DETERMINATION OF PERCENTAGE LOSS OF VITAMIN C IN SOME LEAFY VEGETABLES AT DIFFERENT BLANCHING CONDITIONS

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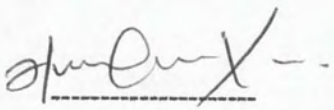

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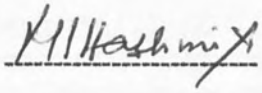
   (DR. MUHAMMAD IQBAL HASHMI) 

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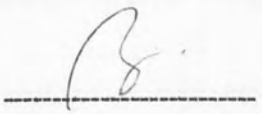
   (DR. LEE JAU SHYA) 

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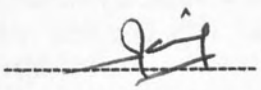
   (ASSOC. PROF. DR. MOHD. ISMAIL ABDULLAH) 

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ABSTRAK

PENENTUAN PERATUSAN KEHILANGAN VITAMIN C DALAM SESETENGAH SAYUR-SAYURAN PADA KEADAAN PENCELURAN YANG BERLAINAN

Kajian ini dijalani bagi menentukan peratus (%) kehilangan vitamin C dalam sayuran berdaun hijau akibat daripada kesan masa (2, 4, 6, 8, 10 and 15 minit) dan rupa fizikal (seluruh atau potong). Empat jenis sayuran, bayam putih (*Amaranthus oleraceus* L.), Sawi bunga (*Brassica chinensis* var. parachinensis), Sawi putih (*Brassica chinensis* L.) dan Sawi pahit (*Brassica juncea* (L.) Czern and Cosson), dipilih dari kedai Taman Kingfisher, Kota Kinabalu dan dicelur mengikut masa dan rupa fizikal tertentu. Kandungan vitamin C dalam sayuran segar dan peratus kehilangan akibat daripada penceluran ditentukan mengikut kaedah penitratan indophenol. Keputusan kajian ini menyatakan bahawa kesemua sayuran yang dikaji mengandungi kadungan vitamin C yang berlainan dan kehilangannya bergantung kepada jenis sayur yang dikaji dan keadaan penceluran. Penceluran menyebabkan penurunan yang signifikan ($p<0.05$) dalam kandungan vitamin C [Segar (45.4-68.3 g/100g), dicelur (26.5-75.9 g/100g)] dalam sayur-sayuran itu. Peratus kehilangan vitamin C dalam sayuran akibat daripada penceluran adalah dalam susunan berikut: Sawi bunga>Sawi putih>bayam putih>Sawi pahit. Keadaan ini disebabkan Sawi bunga mempunyai daun yang lebih luas dan nisbah luas permukaan kepada isipadu yang tinggi. Kesan masa penceluran terhadap peratus kehilangan vitamin C adalah signifikan ($p<0.05$), di mana terdapat perbezaan yang signifikan ($p<0.05$) diantara masa penceluran 2, 4, 6, 8, 10 dan 15 minit, seluruh atau potong, kecuali pada minit ke-6 dan 8 bagi kedua-dua Sawi bunga dan Sawi putih. Peratus kehilangan vitamin C bagi kesemua jenis sayuran adalah di dalam susunan 15 minit > 10 minit > 8 minit > 6 minit > 4 minit > 2 minit. Kesan rupa fizikal terhadap peratus kehilangan vitamin C dalam sayuran juga signifikan ($p<0.05$), di mana sayuran yang telah dipotong kehilangan vitamin C yang lebih banyak berbanding yang seluruh. Daripada kajian ini, boleh disimpulkan bahawa penceluran mengurangkan kandungan antioksida dengan banyak walaupun ia menjadikan sayuran lebih sedap untuk dimakan. Maka, dengan itu, adalah dinasihatkan bahawa penceluran harus dilakukan dengan masa singkat dan dalam bentuk seluruh bagi mengurangkan kehilangan vitamin C.

ABSTRACT

DETERMINATION OF PERCENTAGE LOSS OF VITAMIN C IN SOME LEAFY VEGETABLES AT DIFFERENT BLANCHING CONDITIONS

This study was aimed to determine the percentage (%) loss of vitamin C in green leafy vegetables due to the effects of different blanching times (2, 4, 6, 8, 10 and 15 minutes) and physical form (intact and cut). Four types of leafy vegetable, namely Chinese spinach (Amaranthus oleraceus L.), Chinese mustard (Brassica chinensis var. parachinensis), Chinese white cabbage (Brassica chinensis L.) and Indian mustard (Brassica juncea (L.) Czern and Cosson), were selected from the main markets in Taman Kingfisher, Kota Kinabalu and blanched in boiling water at different time and physical form. The vitamin C content of the fresh vegetables and the loss of vitamin (%) in blanched vegetables were subsequently determined by indophenol titration method. The results of the study revealed that all the studied vegetable species possess different vitamin C content and its loss depends on the type of vegetables and blanching conditions. Blanching cause a significant ($p<0.05$) decrease in the vitamin C content [fresh (45.4-68.3 g/100g), blanched (26.5-75.9 g/100g)] content of the green leafy vegetables. The percentage of vitamin C loss in vegetables due to blanching was in the order of Chinese mustard>Chinese white cabbage>Chinese spinach>Indian mustard. This is because Chinese mustard has broader leaves and higher surface to volume ratio. The effect of different blanching times on vitamin C loss was significant ($p<0.05$), in which there were always a significant ($p<0.05$) differences in vitamin C loss at different blanching times of 2, 4, 6, 8, 10 and 15, intact and cut, except for 6 and 8 minutes in both Chinese mustard and Chinese white cabbage. The % vitamin C loss of all the studied vegetables, due to blanching, is in the order of 15 minutes > 10 minutes > 8 minutes > 6 minutes > 4 minutes > 2 minutes. The effect of the vegetable's physical form on vitamin C loss was also significant ($p<0.05$), in which cut leaves were found to loose more vitamin C than intact ones. In view of this it could be concluded that blanching of vegetables though makes green leafy vegetables more palatable, however it reduces their antioxidant properties drastically. Therefore, it is advised that blanching vegetables at shorter time in an intact form may reduce the loss of vitamin C.

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LIST OF ABBREVIATIONS

g	Gram
kg	Kilogram
mg	Miligram
mL	Milliliter
et al	et alia (and other)
%	Percent
ANOVA	Analysis of Variance
RNI	Reference Nutrient Intakes
°C	Celsius
>	More than
<	Less than
/	Per
AA	Ascorbic acid
NO_3	Nitrate

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CHAPTER 1

INTRODUCTION

This study focuses on the effect of different blanching times and the vegetable's physical form on the extent of vitamin C loss. Four vegetables, namely Chinese spinach, Chinese mustard, Chinese white cabbage and Indian mustard were purchased from two main markets in Taman Kingfisher, Kota Kinabalu and determined their vitamin content and its percentage of loss using the indophenol titration method (AOAC, 2000), in which it is based on the reduction of 2,6-dichlorophenol-indophenol with ascorbic acid in acidic solution. This method was chosen over HPLC method because it has simple procedures and is used in many of the past studies.

1.1. Vegetables, vitamin C and its relation to health

Vegetables and fruits are known as a good source of vitamins, minerals and other natural antioxidants such as carotenoids, flavonoids and phenolic compounds (Minussi *et al.*, 2003; Zhang & Hamauzu, 2004; Podsedek, 2005). More than 85% of vitamin C in human diets is supplied by fruits and vegetables (Davey *et al.*, 2000; Lee & Kader, 2000). Therefore, a diet rich in vegetables (more than 5 servings per day) is recommended along with fruits and whole grain (Amin & Cheah, 2003). Leafy vegetables in particular are a rich source of beta-carotene, ascorbic acid, minerals and fibers (Negi & Roy, 2001) meanwhile, dark green leaves constitute a food source for vitamin C and A (Grosvenor & Smolin, 2002), iron and calcium, than lighter

greens. Besides of their low calorie, their high fiber content provides good roughage for our digestive system. Leafy vegetables are abundant in the tropics and can be eaten raw as salads, or "ulam", as they are known to Malaysians (Yap, 1999).

Locally known Chinese spinach or "bayam hijau" (*Amaranthus oleraceus* L.), Indian mustard or "sawi pahit"/ "kai choi" (*Brassica juncea* (L.) Czern and Cosson), Chinese white cabbage or "sawi putih"/ "pak choi" (*Brassica chinensis* L.) and Chinese mustard or "sawi bunga"/ "choi sam" (*Brassica chinensis* var. parachinensis) are abundantly available in the market, and commonly consumed by urban or rural Malaysians (Amin, Norazaidah & Emmy Hainida, 2006). Some of them are sometimes known as different names (Biggs, McVicar & Flowerdew, 2003). According to the data found in NutriWeb Malaysia (Nutrition Society of Malaysia, 2001) and many other journals (Amin & Cheah, 2003; Negi & Roy, 2000), their contents of vitamin C are rated as one of the highest among other potential sources.

In recent years, increasing attention has been paid to the role of diet in human health. Several epidemiological studies have indicated that a high intake of plant products is associated with a reduced risk of a number of chronic diseases, such as atherosclerosis, cancer (Gundgaard *et al.*, 2003; Kris-Etherton *et al.*, 2002; Temple, 2000), cerebrovascular diseases (Dragsted, Strube & Larsen, 1993; Liu *et al.*, 2000; Martin *et al.*, 2002), cardiovascular disease, cataract and macular degeneration (Hunter & Fletcher, 2002; Zhang & Hamauzu, 2004). Yet, Block *et al.* (2004) have found that vitamin C can reduce levels of C-reactive protein (CRP), a marker of inflammation and possibly a predictor of heart disease. These beneficial effects have been partly attributed to the compounds which possess antioxidant activity (Podsedek, 2005), in which, vegetable has been reported to have a high concentration of antioxidant components (Hunter & Fletcher, 2002), and one of these is vitamin C. Due to the detection of many bioactive compounds in food with possible

antioxidant activity, there has been increased interest in the relationship between antioxidant and disease risks (Nilsson, Stegmark & Akesson, 2004).

Vitamin C is an organic micro-nutrient that occurs naturally in foods such as citrus fruits and dark green leafy vegetables are essentials in maintaining the health of the body (Grosvenor & Smolin., 2002). It is water soluble and two forms of it have biological activity: the ascorbic acid and its oxidized derivative, dehydroascorbic acid. One interesting fact is it is essential as a vitamin for only a few animal species; most members of the animal kingdom can synthesize vitamin C from glucose and have no dietary requirement for it. The exceptions are the primates, including humans (Barasi, 2003).

Vitamin C is required for the prevention of scurvy and maintenance of healthy skin, gums and blood vessels also known to have many biological functions in collagen formation, absorption of inorganic iron, reduction of plasma cholesterol level, inhibition of nitrosoamine formation, enhancement of the immune system, and serves as an antioxidant for reaction with singlet oxygen and other free radicals. However, vitamin C is known to be very fragile, it is sensitive to light, transition of metals (Ryley & Kadja, 1994), degree of heating, leaching into the cooking medium, surface area exposed to water and oxygen, pH (Eitenmiller & Landen, 1999) and vulnerable to chemical and enzymic oxidation (Bernhardt & Schlich, 2005). In cooking, the loss in vitamin C content could also be attributed to the fact that vitamin C is very soluble in water (leaching) and not stable at high temperature (Liu *et al.*, 2002). For this reason it is often used to evaluate the influences of food processing on vitamin contents (Bernhardt & Schlich, 2005) and marker for monitoring quality change during transportation, processing, and storage (Favell, 1998).

1.2. Cooking vegetables and vitamin retention

Fresh vegetables have a short durability, and are exposed to conditions that destroy their superior quality and nutrition loss in a short period of time, before cooking and consumption (Fafunso & Bassir, 1976). They are sensitive towards heat, light, oxygen and processing methods: washing, blanching and cooking. In operations such as cutting and slicing, it may induce a rapid enzymatic depletion of several naturally occurring antioxidants as a result of cellular disruption which allows contacts of substrates and enzymes (Podsedek, 2005).

In Malaysia, green leafy vegetables are not usually consumed in their fresh form unlike fruits. Even though some of the vegetables are used in raw form as salad, but most of them require cooking. In fact, most Malaysians do cook their greens prior to eating (Amin, Norazaidah & Emmy Hainida, 2006). Cooking, in this manner, can bring about a change in flavour, texture and colour of vegetables; improve palatability and digestibility of some vegetables; and destroy microorganisms contained in food (Glsslen, 1999). Common vegetable-cooking methods may include, yet not restricted to boiling, baking, steaming, stir-frying, and microwave-ing. The selection of the desirable cooking method is mostly influenced by the type of vegetable, desire for variety and nutrient retention (Drummond & Brefere, 2004). In practice, it is cooked with water, boiling or blanching for instance (Amin, Norazaidah & Emmy Hainida, 2006). Though, green leafy vegetables are always associated with stir-frying and blanching (Halimathul Saadiah, 1998; Hamidah & Roselan, 1996).

However, cooking, the last transformation of foodstuffs before eating, involves a significant destruction of nutrients and therefore a decrease of the nutritional quality. Thus, losses of antioxidant components from vegetables during cooking have been widely reported (Chu, Chang & Hsu, 2000; Yadav & Sehgal, 1995). Domestic

cooking, cooking in excess of 60°C, is expected to affect the content, composition, antioxidant activity and bioavailability of antioxidants, accelerating or promoting loss of vitamins. Generally, the antioxidant concentrations and activities in processed vegetables were lower than those of the corresponding raw samples, which were caused by their degradation, but also by absorption of water during boiling, which diluted the compounds and decreased their content per weight unit (Podsedek, 2005). Moreover, the loss depends on the nature of the foodstuff and on the cooking conditions, for instance, methods, temperature and duration of cooking employed. Some of the important nutrients such as ascorbic acid which is susceptible to oxidation are readily oxidized by brisk cooking (Shahnaz *et al.*, 2003).

However, the lack of data on cooked foods and food composition data, necessary for epidemiological and nutritional studies is merely representative of foodstuffs consumed in the raw state. Many food composition databases never take into consideration the fact that concentrations of nutrients and their activity may change through cooking practices such as boiling and blanching. This is of great importance, considering that only a small amount of vegetables is consumed in the raw state, whilst most need to be processed for safety and quality (Amin, Norazaidah & Emmy Hainida, 2006).

1.3. Objective:

1. To determine the vitamin C content and its percentage loss in intact and cut Indian mustard (*Brassica juncea* (L) Czern and Cosson, Chinese white cabbage (*Brassica chinensis* L.), Chinese mustard (*Brassica chinensis* var. parachinensis) and Chinese spinach (*Amaranthus oleraceus* L.) at different blanching times.

2. To assess the effect of different physical form (intact and cut) on the vitamin C loss for the above four vegetables.

1.4. Justification of the study:

The determination of the vitamin C in our diet (vegetables) is now an important art of nutritional studies as described earlier. This is to assess adequacy of vitamin C content for four varieties of green leafy vegetables and their % loss due to blanching, since the topic is at present unsatisfactory. The existing compilations have only limited use mainly because not much of the data represented the cooked vegetables. A systematically designed effort to obtain the latest data on vitamin C content of vegetables and its %of loss due to different blanching conditions is a basic need for the future application of the growing knowledge of nutrition and human health, as many tend to overcook vegetables, causing it to loose appreciable amounts of nutrients through either heat or leaching.

1.5. Significance of the study:

Data derived from the study will help the community to decide on the best cooking conditions in order to retain the maximum amount of vitamin C. There is a need to obtain up-to-date and accurate data on the vitamin C content for fresh vegetables and the percentage of loss for the blanched counterparts, thus the figures could contribute effectively to the improvement of vitamin C retention through better assessment and planning. Past studies and growing body of knowledge on vitamin C suggest that proper blanching conditions should be opted in order to minimize the loss of vitamin C through blanching. These informations are important in order to make known to the public about the effect of blanching time and vegetable's physical form on vitamin C retention.

CHAPTER 2

LITERATURE REVIEW

2.1. Leafy vegetables

Sabah has been endowed with vast amount of natural resources including luxuriant tropical forest, which is one of the most diverse and complex ecosystems in the world. There are lots of important tropical vegetables that are cultivated in different regions of Sabah. These areas include: Kota Marudu, Kota Belud, Tuaran, Kota Kinabalu, Papar, Beufort, and their adjoining areas like Kundasang, Ranau, Keningau, and Tenom (Department of Agriculture Sabah, 2004). The loose definition for the plant species that are classified as vegetables is, the edible plant parts of a plant (Yap, 1999) or a plant or a plant part used as food (Soanes & Hawker, 2005) or those plants where a part, for instance, leaf, stem or root, can be used for food (Biggs, McVicar & Flowerdew, 2003). Other parts of a plant, such as seeds, fruits, flowers, buds, leaves, stems and roots or tubers, may be consumed as a vegetable (Yap, 1999). Meanwhile, leaf is described as a flattened, typically green, structure of a plant which is attached to a stem and is the chief site of photosynthesis and transpiration (Soanes & Hawker, 2005).

There are over a quarter million plant species in the world, but less than 300 are commercially cultivated as food crops and about 100 species are generally considered as vegetables, although many other wild species are considered edible. Vegetable plants are grown, either commercially or home-grown, for their leaves,

flowers, roots or fruits. Vegetables are cultivated successfully both in the lowlands and highlands of Malaysia (Yap, 1999). The vegetables production in Sabah for year 2004 indicates that spinach has a total of 1503.2 Mt, followed by 1363.7Mt, 1273.5Mt and 1239.8Mt for Indian mustard, Chinese mustard and Chinese white cabbage, respectively (Department of Agriculture Sabah, 2004).

Well, because they are grown mainly for their leaves, these plants are harvested before flowering takes place, that is, at vegetative state. The vegetables are too old and fibrous for consumption by the time they do flower. For instance, Chinese spinach and Indian mustard are never allowed to flower before harvesting. Normally, young stems and shoots are harvested as they fetch a higher market price. In a dish, leafy vegetables are prized both for their food value, shape and colour. Leafy vegetables grow more easily and rapidly than vegetables grown for their other parts and are less susceptible to pests and diseases. In this case, Chinese spinach, Chinese mustard and water spinach are the easiest to grow. Therefore, economically, leafy vegetables provide quick returns as there is no need to wait for complete life cycle of the plant. Thus, they are for sale in all local markets and are the most common vegetables, being cheap and available throughout the year, except rainy seasons, all over the country. Dark green leaves, such as Chinese spinach and Chinese white cabbage are rich in vitamins A and C, iron and calcium, than lighter green lettuce or Chinese mustard. (Yap, 1999).

The campaign "Eat More Vegetables" was re-launched by the Minister of Agriculture in June 1996, after its maiden launch in 1980, which is aimed to boost the consumption of vegetables, especially among the young, for health reasons and to help enhance the development of the agricultural sector, in which the Ministry of Agriculture encourages farmers to increase vegetable production by large-scale planting and by using modern technology. In general, a balanced diet with fish, meat

and lots of vegetables can help reduce health problems and prolong out lifespan (Yap, 1999). Today, people are more health conscious. Recently, it has been brought to attention of the public that there is an increasing use of pesticides and chemical fertilizers in vegetable planting, which is of great concern to the consumers. Home-grown vegetables are particularly nutritious and pesticide-free (Hutton, 1996).

2.1.1. Chinese spinach (*Amaranthus oleraceus* L.)

Photograph 2.1: Chinese spinach

From the family of Amaranthaceae, "Bayam hijau" in Malay language or Chinese spinach, this is what this plant is known locally. It is possibly originating from the Andean regions of South America and Mexico and is now widely distributed throughout the tropics (Yap, 1999). It is one of the most popular leafy vegetables consumed in Malaysia (Amin, Norazaidah & Emmy Hainida, 2006). Basically, there are 2 types of spinach, the English spinach (*Spinacea* spp.) and the Chinese spinach (*Amaranthus spp.*), but Amaranthus spinach is often regarded as the best of all the tropical spinaches in terms of food value and flavour. Despite the reputed health-giving properties of the true English spinach, Chinese spinach has double the amount of vitamins A, B and C (Hutton, 1996). According to the Nutrition Society of Malaysia

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