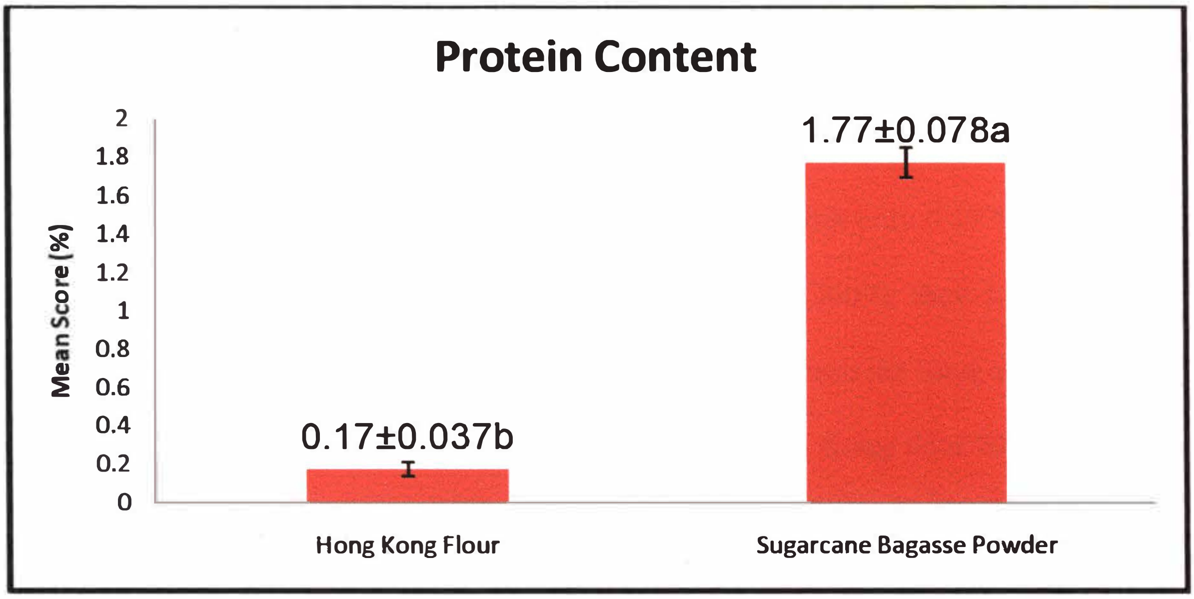
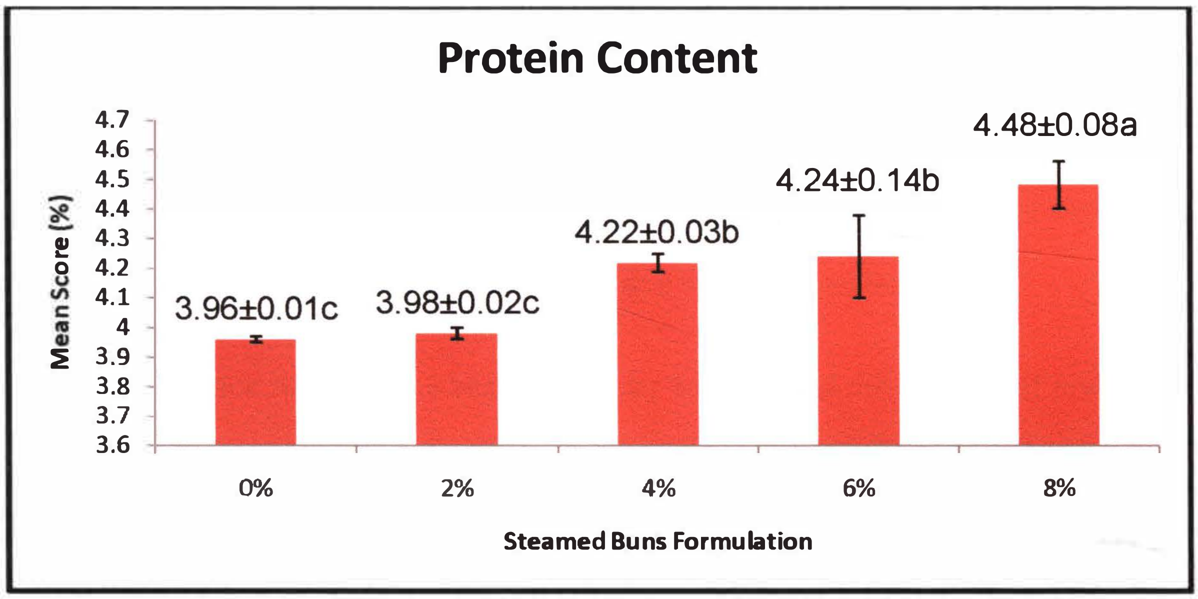


Figure 4.3a: Protein Content for Hong Kong flour and Sugarcane bagasse powder



4.3b: Protein Content for steamed buns with different formulations

* Mean values with different superscript shows significant differences ($p < 0.05$).

Figure above shows the protein content for Hong Kong flour with sugarcane bagasse powder (Figure 4.3a) and five formulations of steamed buns (Figure 4.3b). Comparison in between Hong Kong flour and sugarcane bagasse powder, there are significant differences in among them. Sugarcane bagasse powder contained 1.77 % ± 0.078[a] of protein content and higher than Hong Kong flour with only 0.17 % ± 0.037[b] of protein content. From the research done by Rosell et al. (2009), they found that the protein content of the wheat flour was 0.10 % and it found almost the same with the Hong Kong flour used in this research and with the reason of Hong Kong flour contained more protein content than other wheat flour and very suitable used in steamed buns making for its gluten formation.

The protein content of steamed buns gradually increased among the supplemented sugarcane bagasse powder (Figure 4.3b) with significant increased was observed. The highest protein content value shows in 8 % sugarcane bagasse steamed buns and Chinese steamed buns (control) have a lowest value of protein content, as the amount of sugarcane bagasse powder was added gradually from 2 % to 8 % in steamed buns.

The addition of sugarcane bagasse powder had changed the quantity of protein in sugarcane bagasse steamed buns. This phenomenon had the similarity with the research done by Lim et al. (2011) that the turmeric powder which contain lower amount of protein content compared with wheat flour in the bread making and had changed the quantity protein in wheat flour with turmeric powder system and which affect the uniform structure in bread. Siddiq et al. (2009) also found the lack of uniform structure changes that in the textural characteristics, mainly the firmness/ hardness of the bakery product.

4.1.4 Fat Content

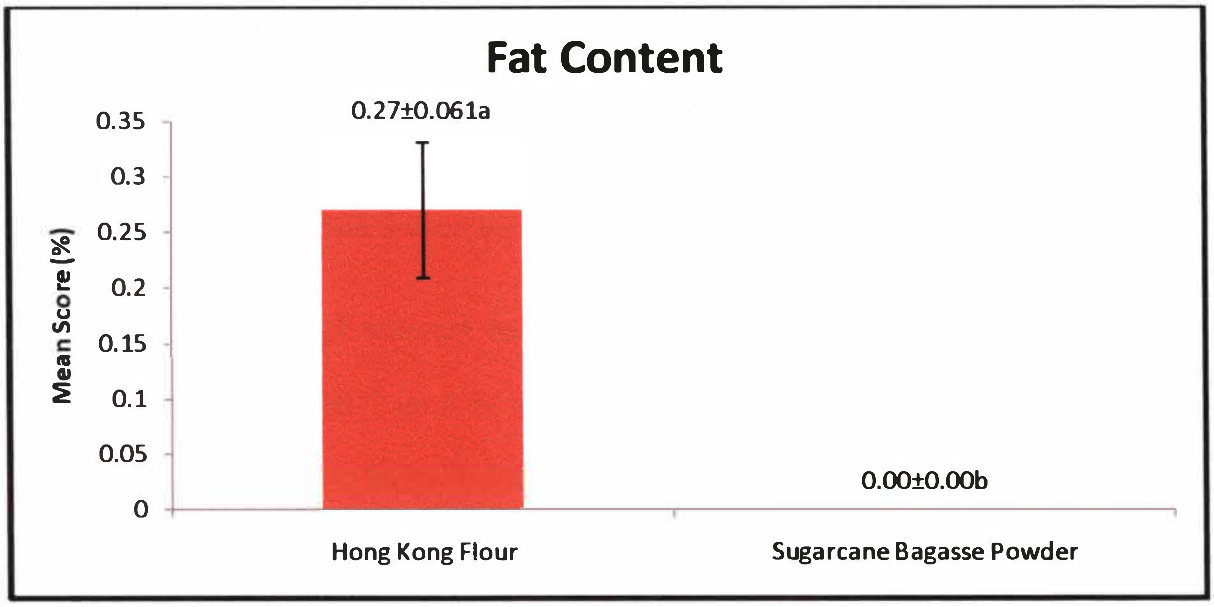


Figure 4.4a: Fat content for Hong Kong flour and sugarcane bagasse powder

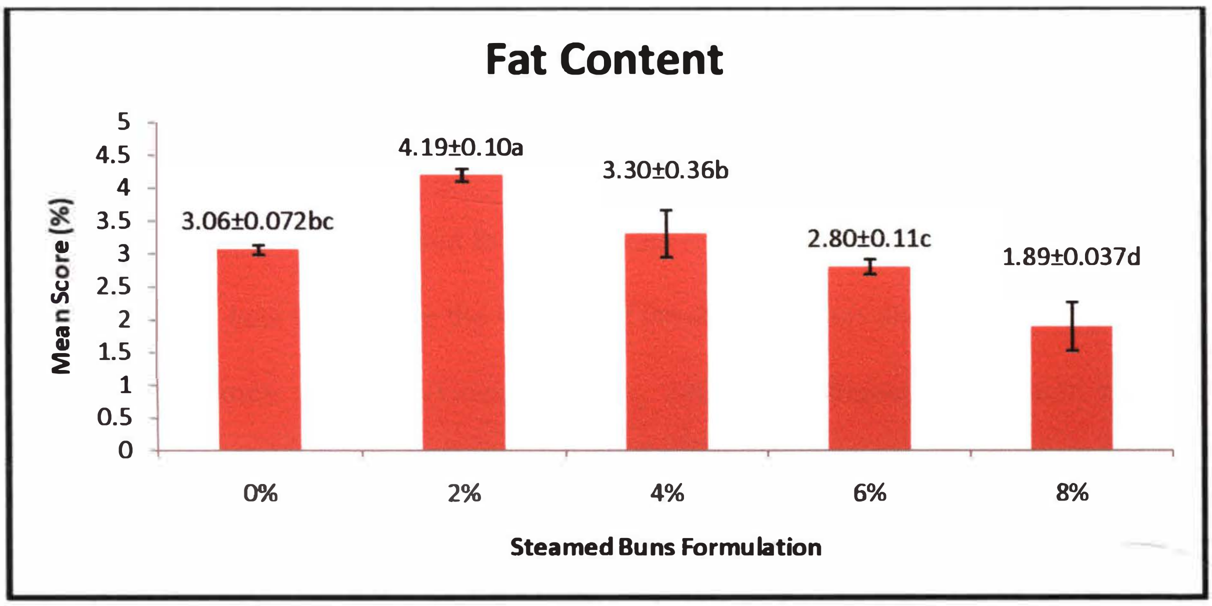


Figure 4.4b: Fat content for steamed buns with different formulations

*Mean value with different superscript shows significant differences ($p< 0.05$).

Compared with Hong Kong flour, sugarcane bagasse powder contains relatively less fat content with 0.0 % ± 0.00^{b} than Hong Kong flour with 0.27 % ± 0.061^{a} (Figure 4.4a). According to Gisslen (2009), fats are also important for gluten development. Upon the researches done by Gaonkar and Kulkarni (1989), among all the wastes, bagasse was found to be almost free from fat content as the result showed as 0.58 % ± 0.04.

The fat content of steamed buns incorporated with sugarcane bagasse powder ranged from 1.89 % ± 0.037^{d} for 8 % sugarcane bagasse steamed buns to 4.19 % ± 0.10^{a} for 2 % sugarcane bagasse steamed buns. It found that, the fat content of steamed buns was decreased significantly upon adding the sugarcane bagasse powder. This is due to the 0 % of fat content found in the previous study in sugarcane bagasse powder. Besides this, there is no significant difference for the Chinese steamed buns (control) with both the 4 % and 6 % sugarcane bagasse steamed buns where the fat content is not much different.

Fats acts as a shortening in the steamed buns making because of it shortens gluten strands and tenderized the steamed buns (Gisslen, 2009). The addition of small amounts of shortening can lead to improve the volume of the steamed buns and finer of the product, more uniform crumb structure (Goesaert et al., 2005). The highest fat content can be found in 2 % sugarcane bagasse steamed buns and lowest fat content can be found in 8 % sugarcane bagasse steamed buns.

4.1.5 Ash Content

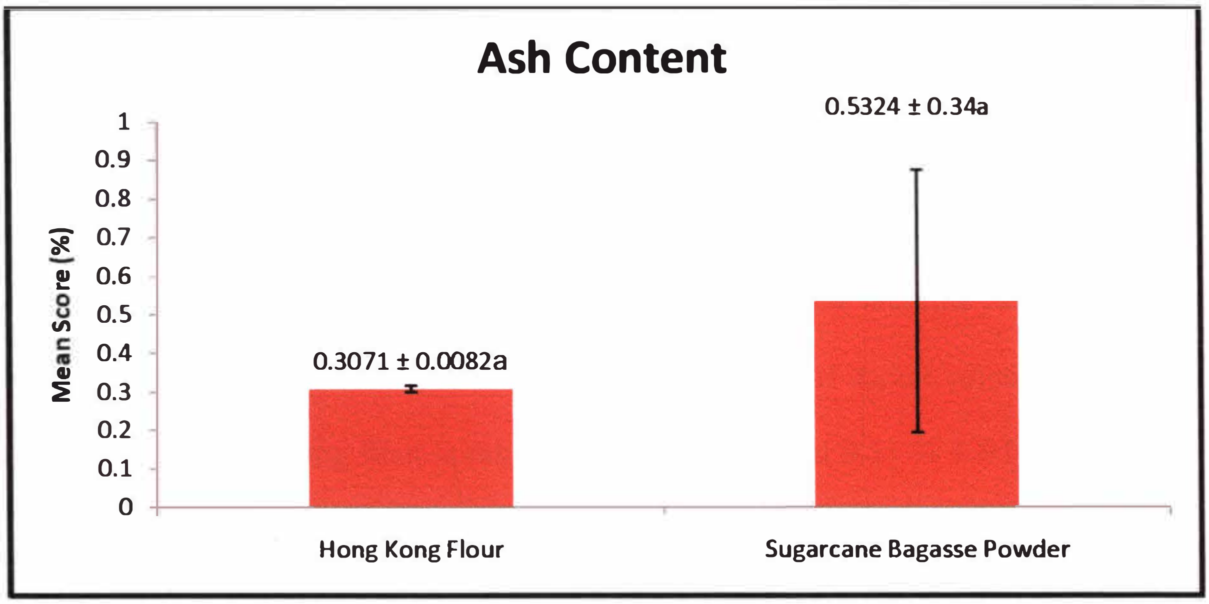


Figure 4.5a: Ash Content for Hong Kong flour and sugarcane bagasse powder

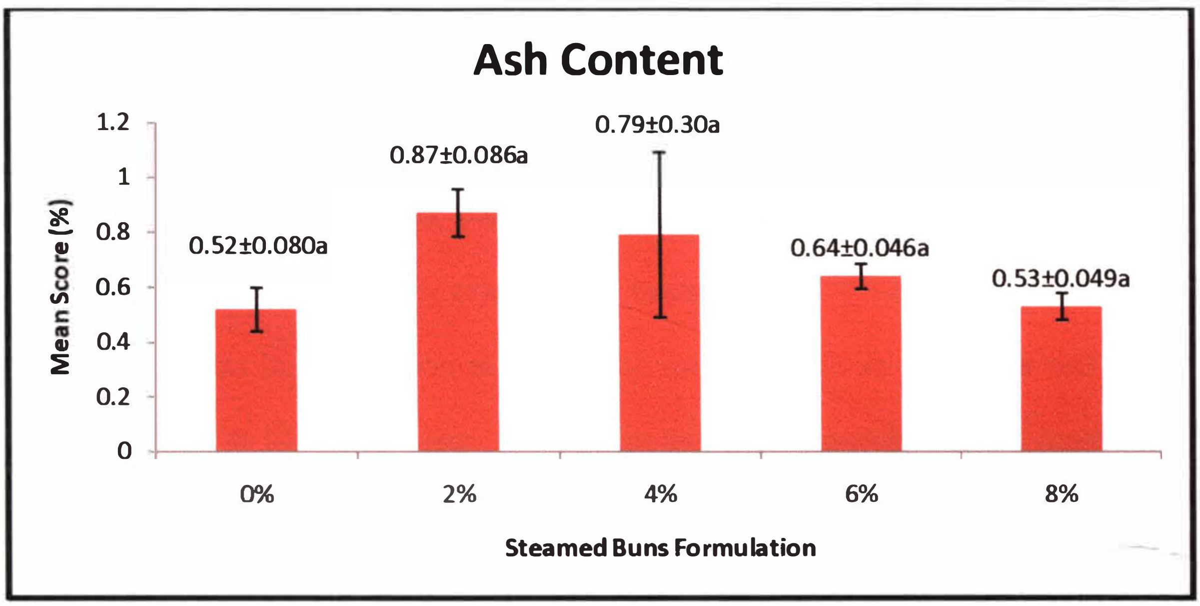


Figure 4.5b: Ash Content for steamed buns with different formulations

* Mean values with different superscript shows significant differences ($p < 0.05$).

Ash also can refer as mineral content of flour. This ash content is determined by burning a sample of flour in a controlled temperature. In general, the higher the ash content, the darker the flour (Gisslen, 2009). This is because the bran and the outer parts of the endosperm contain more minerals than the whiter, inner portions of the endosperm. In other case, whole-grain flour is higher in ash than white flour (Gisslen, 2009). Hong Kong flour is used in this steamed buns making due to its white and fine structure where the consumer wants whiteness of the steamed buns instead of darker colour, so the ash contain of the Hong Kong flour is relatively low as only total 0.31 % ± 0.0082^a (Figure 4.5a) of ash content in Hong Kong flour when compared to the wheat flour that used to make the steamed buns which is 0.8 % (Tseng et al., 2011).

The sugarcane bagasse powder for ash content shows only 0.53 % ± 0.34^a (Figure 4.5b). This is largely different from the research by Pandey et al. (2000) stated that there was 2.4 % ash content found in sugarcane bagasse. The large different may due to different sugarcane bagasse used, place of origin, methods of handling and processing. Besides this, according to Pandey et al. (2000), bagasse offers numerous advantages used in bakery products in comparison to other crop residues such as rice straw and wheat straw because of its low ash content. The product that use sugarcane as fibers supplement in foods included, bread (Sangnark and Noomhorm, 2004) and pizza crust (McKee and Latner, 2000). From the ANOVA test, there are no significant differences for both the Hong Kong flour and sugarcane bagasse powder in terms of ash content as the value for both are almost the same and not much different.

The ash content of the steamed buns was presented in the graph in above (Figure 4.5b). Ash content varied from 0.87 % ± 0.086^a observed in 2 % sugarcane bagasse steamed buns to 0.53 % ± 0.049[a] obtained in 8 % sugarcane bagasse steamed buns. There is a decreasing trend of ash content from 2 % to 8 % sugarcane bagasse steamed buns. From the result obtained, all the sugarcane bagasse steamed buns had higher ash content compared to control Chinese steamed buns with only 0.52 % ± 0.08[a]. The statistical analysis found there are no significant differences in between these five formulations of steamed buns.

4.1.6 Total Carbohydrate Content

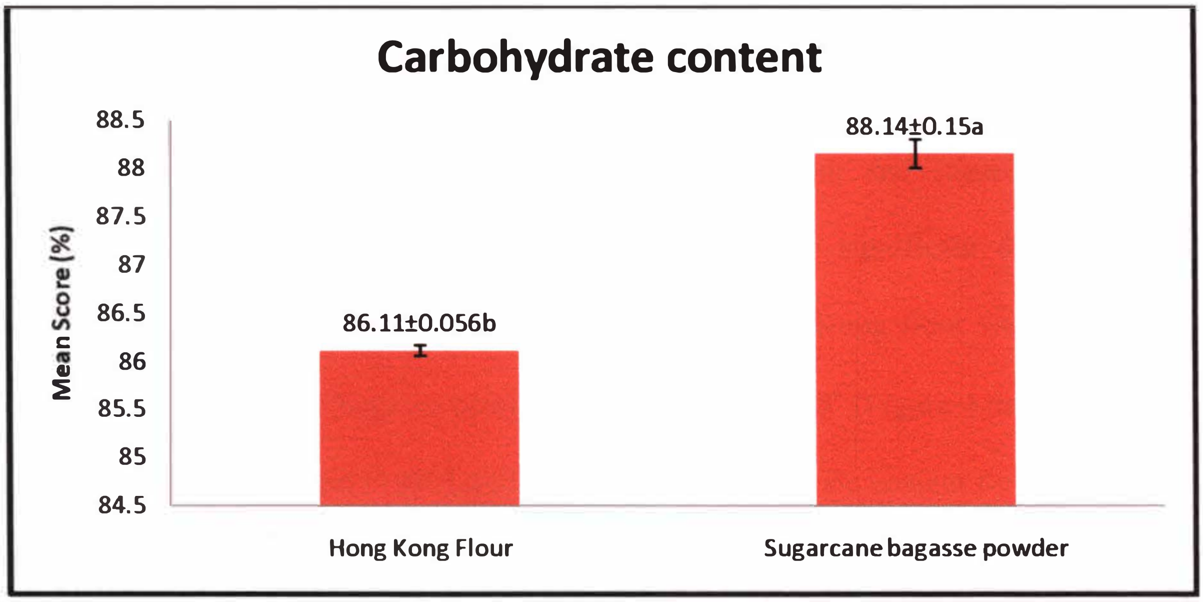


Figure 4.6a: Total carbohydrate content for Hong Kong flour and sugarcane bagasse powder

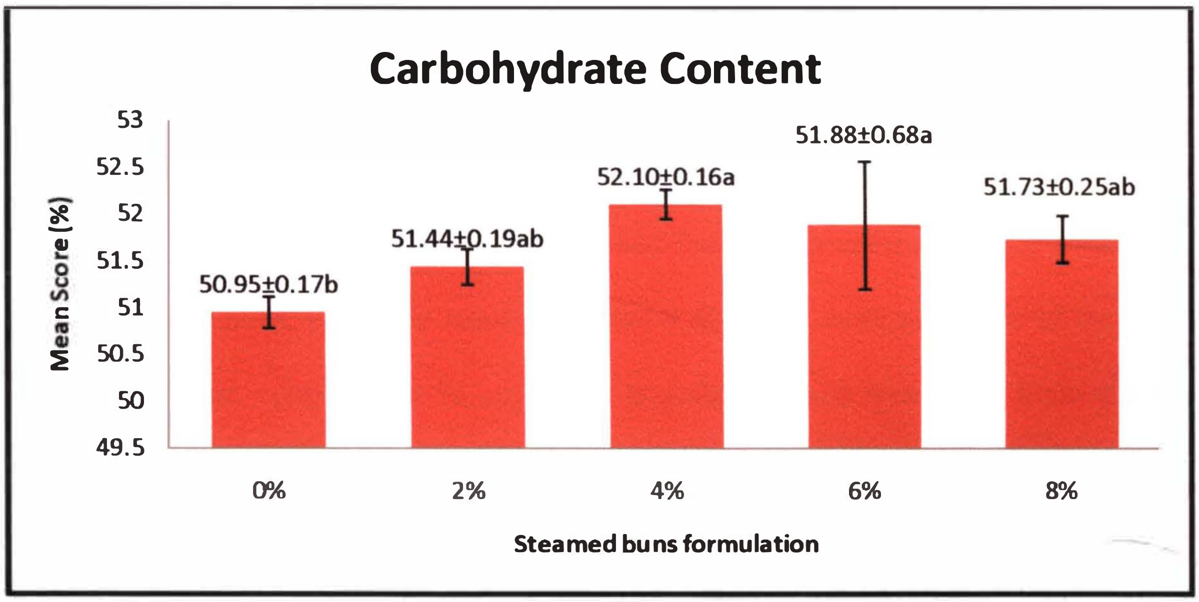


Figure 4.6b: Total Carbohydrate Content for steamed buns with different formulations

*Mean value with different superscript shows significant differences ($p < 0.05$).

Total carbohydrate included all those carbohydrate which is used in the plant body as a source of energy or as building material, either directly or indirectly after having been broken down by enzymes (Weinmann, 1946).

The total carbohydrate content for Hong Kong flour and sugarcane bagasse powder do not show big different, although they shows a significant differences in between. For example, total carbohydrate content for Hong Kong flour was 86.11 % ± 0.056^{b} and for sugarcane bagasse powder was 88.14 % ± 0.15^{a} (Figure 4.6a). Compared with Gaonkar and Kulkarni (1989) studies, the total carbohydrate content for bagasse was found to be a bit higher than this study with total 97.20 % ± 0.50. The lower values obtained in the present study could be attributed to variety difference. Due to the total carbohydrate content count was from difference method, deduction of moisture, fat, ash, and protein content. So, the total carbohydrate content depends on this proximate analysis.

The lower total carbohydrate content in Hong Kong flour caused the lower total carbohydrate content in control Chinese steamed buns when compared with sugarcane bagasse steamed buns. From the result in Figure 4.6b, there were no trends of the total carbohydrate from control to 8 % sugarcane bagasse steamed buns. The highest total carbohydrate content was shows in 4 % sugarcane bagasse steamed buns while lowest total carbohydrate content was shows in control Chinese steamed buns due to no added sugarcane bagasse powder. From the ANOVA test, sample 2 % and 8 % sugarcane bagasse steamed buns do not shows significant differences to others formulations steamed buns. However, control Chinese steamed buns with 4 % and 6 % sugarcane bagasse steamed buns had significant differences among others steamed buns.

4.2 Physical Analysis

4.2.1 Colour Analysis

Among the characters present, colour can be an external appearance of the product will often be a major problem factor which attracts the eyes of the consumer (Cauvain and Young, 2007). Thus, the use of CR-400 Konica Minolta Chroma meter to determine the colour of the Hong Kong flour, sugarcane bagasse powder and steamed buns in the form of L*, a* and b* values.

Crumb colour of the steamed buns was determined for the control Chinese steamed buns and sugarcane bagasse steamed buns. The data result for the Hong Kong flour and sugarcane bagasse powder (Figure 4.7a, 4.8a and 4.9a), while sugarcane bagasse powder replacements steamed buns are in the graph below (Figure 4.7b, 4.8b,and 4.9b).

4.2.1.1 L* Value

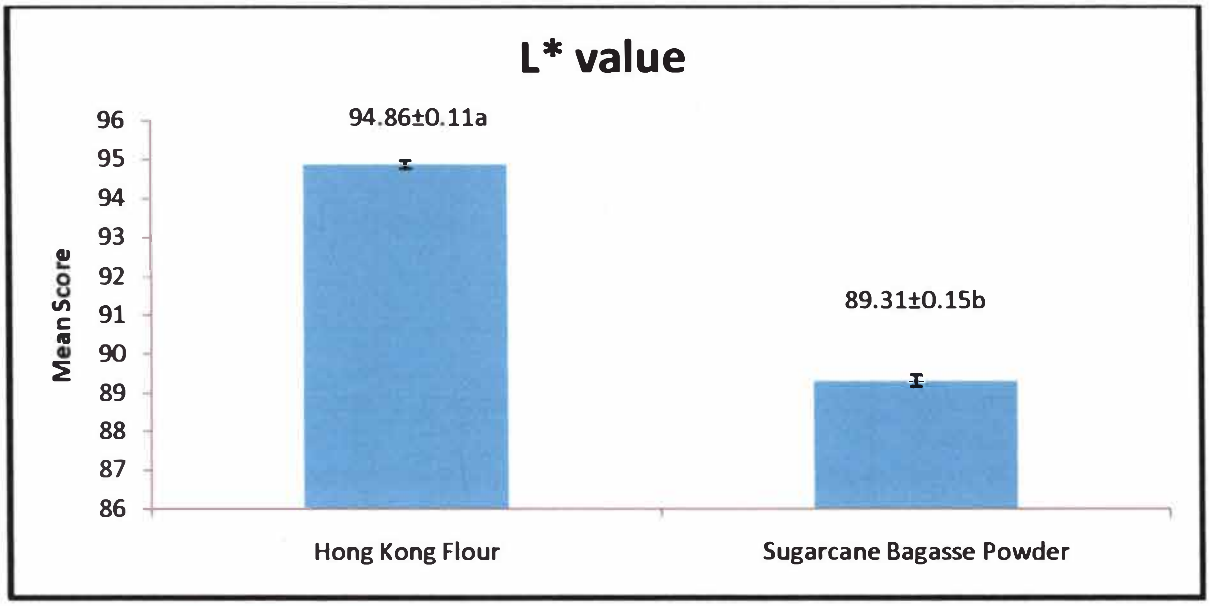


Figure 4.7a: L* value of colour for Hong Kong flour and sugarcane bagasse powder

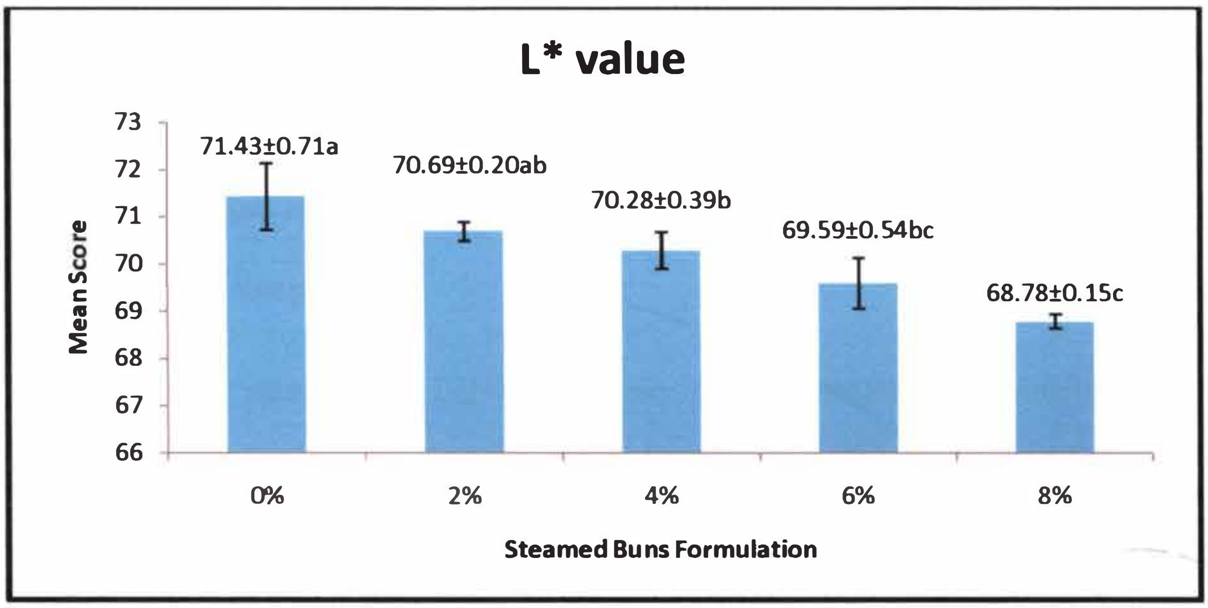


Figure 4.7b: L* value of colour for steamed buns with different formulations

*Mean value with different superscript shows significant differences ($p < 0.05$).

Lightness value (L*) of the Hong Kong flour and sugarcane bagasse powder had significant differences result obtained from colorimeter, where Hong Kong flour showed 98.46 ± 0.11[a] while sugarcane bagasse powder showed 89.31 ± 0.15[b]. As discussed in previous part, ash content, the higher of L* value, whiteness of colour in Hong Kong is highly related to the total ash content. The higher the ash content, the darker colour of the flour (Gisslen, 2009).

The sugarcane bagasse powder used in the present study, was found to be less white in colour compared to Hong Kong flour (Figure 4.7a). Therefore, it is expected that steamed buns with sugarcane bagasse powder added had different colour value from the control Chinese steamed buns. Comparison of lightness for each steamed buns was shown in the Figure 4.7b. In addition, Mohamed et al. (2010) also stated that the lower of L* value is due to the high protein content of the blends and to the additional vital gluten. As showed in the protein content (Figure 4.3a) the sugarcane bagasse powder had higher protein content than Hong Kong flour, so the colour of sugarcane bagasse powder is darker than Hong Kong flour.

In terms of steamed buns lightness intensity, they showed and decreasing lightness from the control steamed buns to 8 % sugarcane bagasse steamed buns, ranged from 71.43 ± 0.71[a] to 68.78 ± 0.15[c]. In conclusion, the colour of the steamed buns was darker as the amount of sugarcane bagasse increased in steamed buns. This is because the colour of sugarcane bagasse powder (89.31 ± 0.15) was less in whiteness value than Hong Kong flour (98.86 ± 0.11). Lightness of ingredients plays an important role in bakery products due to consumers' preferences, especially whiteness in Chinese steamed buns. In fact, numerous efforts have been devoted to lighten the colour of the grains products (Metzger, 2003).

From the ANOVA test, there are significant differences among the sample of Hong Kong flour with sugarcane bagasse powder as well as those five different formulations of steamed buns. Therefore, it can be claimed that, substitution of the Hong Kong flour (wheat flour) with sugarcane bagasse powder significantly affect the lightness of the steamed buns. However, Chinese steamed buns (control) and 8 % sugarcane bagasse steamed buns are relatively significant differences than others different percentage of sugarcane bagasse added.

4.2.1.2 a* Value

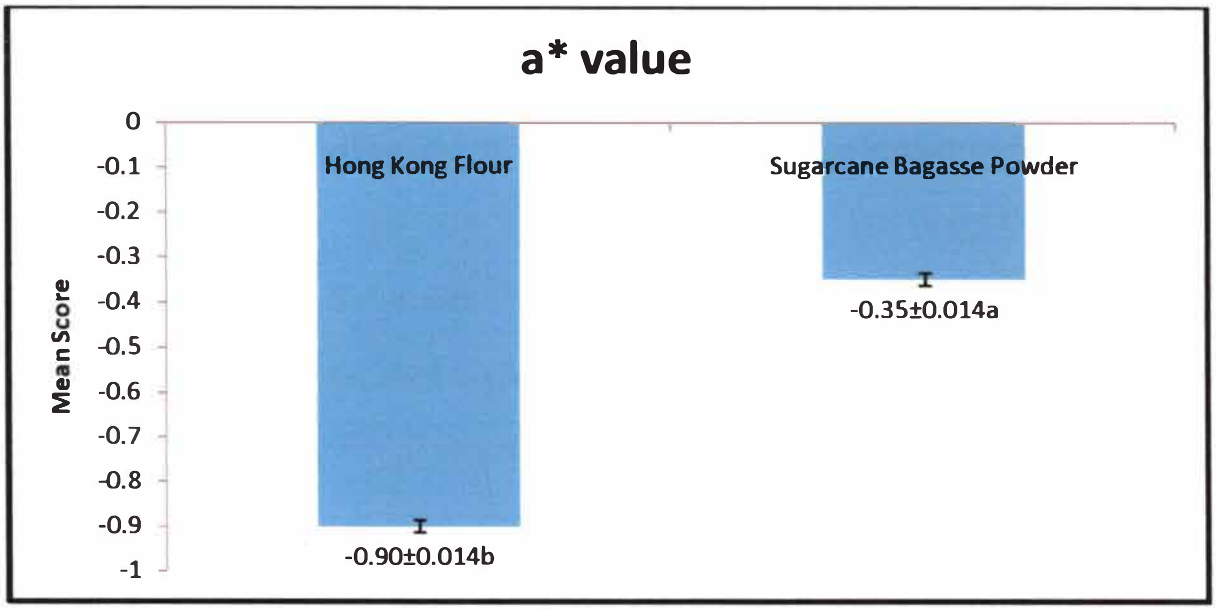


Figure 4.8a: a* value of colour for Hong Kong flour and sugarcane bagasse powder

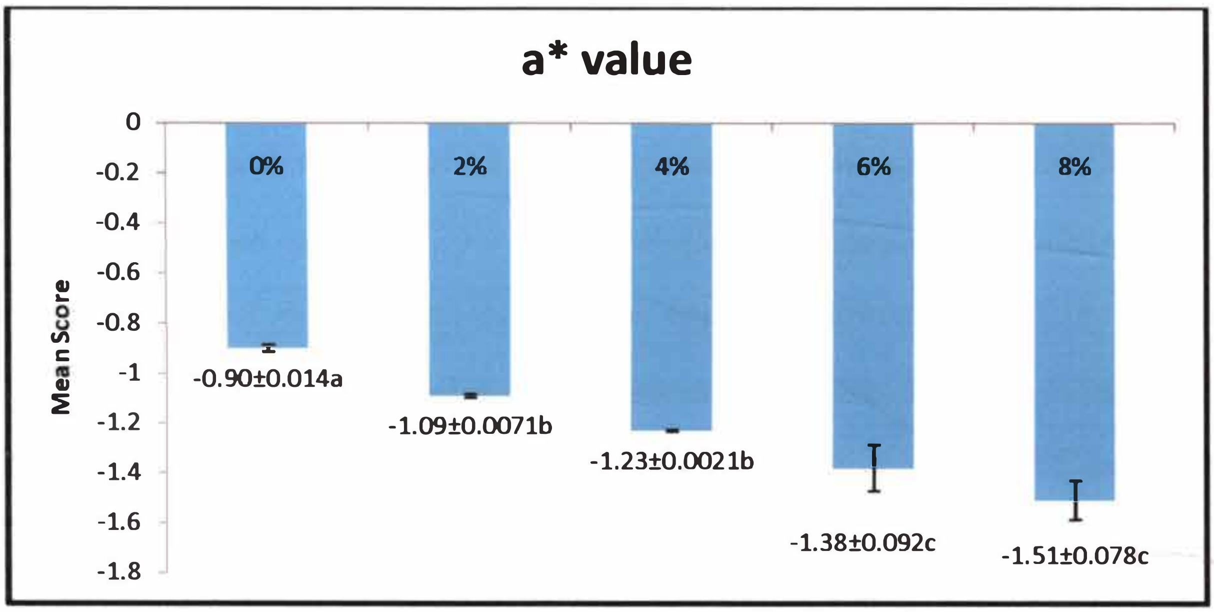


Figure 4.8b: a* value of colour for steamed buns with different formulations

*Mean value with different superscript shows significant differences ($p < 0.05$).

Hong Kong flour and sugarcane bagasse powder were compared in terms of a* value for colour measurement. From the Figure 4.7a, Hong Kong flour shows more in greenness colour measurement than sugarcane bagasse powder, where the result of -0.90 ± 0.014[b] for Hong Kong flour and -0.35 ± 0.014[a] for sugarcane bagasse powder. From the ANOVA test, there are significant differences in between both Hong Kong flour and sugarcane bagasse powder in terms of a* values colour measurement. As compared to wheat flour that commonly used in steamed buns making done by Tseng et al. (2011), the a* value for wheat flour was -0.89 ± 0.06. This result shows similarly in this study.

For steamed buns with more bagasse added, the a* value increases, move to the right or positive regions, this mean that all the steamed buns had move to redness regions. With regard to a* values, four samples of sugarcane bagasse steamed buns showed more redness colour as compared to control Chinese steamed buns (Figure 4.8b).

Sample with 0 % sugarcane bagasse powder (control) had the highest negative values of a* values, which is -1.51 ± 0.078[c], followed by 2 % sugarcane bagasse steamed buns. Besides this, both samples do not show significant differences ($p > 0.05$) among them but do significant difference than others sample. In addition, 4 % and 6 % sugarcane bagasse steamed buns do shows no significant difference with -1.23 ± 0.0021[b] and -1.09 ± 0.0071[b], respectively. Lastly, the lowest negative values of a* values shows by highest amount substitution of sugarcane bagasse powder in 8 % sugarcane bagasse steamed buns, with -0.90 ± 0.014. This 8 % sugarcane bagasse steamed buns has shows significant difference than other formulations steamed buns.

4.2.1.3 b* Value

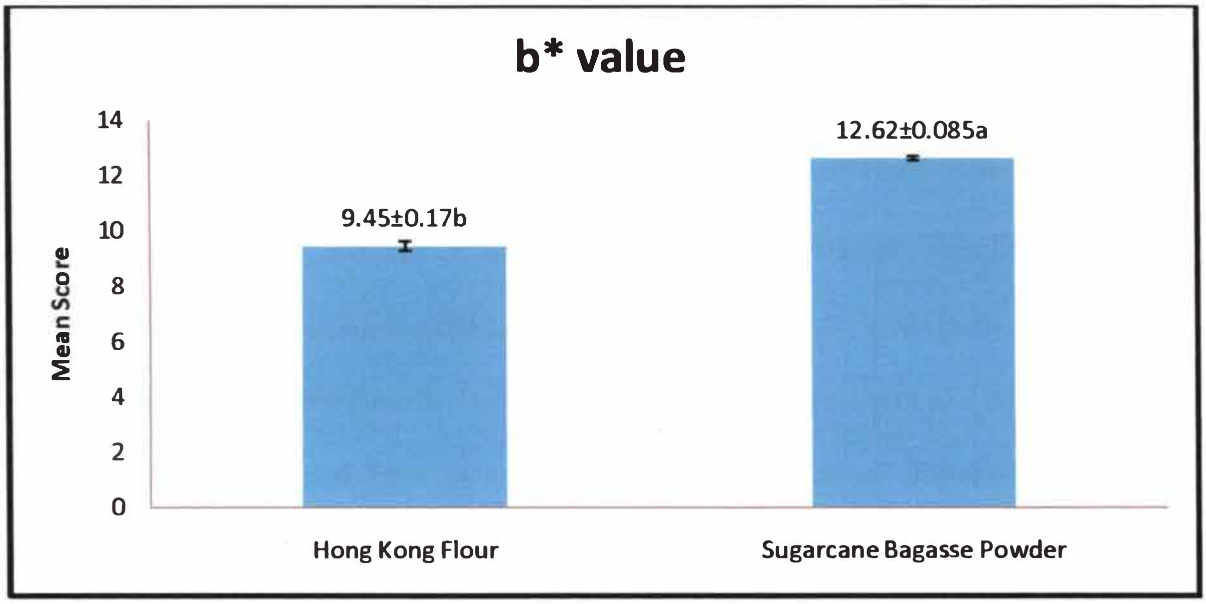


Figure 4.9a: b* value of colour for Hong Kong flour and Sugarcane bagasse powder

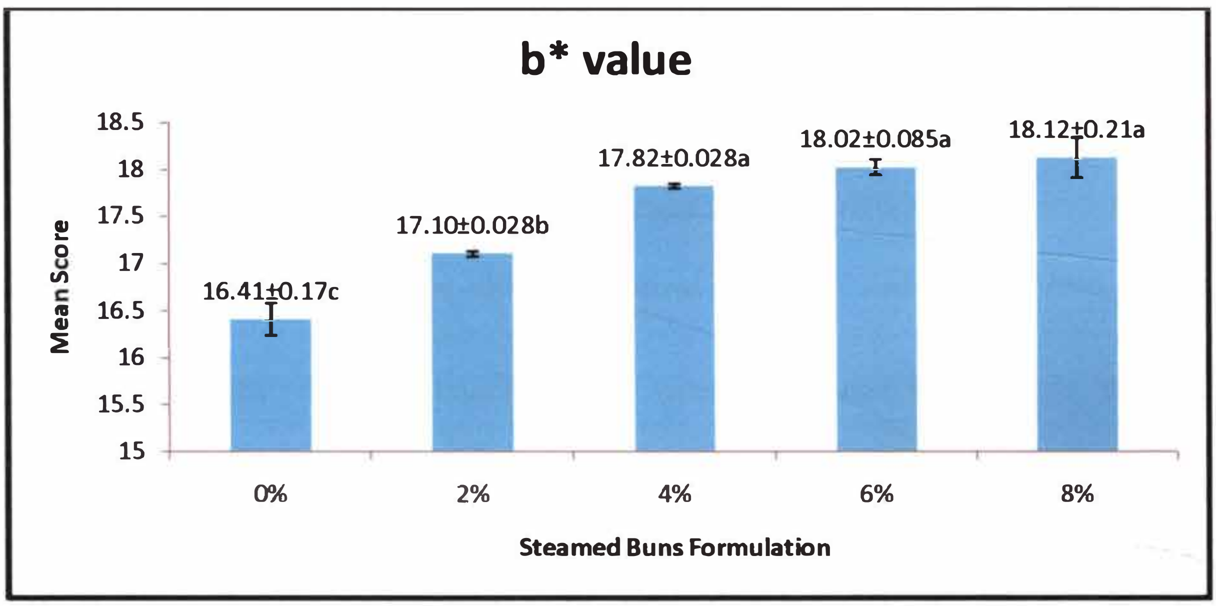


Figure 4.9b: b* value of colour for steamed buns with different formulations

*Mean value with different superscript shows significant differences ($p < 0.05$).

Hong Kong flour and sugarcane bagasse powder shows 9.45 ± 0.18^b and 12.62 ± 0.085^a for b* value of colour, respectively (Figure 4.9a). Both of these basic ingredients showed a significant difference among them in terms of b* values colour analysis.

The trends of b* values of five formulations steamed buns were shows in the Figure 4.9b in above. As the percentage of sugarcane bagasse powder substitution increases, the b* value of steamed buns were increased as well from 0 % to 8 % sugarcane bagasse steamed buns. The result also proved by Tseng et al. (2011) where the b* values of the steamed buns increase as the concentration of shiitake stipe flour as added gradually. The control Chinese steamed buns was showed to be 16.41 ± 0.17^c and the 8 % sugarcane bagasse steamed buns was showed to be 18.12 ± 0.205^a. From the ANOVA analysis, these five formulations show significant difference among the steamed buns. 4 %, 6 % and 8 % sugarcane bagasse steamed buns do not had any significant difference in terms of colour but they are significant difference compared to 0 % and 2 % sugarcane bagasse steamed buns. However, 0 % and 2 % sugarcane bagasse steamed buns alone shows significant difference with other sample of steamed buns formulations.

In conclude that, for crumb colour values, as sugarcane bagasse powder substitution rate increased, L* values changed from white to gray colour, a* values changed from red to green and b* values changed from gray to yellow. Nevertheless, the L*, a* and b* values were all significantly different ($p < 0.05$) between the control steamed buns and the steamed buns with sugarcane bagasse powder at the four levels. In this study, colour was selected as one of the qualities indicates in both the instrumental analysis and sensory evaluation.

4.2.2 Specific Volume

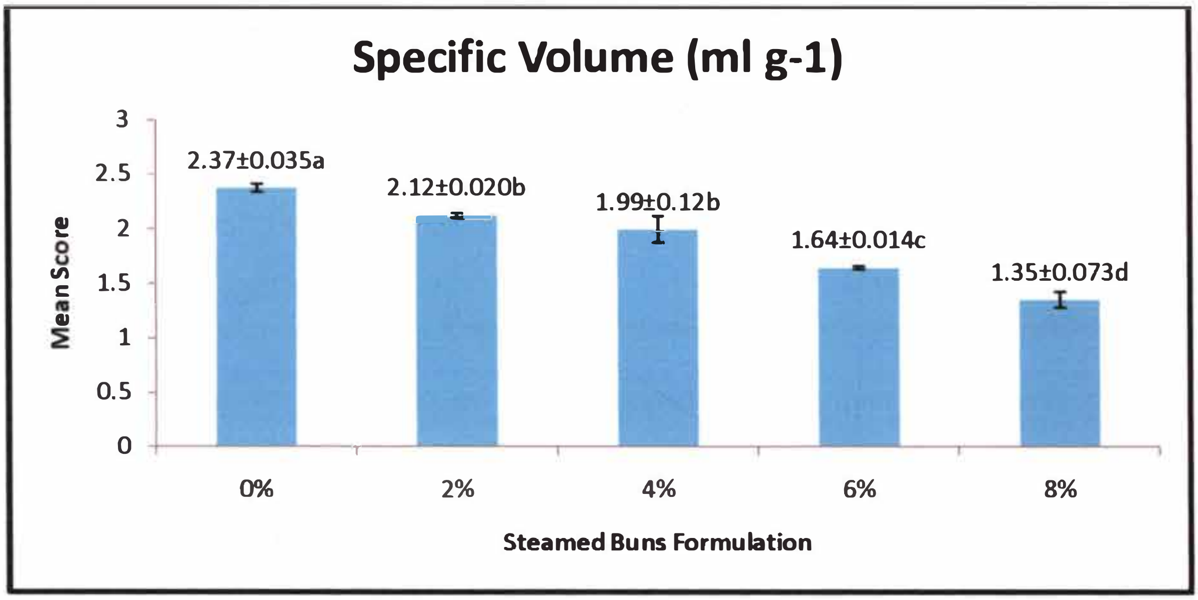


Figure 4.10: Specific volume for steamed buns with different formulations

*Mean value with different superscript shows significant differences ($p < 0.05$).

The effect of the sugarcane bagasse substituted on the steamed buns in terms of specific volume is showed in the Figure 4.10 above. Fiber enriched steamed buns with sugarcane bagasse powder, had the smaller specific volume than control. The addition of sugarcane bagasse powder for 8 % substituted steamed buns promoted the greatest volume reduction, by approximately 43.04 %. From 2.37 ml/g ± 0.035[a] for Chinese steamed buns (control) to 1.35 ml/g ± 0.073[d] for 8 % sugarcane bagasse steamed buns. These results obtained had the similarity to the previous studied about the fiber supplements added into the bread by using carob fiber, inulin and pea fiber which were done by Wang et al. (2002). The inulin and pea fiber promoted the greatest reduction in specific bread volume with 17.14 % and 20 % respectively (Wang et al., 2002). Other researchers also done their research related to apple fiber, where the loaf volume of bread was decreased 57 % when apple fiber was substituted at 12 g/ 100 g in wheat flour (Chen et al., 1988). Similarly, loaf volume of bread decreased when alkaline hydrogen peroxide-treated bagasse was substituted from 896 cm^3 to 540 cm^3 with 0g/100g to 15g/100g of bagasse was added (Sangnark and Noomhorm, 2004).

Wang et al. (2002) stated that the supplementation of wheat flour with other fiber supplement flour which contain no gluten properties can reduces the bakery product potential of the mixture, especially the consequence of gluten dilution, and this is also proved by Pomeranz et al. (1977) which can effects and resulting of difficulties in the dough handling, lower the specific volume and even worsening of softness of the final products with the result from the interaction between the gluten and fiber material (Chen et al., 1988). The specific volume decreased due to fiber addition, which have already been reported (Chen et al., 1988; Pomeranz et al., 1977).

From one way ANOVA test, the specific volume of sugarcane bagasse steamed buns were significantly lower than that of control Chinese steamed buns and there are significant differences for these different formulations of steamed buns in terms of specific volume. Lastly, at the high replacement levels, all tested fibrous materials decreased volume of bakery product substantially more than expected from their gluten-diluting effect.

4.2.3 Microstructure

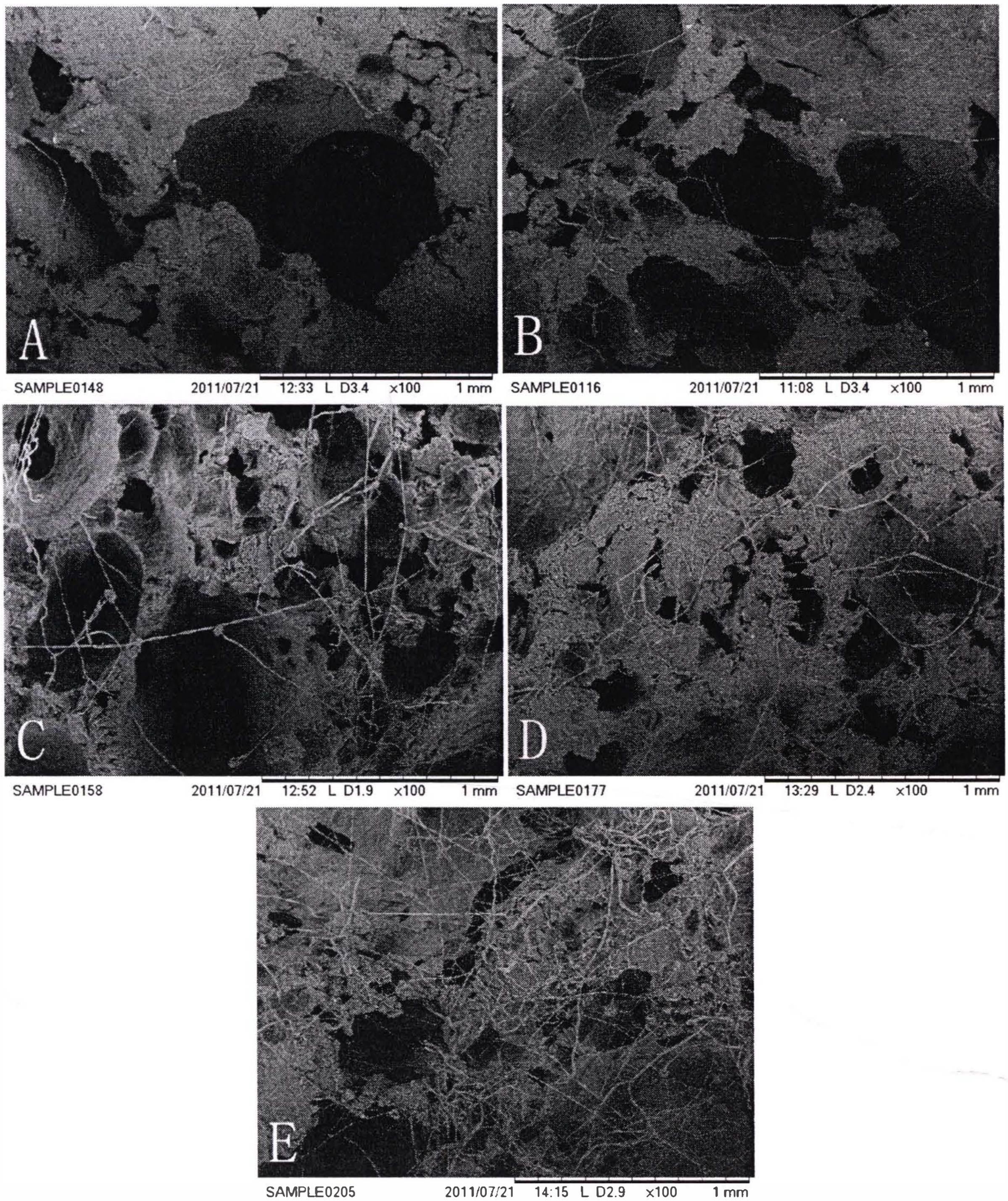


Figure 4.11: Micrographs (100 x) of steamed buns with different formulations.

(A) Control (0% sugarcane bagasse) (B) 2 % sugarcane bagasse (C) 4 % sugarcane bagasse (D) 6 % sugarcane bagasse (E) 8 % sugarcane bagasse

Microstructure of steamed buns is affected significantly by the mixing and proofing process. The air from the gas cells as nucleation sites for the following CO_2 gas generated by the yeast activity during proofing while in the mixing process. The three-dimension protein network in the steamed buns traps gases and embedded gases expend the dough, and leading to a porous structure after steaming.

There are many researches done related to the microstructure evaluation on bakery products, for example, bread which is fortified with concentrated plant proteins (Fleming and Sosulski, 1978), fiber and hydrocolloid content of fresh and frozen stored bread (Polaki et al., 2010), and dough and bread studied by Pomeranz, Meyer and Seibel (1984). So, in this study, the Tabletop microscopy was used to evaluate the microstructure or called as pores size of the steamed buns which were incorporated with different percentage of sugarcane bagasse powder.

The microstructure of produced steamed buns is differed according to their composition of sugarcane bagasse powder as shown in the Figure 4.11. The effects of fibrous materials (sugarcane bagasse fiber) on the steamed buns structure were studied by using Tabletop Microscope. 100x magnifications of cross- sections of interior parts of steamed buns reveals that the structure had a fine structure composed of numerous thin filaments connecting adjacent regions most found in sample 8 % sugarcane bagasse steamed buns (Figure 4.11 E). Figure 4.11 A, control Chinese steamed buns depicts an area in which the fine structure was less pronounced than in the other examined areas. This is due to the fine structure was come from the fibrous of sugarcane bagasse, and control steamed buns does not have any fibrous materials added and shows less fine structure, but have a largest pore size among them.

Besides that, the addition of sugarcane bagasse powder resulted in a smaller average pore size and more clearly the fiber matrix obtained (Figure 4.11 B to E) as the percentage of sugarcane bagasse powder was added gradually from 2 % to 8 %. However, all this sugarcane bagasse steamed buns had small and large pores coexisted in the matrix, creating an uneven pore population. On the contrary, the control Chinese steamed buns, in Figure 4.11 A, containing not sugarcane bagasse powder added had also showed some fibrous materials under microscope evaluation. This fibrous material may due to the dry instant yeast as an ingredient in the steamed buns making. The pores were larger and more uniform in size than those of other types of sugarcane bagasse steamed buns. Differences were noticed in the other classes of pores as well. Small pores were especially evident in highest contain of sugarcane bagasse powder which is in 8 % sugarcane bagasse steamed buns.

The particle size distribution of fibres also give effect on steamed buns making performance, where the fibrous materials have been associated to reduced gas retention which related to low bread volume, darker colour and reduced gritty mouthfeel.

It can be conclude that, the higher the amount of sugarcane bagasse powder substitution, the smaller the pores size of the steamed buns. In sugarcane bagasse steamed buns, the more noticeable differences were in the case between control Chinese steamed buns, and steamed buns structure with large pores was observed, while in the case of sugarcane bagasse substituted steamed buns, displaying a denser structure with numerous pores of medium to very small size.

4.2.4 Textural Analysis

4.2.4.1 Hardness

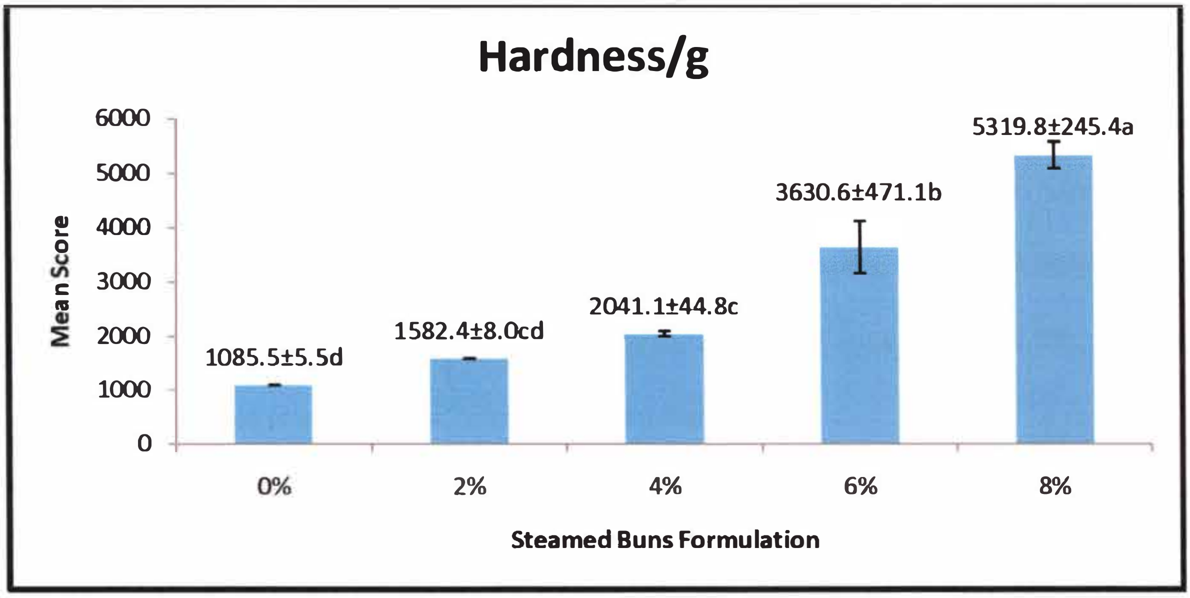


Figure 4.12: Hardness for steamed buns with different formulations

*Mean value with different superscript shows significant differences ($p < 0.05$).

Hardness is one of the most important characteristic that commonly used as an index to determine the bread quality and the changes in hardness of the bread is highly related to the loss of resilience during storage (Spices, 1990). So, it is also suitable to use in the measure quality of the steamed buns in this study. The hardness of steamed buns was found to increase with increased sugarcane bagasse concentration (Figure 4.12).

Comparing the mean values of textural analysis, Texture Profile Analysis (TPA) test revealed that the steamed buns with sugarcane bagasse powder was significantly ($p < 0.05$) harder than the control at the level start from 2 % sugarcane bagasse steamed buns.

TPA results are in agreement with the findings of previous study on the effect of Green Tea Extract on the bread, which reported that there was an increase in bread hardness with the increase of Green Tea Extract (Wang et al., 2007). The lowest hardness characteristics of steamed buns was found to be control Chinese steamed buns with total hardness of 1085.5 ± 5.5[d], this also can say that this control sample have the softest texture of steamed buns among all the five formulations. On the other hand, 8 % sugarcane bagasse steamed buns was the most hardness samples with total hardness of 5319.8 ± 245.4[a]. In comparison, the 8 % sugarcane bagasse steamed buns has 5 times hardness properties than control Chinese steamed buns.

Hardness of the steamed buns is particularly increase above the 8 % sugarcane bagasse powder substitution. Therefore, to produce a satisfactory enrich fiber steamed buns product, this level of sugarcane bagasse powder substitution should not be exceeded.

As steamed buns matrix is a complex system, the mechanism responsible for the increment of steamed buns hardness with elevated sugarcane bagasse still remains unknown. The varied hardness in sugarcane bagasse steamed buns might be explained by the affected enzymes activity and yeast activity (Wang et al., 2007). Others researchers also proved that the difference of firmness of the steamed buns is due to the presence of arabinoxylans in steamed buns with the addition of fiber supplements (Sullivan et al., 2011).

4.3 Sensory Evaluation

4.3.1 Acceptance Test

On a seven-point hedonic scale, there were seven attributes were used to determine the level of acceptability of sugarcane bagasse steamed buns in among 30 untrained panellists from UMT students. From 30 panellists, 50 % was come from male while 50 % was come from female. All of these panellists were below 25 years old because the panels were from UMT students with 56.67 % Malay, 36.67 % Chinese, while other 3.33 % were India and other races. From total 30 panels tested, total 28 panels (93.33 %) shows they like to consumer Chinese steamed buns and 2 panels (6.67 %) do not like to consume.

These seven attributes included colour, aroma, tenderness, pore size, taste, moistness and overall acceptance. All the sensory results were showed in the range of 3.43 to 5.2, indicating that these five different formulations of steamed buns were moderately acceptable. The rating was done by ranging from 1 (extremely dislike) to 7 (extremely like) for each of attribute. The total scoring for each specific sensory characteristics and overall acceptability were showed in the graph below (Figure 4.18 to Figure 4.24).

4.3.1.1 Colour

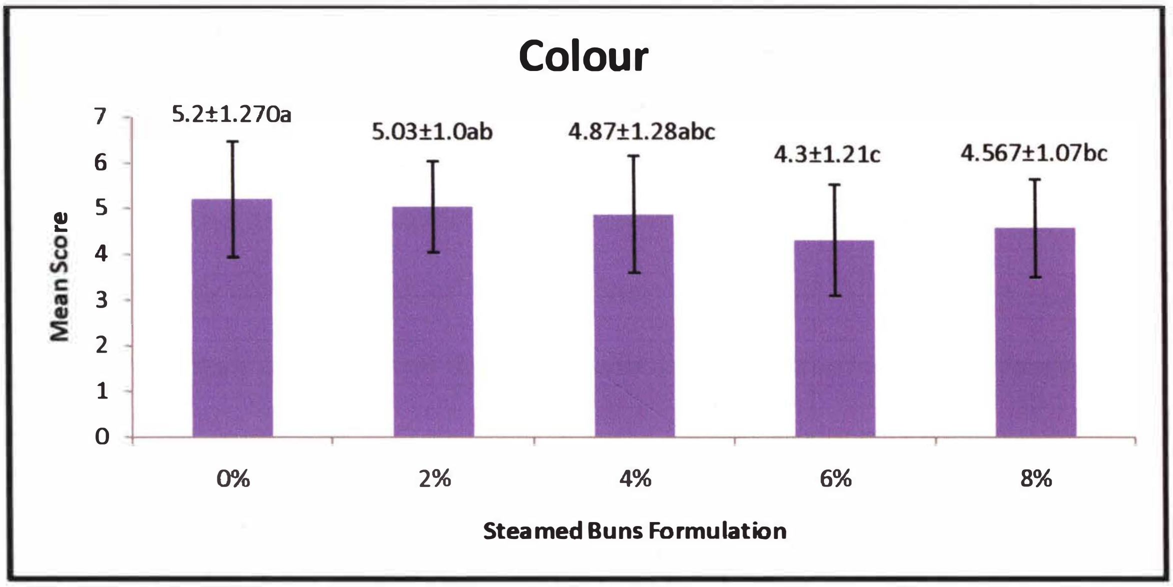


Figure 4.13: Colour attribute for steamed buns with different formulations

*Mean value with different superscript shows significant differences ($p < 0.05$).

Beneficially, the whiteness colour might be noticeable to attract consumer's attention especially on white colour Chinese steamed buns. From the results of the descriptive analysis performed by 30 untrained panellists, five different formulations of steamed buns had significant differences in each other in terms of colour attribute. With an increase of sugarcane bagasse powder in steamed buns, a decrease in brightness was perceived significantly ($p < 0.05$) performed by colorimeter instrument (Figure 4.7b) among the five variants. As well as in the previous study about brightness colour in between Hong Kong flour and sugarcane bagasse powder (Figure 4.7a). This is because, the higher the amount of sugarcane bagasse powder added into steamed buns, the darker the colour of steamed buns due to the present of high mineral content in sugarcane bagasse.

The higher the percentage of sugarcane bagasse powder substituted, the lower the level of the acceptability by the panellists, except in the 6 % sugarcane bagasse steamed buns which found to be lowest acceptability (4.30 ± 1.21[c]) among the five formulations steamed buns. Control Chinese steamed buns had the highest score of acceptability with 5.20 ± 1.27[a]. This can be concluded that, the whiteness colour of steamed buns is more acceptable than darker colour of steamed buns. From the ANOVA test, there are significant differences in between these five formulations of steamed buns towards colour attribute.

4.3.1.2 Aroma

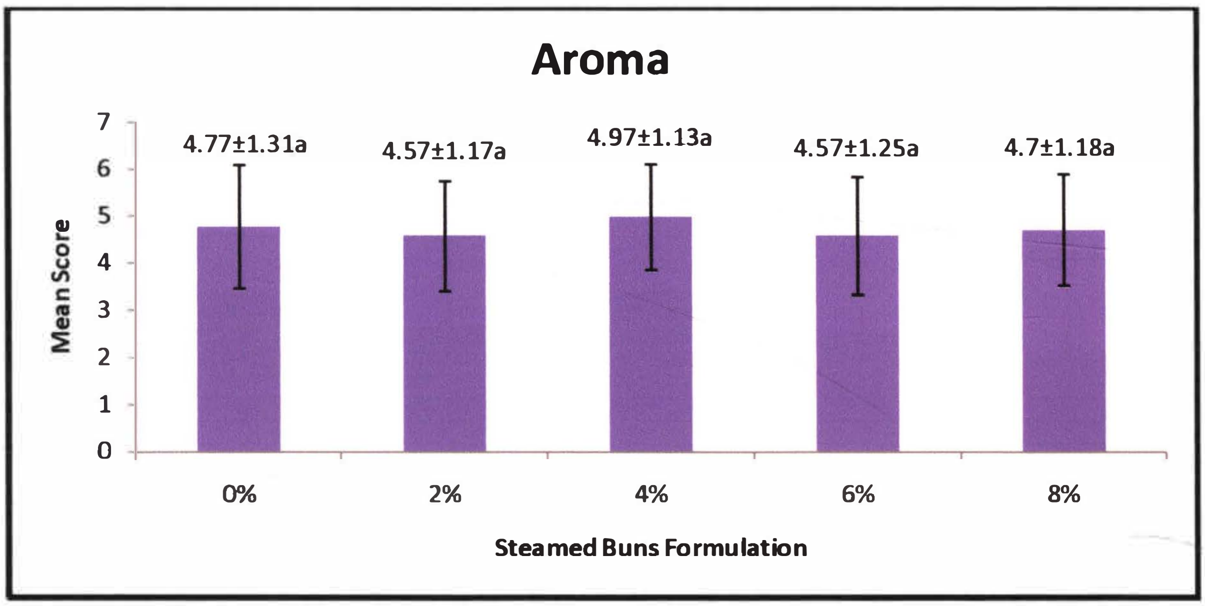


Figure 4.14: Aroma attribute for steamed buns with different formulations

*Mean value with different superscript shows significant differences ($p < 0.05$).

Figure 4.19 in above shows the median score of sensory evaluation for aroma attribute for different five formulations of steamed buns. There is no trend among these five formulations, where 0 %, 2 %, 4 %, 6 %, and 8 % of sugarcane bagasse substituted steamed buns give the result of 4.77 ± 1.31[a], 4.57 ± 1.17[a], 4.97 ± 1.13[a], 4.57 ± 1.25[a], and 4.70 ± 1.18[a], respectively. From the graph above showed that there are no significant differences ($p>0.05$) in between these five formulations of steamed buns. This proved that panellists are unable to detect the significant difference in aroma of steamed buns when different percentage of sugarcane bagasse powder was added. However, majority of panellists prefer to 4 % sugarcane bagasse steamed buns where the mean score for these added sugarcane bagasse had a highest score (4.97 ± 1.13[a]) while 2 % and 6 % sugarcane bagasse steamed buns showed the lowest mean score with 4.70 ± 1.18[a] for aroma attribute.

4.3.1.3 Tenderness

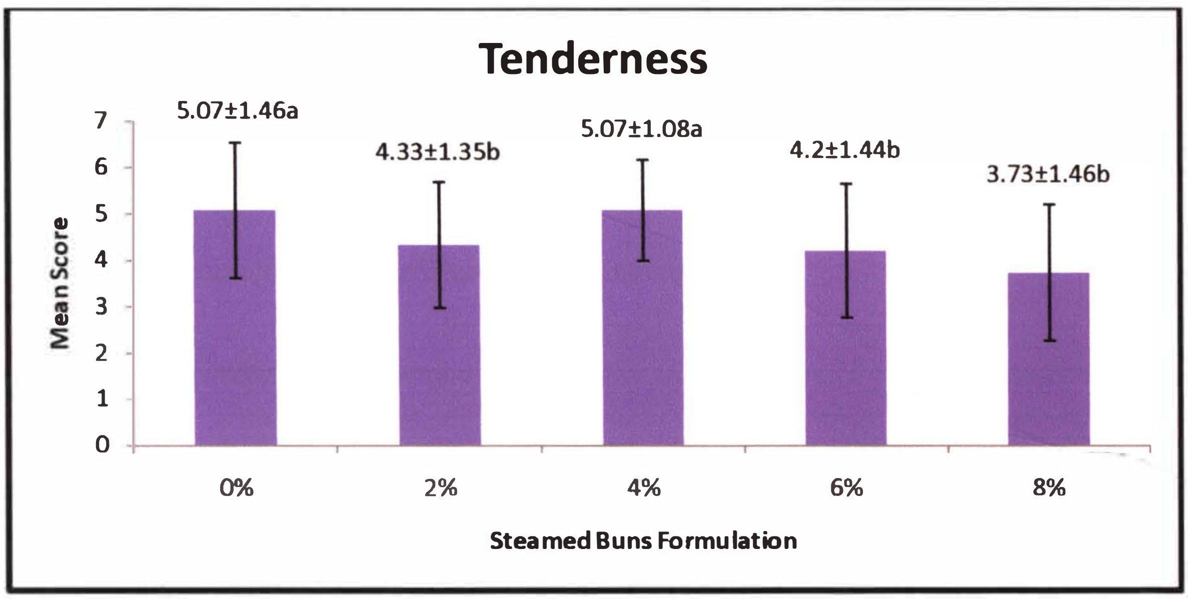


Figure 4.15: Tenderness attribute for steamed buns with different formulations

*Mean value with different superscript shows significant differences ($p< 0.05$).

The physicochemical properties of sugarcane bagasse powder had given some negative impact to steamed buns volume and texture indirectly. The firmness of the steamed buns was increasing and gives a firmness structure to steamed buns as the percentage of sugarcane bagasse powder added gradually.

As showed in the sensory result in terms of tenderness attribute (Figure 4.15), the control Chinese steamed buns and 4 % sugarcane bagasse steamed buns had a highest acceptance score with 5.07 ± 1.46^{a} and 5.07 ± 1.08^{a} respectively. Both of them do not shows significant differences in terms of tenderness attribute for acceptance test. On the other hand, 8 % sugarcane bagasse steamed buns had lowest score of acceptance among these five formulations steamed buns, due to the highest percentage of sugarcane bagasse powder substituted. The panels do not accept higher percentage of sugarcane bagasse steamed buns due to the tenderness. Some of them rejected because this steamed buns was said to be too hard and not as soft as others like. However, three of the samples, 2 %, 6 % and 8 % sugarcane bagasse steamed buns do not shows any significant differences among them. Some of the panels suggest improving the tenderness in order to increase the level of acceptance of sugarcane bagasse steamed buns.

The tenderness of the steamed buns have strongly related to the physicochemical properties of sugarcane bagasse powder. When added to the steamed buns making, the sugarcane bagasse powder could tightly bind appreciable amounts of water and decrease the available of development of gluten network, thus resulting in underdeveloped gluten network and increase firmness (Brennan and Cleary, 2007) and indirectly reduce the tenderness of steamed buns.

4.3.1.4 Pore Size

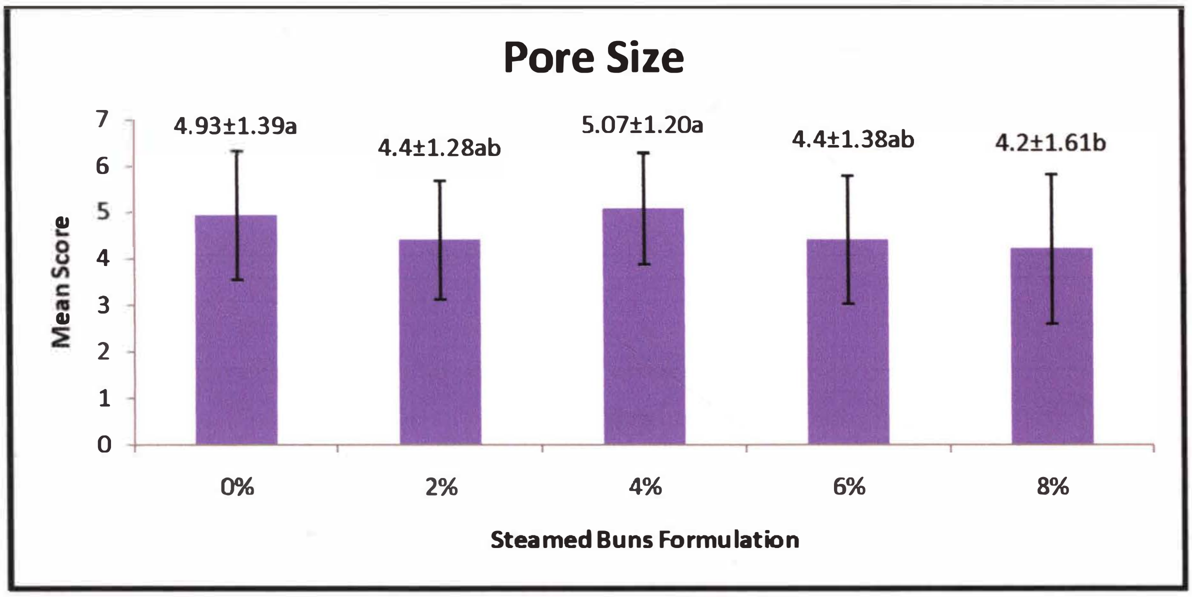


Figure 4.16: Pore Size attribute for steamed buns with different formulations

*Mean value with different superscript shows significant differences ($p < 0.05$).

Figure 4.16 in above showed the acceptance level of pore size attribute for different formulations of steamed buns. Panellists preferred the pore size of steamed buns containing sugarcane bagasse powder in percentage of 4 % sugarcane bagasse steamed buns (5.07 ± 1.20^{a}) more than 2 % sugarcane bagasse steamed buns (4.40 ± 1.28^{ab}) and even control Chinese steamed buns (4.93 ± 1.39^{a}). The pore size of the steamed buns is highly related to the specific volume of steamed buns.

When referring to specific volume of steamed buns (Figure 4.10), higher sugarcane bagasse powder substitution gives lower specific volume and thus gives the lower acceptance level for sugarcane bagasse steamed buns, except for the 4 % sugarcane bagasse steamed buns. Highest acceptance level score was found to 4 % sugarcane bagasse steamed buns, with 5.07 ± 1.20^{a}, while lowest acceptance scores was found to be

8 % sugarcane bagasse steamed buns, with 4.20 ± 1.61[b]. Statistical calculation stated that there are significant difference between control and 8 % sugarcane bagasse steamed buns. In other hand, that control Chinese steamed buns do not shows significant difference to 4 % sugarcane bagasse steamed buns.

4.3.1.5 Taste

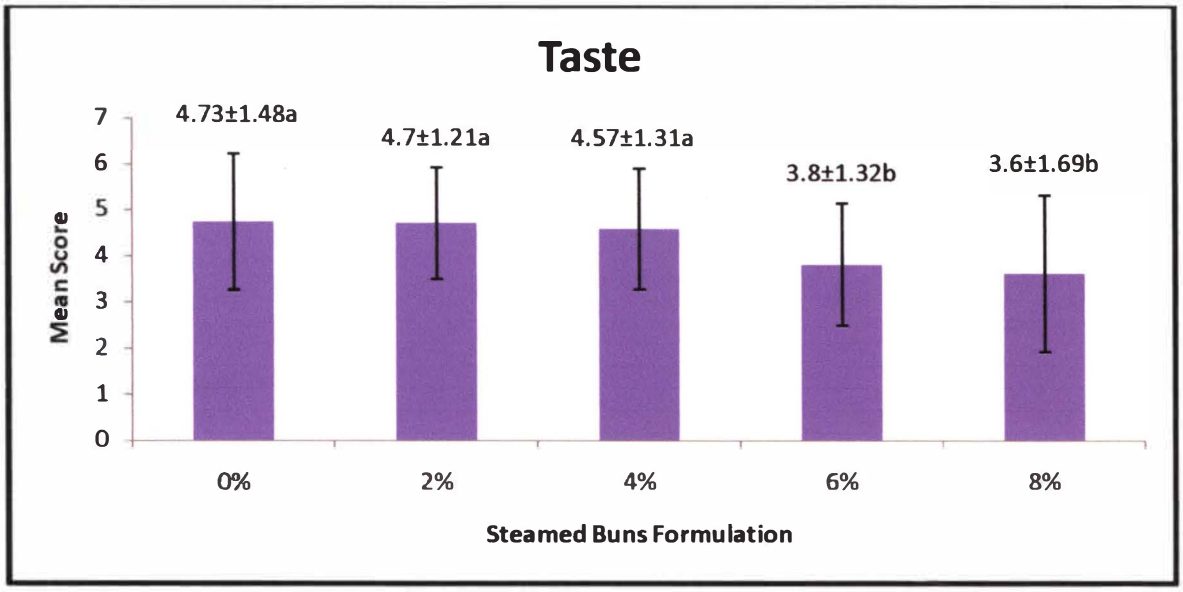


Figure 4.17: Taste attribute for steamed buns with different formulations

*Mean value with different superscript shows significant differences ($p < 0.05$).

The texture was better with control Chinese steamed buns but decreased when sugarcane bagasse powder was added gradually from 2 % to 8 %. The results exhibited that adding sugarcane bagasse powder in steamed buns formulation did lower the steamed buns acceptability in terms of taste attribute. However, the statistically analysis showed no significant ($p > 0.05$) decrease of acceptable level of steamed buns taste as the percentage of sugarcane bagasse powder were added for control (4.73 ± 1.48[a]), 2 % (4.70

± 1.21[a]) and 4 % (4.57 ± 1.31[a]) , but showed significantly decreased for 6 % (3.80 ± 1.32[b]) and 8 % (3.60 ± 1.69) added of sugarcane bagasse powder.

Some of the panels commented that the taste of sugarcane bagasse steamed buns was not acceptable due to the coarse and fibrous texture of sugarcane bagasse powder. However, some of them like the taste and acceptable because of enriched fiber product but until a certain level. As can seen from the Figure 4.17, the acceptable sensory evaluation taste are significantly ($p > 0.05$) low acceptable above 6 % of sugarcane bagasse powder added. In order to reach the high acceptability of sugarcane bagasse steamed buns, the limit of 4 % sugarcane bagasse powder should not be exceeded.

4.3.1.6 Moistness

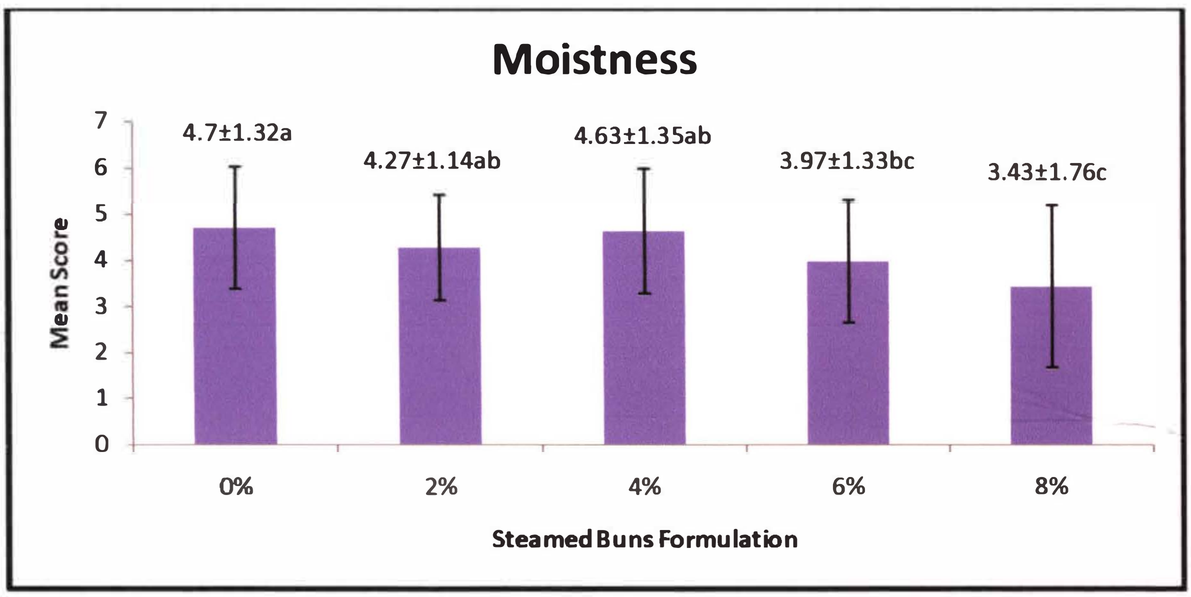


Figure 4.18: Moistness attribute for steamed buns with different formulations

*Mean value with different superscript shows significant differences ($p < 0.05$).

Sensory scores of moistness attribute for steamed buns samples supplemented with sugarcane bagasse powder are showed in Figure 4.18. Results from sensory evaluation indicated that addition of fiber materials had significant effects on the steamed buns quality for moistness. Steamed buns containing sugarcane bagasse powder added had lower sensory scores than steamed buns without sugarcane bagasse powder added (control).

The highest sensory moistness score was found in control Chinese steamed buns with total average score of 4.70 ± 1.32^{a}. This control steamed buns was statistically no significant difference to 2 % (4.27 ± 1.14^{ab}) and 4 % (4.63 ± 1.35^{ab}) sugarcane bagasse steamed buns but showed significant with 6 % (3.97 ± 1.33^{bc}) and 8 % (3.43 ± 1.76^{c}) sugarcane bagasse steamed buns.

The coarse texture and dryness of the steamed buns caused the lower acceptability score to the panels, as the fiber material are tend to absorb more water and loss its soft characteristics.

4.3.1.7 Overall Acceptance

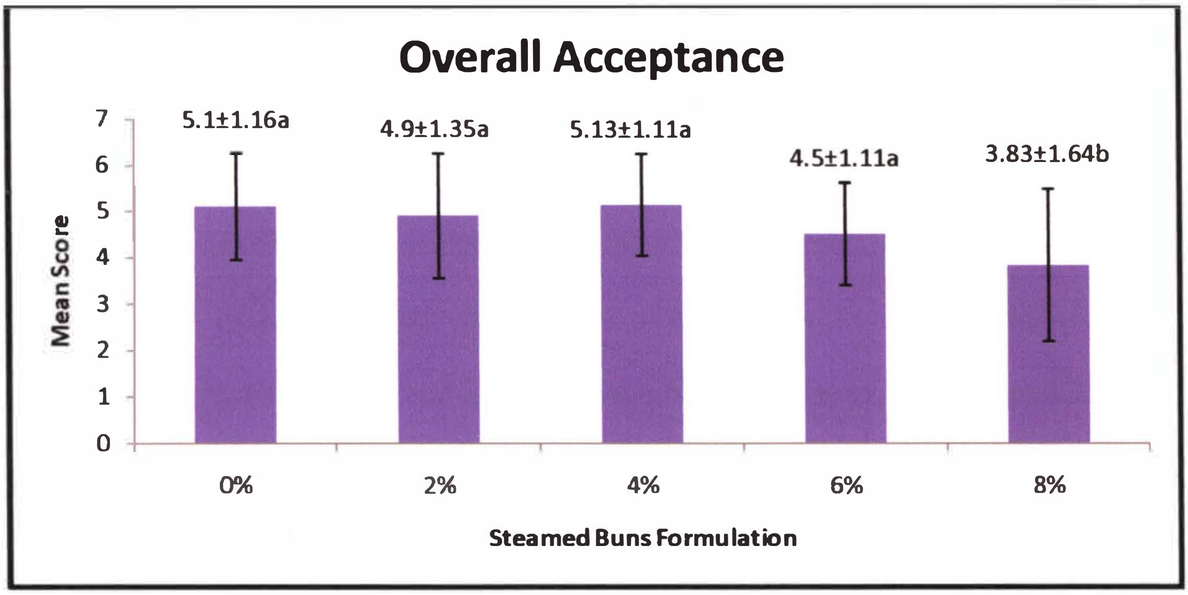


Figure 4.19: Overall acceptance for steamed buns with different formulations

*Mean value with different superscript shows significant differences ($p < 0.05$).

Figure 4.19 shows the average sensory scores of the control and sugarcane bagasse supplemented steamed buns. Control Chinese steamed buns was 5.10 ± 1.16^{a}; 2 % sugarcane bagasse steamed buns was 4.90 ± 1.35^{a}; 4 % sugarcane bagasse steamed buns was 5.13 ± 1.11^{a}; 6 % sugarcane bagasse steamed buns was 4.50 ± 1.11^{a}; and 8 % sugarcane bagasse steamed buns was 3.83 ± 1.64^{b}.

Panellists rated the overall acceptability of steamed buns containing 4 % sugarcane bagasse powder substitution significantly better than steamed buns containing 8 % sugarcane bagasse powder as shows in the Figure 4.19 in above. However, the result shows no significant difference between control Chinese steamed buns with 2 %, 4 % and 6 % of sugarcane bagasse steamed buns but do significant difference than 8 % sugarcane bagasse steamed buns where highest substitution sugarcane bagasse powder (8%) score lowest acceptability in terms of overall acceptance.

The result also showed that the substitution of sugarcane bagasse powder into steamed buns formula caused the decreasing of acceptability for overall sensory acceptability, except for 4 % sugarcane bagasse steamed buns. This is because the result was sensory evaluated based on the level of acceptance from the panels rather than focused on its component and health functionality. However, the acceptability of the sensory evaluation might possible to increase if the samples labelled as new functional product with sugarcane bagasse powder added.

In conclusion, there were no statistical significant difference between control Chinese steamed buns and sugarcane steamed buns was found only in aroma sensory attribute. Control Chinese steamed buns showed a better colour, tenderness and moistness than did sugarcane bagasse steamed buns.

4.3.2 Preference Test

Table 4.1: Result of steamed buns sensory evaluation (Preference Ranking Test)

Steamed buns formulation	Total score	Superscript
0 % (control)	104	ab
2 %	91	abc
4 %	110	a
6 %	80	bc
8 %	65	c

Score with different superscript shows significant difference ($p < 0.05$)

LSD= 29.4

Table 4.1 in above results shows the table result of steamed buns from sensory evaluation for preference ranking test. Panellists were asked to rank the steamed buns from the least preferred to most preferred, with the number from 1 to 5. The higher the number indicated the higher preferred steamed buns by panels.

From the result, steamed buns substituted with 4 % sugarcane bagasse powder was the most preferred steamed buns among these 30 untrained panellists with the total score of 110 followed by control steamed buns with 104 total scores. This mean that, steamed buns substituted with 4 % sugarcane bagasse powder were preferred than original control Chinese steamed buns. However, both the control steamed buns and 4 % sugarcane bagasse steamed buns were showed no significant differences in term of the degree of preference by the panels. On the other hand, both the control steamed buns and 4 % sugarcane bagasse steamed buns were significantly difference with 8 % sugarcane bagasse steamed buns where there is a lowest total scores ranking scores with only 65 total scores.

When related to the acceptance test result in previous part, the steamed buns with the highest sugarcane bagasse powder substituted, 8 % sugarcane bagasse steamed buns was in the lowest acceptability level in terms of pore size, taste, moistness and also overall acceptance. So, it is not surprise that 8 % sugarcane bagasse steamed buns showed in lowest rank of liking test.

Most sensory characteristics of steamed buns, including colour, aroma, pore size and taste acceptability were moderately accepted when sugarcane bagasse powder were less than 8 % substitution. So it is impossible to substitute higher than 8 % sugarcane bagasse powder into steamed buns without impacting on steamed buns characteristics.

CHAPTER 5

CONCLUSIONS AND SUGGESTIONS

5.1 Conclusions

This study showed that different percentage of sugarcane bagasse powder substitution gives effect to proximate, physical analysis and sensory characteristics. All the proximate analysis showed significant difference between Hong Kong flour and sugarcane bagasse powder except for ash content and significantly difference in between five formulations of steamed buns. As the percentage of sugarcane bagasse powder added gradually from 2 % to 8 % steamed buns, moisture, fiber and protein were increase while ash and fat content were decrease and carbohydrate do not shows a trends.

The physical analyses were done with colour, specific volume, hardness and microstructure properties. The decreasing of L* value (lightness) indicating that the darker of the steamed buns as the amount of bagasse added from 0 % to 8 % while increasing of a* and b* indicating the colour of steamed buns were move to more redness and yellowness. Specific volume was significantly decreases and significantly increases in hardness properties when amount of sugarcane bagasse was added. Microstructure of steamed buns were evaluated using Tabletop Microscope showed that the pore size of control steamed buns was larger than those of sugarcane bagasse steamed buns and the fibrous material was more obvious.

The acceptance test in sensory had showed that all the sensory attribute were average acceptable by panels and there are significant difference for each attribute in between five formulations of steamed buns. In general, 4 % sugarcane bagasse steamed buns showed highest acceptable for overall acceptance while 8 % sugarcane bagasse steamed buns score lowest acceptance level. The result ranking preference test gives proved that the 4 % sugarcane bagasse steamed buns score highest preference value than control steamed buns.

5.2 Suggestions

The shelf life of the steamed buns should be observed and appropriate food additive can be use to extend the shelf life of the product, since most of the steamed buns are freshly produced and consume and frozen product are convenience to the consumer. Besides that, the addition of water or hydrocolloid can be used in order to improve the hardness texture of the steamed buns product since the fiber waste from sugarcane bagasse tend to absorb water. So, it is necessary further study of the Chinese steamed buns be done when incorporated with fiber waste.

Some of the panel can feel the fibrous in mouthfeel after taste and dryness, so in order to solve this problem the sugarcane bagasse powder have to mill to more smaller size and moistness of the steamed buns have to improve. Lastly, sugarcane bagasse can be incorporated into others no bakery product due to the higher content of fiber for more diversity and healthy food product.

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APPENDIX A

Raw data for moisture content determination

	Hong Kong Flour		Sugarcane Bagasse Powder		Chinese steamed buns		Sugarcane Bagasse steamed buns							
					0 %		2 %		4 %		6 %		8 %	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Weight of crucible (g)	59.8583	69.3524	59.5298	53.0340	71.5148	69.9215	51.8157	66.7921	60.7978	77.5166	56.0146	51.0519	66.1632	51.3954
Weight of sample (g)	5.0021	5.0018	3.0007	3.0012	2.0317	2.0814	2.0126	2.0694	2.0226	2.0016	2.0361	2.0101	2.0106	2.0431
Weight of crucible + sample (g)	64.8604	74.3542	65.5305	56.0352	73.5465	72.0029	53.8283	68.8615	62.8004	79.5182	58.0507	53.0620	68.1738	56.4385
Weight of crucible + sample after dried (g)	64.2044	73.6954	62.2451	55.7539	72.7032	71.1388	53.0356	68.0411	62.0068	78.7267	57.2367	52.2394	67.3410	55.5946
Weight of dried sample (g)	4.3461	4.3430	2.7153	2.7199	1.1884	1.2173	1.2199	1.2490	1.2090	1.2101	1.2221	1.1875	1.1778	1.1992
% dry sample	86.8855	86.8287	90.4889	90.6271	58.4929	58.4847	60.6131	60.3557	60.3715	60.4566	60.0216	59.0767	58.5795	58.6951
% moisture content	13.1145	13.1713	9.5111	9.3729	41.5071	41.5153	39.3869	39.6443	39.6285	39.5434	39.9784	40.9233	41.4205	41.3049

APPENDIX B

Raw data for fiber content determination

	Hong Kong Flour		Sugarcane Bagasse Powder		Chinese steamed buns		Sugarcane Bagasse steamed buns							
					0 %		2 %		4 %		6 %		8 %	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Weight of capsule (g)	1.5183	1.5202	1.5273	15253	1.5265	1.5213	1.5151	1.4879	1.5151	1.5224	1.5176	1.5177	1.5143	1.5209
Weight of sample (g)	2.0501	2.0068	1.0016	1.0017	2.0091	2.0232	2.0076	2.0124	2.0260	2.0442	2.0211	2.0146	2.0326	2.0019
Weight of capsule + residues (g)	1.5204	1.5212	2.0966	1.9771	1.5319	1.5260	1.5288	1.5015	1.5363	1.5445	1.5441	1.5445	1.5474	1.5536
Weight of crucible (g)	59.6753	60.2386	70.9477	70.7352	52.6501	57.7447	52.6325	77.5181	62.6342	100.3710	93.1975	103.6823	95.3082	87.7303
Weight of total ash (g)	59.6768	60.2406	70.9509	70.7384	52.6462	57.7404	52.6230	77.5058	62.6308	100.3610	93.1935	103.6784	95.2985	87.7199
% of fiber content	0.00	0.00	55.7085	43.9738	0.05874	0.04476	0.7539	0.8929	0.81626	1.1741	1.1095	1.1230	1.7091	1.7487

For Blank, Weight of capsule= 1.5234 g Weight of capsule + residue = 1.5308 g

Weight of crucible = 60.2399 g Weight of total ash = 60.2393 g

APPENDIX C

Raw data for protein content determination

	Hong Kong Flour		Sugarcane Bagasse Powder		Chinese steamed buns		Sugarcane Bagasse steamed buns							
					0 %		2 %		4 %		6 %		8 %	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Weight of samples (g)	2.0365	2.0156	2.0561	2.0135	1.0038	1.0051	1.0017	1.0028	1.0008	1.0236	1.0187	1.0072	1.0141	1.0119
Initial volume of 0.1 N HCl (ml)	30.0	32.0	33.0	37.0	0.0	8.0	18.0	25.0	5.0	13.0	24.0	33.0	16.0	24.0
Final volume of 0.1 N HCl (ml)	30.5	32.37	37.03	41.2	6.47	14.5	24.8	31.53	12.37	20.3	31.2	39.8	23.5	34.3
Total volume of 0.1 N HCl used in titration (ml)	0.5	0.37	4.03	4.2	6.47	6.5	6.8	6.53	7.37	7.3	7.2	6.8	7.5	7.3
% Nitrogen	0.0349	0.02571	0.2745	0.2922	0.9028	0.9058	0.9059	0.9121	0.9685	0.9579	0.9900	0.9457	1.0359	1.0105
Factor, F	5.7	5.7	6.25	6.25	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38
% Protein content	0.1989	0.1465	1.7156	1.8263	3.9543	3.9674	3.9678	3.9950	4.2420	4.1956	4.3362	4.1422	4.5372	4.4260

APPENDIX D

Raw data for fat content determination

	Hong Kong Flour		Sugarcane Bagasse Powder		Chinese steamed buns		Sugarcane Bagasse steamed buns							
					0 %		2 %		4 %		6 %		8 %	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Weight of sample (g)	2.0082	2.0013	1.0043	1.0001	2.0095	2.0046	2.0120	2.0079	2.0000	2.0004	2.0024	2.0217	2..0104	2.0030
Weight of extraction cup (g)	46.3149	46.7244	46.5230	46.4393	46.3286	46.3217	46.2217	46.7015	46.4426	46.3751	46.4550	46.2684	46.3047	46.1546
Weight of extraction cup + fat (g)	46.3195	46.7307	46.5143	46.4346	46.3891	46.3841	46.3075	46.7843	46.5138	46.4361	46.5095	46.3265	46.3433	46.1920
Weight of fat (g)	0.0046	0.0063	-0.0087	-0.0047	0.0605	0.0624	0.0858	0.0828	0.0712	0.0610	0.0545	0.0581	0.0386	0.0374
% fat content	0.2291	0.3148	0.00	0.00	3.0107	3.1128	4.2644	4.1237	3.5600	3.0494	2.7217	2.8738	1.9200	1.8672

APPENDIX E

Raw data for ash content determination

	Hong Kong Flour		Sugarcane Bagasse Powder		Chinese steamed buns		Sugarcane Bagasse steamed buns							
					0 %		2 %		4 %		6 %		8 %	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Weight of crucible (g)	64.9938	60.2429	70.7365	70.9484	21.3547	22.4275	22.3265	23.8034	20.3217	22.2071	19.6480	21.4883	20.9817	22.8245
Weight of sample (g)	2.0452	2.0246	2.0004	2.0006	2.0134	2.0166	2.0210	2.0255	2.0471	2.0185	2.0575	2.0371	2.0013	2.0406
Weight of crucible + sample after heated (g)	65.0002	60.2490	70.7424	70.9638	21.3640	22.4391	22.3429	23.8223	20.3335	22.2272	19.6604	21.5019	20.9929	22.8346
Weight of dried sample (ash) (g)	0.0064	0.0061	0.0059	0.0154	0.0093	0.0116	0.0164	0.0189	0.0118	0.0201	0.0124	0.0136	0.0113	0.0101
% Ash content	0.3129	0.3013	0.2949	0.7698	0.4619	0.5752	0.8115	0.9331	0.5764	0.9958	0.6027	0.6676	0.5646	0.4950

APPENDIX F

Raw data for total carbohydrate content determination

	Hong Kong Flour		Sugarcane Bagasse Powder		Chinese steamed buns		Sugarcane Bagasse steamed buns							
					0 %		2 %		4 %		6 %		8 %	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
% Moisture content	13.1145	13.1713	9.5111	9.3729	41.5071	41.5153	39.3869	39.6443	39.6285	39.5434	39.9784	40.9233	41.4205	41.3049
% Protein content	0.1989	0.1465	1.7156	1.8263	3.9543	3.9674	3.9678	3.9950	4.2420	4.1956	4.3362	4.1422	4.5372	4.4260
% Fat content	0.2291	0.3148	0.00	0.00	3.0107	3.1128	4.2644	4.1237	3.5600	3.0494	2.7217	2.8738	1.9200	1.8672
% Ash content	0.3129	0.3013	0.2949	0.7698	0.4619	0.5752	0.8115	0.9331	0.5764	0.9958	0.6027	0.6676	0.5646	0.4950
% Carbohydrate content	86.1446	86.0661	88.2409	88.0310	51.0660	50.8293	51.5694	51.3039	51.9931	52.2158	52.3610	51.3931	51.5577	51.9069

APPENDIX G

Raw data for colour value determination

	Hong Kong Flour		Sugarcane Bagasse Powder		Chinese steamed buns		Sugarcane Bagasse steamed buns							
					0 %		2 %		4 %		6 %		8 %	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
L*	94.78	94.94	89.41	89.20	70.93	71.39	70.55	70.83	70.55	70.00	69.97	69.21	68.67	68.88
a*	-0.91	-0.89	-0.36	-0.34	-1.56	-1.45	-1.44	-1.31	-1.21	-1.24	-1.08	-1.09	-0.89	-0.91
b*	9.58	9.32	12.68	12.56	16.29	16.53	17.08	17.12	17.80	17.84	18.08	17.96	17.97	18.26

APPENDIX H

Raw data for specific volume determination

	Chinese steamed buns		Sugarcane bagasse steamed buns							
	0 %		2 %		4 %		6 %		8 %	
	1	2	1	2	1	2	1	2	1	2
Volume of rapeseed in empty container (ml)	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
Volume of rapeseed in container containing sample (ml)	990	1000	1010	1010	1015	1020	1030	1030	1040	1040
Total rapeseed used (ml)	110	100	90	90	85	80	70	70	60	65
Weight of steamed buns (g)	46.00	42.70	42.20	42.77	41.03	42.00	42.83	42.32	42.71	42.24
Specific volume (ml/g)	2.3913	2.3419	2.1327	2.1043	2.0717	1.9048	1.6344	1.6541	1.4048	1.3021

APPENDIX I

Raw data for textural analysis determination

	Chinese steamed buns		Sugarcane bagasse steamed buns							
	0 %		2 %		4 %		6 %		8 %	
	1	2	1	2	1	2	1	2	1	2
Hardness	1081.591	1089.4355	1576.7395	1588.029	2072.7365	2009.4285	3297.049	3964.156	5493.311	5146.3305

APPENDIX J

Calculation for One-way ANOVA Test (Moisture content)

HONG KONG FLOUR AND SUGARCANE BAGASSE POWDER

Hypothesis:

Ho: mean for all the two samples is equal
Ha: at least one pair of mean is not equal

One-way ANOVA: Moisture Content of flour versus Samples

```
Source    DF        SS        MS        F      P
Samples    1  13.69666  13.69666  2454.00  0.000
Error      2   0.01116   0.00558
Total      3  13.70782

S = 0.07471   R-Sq = 99.92%   R-Sq(adj) = 99.88%


                                    Individual 95% CIs For Mean Based on
                                    Pooled StDev
Level             N     Mean   StDev  ---+---------+---------+---------+------
Bagasse powder    2   9.4420  0.0977  (-*-)
Hong Kong flour   2  13.1429  0.0402                                 (-*)
                                      ---+---------+---------+---------+------
                                       9.6      10.8      12.0      13.2

Pooled StDev = 0.0747


Grouping Information Using Fisher Method

Samples           N     Mean  Grouping
Hong Kong flour   2  13.1429  A
Bagasse powder    2   9.4420    B

Means that do not share a letter are significantly different.


Fisher 95% Individual Confidence Intervals
All Pairwise Comparisons among Levels of Samples

Simultaneous confidence level = 95.00%


Samples = Bagasse powder subtracted from:

Samples           Lower  Center   Upper
Hong Kong flour  3.3795  3.7009  4.0223

Samples          ---+---------+---------+---------+------
Hong Kong flour                                (--*--)
                 ---+---------+---------+---------+------
                   0.0       1.2       2.4       3.6
```

Result:
Ho is accepted where p=0.00 ($p<0.05$), there is significant different between the Hong Kong flour and sugarcane bagasse powder in terms of moisture content.

From Fisher's test,

```
                                    Individual 95% CIs For Mean Based on
                                    Pooled StDev
Level            N     Mean   StDev  ---+---------+---------+---------+------
Bagasse powder   2   9.4420  0.0977  (-*-)b
Hong Kong flour  2  13.1429  0.0402                                (-*)a
                                     ---+---------+---------+---------+------
                                       9.6      10.8      12.0      13.2

Pooled StDev = 0.0747
```

Simplified result:

Samples	Mean Moisture content	St Dev
Hong Kong flour	13.14[a]	0.040
Sugarcane bagasse powder	9.44[b]	0.098

Note: mean with same superscript alphabet having no significant difference ($p>0.05$)

STEAMED BUNS

Hypothesis:

Ho: mean for all the five samples is equal
Ha: at least one pair of mean is not equal

One-way ANOVA: Moisture Content of Steamed bun versus Samples

```
Source   DF      SS      MS      F      P
Samples   4  7.1453  1.7863  18.23  0.003
Error     5  0.4899  0.0980
Total     9  7.6352

S = 0.3130   R-Sq = 93.58%   R-Sq(adj) = 88.45%

                            Individual 95% CIs For Mean Based on
                            Pooled StDev
Level  N    Mean  StDev  ---+---------+---------+---------+------
0%     2  41.511  0.006                         (------*------)
2%     2  39.516  0.182  (------*------)
4%     2  39.586  0.060   (------*------)
6%     2  40.451  0.668            (------*------)
8%     2  41.363  0.082                     (------*------)
                         ---+---------+---------+---------+------
                         39.20     40.00     40.80     41.60
```

```
Pooled StDev = 0.313


Grouping Information Using Fisher Method

Samples  N     Mean  Grouping
0%       2  41.5112  A
8%       2  41.3627  A
6%       2  40.4509    B
4%       2  39.5859      C
2%       2  39.5156      C

Means that do not share a letter are significantly different.


Fisher 95% Individual Confidence Intervals
All Pairwise Comparisons among Levels of Samples

Simultaneous confidence level = 78.84%


Samples = 0% subtracted from:

Samples     Lower   Center    Upper  ---------+---------+---------+---------+
2%        -2.8002  -1.9956  -1.1910  (-----*----)
4%        -2.7299  -1.9253  -1.1206   (----*-----)
6%        -1.8650  -1.0603  -0.2557         (----*----)
8%        -0.9531  -0.1485   0.6561               (----*----)
                                     ---------+---------+---------+---------+
                                           -1.5       0.0       1.5       3.0


Samples = 2% subtracted from:

Samples     Lower  Center   Upper  ---------+---------+---------+---------+
4%        -0.7343  0.0703  0.8750                (----*-----)
6%         0.1306  0.9353  1.7399                      (----*-----)
8%         1.0425  1.8471  2.6517                            (----*-----)
                                   ---------+---------+---------+---------+
                                         -1.5       0.0       1.5       3.0


Samples = 4% subtracted from:

Samples    Lower  Center   Upper  ---------+---------+---------+---------+
6%        0.0603  0.8649  1.6695                     (-----*----)
8%        0.9721  1.7768  2.5814                           (-----*----)
                                  ---------+---------+---------+---------+
                                        -1.5       0.0       1.5       3.0


Samples = 6% subtracted from:

Samples    Lower  Center   Upper  ---------+---------+---------+---------+
8%        0.1072  0.9119  1.7165                      (----*----)
                                  ---------+---------+---------+---------+
                                        -1.5       0.0       1.5       3.0
```

Result:
Ho is accepted where p=0.003 (p<0.05), there is significant different between the samples in term of moisture content in steamed buns.

From Fisher's test,

```
                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level  N    Mean  StDev  ---+---------+---------+---------+------
0%     2  41.511  0.006                         (------*------)a
2%     2  39.516  0.182  (------*------)c
4%     2  39.586  0.060   (------*------)c
6%     2  40.451  0.668             (------*------)b
8%     2  41.363  0.082                       (------*------)a
                         ---+---------+---------+---------+------
                         39.20     40.00     40.80     41.60

Pooled StDev = 0.313
```

Simplified result:

Samples	Mean Moisture content	St Dev
0 %	41.51^{a}	0.006
2 %	39.52^{c}	0.18
4 %	39.59^{c}	0.06
6 %	40.45^{b}	0.67
8 %	41.36^{a}	0.082

Note: Mean with same superscript alphabet having no significant difference ($p>0.05$).

APPENDIX K

Sugarcane bagasse Steamed Buns Questionnaire Form

Name:

Course:

Date:

A.General Information

Please tick (/) your answer in the box given

1. Sex: ☐ Female ☐ Male
2. Age: ☐ < 25 years old ☐ 25-35 years old

   ☐ 36-54 years old ☐ > 55 years old
3. Races: ☐ Malay ☐ Chinese

   ☐ India ☐ Others (Please state):
4. Do you have taken part in any food sensory evaluation?

   ☐ Yes ☐ No
5. Do you like to eat Chinese Steamed buns (Pau)?

   ☐ Yes ☐ No
6. Do you know about the fiber Chinese steamed bun?

   ☐ Yes ☐ Not sure ☐ No
7. Do you think that it is possible to have a fiber steamed buns in nowadays?

   ☐ I think so ☐ I don't know ☐ I don't think so

B. Sensory Evaluation Form (Hedonic Scale) for sugarcane bagasse steamed buns

Panel No.:

Date:

Instruction:

- Please rinse your mouth before starting every sample.
- Evaluate the products in front of you starting from the left to the right.
- Check the boxes and represent your responses with (/).
- Below is the guidelines for the scores:

1- Dislike extremely
2- Dislike moderately
3- Dislike slightly
4- Neither like nor dislike
5- Like slightly
6- Like moderately
7- Like extremely

Sample code:

1. Colour

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

Dislike extremely — Like Extremely

2. Aroma

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

Dislike extremely — Like Extremely

3. Tenderness

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

Dislike extremely — Like Extremely

4. Taste

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

Dislike extremely — Like Extremely

5. Moistness

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

Dislike extremely — Like Extremely

6. Pore size

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

Dislike extremely — Like Extremely

7. Overall acceptance

1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

Dislike extremely — Like Extremely

Comment:

C. Ranking Preference for sugarcane bagasse steamed buns

No. of panel:

Date:

Please rinse your mouth before starting. Please taste the six samples from the left to the right. **Rank the sample from most preferred to least preferred using the following numbers:**

1= Least preferred; 5= Most preferred

Sample	....	....	....	....	....
Rank	___.	___.	___.	___.	___.

(Repeated number is not allowed)

Comment:

____

APPENDIX L

Master sheet for sensory evaluation

No. Panel	Permutation	A (Control)	B (2%)	C (4%)	D (6%)	E (8%)
1	54132	132^{5}	129^{4}	319^{1}	825^{3}	052^{2}
2	45213	104^{4}	607^{5}	~~378~~^{2}	407^{1}	438^{3}
3	21435	738^{2}	401^{1}	140^{4}	528^{3}	105^{5}
4	35421	906^{3}	234^{5}	089^{4}	283^{2}	720^{1}
5	15243	069^{1}	152^{5}	974^{2}	980^{4}	875^{3}
6	24531	501^{2}	068^{4}	943^{5}	981^{3}	384^{1}
7	14532	921^{1}	674^{4}	034^{5}	306^{3}	174^{2}
8	42153	871^{4}	489^{2}	562^{1}	279^{5}	768^{3}
9	14253	801^{1}	891^{4}	936^{2}	063^{5}	361^{3}
10	14235	589^{1}	672^{4}	210^{2}	402^{3}	406^{5}
11	25413	107^{2}	632^{5}	408^{4}	475^{1}	197^{3}
12	25413	968^{2}	918^{5}	059^{4}	482^{1}	219^{3}
13	25143	395^{2}	023^{5}	046^{1}	836^{4}	125^{3}
14	25134	748^{2}	837^{5}	075^{1}	082^{3}	752^{4}
15	21453	975^{2}	248^{1}	683^{4}	203^{5}	743^{3}
16	34512	216^{3}	163^{4}	824^{5}	895^{1}	703^{2}
17	41253	146^{4}	302^{1}	529^{2}	572^{5}	085^{3}
18	53241	273^{5}	209^{3}	519^{2}	930^{4}	458^{1}
19	14352	137^{1}	267^{4}	147^{3}	613^{5}	491^{2}
20	14523	657^{1}	658^{4}	642^{5}	573^{2}	643^{3}
21	41352	852^{4}	178^{1}	810^{3}	045^{5}	472^{2}
22	15324	164^{1}	403^{5}	952^{3}	759^{2}	643^{4}
23	43521	230^{4}	189^{3}	207^{5}	623^{2}	149^{1}
24	35214	159^{3}	167^{5}	013^{2}	954^{1}	820^{4}
25	21534	840^{2}	957^{1}	168^{5}	284^{3}	367^{4}
26	53241	713^{5}	142^{3}	718^{2}	138^{4}	187^{1}
27	53241	035^{5}	783^{3}	520^{2}	524^{4}	348^{1}
28	41253	531^{4}	817^{1}	521^{2}	782^{5}	548^{3}
29	54123	374^{5}	471^{4}	245^{1}	789^{2}	758^{3}
30	15342	301^{1}	409^{5}	705^{3}	237^{4}	405^{2}
31	23541	139^{2}	318^{3}	079^{5}	698^{4}	297^{1}
32	24135	305^{2}	917^{4}	509^{1}	325^{3}	396^{5}
33	43251	830^{4}	714^{3}	915^{2}	410^{5}	359^{1}
34	23541	201^{2}	704^{3}	309^{5}	670^{4}	819^{1}
35	13245	435^{1}	513^{3}	987^{2}	351^{4}	345^{5}

APPENDIX M

Raw data for panelist summary

		Frequency	Percent (%)
Sex	Female	15	50
	Male	15	50
Age	< 25 years old	30	100
	25-35 years old	0	0
	36-40 years old	0	0
	> 55 years old	0	0
Races	Malay	17	56.67
	Chinese	11	36.67
	India	1	3.33
	Others	1	3.33
Do you have taken part in any food sensory evaluation?	Yes	21	70
	No	9	30
Do you like to eat Chinese steamed buns (pau)?	Yes	28	93.33
	No	2	6.67
Do you know about the fiber Chinese steamed buns?	Yes	4	13.33
	Not sure	19	63.33
	No	7	23.33
Do you think it is possible to have fiber steamed buns in nowadays?	I think so	24	80
	I don't know	5	16.67
	I don't think so	1	3.33

APPENDIX N

Raw data for sensory evaluation (Acceptance Test)

No. Panel		colour	Aroma	Tenderness	Pore size	Taste	Moistness	Overall acceptance
1	A	3	6	3	4	5	3	5
2	A	7	2	7	6	3	7	4
3	A	6	6	6	6	6	6	6
4	A	6	4	6	5	6	6	6
5	A	4	4	4	3	4	2	4
6	A	4	4	5	3	6	5	5
7	A	6	5	6	6	5	4	5
8	A	6	6	6	4	7	6	6
9	A	3	3	3	3	3	3	3
10	A	7	7	7	7	5	5	6
11	A	6	5	2	5	4	4	4
12	A	6	3	5	4	5	5	5
13	A	4	5	3	3	3	4	4
14	A	4	4	4	6	4	5	5
15	A	5	4	4	3	4	4	4
16	A	6	5	6	6	6	5	6
17	A	5	3	4	6	3	6	6
18	A	7	6	6	5	6	4	7
19	A	5	4	3	3	3	2	4
20	A	5	6	7	6	4	5	5
21	A	3	2	3	4	2	3	3
22	A	6	5	6	5	2	6	5
23	A	4	4	5	5	5	4	6
24	A	6	6	6	5	4	4	5
25	A	6	6	6	6	7	5	6
26	A	6	6	6	5	5	5	5
27	A	5	5	6	7	7	4	7
28	A	5	6	6	7	7	6	6
29	A	7	6	7	7	6	7	7
30	A	3	5	4	3	5	6	3
1	B	5	4	5	3	6	4	6
2	B	3	4	3	2	5	5	5
3	B	5	5	4	5	5	4	5
4	B	6	4	4	4	5	4	5
5	B	5	4	4	4	5	5	5
6	B	4	4	3	4	4	4	4
7	B	6	4	4	4	4	5	5
8	B	6	3	1	3	6	6	5
9	B	5	5	5	3	3	3	4
10	B	5	1	3	3	4	2	3
11	B	4	5	4	6	2	4	4

12	B	4	4	3	4	5	5	4
13	B	5	6	6	4	4	4	4
14	B	5	4	6	3	3	3	4
15	B	6	6	3	3	3	2	4
16	B	6	5	6	6	6	6	6
17	B	5	4	5	6	5	5	6
18	B	6	6	6	6	5	4	7
19	B	6	5	6	5	5	5	7
20	B	6	4	4	5	6	6	7
21	B	5	6	5	5	6	5	6
22	B	6	5	3	5	3	2	4
23	B	3	4	5	5	5	4	5
24	B	5	5	4	4	4	4	4
25	B	5	5	4	5	3	4	4
26	B	7	7	6	6	6	5	6
27	B	3	3	3	5	5	4	4
28	B	5	6	3	2	5	3	1
29	B	4	5	5	5	6	6	6
30	B	5	4	7	7	7	5	7
1	C	6	6	5	5	6	5	6
2	C	5	5	6	6	6	6	6
3	C	5	6	5	5	4	5	5
4	C	6	6	6	7	7	6	7
5	C	4	5	4	3	3	2	4
6	C	5	5	5	4	5	5	5
7	C	5	5	6	5	4	4	5
8	C	5	6	3	5	3	5	5
9	C	1	3	3	3	3	3	3
10	C	5	4	4	5	5	3	4
11	C	6	5	6	5	2	5	4
12	C	5	4	5	5	5	5	5
13	C	4	5	6	4	3	2	3
14	C	4	4	3	4	4	5	5
15	C	4	3	4	3	2	4	3
16	C	6	5	6	6	6	6	6
17	C	4	4	6	6	6	4	6
18	C	5	7	3	4	4	3	4
19	C	4	4	6	4	4	5	6
20	C	6	6	6	5	4	5	5
21	C	5	2	4	5	4	5	5
22	C	6	5	6	5	5	5	5
23	C	3	4	5	5	5	5	6
24	C	6	6	6	6	4	4	5
25	C	6	5	5	7	6	6	7
26	C	7	6	5	7	6	6	6
27	C	2	6	6	4	5	4	5
28	C	5	6	6	7	6	7	6

29	C	6	5	6	7	6	7	7
30	C	5	6	5	5	4	2	5
1	D	4	6	4	5	5	4	5
2	D	2	6	4	4	4	2	4
3	D	5	6	7	3	5	6	6
4	D	6	5	6	6	6	6	6
5	D	4	5	4	1	3	3	4
6	D	3	3	1	2	3	3	3
7	D	4	4	5	5	4	4	4
8	D	2	4	4	4	5	4	5
9	D	6	6	6	5	5	5	5
10	D	5	3	4	4	3	2	3
11	D	5	6	3	5	2	5	4
12	D	4	5	3	2	2	2	3
13	D	5	3	6	5	4	4	4
14	D	5	6	4	5	3	3	6
15	D	4	5	4	4	3	3	4
16	D	5	5	5	6	4	4	4
17	D	4	4	6	6	5	6	7
18	D	6	4	4	3	4	3	4
19	D	5	4	3	3	2	4	3
20	D	4	3	3	5	2	4	3
21	D	2	5	6	5	5	4	5
22	D	5	5	3	5	5	3	4
23	D	3	3	4	4	4	4	5
24	D	5	6	4	5	4	3	6
25	D	6	6	5	5	3	6	4
26	D	2	2	3	6	1	6	5
27	D	4	2	1	2	2	2	3
28	D	5	5	3	5	5	3	5
29	D	5	5	5	6	5	5	5
30	D	4	5	6	6	6	6	6
1	E	5	5	5	4	5	5	5
2	E	4	3	5	5	7	3	7
3	E	6	6	5	3	5	5	6
4	E	6	7	6	6	6	5	6
5	E	4	5	2	4	3	1	2
6	E	2	3	3	3	2	2	3
7	E	5	5	4	4	3	3	2
8	E	4	5	2	6	3	2	3
9	E	5	5	3	1	1	1	2
10	E	4	2	3	1	2	1	2
11	E	6	6	5	6	2	6	4
12	E	4	5	3	3	3	3	3
13	E	3	4	2	4	2	1	2
14	E	4	5	4	4	5	5	7
15	E	4	3	3	4	3	2	4

16	E	5	5	4	5	3	4	3
17	E	4	4	6	6	4	6	7
18	E	6	5	2	3	2	1	2
19	E	3	5	4	5	2	5	5
20	E	5	6	3	4	5	3	4
21	E	3	5	2	3	3	5	3
22	E	5	5	1	5	2	1	3
23	E	3	2	4	5	3	4	5
24	E	6	4	4	5	4	4	4
25	E	6	6	5	6	6	6	4
26	E	5	6	7	7	7	6	5
27	E	5	5	2	1	1	2	2
28	E	5	5	3	2	6	3	2
29	E	5	5	5	6	4	5	5
30	E	5	4	5	5	4	3	3

APPENDIX O

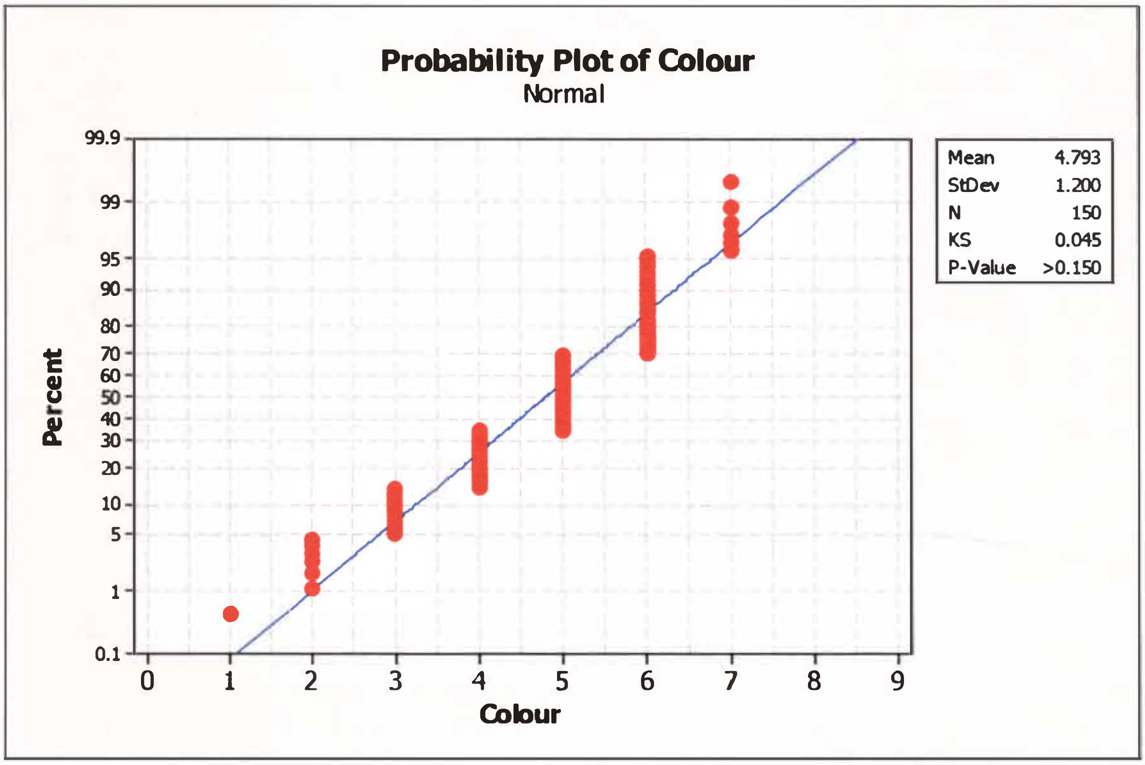
Calculation for One-way ANOVA (Acceptance Test)- Colour attribute

1.Colour

1. Normality Test

Hipothesis:
Ho: data is normally distributed
Ha: data is abnormally distributed

Probability Plot of Colour

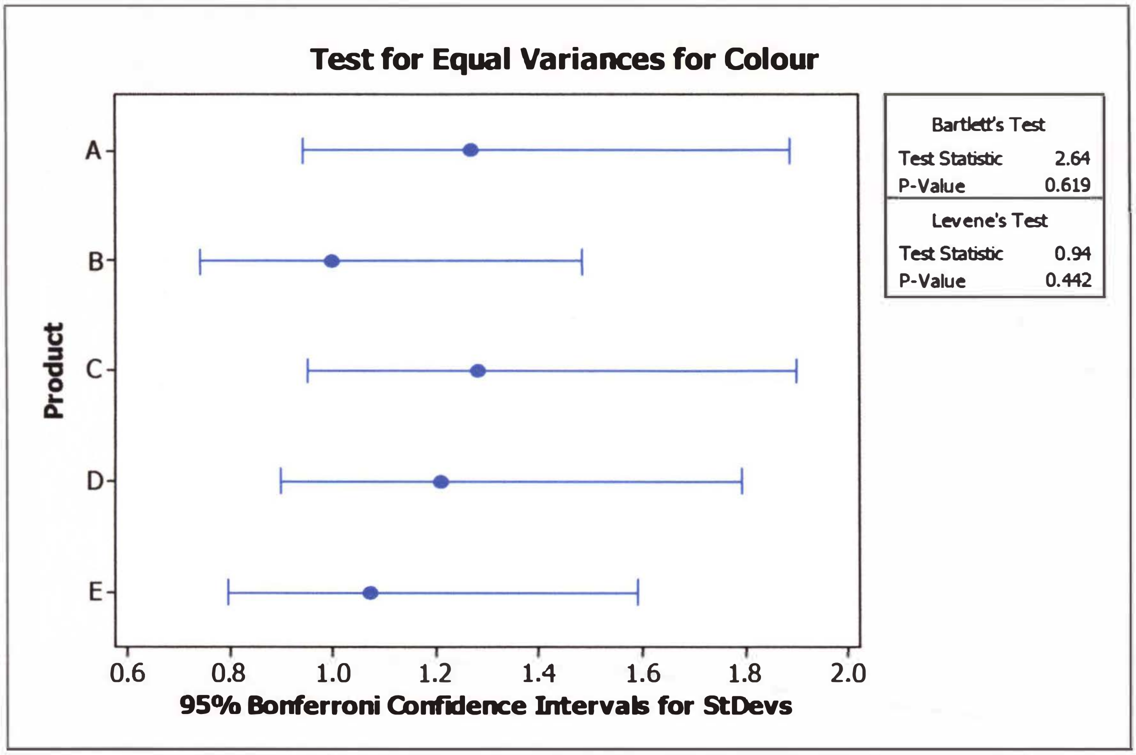


AD: p-value = >0.150, P > 0.05
Result: Since p > 0.150, so Ho is accepted and data is normally distributed.

2. Test for Equal variances

Hipothesis:
Ho: σ1 = σ2 = σ3 = σ4 = σ5
Ha: at least two variances from two samples are different from each others

Test for Equal Variances: Colour versus Product



95% Bonferroni confidence intervals for standard deviations

Product	N	Lower	StDev	Upper
A	30	0.945637	1.27035	1.88859
B	30	0.743962	0.99943	1.48581
C	30	0.952348	1.27937	1.90199
D	30	0.899024	1.20773	1.79550
E	30	0.798468	1.07265	1.59467

Bartlett's Test (normal distribution)
Test statistic = 2.64, p-value = 0.619

Levene's Test (any continuous distribution)
Test statistic = 0.94, p-value = 0.442

Test for Equal Variances: Colour versus Product

Result:

It is found that both the Barlett's and Levene's gave $p > 0.05$. Therefore Ho is accepted where all three samples have the same variance.

With this, the requirement for ANOVA has been fulfilled.

Therefore, can proceed with One-Way ANOVA

3. One- way ANOVA

One-way ANOVA: Colour versus Product

Source	DF	SS	MS	F	P
Product	4	15.69	3.92	2.86	0.026
Error	145	198.90	1.37		
Total	149	214.59			

S = 1.171   R-Sq = 7.31%   R-Sq(adj) = 4.76%

```
                               Individual 95% CIs For Mean Based on
                               Pooled StDev
Level   N   Mean  StDev  --+---------+---------+---------+-------
A      30  5.200  1.270                     (-------*-------)
B      30  5.033  0.999                 (--------*-------)
C      30  4.867  1.279              (-------*--------)
D      30  4.300  1.208  (-------*-------)
E      30  4.567  1.073       (-------*--------)
                         --+---------+---------+---------+-------
                         4.00      4.50      5.00      5.50

Pooled StDev = 1.171
```

Fisher 95% Individual Confidence Intervals
All Pairwise Comparisons among Levels of Product

Simultaneous confidence level = 71.73%

Product = A subtracted from:

```
Product    Lower   Center    Upper   ---------+---------+---------+---------+
B         -0.764   -0.167    0.431             (-------*------)
C         -0.931   -0.333    0.264           (-------*------)
D         -1.498   -0.900   -0.302   (-------*------)
E         -1.231   -0.633   -0.036       (------*-------)
                                     ---------+---------+---------+---------+
                                           -0.80      0.00      0.80      1.60
```

```
Product = B subtracted from:

Product    Lower   Center    Upper   ---------+---------+---------+---------+
C         -0.764   -0.167    0.431             (-------*------)
D         -1.331   -0.733   -0.136     (-------*------)
E         -1.064   -0.467    0.131         (------*-------)
                                     ---------+---------+---------+---------+
                                           -0.80      0.00      0.80      1.60
```

```
Product = C subtracted from:

Product    Lower   Center   Upper   ---------+---------+---------+---------+
D         -1.164   -0.567   0.031       (-------*------)
E         -0.898   -0.300   0.298           (------*-------)
                                    ---------+---------+---------+---------+
                                          -0.80      0.00      0.80      1.60
```

```
Product = D subtracted from:

Product    Lower   Center   Upper   ---------+---------+---------+---------+
E         -0.331    0.267   0.864                  (------*-------)
                                    ---------+---------+---------+---------+
                                          -0.80      0.00      0.80      1.60
```

Overall results:
Ho is accepted where $p > 0.05$. So there is no significant different between the samples in terms of colour property.

From Fisher's LSD test;

```
                             Individual 95% CIs For Mean Based on
                             Pooled StDev
Level    N    Mean   StDev   --+---------+---------+---------+-------
A       30   5.200   1.270                 (-------*-------)a
B       30   5.033   0.999             (--------*-------)a
C       30   4.867   1.279          (-------*--------)a
D       30   4.300   1.208   (-------*-------)a
E       30   4.567   1.073        (-------*--------)a
                             --+---------+---------+---------+-------
                             4.00      4.50      5.00      5.50

Pooled StDev = 1.171
```

It is known that there is no significant difference between the 5 samples of Chinese steamed buns and sugarcane bagasse Steamed buns in terms of colour property.

APPENDIX P

Calculation for Preference test (Ranking Test)

1)Fast method

No. of Sample: 5 (P)

No. of Panel: 30 (P)

Total Lowest Score: 80

Total Highest Score: 104

Therefore, range from this test: 80 – 104

From Kramer (1974) Table, α= 0.05, range = 77-103

↓--↓ (From Table,t)

77 103

↓---↓ (From test)

80 104

Found that, the range from this test is out from the range from the table.

So, there are significant differences between these samples at α= 0.05 ($p<0.05$).

2)Friedman Test, Chi- Square Method (χ_r^2)

$$X^2_{rk} = \frac{12}{np\,(p+1)}(E_1 + E_2 + E_3 + \ldots\ldots + E_n) - (3n\,(p+1))$$

$$= \frac{12}{(30)(5)(5+1)}(76^2 + 89^2 + 70^2 + 100^2 + 115^2) - (3(30)(5+1))$$

$$= \frac{12}{900}(41822) - 540$$

$$= 557.63 - 540$$

$$= 17.63$$

$$\approx 18$$

From the table χ_r^2, dk= p-1 = 4, and α= 0.05, χ^2_{rt} = 9.49.

Since $\chi_r^2 > \chi^2_{rt}$, 18 > 9.49, indicating the significant different between the level of preferences among five samples of steamed buns.

Thus, Least Significant Difference (LSD) test was done for further analysis.

3)LSD Test for Friedman Test (Least Significant Difference, LSD)

$LSD = t_{\alpha=0.05}, dk_{\rightarrow\infty} \sqrt{\frac{np(p+1)}{dk}}$ where $t_{\alpha=0.05}, dk_{\rightarrow\infty} = 1.96$ (two-tailed)

$= 1.96 \sqrt{\frac{30(5)(5+1)}{4}}$

$= 1.96\ (15)$

$= 29.4$

≈ 29

Therefore, significance differences for each pair of sample have to test.

Rearrange the score from highest score to lowest score and get the different value between two samples. Compare by using LSD value. If difference value > LSD = 29, then there is significant difference between two samples, give the different alphabet and if wise verse, use same alphabet.

4%	0%	2%	6%	8%
110	104	91	80	65
a	ab	abc	bc	c

-------------------------------------a

-----------------------------------b

-------------------------------------c

Sample with the same line in below / with the same alphabet, indicating no significant difference between the sample at $\alpha = 0.05$ ($p < 0.05$).

Rearrange the samples

Table: Result of Steamed buns sensory evaluation for preference test (ranking test)

Samples	Total score	Superscript
0 %	104	bc
2 %	91	abc
4 %	110	a
6 %	80	bc
8 %	65	c

APPENDIX Q

Picture of sugarcane bagasse, bagasse powder and Hong Kong flour

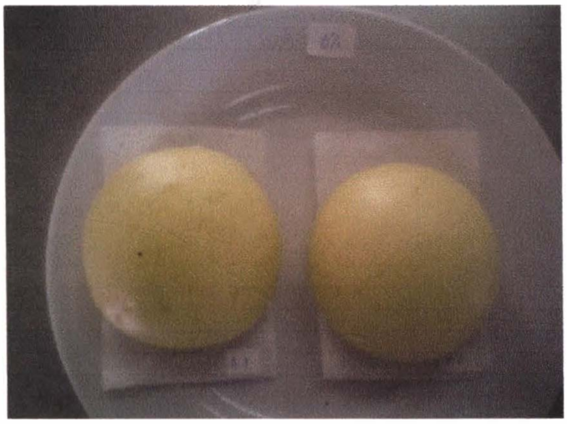
Sugarcane bagasse

Hong Kong flour

Sugarcane bagasse powder

APPENDIX R

Picture of Chinese steamed buns and sugarcane bagasse steamed buns



Control Chinese steamed buns (0%)

2 % sugarcane bagasse steamed buns

4 % sugarcane bagasse steamed buns

6 % sugarcane bagasse steamed buns

8 % sugarcane bagasse steamed buns

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2001-2005 Sekolah Menengah kebangsaan Bandar Baru Sungai Long, Selangor

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Others:

March 2010 : Attended the seminar "Evolution and Innovations in Food Industry"

December 2010: Attended the seminar on "The Science and Practice of GMP"

October 2011 : Participated in Hand-made Chocolate Course (Intermediate)

November 2011: Completed the course "Best Halal Practice in the Food Industry"

November 2011: Attended to "Program Bengkel Kerjaya"