DEVELOPMENT OF BEVERAGE FROM CORNSIK TREATED WITH DIFFERENT THERMAL TREATMENTS AND ITS EFFECT ON MORPHOLOGICAL CHARACTERIZATION, MINERAL COMPOSITION, PHYSICOCHEMICAL PROPERTIES, AND SENSORY QUALITIES

by

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Thesis submitted in partial fulfilment of the requirements for the degree of

Bachelor of Health Sciences (Nutrition)

June 2016

ACKNOWLEDGEMENT

Praise to the Al-Mighty as I am able to complete this final year project with the endless support and encouragement from numerous people including my parents, my friends, staffs, colleagues and all people who have been involved in this remarkable journey which I know I am unable to thank them enough. The completion of this thesis is finally possible and was an unforgettable experience for me.

At this moment of accomplishment, first of all I would like to express my gratitude to my supervisor Assoc. Prof. Dr. Wan Rosli Wan Ishak for his guidance, patience, support and encouragement. Under his supervision, I successfully overcame many difficulties and learned a lot. I also would like to thank him for financially supporting my final year project. May Allah bless him.

I also owe a deep sense of gratitude to Dr. Nurhanan Abd. Rahman for her valuable advice, constructive criticism and her willingness to help me during my final year project. Besides, a big appreciation also goes to all my friends who have helped me a lot from the start until the end of this journey.

Finally, I would like to thank all staffs and students of School of Health Sciences for participating in my sensory evaluation test, and helping me during my laboratory works. They have given a great cooperation and made all related processes run smoothly.

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LIST OF SYMBOL, ABBREVIATION AND ACRONYM

SEM	Scanning Electron Microscope
ICP-MS	Inductive Coupled Plasma Mass Spectrometer
ANOVA	Analysis of variance
SPSS	Statistical Package for Social Science
TSS	Total soluble solids
TA	Titratable acidity

ABSTRAK

Sutera jagung ialah sisa tuaian daripada jagung dan telah diguna secara tradisional sebagai penawar pelbagai jenis penyakit sejak berzaman lagi. Penggunaan sutera jagung ke dalam produk minuman bukan sahaja dapat mengelakkan pembaziran yang besar, tetapi juga boleh menawarkan rawatan alternatif kepada pengguna. Kajian ini bertujuan untuk mengkaji kesan rawatan haba yang berbeza ke atas ciri-ciri morfologi, komposisi mineral, ciri fizikokimia, dan ciri-ciri sensori. Sutera jagung diperkenalkan kepada dua jenis rawatan haba (kukus dan celur), dan tanpa rawatan haba. Selepas rawatan haba, sutera jagung tersebut dikeringkan semalaman di dalam ketuhar sebelum ciri-ciri morfologi nya dilihat dengan menggunakan *Scanning Electron Microscope* (SEM). Kemudian, sutera jagung yang kering telah dikisar menjadi serbuk untuk penyediaan minuman. Kedua-dua serbuk dan minuman tersebut dihantar untuk menentukan kepekatan mineral menggunakan *Inductively Coupled Plasma Mass Spectrometry* (ICP-MS). Hasil kajian mendapati tiada perbezaan yang ketara terhadap ciri-ciri morfologi dan ciri-ciri fizikal antara sutera jagung segar dan sutera jagung kering yang dirawat dengan rawatan haba yang berbeza dalam. Perbezaan hanya dapat dilihat dari segi diameter dan lebar dalam semua sampel sutera jagung. Pengecutan jelas terlihat dalam sampel sutera jagung kering berbanding sampel sutera jagung segar. Hasil ICP-MS pula menunjukkan sejumlah besar K dan Ca terdapat di dalam serbuk dan minuman sutera jagung. Selain itu untuk mineral surih, didapati Mn dan Zn terdapat di dalam serbuk dan minuman sutera jagung. Bagi logam berat, serbuk sutera jagung mengandungi jumlah Cr yang rendah, manakala minuman sutera jagung pula mengandungi jumlah Ar yang rendah tetapi masih di bawah had yang ditetapkan oleh Akta Makanan 1983 dan Peraturan-Peraturan Makanan 1985. Minuman sutera jagung daripada hasil kukusan (SCB) merekodkan jumlah pepejal (TSS) dan nilai pH tertinggi, manakala minuman sutera jagung tanpa

dirawat (UCB) mencatatkan nilai keasidan (TA) tertinggi. Bagi penilaian sensori, tiada perbezaan ketara dicatatkan dari hasil penilaian sifat-sifat sensori untuk semua sampel minuman sutera jagung di mana kesemua penilaian hampir sama antara satu sama lain. Walau bagaimanapun, tahap penerimaan hasil daripada dapat disimpulkan seperti berikut: UCB > SCB > BCB. Formulasi minuman sutera jagung perlu dirumus kembali untuk meningkatkan penerimaan pengguna.

ABSTRACT

Cornsilk is the by-product of maize and traditionally has being used to treat many ailments since ancient time. Utilization of cornsilk into beverage product not only able to prevent huge wastage, but also can offer alternative remedy to the consumers. This study aims to investigate the effect of different thermal treatments of cornsilk on morphological characterization, mineral compositions, physicochemical properties, and sensory properties. Cornsilk was introduced into two types of thermal treatments (steaming and blanching), and untreated. After the treatments, the cornsilk was dried overnight in an oven before viewed using scanning electron microscope (SEM) for morphological characterization. Later, the dried cornsilk was ground into powder form prior to beverage preparation. Both powder and beverage prepared from different treatments were analysed for mineral concentration determination using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). There was no significant differences between fresh and dried cornsilk treated with different thermal treatments in morphological features and physical characteristics. Differences were only observed in the diameter and width in all cornsilk samples. Shrinkage was obviously seen in dried cornsilk samples compared to fresh cornsilk samples. The result of ICP-MS showed significant amount of K and Ca compared to other macrominerals in both powder and cornsilk beverages. Similarly, the concentration of Mn and Zn were significant in both powder and cornsilk beverages. For heavy metals, cornsilk powder contain low amount of Cr whereas cornsilk beverage contain low amount of Ar but still under the limit set by Food Act 1983 and Food Regulations 1985. Steamed cornsilk beverage recorded highest total soluble solids value (TSS) and pH value while untreated cornsilk beverage (UCB) recorded highest titratable acidity value (TA). Similarly for sensory evaluation, no significant differences observed from the results whereby the scoring of attributes for all cornsilk beverages samples was

likely similar from each other. However, the degree of acceptance from the sensory evaluation was ranked as follows; UCB > SCB > BCB. Reformulation of the cornsilk beverages is suggested to improve acceptancy.

CHAPTER 1: INTRODUCTION

1.1 Background of the Study

Cornsilk is by-product of the maize that has broad roles in health application. Cornsilk is derived from stigmas, the yellowish thread like strands from the female flower of maize (Khairunnisa et al., 2012) and always been seen as a waste or by-product from corn cultivation (Sarepoua et al., 2013). However the usage of cornsilk is abundant and used in many parts of the world mainly for the treatment of various diseases. It is widely recognized and used in both traditional and official medicine, such as a mild diuretic, urinary demulcent, to pass stones and gravel from kidneys and urinary bladder, against benign prostatic hyperplasia, cystitis, gout, chronic nephritis and similar ailments (Maksimović et al., 2005).

Today, foods are not intended to only satisfy hunger, but also to prevent nutrition-related diseases and improve physical and mental well-being (Maran et al., 2013). Nature has become the source of medicine since thousands of years, and many modern drugs have been derived from the natural sources, based on their used in traditional medicine (Ghorbani et al., 2006). It has been reported that natural products play a dominant role in the discovery of leads for the development of drugs for human diseases treatment (Newman et al., 2003). Cornsilk is rich in natural antioxidants such as flavonoids and phenolic compounds which are known to give beneficial effects to human health. The extracts from cornsilk or its derived phytonutrients have great potential to prevent disease due to overproduction of radicals (Liu et al., 2011). Up to this point, there is no effort in utilizing this herb as ready-to-drink (RTD) functional beverage/drink.

Beverage products cover alcoholic beverages, hot beverages, soft drinks and juices. All beverages perform an essential nutritional functions, which is for hydration as well as giving enjoyment to the consumer (Ashurst, 2001; Lee and Faridah, 2005). The trend now is that consumers are more likely to choose nutritious food products. This contributes to availability of many kinds of drinks from local or imported fruits such as apple, guava, strawberries, pineapple, mango, tamarind, soursop and others, in the market. Fruit-based beverages are more desired by consumers over flavored drinks due to its nutrient composition (Nur Farah Hani et al., 2012).

Consumption of cornsilk has been reported to have no adverse effects and safe for humans (Wang et al., 2011).The availability of commercial product made from cornsilk is also numerous today especially for medicinal purpose (El-Ghorab et al., 2007). However, development of beverage product derived from cornsilk is still lacking unlike those commercial fruit juices. Of all the benefits contained in the cornsilk, and high demand for nutritious food product in the market, this study aimed to fully utilize this by-product by developing them into health alternative beverages that can be accepted by the consumers.

1.2 Rationale

It is important to fully utilize maize crops due to its richness of universal importance. It is found to be that about 50 000 tonnes of cornsilk are being discarded in Malaysia alone each year, in which the estimation is made based on the fact that the weight of total cornsilk often similar to the weight of the young baby corn as well as the number of small holders planting corns which supply baby corns in the country (Nurhanan et al., 2012). Even though cornsilk is being considered as a by-product in the process of maize grain production, cornsilk is inexpensive and readily available at a large scale, thus potentially attractive as a raw material for the pharmaceutical industry (Maksimović et al., 2005).

Cornsilk is known for its faintly sweetish taste (Saheed et al., 2015). The presence of off-flavours in a functional food give effect to consumer liking for the product as well as consumers' likelihood of consuming it regardless of the health benefits contained in the product. Besides, liking is a very important predictor of consumption and, if the first impression of taste is poor, a person will not tend to try the product for a second time, nor to repeat its consumption over an extended period (Tuorila and Cardello, 2002). Thus, this study is important to enhance utilization and modification of cornsilk to produce a beverage that is well accepted by the consumers. Through sensory evaluation, the quality of the cornsilk beverage can be evaluated.

The beverage produced from cornsilk also will be tested for its mineral contents. It is important to determine both major and trace levels of metal contents in food to ensure food safety and nutritional considerations. Trace metals are present in foods in amounts below 50 ppm and have some toxicological or nutritional significance. Some inorganic elements such as sodium (Na), potassium (K), calcium (Ca), and phosphorus (P) are essential for man, and some elements like lead (Pb), cadmium (Cd), mercury (Hg,) and

Arsenic (As) are harmful even in low levels of 10–50 ppm. Although Iron (Fe), Copper (Cu), and Zinc (Zn) are found to be necessary in certain quantities in foods, the same elements can cause ill effects when consumed at higher levels (Ministry of Health and Family Welfare, 2005).

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1.3 Objective

General:

To develop cornsilk beverage and examine its effect on sensory properties and nutritional qualities.

Specific:

1. To develop cornsilk beverage from different thermal treatments.
2. To determine morphological characterization of cornsilk treated with different thermal treatments.
3. To determine mineral composition of cornsilk beverage treated with different thermal treatments.
4. To determine the physicochemical properties of cornsilk beverage from different thermal treatments.
5. To evaluate acceptability of cornsilk beverage developed from different thermal treatments.

1.4 Hypothesis

Null Hypothesis:

There is **no significant difference** of morphological characterization, mineral compositions, physicochemical properties and sensory, between different thermal treatments of cornsilk.

Alternate Hypothesis:

There is **significant difference** of morphological characterization, mineral compositions, physicochemical properties and sensory, between different thermal treatments of cornsilk.

1.5 Conceptual Framework

Not applicable for this study.

CHAPTER 2: LITERATURE REVIEW

2.1 Corn and Cornsilk

Maize or corn (*Zea Mays L.)* is the world's third leading cereal crop after wheat and rice. It leads all other crops in terms of value and production volume. Maize is probably originated in Central America, specifically Mexico. Maize belongs to the family of Poaceae and is a tall annual herb with an extensive fibrous root system. It formed through cross-pollinating process between female and male flowers at separate places on the plant (Milind and Isha, 2013). In Malaysia, maize is one of the commonly consumed food item (Solihah et al., 2015). The plant is a multipurpose crop, known for its function to provide food and fuel for human being and feed for animals (poultry and livestock) (Afzal et al., 2009).

Cornsilk, is the by-product of fresh corn production and always been discarded as waste. Cornsilk is named of the long styles and stigmas on flower pistils. The stigmas are fine and soft, yellowish to green or purple threads of female flowers depending on varieties (Sarepoua et al., 2013).The function of cornsilk is to trap the pollen for pollination and each silk may be pollinated to produce one kernel of corn. The cornsilk can be 30 cm long or longer and have faintly sweetish taste. Cornsilk will be harvested just before pollination occurs if they will be used for medicinal purpose, and it can be used in fresh or dried form (Khairunnisa et al., 2012).

2.2 Nutritional Composition of Cornsilk

A study found that both immature and mature silks are rich in nutritional compositions. Immature silks contained significantly higher moisture (89.31%) (fresh basis), lipid (1.27%) and protein (12.96%) content compared to mature silks. Mature silks contained higher composition of ash (5.51%), carbohydrate (29.74%) and total dietary fibre (51.25 g/100 g), than the immature silk, but the difference was not significant. In mineral determination, immature silks contained higher Calcium (Ca) (1087.08 lg/g), Magnesium (Mg) (1219.17 lg/g), Copper (Cu) (5.60 lg/g) and Zinc (Zn) (46.37 lg/g) than the mature silks whereas other minerals such as Potassium (K) (35671.67 lg/g), Sodium (Na) (266.67 lg/g), Iron (Fe (4.50 lg/g) and Mn (35.57 lg/g) were found higher in the mature silk (Nurhanan and Wan Rosli, 2014). Study also found the presence of alkaloids, vitamins, saponins, fixed and volatile oils, steroids such as sitosterol and stigmasterol, tannins and flavonoids in the cornsilk (Wang et al., 2012; Sahib et al., 2012).

The presence of significant amount of polyphenols and flavonoids in the cornsilk is important as the source of natural antioxidant to benefit food and for health industries (Nurhanan et al., 2012). The antioxidant activity of fruits and vegetables is often assumed to be very necessary in combating a number of degenerative diseases caused by free radicals. Besides, antioxidant components from natural products are account for the major source of human health promotion and maintenance, whereas the use of synthetic antioxidants, such as butylated hydroxytoluene (BHT) has been questioned due to their health risks and toxicity (Asif, 2015).

Previous study demonstrated that cornsilk has the highest content of total phenolics and flavonoids, as well as significant antioxidant activities (Liu et al., 2011). Moreover, total phenolics and total flavonoids are found to be higher at the upper parts of cornsilk than lower parts (Alam, 2011). Free radicals have been claimed to affect human health by causing diseases such as cancer, hypertension, heart attack and diabetes (Prasad et al., 2009). Therefore it can be assumed that dietary intake rich in antioxidants able to reduce the risk of many health related disease mainly triggered by free radicals.

Recently, interest in discovering antioxidants derived from plant sources has grown in order to replace artificial antioxidants because it seems like natural antioxidants are safer and more desirable than their synthetic counterparts because they occur in plant food. Furthermore, data from scientific reports and laboratory studies also indicate plants contributes large variety of phytochemicals that possess antioxidant activities (Chanwitheesuk et al., 2005).

2.3 The Use of Natural Plant Sources

According to World Health Organization (WHO), herbal medicines is a part of traditional medicine where they consists of herbs, herbal materials, herbal preparations and finished herbal products, that contain active ingredients parts of plants, or other plant materials, or combinations thereof.

Medicinal plants have become mainstreams globally in the latter part of the 20th century. This is because the importance of traditional and indigenous remedies, and the integration of derivatives from natural sources in pharmaceutical products have been widely accepted by the societies (De Smet, 1997; Dukes, 1992; Winslow and Kroll, 1998; Alsarhan et al., 2014). Besides, there are demands from consumer for healthier foods with functional properties, as well as the presence of strong evidence of possible toxicity in the synthetic additives have shifted the research interest in the extraction of bioactive compounds from plants sources (Maran et al., 2013).

Approximately 80% of the world's population depends exclusively on plants for their health and healing. Reliance on surgery and pharmaceutical medicine is more usual in the developed world, but there is an increment of people who are complementing their treatment with natural supplements (Esiyok et al., 2004). It is usually the "extracts" not the plants themselves or their parts such as fruits, seeds leaves etc; that are used for treatments. However, medicinal plants possess what is referred to as pathological niche and they assume pathogenomic structure, meaning that medicinal herbs can be applied for different ailments with respect to its on human physiology (Nwachukwu et al., 2010).

2.4 Health and Therapeutic Effect of Cornsilk

In China, cornsilk is recognized as popular traditional herb drug (Liu et al., 2011) and has been used for herb treatment of hypertension, tumor, hyperglycemia, hepatitis, cystitis, gout, kidney stones, diabetes nephritis and prostatitis in many parts of the world (Velazquez et al., 2005; Li and Yu, 2009; Hu et al., 2010; Hu and Deng, 2011). It has long been reported in ancient literatures that cornsilk able to assist with prostate problems, bed-wetting, carpel tunnel syndrome, edema and obesity. Similarly, cornsilk has also been used to reduce the effects of premenstrual syndrome, and said to promote relaxation. Plus, cornsilk was also reported to be useful to treat urinary infections and cystitis. It also found to be helpful for frequent urination caused by irritation of the bladder and urethral walls including difficulty in passing urine, such as prostate disorders. Furthermore, cornsilk able to relaxes the lining of the urinary tubules and bladder, thus soothing irritation and improving urine excretion (Steenkamp, 2003; Alam, 2011).

Scientifically, cornsilk has been reported for able to reduce hyperglycemia by increasing the insulin level and recovering the beta-cells (Guo et al., 2009). In another study, it was found that cornsilk polysaccharides were found to exhibit an anti-diabetic effect on streptozotocin (STZ)-induced diabetic rats. The results demonstrated that daily treatment with 100–500 mg/kg body weight of the polysaccharides on the diabetic rats could lead to a significant decrease on the animal's blood glucose level, reduce the serum lipid level including total cholesterol and total triglyceride after determination (Zhao et al., 2012).

Furthermore, the diuretic action of cornsilk have been proven in many studies and found to be important especially for health applications. In one study, different doses of cornsilk aqueous extract (25, 50, 200, 350, and 500 mg/kg body) were administered to conscious rats, with ad libitum access to food and water prior to the experiment. The urine volume, sodium (Na^+), potassium (K^+) and uric acid excretions, glomerular and proximal tubular function, as well as sodium (Na^+) tubular handling, were then measured. Chemical compounds and the acute toxicity of cornsilk extract were also evaluated. The result found that in 2.5 ml/100 g body wt. water-loaded conscious rats, cornsilk aqueous extract is diuretic at 500 mg/kg body wt. and is kaliuretic at 350 and 500 mg/kg body wt. Meanwhile in 5.0 ml/100 g body wt. water-loaded conscious rats, cornsilk aqueous extract is kaliuretic at 500 mg/kg body wt., but glomerular function and, consequently, the filtered load decrease, without affecting proximal tubular function, or Na^+ and uric acid excretions. The results obtained supports the traditional use of cornsilk for its diuretic effect. The kaliuresis is possibly due to the amount of K^+ present in the extract. The glomerular function decrement could be attributed to a reducing effect of the area of filtration or to the effective filtration pressure mediated, respectively, by glomerular mesangial cells or a change of tonus of the glomerular afferent and efferent arterioles (Velazquez et al., 2005).

Another study found that cornsilk unable to act as decompose for kidney stones in contrast with Alkalinizeragent (uralyte), but able to increase urinary output and increase the percentage passage of urinary stones through the urinary tracts without decomposing the stones. It also plays an important physical role in the treatment by increasing the contraction of smooth muscles which led to increment of urinary output (Shamkhy et al., 2012). Besides, application of cornsilk extract is found to be effective in reducing skin pigmentation on faces with hyperpigmentation, without leaving any abnormal reactions (Choi et al., 2014).

2.5 Product Development from Cornsilk

Currently, products from cornsilk such as tea, powder, and cosmetics are commercially available in China, Korea, Japan, USA and UK (Sarepoua et al., 2013). A pharmaceutical company in Korea named Kwang Dong Pharmaceutical has developed a beverage product made from cornsilk called Corn Silk Tea which become popular among worldwide consumers. It was reported the sales of the beverage increased from 45 billion won ($40 million) in 2006 to 52.4 billion won in 2011 as more people recognize its health benefits. The product also receive high demands from other country like United States, China, Japan and Taiwan. However, Kwang Dong emphasized that the product is not for medicinal use, and mentioned consumer should not assume the drink for the purpose to improve their health although studies have shown that cornsilk is widely used in traditional Korean medicine (Whan-woo, 2012).

In another study, cornsilk have been utilized and incorporated into both beef patties and chicken patties. Addition of cornsilk resulted in increasing of protein, cooking yield, moisture and fat retention but decreasing fat content. Moreover, the sensory quality of beef and chicken patties able to be maintained so that they are acceptable to consumers as normal patties (Wan Rosli et al., 2010). Still, there are lack of study of product made from cornsilk especially beverages can be found in the literature.

2.6 Development of Functional Food and Beverages

There are several reasons that leads to the diffusion of functional foods in daily life, such as health deterioration due to busy lifestyles; low consumption of convenience foods and lack of exercise; increased incidence of self-medication; increased awareness of link between diet and health due to information received from health authorities and media on nutrition; and a crowded and competitive food market (Siró et al., 2008; Granato et al., 2010). However various stakeholders have recognized the potentiality of functional foods as one of the public health strategies (Corbo et al., 2014) and extensive consumption of functional foods has shown 20% of annual reduction in health care (Holub, as cited in Sun-Waterhouse, 2011).

Besides foods, beverages are also important part of humans' daily diet which are consumed regularly around the world. They are well known mostly due to variety of pleasant taste and sensation, such as sweet, cool or refreshing. Besides, beverages are also consumed for health reasons, for example for the vitamin supplementation, as in fruit juices, or the intake of minerals and trace elements, especially in mineral water (Zbakh and El Abbassi, 2012).

The term functional drinks are drinks that offer consumers additional perceived benefits besides its primary function, which is for hydration. The benefits are usually directed towards some aspect of maintaining good health or coping with the pressures of modern lifestyles. Functional drinks can be produced using wide range of functional ingredients including herbal extracts (Koushe, 2009). The worldwide nutritional health products (NHPs) market, which includes organic food, nutraceuticals, functional food and dietary supplements, shows increasing speed of growing market (Rakić et al., 2006). There are also rising of consumers' confidence and attitudes towards herbal supplements thus indicating a significant growth demand (Molyneaux, 2002; Rakić et al., 2006).

It has been found that natural ingredients with strong antioxidant activity able to produce unique functional beverages (Sun-Waterhouse, 2011; Corbo et al., 2014). A possible approach relies upon the fortification with polyphenols due to increasing interest about their beneficial role against certain cancers, cardiovascular diseases, type 2 diabetes, obesity, and age-related macular degeneration (Servili et al., 2011; Törrönen et al., 2012; Corbo et al., 2014). For example, feverfew (*Tanacetum parthenium*), a kind of medicinal herb, has been reported to be source of nutraceuticals in the development of a functional beverage with anti-inflammatory properties (Marete et al., 2011).

2.7 Plant By-Products as Functional Food Ingredients

In recent days, efforts have been made to transform natural wastes into products of commercial utility as they are very rich in bioactive compounds such as vitamins, minerals, amino acids, polyphenols, etc. Among these bioactive compounds, some essential mineral elements play an important role as cofactors in many enzymatic processes involved in humans, plants, animals and soil microbes. Mineral and polyphenol-rich plant materials are of interest to the cosmetic, nutraceutical, remedial and food industries (Kuppusamy et al., 2015; Kuppusamy et al., 2016).

The use of by-products as a source of active ingredients to produce functional beverages something that has been looking forward to in the future. The treatment, minimization, and prevention of environmental effects induced by the disposal of the food processing wastes have been considered for such a long time (Galanakis, 2012). As reported by the Food and Agriculture Organization, roughly one-third of the edible parts of food produced for human consumption being discarded globally. This amount accounts about 1.3 billion ton/year and reflects not only the food processing wastes, but also the "food losses" (Gustavsson et al., 2011; Galanakis, 2012).

Food wastes are composed of complex ingredients, which have been eliminated from the original material (Galanakis, 2012). For example, processing of potatoes is conducted mainly to produce chips or French fries and their corresponding solid wastes consist of peels or cull potatoes (Schieber et al., 2001; Galanakis, 2012). However, the potato peels and processing wastewater have been thoroughly investigated for the extraction of phenols (Oreopoulou and Tzia, 2007; Galanakis, 2012).

Meanwhile a study found out that the plum skins which are the waste products during production of plum juice or plum pulp contains large amounts of polyphenols, which could be recovered for the production of beverages with enhanced polyphenol content and antioxidant capacity. In an industrial setting, the plum skin extract could be concentrated or dried to provide a functional ingredient, such as plum nectars but as well as other functional beverages such as fruit juice-based beverages and flavoured iced teas (de Beer et al., 2012; Corbo et al., 2014). However, increase of astringency or bitter taste are known as the drawback which could affect acceptability of the beverages. One of the solution is to add sweet substances and salts, in order to reduce bitterness perception and also to change sensory profile and the nutritional value (Kranz et al., 2010).

On the other hand, a study by Dominguez-Perles et al., (2011) suggested broccoli by-products consisting of leaves and stalks, are rich in bioactive compounds, including nitrogen–sulphur compounds (glucosinolates and isothiocyanates) and phenolics (chlorogenic and sinapic acid derivatives, and flavonoids), as well as essential nutrients (minerals and vitamins). They found that green tea enriched with broccoli by-products showed improved quality, phytochemical composition and antioxidant capacity. These functional ingredients able to create novel health promoting beverages, thus adding value to food products and reducing agricultural wastes.

Meanwhile, Pomegranate seeds are known as the by-product of juice and concentrate manufacture. They contain valuable pharmaceutical and nutritional compounds such as unsaturated fatty acids and phenolic compounds with antioxidant properties. Thus the seeds can be utilize by extracting the oil which are useful for food applications (especially in juice and beverage industries) as a functional agent. Therefore, it is a very beneficial applications in the functional beverage industry, apart of their uses as animal feed or in commercial cosmetic products. (Mohagheghi et al., 2011).

2.8 Thermal Treatments of Cornsilk

A study indicates that physicochemical and nutritional qualities of vegetables are deeply modified by domestic cooking and that modifications of the evaluated parameters are also strongly dependent upon the vegetable species (Miglio et al., 2007). Two types of thermal treatments will be carried out in this study prior to the development of cornsilk beverages. The first one is blanching. Blanching is commonly used in food processing to inactivate enzymes and destroy microorganisms. It is a process of exposing vegetables or fruits to high temperatures for a short period (Nurhuda et al., 2013).

Blanching is a unit operation prior to freezing, canning, or drying in which fruits or vegetables are heated in order to inactivate the enzymes; modify the texture; preserving colour, flavour, and nutritional value; as well as to remove trapped air. Types of blanching includes water blanching, steam blanching, microwave blanching and gas blanching. Food quality is greatly affected by the type and extent of blanching. Generally, blanching process decreases the nutritional value of foods, and nutrients will leach out from the product, especially during water blanching. Besides, blanching can indirectly and directly give effects to the flavour of many products by inactivate the enzymes that responsible to produce off-flavour. The blanching process will also increases flavour retention, and sometimes able to remove undesirable bitter flavours from the product. The colour of the product also will be directly and indirectly affected for example through the destruction of pigments, such as chlorophyll, by the heat. Furthermore, blanching also can result in undesirable softening of vegetable tissues (De Corcuera et al., 2004).

A study was carried out to determine the effect of water and steam blanching on browning enzymes and antioxidant activities of rambutan peel extracts and the results demonstrated both blanching methods showed gradual decrease in peroxide and polyphenol oxidase activities with increasing blanching period up to 5 minutes. Besides, both water and steam blanching period up to 5 and 15 minutes did not give effect to the antioxidant activity and the total phenol content. There are also an increment of total of anthocyanin in the rambutan peel extracts when it was blanched for 2.5 minutes but decreased after 5 minutes for both water and steam blanching. However, loss of colour was observed for both water and steam blanching (Nurhuda et al., 2013).

The next thermal treatment is by steaming. Steaming process is generated when food is heated with direct contact with the steam of boiling water. This process allow retention of food texture, colour, taste and nutrients, and cooked vegetables are at their best when steamed (Brown, 2011).

Steaming has been reported to better retain the glucosinolates content in *Brassica* vegetables than boiling and blanching. Boiled or steamed cool season food legumes still contained substantial amounts of antioxidants, and through steaming process, only smaller losses of total phenolic content, antioxidant activities and solid mass occurred compared to boiling processes (Xu and Chang, 2008).

Afek et al. (1999) stated that steam treatment able to reduce decaying of carrot during storage. Similarly in India, steaming was found to reduce spoilage in sugar cane (Singh et al., 1987). Moreover, the ability of steaming process in raising the levels of ascorbic acid and vitamins in broccoli was also identified (Petersen, 1993), as well as in changing the evaporation levels in mandarin oranges (Lin et al., 1992).

Meanwhile, Afek and Orenstein (2002) suggested that using steam as an alternative treatment against pathogens in tubers is efficacious, environmentally friendly, easy to implement, and inexpensive. Additionally, the results of their study identified steam may have wider application for general postharvest treatment against many other pathogens in fruit and vegetable crops.

In the present study, the fresh cornsilk will undergo either steaming or blanching treatments prior to determine whether these treatments able to give palatial effects to the taste, mineral contents as well as physicochemical qualities of the beverages.

CHAPTER 3: MATERIALS AND METHODS

3.1 Sample

Fresh cornsilk (*Maydis stigma*) of young corns were obtained from a supplier of Siti Khadijah Wet Market, Kota Bharu district of Kelantan state of Peninsular Malaysia. The young corns were brought to the Nutrition Preparation Laboratory, School of Health Sciences, Universiti Sains Malaysia for further processing. The silks of the young corns were detached from it cob, washed with filtered water and drained.

3.2 Sample Preparation

3.2.1 Treatments of Cornsilk

Two hundreds grams of cornsilk was introduced into two types of thermal treatments, and one without treatment. The thermal treatments involved required different temperature and time parameters as shown below:

Steaming. The samples were steamed above 100°C of distilled water for 5 minutes, and cooled immediately.

Blanching. The samples were immersed in 93°C of boiling distilled water for 2 minutes, cooled immediately in ice water, and drained (Talburt and Kueneman, 1987; Maté et al., 1998).

Control. The samples were left untreated.

3.2.2 Drying of Fresh Cornsilk after Thermal Treatments

The treated and untreated samples of cornsilk were oven dried at 55°C overnight to remove all moisture retained and until obtaining brownish colour of threads. The dried cornsilk were labelled with dried steamed cornsilk (DSC), dried blanched cornsilk (DBC), and dried untreated cornsilk (DUC).

3.2.3 Grinding of Dried Cornsilk

The brownish dried cornsilk (DSC, DBC, and DUC) were ground into powder form by using Food Grinder (Panasonic MX-337), weighed and kept into three different screw cap duran bottles to prevent absorption of moisture. Three different screw cap duran bottles represents three different treatments of cornsilk. They were labelled with steamed cornsilk powder (SCP), blanched cornsilk powder (BCP), and untreated cornsilk powder (UCP) on each bottles.

3.2.4 Preparation of Cornsilk Beverages

The procedure to develop beverage from cornsilk extract is a modification from processing technique of juices from Malaysian Agricultural Research and Development Institute (MARDI).

The ingredients used to prepare cornsilk beverage consisted of cornsilk powder from each thermal treatments (SCP, BCP and UCP), brown sugar, lemon juice, and filtered water. Brown sugar was used to standardize the colour of the beverage while lemon juice functions to keep extract in acidic condition to preserve or reduce degradation of bioactive compound and antioxidant component. The quantity of cornsilk powder used was constant (5 g) during the whole preparation.

The procedure began by boiling the filtered water. While waiting for the water to boil, the ingredients to formulate the beverage were prepared. 5 g of cornsilk powder from each different thermal treatments were added into three different glasses. Next, 16 g of brown sugar and 2 ml of lime extract were added. 16 g of brown sugar was used after several Brix test were done onto the beverage. Next, the boiled filtered water was poured into each glasses and mixed with the ingredients. The infusion technique was used whereby the boiled water was added into the ingredients, instead of boiling altogether the ingredients with the water. The mixture were stirred for 3 minutes to ensure the ingredients mix well. Aluminium foil was used to wrap the glass and the beverages were left for 30 minutes to allow the cornsilk powder to be fully extracted in the water. After 30 minutes, cloth coffee strainer was used to separate the residue from its extract. The beverages were filtered into three different thermos to keep them warm. At the end, there were 3 types of cornsilk beverages named, steamed cornsilk beverage (SCB), blanched cornsilk beverage (BCB), and untreated cornsilk beverage (UCB). All cornsilk beverages were then packed in glass bottles and aseptically capped. All these beverages were evaluated for their mineral contents, psychochemical properties and sensory acceptance.

3.3 Morphological Characterization of Cornsilk using Scanning Electron Microscope (SEM)

All cornsilk samples were analyzed using Scanning Electron Microscope (SEM) at two situations. SEM is an ideal technique for examining plant surfaces at high resolution. Plant tissues must be preserved by dehydration for observation in an electron microscope because the coating system and the microscopes operate under high vacuum and most specimens cannot withstand water removal by the vacuum system without distortion (Holloway and Baker, 1974 as cited by Pathan et al., 2010). The samples were coated with a thin-layer of gold in a vacuum evaporator (Baltex SCD005 Sputter Coater, Hi-Tech Germany) before their structure and morphology were observed using FEI Quanta 450 Scanning Electron Microscope under 6.0 Pascal pressure, by using the secondary electron mode at 4 different working distances. The microstructures of the cornsilk were noted and discussed.

Table 1: Types of fresh and dried cornsilk sent for morphological characterization using SEM

Fresh Cornsilk	Dried Cornsilk
fresh steamed cornsilk (FSC)	dried steamed cornsilk (DSC)
fresh blanched cornsilk (FBC)	dried blanched cornsilk (DBC)
fresh untreated cornsilk (FUC)	dried untreated cornsilk (DUC)

3.4 Determination of Mineral Composition by using ICP-MS

All 3 types of cornsilk powder and beverages were sent to the Advanced Analytical Laboratory of Universiti Sains Malaysia for determination of mineral contents through Inductive Coupled Plasma Mass Spectrometer (ICP-MS).

Table 2: Type of cornsilk samples sent for mineral composition determination using ICP-MS

Powder	Solution
steamed cornsilk powder (SCP)	steamed cornsilk beverage (SCB)
blanched cornsilk powder (BCP)	blanched cornsilk beverage (BCB)
untreated cornsilk powder (UCP)	untreated cornsilk beverage (UCB)

All samples were digested using microwave digester (Multiwave 3000, Anton Paar model). All powder samples were diluted with 50ml deionised water before added with reagents Nitric acid, HNO_3 (4 ml), Hydrochloric acid, HCl (1 ml) and Hydrogen peroxide, H_2O_2 (1 ml). Meanwhile for cornsilk beverages, they were acidified with trace metal grade HNO_3 until pH value achieved below 2 before proceed with the process.

All minerals were measured by using ICP-MS. For solution samples, they were vaporized using a nebulizer. The samples were introduced into high-energy argon plasma that consists of electrons and positively charged argon ions. In the plasma, the material was split into individual atoms. These atoms will lose electrons and become (singly) charged positive ions. Most elements ionize very efficiently (> 90%) in the hot plasma (Philips Innovation Services, 2013).

3.5 Determination of Physicochemical Properties of Cornsilk Beverages

All cornsilk beverages were tested for their physicochemical properties mainly, total soluble solids, titratable acidity, and pH.

Total soluble solids (TSS) were measured with a pocket food digital refractometer (PAL-BX/RI, Atago, Japan) with values being expressed as °Brix. The titratable acidity (TA) were determined by titrating 10 ml of each cornsilk beverage samples with 0.1 M NaOH. Results were expressed as tartaric acid (g/100 ml) sample. Finally, the pH of each cornsilk beverage samples were measured using a pH meter.

3.6 Sensory Evaluation of Cornsilk Beverages

About 59 untrained panels among students and staffs from School of Health Sciences, Universiti Sains Malaysia Health Campus were recruited for the sensory evaluation test. Each panels received 3 samples of cornsilk beverages UCB, SCB, and BCB. All samples were kept in the thermos prior to evaluation session. Small clear plastic cup were used and approximately 30 ml of each samples were poured into the cup for sensory evaluation. Random sampling were performed, whereby three-digit random permutated numbers method was used for product coding.

The parameters tested were colour, aroma, taste, flavour, aftertaste-feeling, and overall. The panels rated the degree of their preferences using seven-point hedonic scale (1= dislike the most, 4 = moderate, 7 = like the most). All panels were required to evaluate the samples in the Food Preparation Laboratory as the testing area. Every panels were provided with drinking water for them to rinse their mouths between each samples to minimize any residual effects.