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DETERMINATION OF MINERALS FROM SPINACH
(AMARANTHUS VIRIDIS) CHIPS FOR NUTRIENT FACTS

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ABSTRACT

The objective of this study is to determine the composition of vitamin C, iron (Fe), calcium (Ca) and potassium (K) that contain in spinach chips by using titration method and Atomic Absorption Spectrophotometer (AAS) method. Besides, the vitamin and minerals content that being determined were compared with other commercial chips such as banana chips and potato chips. This study was conducted due to the less food product that used vegetables as the main ingredient and provides the information which is the nutrient fact for the spinach chips. The study involved the preparation of 100 g spinach (*Amaranthus Viridis*) chips and the analysis of Vitamin C using AOAC 967.21 test method and also the determination of mineral such as Fe, Ca and K using AOAC 968.08, 965.09. The results showed that the composition of vitamin C was 0.1 % Fe was 0.55 %, Ca was 16.29% and K was 14.18 % respectively. The total vitamin and minerals amount of nutrients were 4.8 mg/ 100 g for vitamin C, 814.9 mg/ kg for Ca, 27.4 mg/ kg for Fe and 709.8 mg/ kg for K. It was found that, spinach contained nutrients value even though it was cooked as chips. High nutrients value especially in vitamin C and minerals provide health benefits to human bodies.

ABSTRAK

Tujuan analisis ini dijalankan adalah untuk mengetahui kandungan vitamin C, besi (Fe), kalsium (Ca) dan kalium (K) yang terdapat dalam kerepek bayam dengan menggunakan kaedah pentitratan dan penyerapan spektroskopi atom. Di samping itu, kandungan vitamin dan mineral yang diperoleh akan dibandingkan dengan kerepek-kerepek lain yang telah dijual di dalam pasaran seperti kerepek pisang dan kerepek kentang. Analisis ini dijalankan kerana produk makanan yang menggunakan sayur-sayuran sebagai bahan utama adalah sedikit dan juga member maklumat iaitu kandungan nutrisi yang terdapat dalam kepek bayam. Kajian ini melibatkan penyediaan 100 g kerepek bayam dan analisis vitamin C menggunakan kaedah AOAC 967.21 dan kandungan mineral seperti Fe, Ca dan K akan menggunakan AOAC 968.08, 965.09. Dari keputusan yang diperoleh, kandungan vitamin C adalah 0.1%, Fe mencatatkan 0.55 % , Ca mencatatkan 16.29 % dan K adalah 14.18 %. Jumlah sebenar kandungan vitamin dan minerals adalah 4.8 mg/100g bagi vitamin C, 814.9 mg/kg bagi Ca, 27.4 mg/kg bagi Fe dan 709.8 /kg bagi K. Menerusi analisis ini, bayam turut mengandungi kandungan nutrient walaupun dihasilkan dalam bentuk kerepek. Kandungan nutrient yang tinggi terutamanya dalam vitamin C dan mineral menambahkan kesihatan kepada tubuh badan manusia.

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LIST OF SYMBOLS

°C degree Celcius

% percentage

LIST OF ABBREVIATIONS

AAS	Atomic absorption spectrophotometer
AOAC	Association of Official Analytical Chemists
DHAA	L-dehydroascorbic acid
DCIP	2, 6-dichlorophenolindophenol
DRI	Dietary Reference Intakes
HPLC	High performance liquid chromatography
TFM	Tetrafluoromethaxil
ANOVA	One-Way Analysis of Variance
g	gram
g/kg	gram per kilogram
kg	kilogram
mg	milligram
mg/kg	milligram per kilogram
mL	milliliter
ppm	part per million
µg	microgram
µg/day	microgram per day

CHAPTER 1

INTRODUCTION

1.2 INTRODUCTION

Spinach (*Spinacia oleracea L.*) an edible flowering plant in the family of Amaranthaceous is the most important leafy vegetable and an important source of minerals ((Kansal *et al.*, 1981). According to Beis (2002) , the age to leaves will determine the chemical composition of the spinach. Every 100 grams of spinach will provide 22 kcal of energy. Spinach contains lower calories, vitamin C, vitamin A and minerals, especially iron (Toledo *et al.*, 2003). It also contains very good amount of vitamin B complex, E, K, carotenes, folate, manganese, calcium, iodine, magnesium, phosphorus, protein, potassium, sodium, carbohydrates, amino acids and a lot of water.

Spinach always available every year and never finished. There are four types of spinach in Malaysia which are *Amaranthus paniculatus*, *Amaranthus gangeticus*, *Amaranthus blitum* and *Amaranthus viridis* (Ismail,A. *et al.*, 2004).

1.2 PROBLEM STATEMENT

The spinach leaves contain high amount of the nutrients. By using the spinach leaves as the raw material to produce new type of food product which is spinach chips, it will contribute to the increasing number of the people that consume vegetables everyday and also increase the number of the food product that being produce now.

From the observation, there are lots of food products that have been produced and distributed to the consumers. But, the food product that used vegetables as the main ingredient is less. This situation occurs because less research has been done to discover the advantages and benefits that humans can get when they eat these vegetables in their daily life, although in small quantities. Thus, the problem is also that consumers do not know the actual amount of vitamins and minerals contained in the food sample, unless the amounts are stated on the label of the package.

This problem also will give difficulties for the vegetarian people who just eat vegetables. They have difficulty finding and choosing their food. So, this research will give them a variety of food to choose.

1.3 RESEARCH OBJECTIVE

The aim of this research is to study the composition of Vitamin C, iron (Fe), calcium (Ca) and potassium (K) that are contained in spinach chips.

1.4 RESEARCH QUESTION

- a. What are the compositions of Vitamin C, iron, calcium and potassium that are contained in spinach chips?
- b. How to prove that spinach chips are nutrient food?

1.5 SCOPE OF STUDY

In order to achieve the objective of this project, a few scopes have been identified to be studied in this experiment. The scopes of study are:

- a. Collecting the spinach chips sample
- b. Analyze the composition of Vitamin C, iron, calcium and potassium in spinach chips by using titration method and atomic absorption spectrophotometer (AAS)

- c. Compare the composition of Vitamin C, iron, calcium and potassium in spinach chips with the other commercial chips

1.6 SIGNIFICANCE OF STUDY

Spinach is known as the most nutrient vegetables which are contain lots of nutrients and vitamin that good for human body and health. So, from this study it will determine the actual composition of Vitamin C, iron, calcium and potassium contains in spinach chips in order to introduce these chip as one of the chips which can improve human health. It also will help when doing the comparison between the composition of Vitamin C, iron, calcium and potassium in spinach chips with the composition of the other commercial chips. Besides, this study also can give benefits in the food production by increasing the amount of vegetables that can be produce as chips.

CHAPTER 2

LITERATURE REVIEW

2.1 NUTRIENT IN SPINACH

Spinach (*Spinacia oleracea* L.) is leafy vegetables that can just be eaten, boiled or cooked into various dishes (Ozkan & Akbudak, 2005). According to Toledo (2003), it contain lower amount of calories but high amount of vitamin, carotenoids, organic acid, alkaline mineral consist of antioxidant, protein, nitrate, ascorbic acid (vitamin C), vitamin A, and iron. Ascorbic acid is a hydro-soluble vitamin and easy to lose the amounts of the vitamin during undergo some process and storage (Soysal & Söylemez, 2005).

2.2 HEALTH BENEFITS OF SPINACH

Nutrients that contain in the spinach have numerous health benefits. There are 13 different flavonoids compound in spinach that has anti oxidant and anti cancer properties. Flavonols and flavones are the flavonoids that contain in spinach have the function to act as antioxidant and free radical scavenging activities. Some study that have been conduct shows that, spinach also can reduced risk of cancer and prevent lots of chronic diseases (Denkharghanian,M. *et al.*, 2010).Spinach have high content of water, superior 92% with 22 kcal of energy in every 100 grams of raw green spinach, it is appropriate in diets to lose weight and assist in cholesterol lowering. Vitamin A that contain in spinach will be more helpful for people that have eye problems. It will reduce the strain on the eyes and make the eyes muscles become stronger. Eating spinach during pregnancy is beneficial for the mother and child. Iron and fiber content will relieve her constipation while vitamins A, B and K

present in spinach help the fetus to growth healthy. Magnesium presence in spinach will help to calm down headaches and migraines in order to normalizing blood pressure. In the recent evidence that have been found state that carotenoids may protect from cardiovascular diseases (Voutilainen, *et al.*, 2006) and also play an important role in protecting the human retina (Bernstein et al.,2001).Caratenoids also can delay the development of several types of cancer, such as cancer of the prostate (Giovannucci *et al.*, 2002).

2.3 TYPES OF SPINACH

There are four types of spinach in Malaysia which are 'bayam putih' (*Amaranthus paniculatus*), 'bayam merah' (*Amaranthus gangeticus*), 'bayam itik' (*Amaranthus blitum*) and 'bayam panjang' (*Amaranthus viridis*) (Ismail,A. *et al.*, 2004).

2.3.1 'Bayam Putih' (*Amaranthus Paniculatus*)

Amaranthus paniculatus (Linn.) is one of the Amaranthaceae. It does contain high amount of carotenoids, Vitamin C, amino acid and protein. (Bhatia & Jain, 2002).



Figure 2.1: 'Bayam putih' (*Amaranthus paniculatus*)

Source: <http://www.tuninst.net> (2011)

2.3.2 'Bayam Merah' (*Amaranthus Gangeticus*)

Amaranthus gangeticus is one of to the Amaranthaceae family. This type of spinach can be used to astringent, diuretic, appetizing, and also for diarrhea and dysentery treatment. It's also have good amount of carotene, ascorbic acid, and folate (Sarkar *et al.*, 2009).



Figure 2.2: 'Bayam merah' (*Amaranthus gangeticus*)

Source: <http://barkyrzone.wordpress.com> (2011)

2.3.3 'Bayam Itik' (*Amaranthus Blitum*)

Amaranthus Blitum is commonly called purple Amaranth. This type of Amaranthaceae need warm temperature (Costea & Tardif, 2003). According to Hugin (1986) and Costea *et al.* (2001) in (Costea & Tardif, 2003), its state that *Amaranthus Blitum* can be planted in many types of soil such as in humid and nitrophilous alluvial sand.



Figure 2.3: 'Bayam itik' (Amaranthus blitum)

Source: www.prota.org (2011)

2.3.4 'Bayam Panjang' (Amaranthus Viridis)

Amaranthus viridis L. has been used to reduce labor pain and act as antipyretic for Indian traditional system in Nepal (Mark & Turin, 2003). It is used as anti-inflammatory of the urinary tract, vermifuge, diuretic, antirheumatic, antiulcer, analgesic, antiemetic, laxative, improves appetite, antileprotic, respiratory problems, eye treatment and for asthma (Ashok Kumar *et al.*, 2010). It also have been reported that this type of spinach contain high concentration of antioxidant components (Saravanan *et al.*, 2011).



Figure 2.4: 'Bayam panjang'(Amaranthus viridis)

Source: <http://www.metafro.be> (2011)

2.4 NUTRIENT COMPOSITION OF SPINACH

Spinach contains a lots of mineral and vitamins that good for human health and body. There composition of minerals and vitamin that contain in spinach leaves are listed in the table below.

Table 2.1 shows the composition of the nutrient that contain in the raw spinach leaves.

Table 2.1: Composition of Spinach in 100g of Raw Spinach

COMPOSITION	AMOUNT
Water	99.2 g
Energy Kcal	22
Fat	0.30 g
Carbohydrate	3.90 g
Fiber	2.8 g
Potassium	466 mg
Sodium	21 mg
Phosphorus	56 mg
Magnesium	87 mg
Calcium	136 mg
Vitamin C	9.8 mg
Vitamin A	18865.80 IU
Vitamin B6	0.244 mg
Niacin	0.489 mg
Folic acid	159 mcg
Iron	3.57 mg
Zinc	0.761 mg
Protein	2.972 gr.
Vitamin E	1.7 mg
Vitamin B2	0.233 mg

Source: <http://www.whfoods.com> (2011)

From Table 2.1, it is shown that raw spinach leaves contain lots of vitamin and minerals. Although some composition of vitamins and minerals have lower amount, but it has proved that spinach is one of the good vegetables for human

2.4.1 Vitamin C

Vitamin C also known as ascorbic acid has chemical formula of $C_6H_8O_6$. It is one of the water soluble vitamins and shows the major water soluble antioxidant in plasma and tissues. Vitamin C will not be harmful to our body when taken in the large amount because it will excrete through the urine. Ascorbic acid can be used as nutritional food additive, antioxidant, browning inhibitor, reducing agent, flavour stabilizer and colour stabilizer. The health effects of vitamin C are antihistamine reaction, affect immune function, protection from inflammation, reduce

cardiovascular disease, prevent diabetes, reduce or delay tumor formation and antioxidant protection of the lung (Combs, 2008).

Table 2.2 shows the amount of vitamin C that contain in various type of vegetables in form of raw leaves.

Table 2.2: Vitamin C Content of Vegetables

VEGETABLES	VITAMIN C (mg/100g)
Spinach	50-90
Potatoes	10-30
Peas	10-30

Source: Eitenmiller *et al.*, (2008)

Table 2.3 show the amount of vitamin C that should be consumed for human body based on the group age.

Table 2.3: Amount of Vitamin C Need for Human Body

AGES	AMOUNT OF VITAMIN C (mg)
Children 4–8 years	25
Children 9–13 years	45
Teens 14–18 years (boys)	75
Teens 14–18 years (girls)	65
Adults (men)	90
Adults (women)	75
Pregnant women	85

Source: Office of Dietary Supplement, National institutes of Health United State
(<http://ods.od.nih.gov>, 2010)

2.4.2 Vitamin B6

Vitamin B6 is a derivative of 3- hydroxyl-2-methyl-5- hydroxypyridine. It is stable under acidic conditions but unstable under neutral and alkaline conditions and become worse when being exposure to heat or light. Low vitamin B6 in our body

will cause homocysteinemia that will promote to increasing risk in vascular disease and cardiovascular disease which is related to stroke, Alzheimer's disease, fracture and heart disease (Combs, 2008).

Table 2.4 shows the amount of vitamin B6 that contain in three types of vegetables in form of raw leaves.

Table 2. 4: Vitamin B6 Contents in Vegetables

VEGETABLES	VITAMIN B6 (mg/100g)
Potatoes	0.25
Spinach	0.28
Peas	0.16

Source: Combs (2008)

2.4.3 Folate

Folate is also known as folic acid. Liver mushrooms and green, leafy vegetables, oil seed meal and animal by product are the important sources of folate. It is easily to be oxidized but unstable to undergo oxidation under aerobic condition. When folate is taken at least 200 µg/day, it will help to reduce coronary artery disease death. It also helps to lower the risk of delivering baby that has neural tube defects and helps in the prevention of anemia (Combs, 2008).

In the Table 2.5 the amount of folate contents in various types of vegetables are being listed.

Table 2.5: Folate Contents in Vegetables

VEGETABLES	FOLATE (µg/100 g)
Spinach	50-190
Banana	30
Potatoes	9
Peas	90
Apples	5

Source: Combs (2008)

2.4.4 Iron

Iron that contain in foods is essential for human life at low concentrations but it's can be toxic at high concentrations (Celik & Oehlenschlager, 2007). Iron that contain in food will act as integral part of many proteins and enzymes. The essential component of proteins will involve in oxygen transport, regulation of cell growth and differentiation. Decreasing in the amount of iron will lead to limits oxygen delivery to cells, leading to fatigue, poor work performance, decreased immunity and death. (Thavarajah *et al.*, 2009).

Based on the information that obtained, the recommended dietary allowance (RDA) of iron that should people consume everyday are listed in Table 2.6.

Table 2.6: Recommended dietary allowance (RDA) of Iron

AGE	AMOUNT OF IRON (mg/daily)
Male children 14 - 18 year	11
Female children 14 - 18 years	15
Male 19 - 50 years	8
Female adults 19 - 50 years	18
Adults 51 years and older	8
Pregnant females ages 14 - 50 years	27

Source: <http://www.umm.edu> (2011)

2.4.5 Calcium

Calcium that contain in food have been study since the early part of the century. Calcium is an essential macronutrient for humans. It has mainly a structural function in bones and teeth. Some studies shows that calcium can control the blood pressure (McCarron, 1997; Seelig *et al.*, 2001), the appearance of colon cancer (Slattery *et al.*, 1988), pancreatitis (Ward *et al.*, 1996) and the surrounding vascular tissue (Iskra *et al.*, 1997).

Based on the information that obtained, the recommended dietary allowance (RDA) for calcium that people should consume daily according to the age group are listed in Table 2.7.

Table 2.7: Recommended Dietary Allowances (RDA) for Calcium

AGE	AMOUNT OF CALCIUM (mg/daily)
0–6 months	200
7–12 months	260
1–3 years	700
4–8 years	1000
9–18 years	1300
19–70 years	1000
71+ years	1200

Source: <http://ods.od.nih.gov/> (2011)

2.4.6 Potassium

Potassium that contain in food plays an important role in cellular and electrical function. Low potassium levels in human body will lead to hypertension, congestive heart failure, cardiac arrhythmia, fatigue, depression, and other mood changes. Decreasing in the amount of potassium taken in body can cause serious muscles weakness, bone fragility, central nervous system changes, decreased heart rate, and even death (Akhter *et al.*, 2002).According to the information that obtained, the adequate intake for potassium that should people consume daily based to the age group, life stage and gender are listed in Table 2.8.