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QUANTITATIVE ANALYSIS OF MINERALS AND VITAMIN C IN POTATOES (Solanum tuberosum)

HUM PENG YONG

PERPUSTAKAAN UNIVERSITI MALAYSIA SABAH

DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT FOR BACHELOR OF SCIENCE WITH HONOURS

> INDUSTRIAL CHEMISTRY PROGRAM SCHOOL OF SCIENCE AND TECHNOLOGY UNIVERSITI MALAYSIA SABAH

> > APRIL 2007



DECLARATION

I declare that this thesis is the result of my own research except as cited in references. The thesis that has not been accepted for any degree and is not concurrently submitted in candidature of any degree.

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ABSTRACT

Quantitative analysis of selected minerals (i.e. calcium, iron, magnesium, potassium, sodium and phosphorus) and vitamin C in 'Russet Burbank' potato, 'Red Gold' potato and 'Yellow Fin' potato have been carried out. Minerals were determined according to the AOAC method 965.09 and method 975.03, whilst vitamin C by iodometric back-itration method. In general, the concentration of calcium, iron, magnesium, potassium, sodium and phosphorus in the potatoes that available in Sabah are ranging from 1.17-2.23 mg, 0.37-0.61 mg, 16.25-26.18 mg, 235.11-355.69 mg, 7.88-15.36 mg and 57.02-58.38 mg per 100 g of fresh potato, respectively. The concentration of vitamin C in 'Russet Burbank', 'Red Gold' and 'Yellow Fin' potatoes were determined as 17.99 ± 3.29 mg, 28.36 ± 3.79 mg and 20.26 ± 2.90 mg per 100 g of fresh potato, respectively.



V

ANALISIS KUANTITATIF BAGI KANDUGAN MINERAL DAN VITAMIN C DALAM UBI KENTANG

ABSTRAK

Analisis kuantitatif bagi kandungan mineral terpilih (kalsium, ferum, magnesium, kalium, natrium dan fosforus) dan vitamin C telah dijalankan ke atas ubi kentang jenis 'Russet Burbank', 'Red Gold' dan 'Yellow Fin'. Kandungan mineral telah ditentukan mengikut kaedah AOAC 965.09 dan 975.03, manakala vitamin C pula ditentukan berdasarkan kaedah penitratan keterbalikan iodometrik. Secara amnya, kandungan kalsium, ferum, magnesium, kalium, natrium dan fosforus dalam ubi kentang yang terdapat di Sabah adalah masing-masing berada dalam lingkungan 1.17-2.23 mg, 0.37-0.61 mg, 16.25-26.18 mg, 235.11-355.69 mg, 7.88-15.36 mg dan 57.02-58.38 mg per 100 g ubi kentang segar. Kepekatan vitamin C dalam ubi kentang jenis 'Russet Burbank', 'Red Gold' dan 'Yellow Fin' adalah masing-masing 17.99 \pm 3.29 mg, 28.36 \pm 3.79 mg dan 20.26 \pm 2.90 mg per 100 g ubi kentang segar.



CONTENT

		Page
DECI	LARATION	ii
VERI	FICATION	iii
ACK	NOWLEDGEMENT	iv
ABST	TRACT	v
ABST	TRAK	vi
CON	TENT	vii
LIST	OF TABLE	х
LIST	OF FIGURE	xi
LIST	OF PHOTO	xii
LIST	OF SYMBOLS AND ABBREVIATION	xiii
СНА	PTER 1 INTRODUCTION	1
1.1	Potato and Its Nutrients	1
1.2	Objectives of Research	3
1.3	Scope of Research	4
СНА	PTER 2 LITERATURE REVIEW	5
2.1	Nutrition and Quantitative Analysis of Nutrients	5
2.2	Potato	7
	2.2.1 Varieties of Potato	8
2.3	Nutrition Value in Potato	10
2.4	Dietary Reference Intake (DRI)	13
	2.4.1 Food Guide Pyramid	14
2.5	Vitamins	15
	2.5.1 Water Soluble Vitamins	17
	2.5.2 Fat Soluble Vitamins	19
2.6	Minerals	21
	2.6.1 Major Minerals	21
	2.6.2 Trace Minerals	23
2.7	Analytical Instruments	25
	2.7.1 Atomic Absorption Spectroscopy (AAS)	26

UNIVERSITI MALAYSIA SABAH

	2.7.2	Ultra	aviolet-Visible Spectrophotometer	27
CHA	PTER	3	METHODOLOGY	28
3.1	Samp	le Coll	lection	28
3.2	Analy	tical In	nstrument and Apparatus	29
3.3	Chem	ical an	id Reagents	29
3.4	Analy	sis of l	Moisture Content	30
3.5	Analy	sis of .	Ash Content	31
3.6	Analy	sis of	Minerals Content	32
	3.6.1	Prepa	aration of Aqueous Solution	33
		a.	Preparation of Lanthanum Stock Solution	33
		b.	Vanadate-molybdate Reagent	33
		c.	Standard Calibration Solution	34
		d.	Preparation of Mineral Sample Solution	36
	3.6.2	Deter	rmination of Calcium, Iron, Magnesium, Sodium and	36
		Potas	ssium Content	
	3.6.3	Deter	rmination of Phosphorus	37
		a.	Standard Calibration Solution	37
		b.	Determination of Phosphorus Content	38
3.7	Analy	sis of '	Vitamin C	38
	3.7.1	Prepa	aration of Thiosulfate Solution	39
	3.7.2	Prepa	aration of Standard Potassium Iodate Solution	40
	3.7.3	Stand	lardization of Sodium Thiosulfate Solution	40
	3.7.4	Prepa	aration of Sample Solution	41
	3.7.5	Deter	rmination of Vitamin C	41
СНА	PTER 4	RES	ULT AND DISCUSSION	42
4.1	Moist	ure and	Ash Contents of Potato	42
4.2	Miner	als Con	ntent of Potato	44
4.3	Vitam	in C C	ontent of Potato	48



viii

CHAPTER 5 CONCLUSION AND FUTURE WORKS	50
REFERENCES	53
APPENDIXES	57



LIST OF TABLES

Table

Page

x

Table 2.1	Six categories of nutrients.	6
Table 2.2	Top potato producers in 2005	8
Table 2.3	Some potato varieties and their description.	9
Table 2.4	Nutritional values of 100 g raw potato with peel.	12
Table 2.5	Differences between the water soluble vitamins and fat soluble	
	vitamins.	16
Table 2.6	A summary of water soluble vitamins.	18
Table 2.7	A summary of fat soluble vitamins.	20
Table 2.8	The major minerals.	22
Table 2.9	The tarce minerals.	24
Table 3.1	List of apparatus.	29
Table 3.2	Chemical and reagents.	30
Table 3.3	Concentration of standard solutions for each element.	35
Table 4.1	The minerals content in three varieties of potato.	45
Table 4.2	The comparison of nutrition value between the result obtained an	d
	literature review.	49
Table 5.1	Nutrition values of three varieties of potato.	50



LIST OF FIGURES

Figure

Figure 2.1	The USDA food guide pyramid.	15
Figure 4.1	The moisture content in three varieties of potato.	42
Figure 4.2	The ash content in three varieties of potato.	44
Figure 4.3	The vitamin C content in three varieties of potato	48



Page

Page

LIST OF PHOTOS

Photo

Photo 3.1	The potato samples analysed in this study.	28
Photo 3.2	The Hitachi Z5000 series atomic absorption spectroscopy system.	32



LIST OF SYMBOLS AND ABBREVIATIONS

AAS	Atomic Absorption Spectroscopy
AOAC	Association of Official Analytical Chemists
UV-vis	Ultraviolet-visible
FAO	Food and Agricultural Organization
GI	Glycemic Index
USDA	United State Department of Agricultural
DRI	Dietary Reference Intake
RDA	Recommended Dietary Allowance
DRI	Dietary Reference Intake
RNI	Recommended Nutrients Intake
EAR	Estimated Average Requirement
AI	Adequate Intake
UL	Upper Intake Level
RDI	Reference Daily Intake
DRV	Daily Reference Value





CHAPTER 1

INTRODUCTION

1.1 Potato and Its Nutrients

Potato or its scientific name, *Solanum tuberosum*, which categorized under root and tuberous vegetables, are the world's most widely grown tuber crop, and the fourth largest crop in terms of fresh produced (after rice, wheat, and maize). Since the 1960s, global potato production has remained relatively static, that was about 285.4 million tonnes per year. In Malaysia, the consumption per household capacity of potato increased two times from 2.4 kg per year to 5.2 kg per year between 1970-1990 (Saharan and Tengku, 1994).

Nutrition is a science that studies all the interactions that occur between living organism and food. Food includes plant and animal products that, when consumed, can yield energy and provide nutrients needed to maintain life and allow growth and reproduction. On the other hand, nutrients are chemical substances in foods that provide energy, form body structures, and regulate the body processes. Indeed, an optimal amount of a nutrient is essential to avoid deficiencies and excesses in



nutrients consumption as well as optimize short term and long term health (Grosvenor and Smolin, 2002).

The typical diet in the world today comes closely to the recommended proportions of protein, carbohydrate, and fat. However, the population does not meet the recommendations for fruits, vegetables, dairy products, lean meats and meat substitutes or grains and exceeds the recommended intake of added fats and sugars. This dietary pattern, along with a lack of physical activity, is a major contributor to the development of chronic disease such as diabetes, obesity, heart disease, and cancer, which are the major illnesses that cause death in our population (Bowman *et al.*, 1998; Kantor, 1998).

It is intense important to live in a healthy lifestyle, thus many people have included vegetables into their daily diets. The World Health Organization has highlighted the fact that low vegetable intake is among the top ten selected risk factors for global mortality. The Food Guide Pyramid is a guide for planning diets that meet nutritional recommendations. It proposes a diet plan based on servings from five food groups: bread, cereal, rice, and pasta group; vegetable group; fruit group; milk, yogurt, and cheese group; and meat, poutry, fish, dry beans, eggs, and nuts group (Grosvenor and Smolin, 2002).

In contrast, potato is one of the most important vegetable in the world. It possesses high carbohydrate content along with protein, minerals and vitamins. On the other hand, it is very low in saturated fat, cholesterol and sodium. Potato is classed as a protective vegetable because of its high vitamin C content. It has been noted in the

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past that, as the potato became common, scurvy, which is prevalent where vitamin C is absent, became uncommon and soon disappeared almost entirely in potato-eating countries (Ricardo, 2003).

1.2 Objectives of Research

Dietary Reference Intakes (DRI) is the recommendations for the amounts of nutrients and other food components that should be consumed each day. It is necessary to establish nutritional standard for the meals served at our daily diet. This emphasizes the need for a deeper study of nutritional value in potato. The objectives of this research are:

- a. to quantitatively determine the mineral contents (i.e. calcium, iron, magnesium, phosphorus, potassium and sodium) in potato samples, and
- to quantitatively determine the content of vitamin C in the same potato samples.



1.3 Scope

Three types of potato, with different varieties, namely 'Russet Burbank', 'Yellow Finn' and 'Red Gold' that commercially available in Sabah market were analyzed to determine the content of moisture, ash, minerals and vitamins. Quantification of calcium, iron, magnesium, potassium and sodium were carried out by using AAS system according to the AOAC methods 965.09 and 975.03. The content of phosphorus was determined by using UV-Vis Spectroscopy system according to AOAC method 986.24. While the determination of vitamin C was carried out by using iodometric back-titration method.



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CHAPTER 2

LITERATURE REVIEW

2.1 Nutrition and Quantitative Analysis of Nutrients

Nutrition is defined as the science of foods and its nutrients and other substances they contain, as well as their actions within the body (including ingestion, digestion, absorption, transport, metabolism and excretion) (Whitney and Rofles, 2005). It is a good combination of processes by which all parts of the body receive and utilize the materials necessary for the performance of their functions and for the growth and renewal of all the components (Joshi, 2002).

People in different parts of the world consume very different foods and can still maintain a healthy life. The reason is that almost all the foods contain a mixture of materials which are called nutrient. Nutrients are chemical components in food that supply nourishment to the body. In contrast, everything that is in our body was once a nutrient in food we consumed (Joshi, 2002; Muller, 1988).

There are six categories of nutrients; they are carbohydrates, proteins, lipids (fats), vitamins, minerals and water (Desai, 2000). Each category can be further divided into smaller group as shown in Table 2.1.

Table 2.1 Six categories of nutrients.

Nutrients	Description
Carbohydrates	Include simple sugars (monosaccharides) and complex carbohydrates (polysaccharides) such as starch and dietary fiber.
Proteins	Include 20 amino acids, are specific chemical substances from which proteins are made.
Lipids (fats)	Organic molecules, most of which do not dissolve in water, include fatty acids, glycerides, phospholipids and sterols.
Vitamins	Consist 13 vitamins which are water soluble (9 vitamins) and fat soluble (4 vitamins).
Minerals	Include 15 minerals, which are chemical substances that make up the ash that remains when food is completely burned.
Water	Essential for life, adults need about 11-15 cups (equivalent to 2-3 litres) of water each day from food and fluids.

(Source: Brown, 2005)

Carbohydrate, fat and protein are three organic nutrients that provide energy in the body. When the body uses carbohydrate, fat, or protein for energy, the bonds between the nutrient's atoms break. As the bonds break, they release energy. Some of the energy is released as heat, but some is used to send electrical impulses through the brain and nerves, to synthesize body compounds, and to move muscle (Whitney and Rofles, 2005).

Vitamins are also organic nutrients, they facilitate the release of energy from carbohydrate, fat, and protein and participate in numerous other activities throughout the body. In the body, some minerals are put together in orderly arrays in such structures as bones and teeth. Minerals are also found in the fluids of the body and influence their properties (Whitney and Rofles, 2005).



In analytical chemistry, quantitative analysis seeks to establish the amount of a given element or compound in a sample. Quantitative analysis can be further split into different areas of study. The material can be analyzed for the amount of an element, or for the amount of an element in a specific chemical species. The latter is of particular interest in biological systems; the molecules of life contain carbon, hydrogen, oxygen, nitrogen, and others, in many complex structures. Analytical chemists have developed numerous methods for the identification and quantification of components of fruit species. These include SNIF-NMR, HPLC, and electrochemical pattern recognition (Linden, 1996; Linskens & Jackson, 1995; Robards & Antolovich, 1995).

2.2 Potato

The Potato (*Solanum tuberosum*) is a perennial plant of the Solanaceae, or nightshade, family, commonly grown for its starchy tuber. Potatoes are the world's most widely grown tuber crop, and the fourth largest crop in terms of fresh produce (after rice, wheat, and maize), but this ranking is inflated due to the high water content of fresh potatoes relative to that of other crops. The potato originated in South America, somewhere in present-day Peru. Potatoes spread to the rest of the world after European contact with the Americas in the late 1400s and early 1500s and have since become an important field crop. The scientific classification of potato is as follow (Burton, 1989; Hawkes, 1990):



Kingdom:PlantaeDivision:MagnoliophytaClass:MagnoliopsidaSubclass:AsteridaeOrder:SolanalesFamily:SolanaceaeGenus:SolanumSpecies:Solanum tuberosum

According to the Food and Agriculture Organization (FAO), the worldwide production of potatoes in 2005 was 322 million metric tons which makes it the fifth highest production crop in the world.

Table 2.2	Top	potato	producers	in	2005	j,
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Country	Potato Produced (million metric tons)	
China	73	
Russia	36	
India	25	
Ukraine	19	
USA	19	
Germany	11	
Poland	11	
World Total	322	

(Source: UN Food and Agriculture Organization [FAO], 2007)

2.2.1 Varieties of Potato

From a growing point of view potatoes are divided into "first earlies", "second earlies", and "main crop". The former rapidly produce small tubers, the latter more slowly but produce large ones. Potato's skin comes in the colors brown, yellow, pink, red, and purple (sometimes called "blue"). Their flesh may appear white or may reflect

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the color of the skin. Potato retailers may label potato as different types as: boiling, baking, roasting, salad and mashing (Rivcardo, 2003).

Potato Varieties	Description
North American:	
Russet Burbank	Large, brown skin, white-fleshed, from a potato developed by Luther Burbank
Yellow Finn	Small, with yellow skin and flesh
Red Gold	Red skin, yellow flesh
German Butterball	A yellow-fleshed small oval potato. Won first place in Rodale's Organic Gardening "Taste Off"
Yukon Gold	Yellow skin and flesh
British:	
Maris Piper	A good general-purpose white main-crop potato, not suitable for salads. The favorite potato of chip shops
King Edward	A popular roasting potato, often served with the Sunday roast, white, main-crop
Desiree	A red-skinned main-crop potato originally bred in the Netherlands, a favorite with allotment-holders because of its resistance to disease and drought. It has a yellow flesh with a distinctive flavor.
International Kidney	Trademarked as Jersey Royal, a salad new potato, grown on the island of Jersey and in Spain
Pink Fir Apple	A pink-skinned salad potato which grows in irregular shapes
Golden Wonder	Famous Scottish frying potato, used to make the eponymous crisps
Kerr's Pink	Bred in Scotland: an excellent potato for boiling.
Comber Spuds	Grown in Comber, Northern Ireland, these 'new' potatoes are picked in April and best used sautéed or for making champ
French:	
Amandine	Bred in Brittany, France, it entered the national list of potato varieties in 1994. Amandine shaws typically produce long tubers with very pale, unblemished skin.

Table 2.3 Some potato varieties and their description.

(Source: Wikipedia, 2007)

In the United States the term "Idaho potato" often refers to the Russet Burbank, the principal variety grown in Idaho, that country's principal potato-growing region. The term also occurs generically for other potatoes grown in Idaho. It is claimed that russets grown in Idaho have a less earthy taste than Russets grown elsewhere. Many potato varieties in the United Kingdom originated on breeding stations which give part of the potato's name. Thus the Maris breeding station

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developed the above-mentioned Maris Piper and the Maris Peer. Another well-known station, Pentland, produced such varieties as Pentland Javelin and Dell. Peru, as the native area of origin for potatoes, is home to a wide range of more than 4,200 varieties. The sweet potato is not a true potato, it is a separate species and part of a different plant family: the Convolvulaceae (Wikipedia, 2007).

2.3 Nutrition Value in Potato

Potatoes have a high carbohydrate content and include protein, minerals (particularly potassium), and vitamins, including vitamin C. Freshly harvested potatoes retain more vitamin C than stored potatoes. New and fingerling potatoes offer the advantage that they contain fewer toxic chemicals. Such potatoes offer an excellent source of nutrition. Peeled, long-stored potatoes have less nutritional value, although they still have potassium and vitamin C. Potatoes also provide starch, flour, alcohol, dextrin, and livestock fodder (Burton, 1989).

The potato is an important source of vitamin C, not because one potato by itself meets the daily need, but because potatoes are such a common staple that they make significant contributions. In fact, scurvy was unknown in Ireland until the potato blight in the mid 1840s when some two million people died of malnutrition and infection. When vitamin C intake is below 10 mg per day, the symptom of scurvy may appear (Whitney and Rofles, 2005). They reflect the role of vitamin C in the maintenance of connective tissue. Without vitamin C, the bonds holding adjacent collagen molecules together cannot be formed and maintained, resulting in poor wound healing, the reopening of previously healed wounds, bone and joint aches, one

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