PROXIMATE ANALYSIS OF FIBRE, PROTEIN, LIPID AND CARBOHYDRATE IN POTATOES
(Solanum tuberosum)

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ABSTRACT

Proximate analysis was carried out on three varieties of potatoes (*Solanum tuberosum*), namely ‘Russet Burbank’, ‘Red Gold’, and ‘Yellow Finn’. The parameters analyzed were moisture, ash, lipid, dietary fibre, protein, and carbohydrate content. The methods used were based on AOAC (1990) and James (1995). From the analytical results, ‘Russet Burbank’ contains the moisture, ash, lipid, dietary fibre, protein, and carbohydrate content of 80.88 ± 0.33 g, 1.45 ± 0.14 g, 0.09 ± 0.01 g, 3.45 ± 0.19 g, 3.98 ± 0.14 g, and 13.60 ± 0.17 g over 100 g of fresh sample, respectively. Meanwhile, ‘Red Gold’ contains the moisture, ash, lipid, dietary fibre, protein, and carbohydrate content of 79.12 ± 0.12 g, 1.34 ± 0.09 g, 0.06 ± 0.02 g, 2.63 ± 0.21 g, 3.05 ± 0.11 g, and 16.43 ± 0.09 g per 100 g of fresh sample, respectively. Lastly, ‘Yellow Finn’ contains the moisture, ash, lipid, dietary fibre, protein, and carbohydrate content of 79.51 ± 0.02 g, 1.08 ± 0.07 g, 0.05 ± 0.01 g, 2.18 ± 0.07 g, 3.16 ± 0.09 g, and 16.20 ± 0.17 g per 100 g of fresh sample, respectively. Comparatively, ‘Russet Burbank’ contains the highest amount of moisture, ash, lipid, total dietary fibre, and protein content. ‘Red Gold’ instead contains the highest amount of carbohydrate.
Analisis proksimat telah dijalankan ke atas tiga jenis varieti ubi kentang (Solanum tuberosum), iaitu 'Russet Burbank', 'Red Gold', dan 'Yellow Finn'. Parameter-parameter yang dianalisis ialah kandungan air, abu, lipid, serat makanan, protein, dan karbohidrat. Kaedah yang digunakan adalah berdasarkan kepada kaedah AOAC (1990) dan James (1995). Daripada hasil analisis, 'Russet Burbank' masing-masing mengandungi 80.88 ± 0.33 g, 1.45 ± 0.14 g, 0.09 ± 0.01 g, 3.45 ± 0.19 g, 3.98 ± 0.14 g, dan 13.60 ± 0.17 g per 100 g sampel segar dalam kandungan air, abu, lipid, serat makanan, protein dan karbohidrat. Manakala, 'Red Gold' masing-masing mengandungi 79.12 ± 0.12 g, 1.34 ± 0.09 g, 0.06 ± 0.02 g, 2.63 ± 0.21 g, 3.05 ± 0.11 g, dan 16.43 ± 0.09 g per 100 g sampel segar dalam kandungan air, abu, lipid, serat makanan, protein dan karbohidrat. Akhir sekali, 'Yellow Finn' masing-masing mengandungi 79.51 ± 0.02 g, 1.08 ± 0.07 g, 0.05 ± 0.01 g, 2.18 ± 0.07 g, 3.16 ± 0.09 g, dan 16.20 ± 0.17 g per 100 g sampel segar dalam kandungan air, abu, lipid, serat makanan, protein dan karbohidrat. Secara perbandingan, 'Russet Burbank' mengandungi kandungan air, abu, lipid, serat makanan, dan protein yang tertinggi. 'Red Gold' pula mengandungi kandungan karbohidrat yang tertinggi.
# CONTENTS

<table>
<thead>
<tr>
<th>TITLE OF THESIS</th>
<th>i</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION</td>
<td>ii</td>
</tr>
<tr>
<td>VERIFICATION</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>iv</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>v</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td>vi</td>
</tr>
<tr>
<td>CONTENTS</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>ix</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>x</td>
</tr>
<tr>
<td>LIST OF APPENDIX</td>
<td>xi</td>
</tr>
<tr>
<td>LIST OF SYMBOLS AND ABBREVIATIONS</td>
<td>xii</td>
</tr>
</tbody>
</table>

## CHAPTER 1 INTRODUCTION

1.1 ANALYSIS OF NUTRIENTS IN POTATO 1

1.2 OBJECTIVES 3

1.3 SCOPE OF STUDY 4

## CHAPTER 2 LITERATURE REVIEW

2.1 INTRODUCTION TO NUTRITION 5

2.1.1 Food in the Past 6

2.1.2 Food at Present 7

2.2 WHAT ARE NUTRIENTS? 8

2.2.1 Water 10

2.2.2 Carbohydrates 12

2.2.3 Lipids 15

2.2.4 Protein 18

2.2.5 Vitamins 19

2.2.6 Minerals 20
CHAPTER 3 MATERIAL AND METHOD

3.1 CHEMICALS AND APPARATUS
3.2 PREPARATION OF RESEARCH SAMPLES
3.3 DETERMINATION OF MOISTURE CONTENT IN POTATO
3.4 DETERMINATION OF ASH CONTENT IN POTATO
3.5 DETERMINATION OF LIPID CONTENT IN POTATO
3.6 ANALYSIS OF TOTAL DIETARY FIBRE IN POTATO
   3.6.1 Preparation of Fritted Crucibles
   3.6.2 Preparation of MES-TRIS Buffer Solution
   3.6.3 Preparation of Test Portion
   3.6.4 Determination of Total Dietary Fibre
3.7 DETERMINATION OF PROTEIN CONTENT IN POTATO
3.8 DETERMINATION OF TOTAL CARBOHYDRATE CONTENT IN POTATO

CHAPTER 4 RESULT AND DISCUSSION

4.1 MOISTURE CONTENT IN POTATO
4.2 ASH CONTENT IN POTATO
4.3 LIPID CONTENT IN POTATO
4.4 TOTAL DIETARY FIBRE CONTENT IN POTATO
4.5 PROTEIN CONTENT IN POTATO
4.6 TOTAL CARBOHYDRATE CONTENT IN POTATO

CHAPTER 5 CONCLUSION AND FUTURE WORKS

REFERENCES
APPENDICES
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Comparison of nutrients among potatoes, bread, and cereals</td>
<td>27</td>
</tr>
<tr>
<td>3.1</td>
<td>List of apparatus used in analysis</td>
<td>30</td>
</tr>
<tr>
<td>3.2</td>
<td>List of chemicals and reagents used in analysis</td>
<td>31</td>
</tr>
<tr>
<td>4.1</td>
<td>Comparison of past and present studies on lipid content in potatoes</td>
<td>46</td>
</tr>
<tr>
<td>4.2</td>
<td>Comparison of past and present studies on total dietary fibre in potatoes</td>
<td>49</td>
</tr>
<tr>
<td>4.3</td>
<td>Comparison of past and present studies on protein content in potatoes</td>
<td>52</td>
</tr>
<tr>
<td>4.4</td>
<td>Comparison of past and present studies on carbohydrate content in potato</td>
<td>54</td>
</tr>
<tr>
<td>5.1</td>
<td>Nutrition values in three different varieties of potatoes</td>
<td>56</td>
</tr>
</tbody>
</table>
**LIST OF FIGURES**

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Potato samples, (a) 'Russet Burbank' (b) 'Yellow Finn' (c) 'Red Gold'</td>
<td>32</td>
</tr>
<tr>
<td>3.2</td>
<td>Soxhlet extraction system</td>
<td>35</td>
</tr>
<tr>
<td>4.1</td>
<td>The moisture content in three varieties of potatoes</td>
<td>43</td>
</tr>
<tr>
<td>4.2</td>
<td>The ash content in three varieties of potatoes</td>
<td>44</td>
</tr>
<tr>
<td>4.3</td>
<td>The lipid content in three varieties of potatoes</td>
<td>46</td>
</tr>
<tr>
<td>4.4</td>
<td>The total dietary fibre content in three varieties of potatoes</td>
<td>48</td>
</tr>
<tr>
<td>4.5</td>
<td>The protein content in three varieties of potatoes</td>
<td>51</td>
</tr>
<tr>
<td>4.6</td>
<td>The total carbohydrate content in three varieties of potatoes</td>
<td>53</td>
</tr>
</tbody>
</table>
## LIST OF APPENDICES

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Determination of moisture content among three different varieties of potatoes</td>
<td>66</td>
</tr>
<tr>
<td>B</td>
<td>Determination of ash content among three different varieties of potatoes</td>
<td>69</td>
</tr>
<tr>
<td>C</td>
<td>Determination of lipid content among three different varieties of potatoes</td>
<td>71</td>
</tr>
<tr>
<td>D</td>
<td>Preparation of standard solution in the determination of dietary fibre</td>
<td>73</td>
</tr>
<tr>
<td>E</td>
<td>Determination of total dietary fibre among three different varieties of potatoes</td>
<td>75</td>
</tr>
<tr>
<td>F</td>
<td>Determination of protein content among three different varieties of potatoes</td>
<td>80</td>
</tr>
<tr>
<td>G</td>
<td>Determination of total carbohydrate content among three different varieties of potatoes</td>
<td>82</td>
</tr>
</tbody>
</table>
LIST OF SYMBOLS AND ABBREVIATIONS

\( \alpha \)  \hspace{1cm} \text{Alpha} \\
ppm \hspace{1cm} \text{Parts per million} \\
x_i \hspace{1cm} \text{Content of each replicate} \\
GLC \hspace{1cm} \text{Gas liquid chromatography} \\
HPLC \hspace{1cm} \text{High performance liquid chromatography} \\
MES \hspace{1cm} \text{Morpholinoethane sulphonic acid} \\
TRIS \hspace{1cm} \text{Tris-hydroxymethyl aminomethane} \\
AOAC \hspace{1cm} \text{Association of Analytical Chemist} \\
FAO \hspace{1cm} \text{Food and Agriculture Organization of the United Nations} \\
USDA \hspace{1cm} \text{United States Department of Agriculture} \\
WHO \hspace{1cm} \text{World Health Organization}
CHAPTER 1

INTRODUCTION

1.1 ANALYSIS OF NUTRIENTS IN POTATO

Nutrition is a science that encompasses all the interactions that occur between living organisms and food. These interactions include the physiological processes by which an organism ingests, digests, absorbs, transports, and utilizes food (Smolin and Grosvenor, 1994). Nutrients are substances found in food that are essentially required by the body for growth, maintenance, and reproduction (Stegeman and Davis, 2005). They are those substances that either cannot be made by the body or cannot be made in large enough quantities to meet our nutritional needs (Carr, 2003).

Indeed, our body's metabolism will definitely react, either positively or negatively, depending on the intake of our nutrients (Schwarcz and Berkoff, 2004). As a preventive step, an accurate analysis has to be executed to determine the fluctuating amount of nutrients that are produced by food products. The methods in use today for the analysis of foods are based on a series of procedures and described as Proximate Analysis of Foods (James, 1995). This scheme of analysis involves the estimation of the main components of a food using procedures that allow a
reasonably rapid and acceptable measurement of various food fractions without the need for sophisticated equipment or chemicals. It was developed to provide top level, very broad, classification of food components (Greenfield and Southgate, 2003). Within the guidelines of the Association of Official Analytical Chemists (AOAC), proximate analysis can be used to determine the content of moisture, ash, protein, fat, dietary fibre, and carbohydrate (Nitisewojo, 1995).

Realizing the importance of living a healthy lifestyle, many people have included vegetables into their daily diets as their main source of nutrients (Melina and Davis, 2003). Therefore, to further prove the importance of vegetables, the Food Guide Pyramid strongly suggests three to five servings of any green vegetables in our diet each day (Stegeman and Davis, 2005; Whitney and Rolfes, 2005). Furthermore, the World Health Organization has also highlighted the fact that low vegetable intake is among the top 10 selected risk factors for global mortality. It pointed out that up to 2.7 million lives could be saved annually with sufficient vegetable consumption (WHO, 2003).

Probably one of the most important vegetable in the world is the potato and it is without a doubt a valuable commodity worldwide (Yildrim and Tokusoglu, 2005). Some populations have even made this vegetable the staple part of their diet. The potato is a tuber which originates from the nightshade family and it is a single species, *Solanum tuberosum*, belonging to the plant family Solanaceae (Cochrane, 1990). Native to the Andes in South America and a staple food of the Incas, it has proved invaluable in many areas because of its ability to grow in high and cold areas. Subsequently, the Spaniards took potatoes to Europe in the 16th century and they were
eagerly grown in Ireland by the early part of the 17th century. The potatoes then quickly became the principal crop of Ireland and became known as the “Irish Potato” because of the population’s dependence on them. However, by the mid-19th century, “the Blight”, also known as phytophthora (a type of potato fungus) almost instantly destroyed Ireland’s potato crop and contributed to massive starvation and disease (Stanton, 1996).

Potatoes are an important and nearly complete food source (Ballentine, 1989). They are the most widely cultivated vegetable in the world and have a high nutritional value. Potatoes consist of about 77% water, 18.5% complex carbohydrate, 2.1% protein, and 2.1% dietary fibre (USDA, 2006). They also supply small but significant amounts of minerals including calcium, iron, magnesium, phosphorus, potassium, sodium and sulphur, and also vitamins including niacin, riboflavin, thiamin, and especially vitamin C (Ong, 2003). As a whole, potatoes are significant source of various nutrients and can provide much of the recommended daily allowance (RDA) in the human diet (Stanton, 1996).

1.2 OBJECTIVES

The objectives of this research are:

i. to determine the content of total dietary fibre, protein, lipid, moisture and ash content in potato (i.e. varieties of ‘Red Gold’, ‘Russet Burbank’, and ‘Yellow Finn’), and
ii. to determine the total carbohydrate content in the mentioned potatoes by calculation.

1.3 SCOPE OF STUDY

In order to come up with a specific analysis, three particular varieties of potatoes were initially identified and the varieties of ‘Red Gold’, ‘Russet Burbank’, and ‘Yellow Finn’ were chosen to be analyzed in this research. This research encompasses five parameters, which are protein content, lipid content, moisture, ash, and total dietary fibre content. The protein content was determined by the Kjeldahl method (AOAC Method 955.04), based upon its total nitrogen element. The result of the analysis represents the crude protein content of the food since nitrogen also comes from nonprotein components. Meanwhile, lipid content was determined using Soxhlet extraction method (AOAC Method 920.39C). In the Soxhlet system of fat estimation, lipids were extracted out of the food by continuous extraction with petroleum ether. Moisture content of the sample was instead determined using oven drying method (AOAC Method 952.10), while ash content was determined by ignition method in a muffle furnace (AOAC Method 900.02A). On the other hand, the total dietary fibre content was determined using the gravimetric method (AOAC Method 991.43), where it was estimated using enzymes and a MES-TRIS buffer system. Finally, using the parameters, total carbohydrate content in sample was determined by mathematical calculation, where the sum of the percentage of moisture, ash, protein, and lipid were subtracted from 100.
CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION TO NUTRITION

Nutrition is a science which studies the relationship between diet and states of health and disease (Mann and Truswell, 2002). Between the extremes of optimal health and death from starvation or malnutrition, there is an array of disease states that can be caused or alleviated by changes in the food that we eat. Deficiencies, excesses, and imbalances in diet can produce negative impacts on health, which may lead to diseases, as well as psychological and behavioural problems (Wardlaw et al., 1992). Therefore, the science of nutrition attempts to prove that foods make up our daily diets and are more than just a collection of nutrients (FAO, 1996).

The human body necessarily comprises the various elements that humans eat and absorb into the bloodstream (Smolin and Grosvenor, 1994). The digestive system participates in the first step which makes the different chemical compounds and elements in food available for the cells of the body. In the digestive process of an average adult, digestive juices help to break chemical bonds between ingested compounds, as well as modulate the natural conformation and energetic state of the compounds. However, majority of the compounds are absorbed into the blood stream.
unchanged chemically as a whole (Jensen, 2000).

As a whole, eating a variety of fresh, whole unprocessed foods has proven hormonally and metabolically favourable compared to eating a monotonous diet based on processed foods (Melina and Davis, 2003; Antia, 1973). In particular, fresh foods provide higher amounts and a perfect balance of vital nutrients per unit energy, resulting in better management of cell growth, maintenance, and mitosis (cell division), as well as appetite and energy balance (Carr, 2003). In addition to that, a regular eating pattern has also proven to be more beneficial to our health if compared to infrequent and haphazard food intake (Schwarcz and Berkoff, 2004).

2.1.1 Food in the Past

For early humans, nutrition consisted of merely a biological drive to acquire nourishment (Smolin and Grosvenor, 1994). Our ancestors did not understand their nutrient requirements, but they were able to meet their nutritional needs in a variety of climates, under a variety of living conditions, and with a variety of food choices (Kirschmann and Kirschmann, 1996). To survive, human biology and culture adapted to the foods available. For example, some of our ancestors were foragers. Eating what they could find provided a diet high in fruit tubers, vegetables, and nuts. Other early humans lived in cold climates where little vegetable matter was available for consumption and became hunters consuming a diet high in meat (Toledo and Burlingame, 2006).
The development of agriculture had a major impact on the foods available in the human population (Rydberg and Haden, 2006). Before agriculture, human ancestors obtained most of their nutrition from wild game and fruits and vegetables. As time passed by, the cultivation of plants resulted in the more extensive use of cereal products. Then, the domestication of animals made the consumption of dairy products possible and meat more readily available. These more reliable sources of food allowed population expansion and the development of permanent habitation sites. However, it also decreased the variety of foods consumed since they were limited to those grown or raised in a specific geographic area (Natow and Heslin, 2006).

2.1.2 Food at Present

Food choices today are virtually limitless (Roberta, 2002). Although in the past, survival depended on making the correct choices from a limited selection of foods, today we can make varied food choices, and if nutrients are lacking, we can add them in processing or with vitamin and mineral supplements. Diets before the days of pesticides, food processing, preservatives, and colouring agents are thought as simple, natural and safe (Melina and Davis, 2003).

The changes that have occurred in the human diet since the past are often blamed for nutrition-related chronic diseases, which are prevalent today (Schwarcz and Berkoff, 2004). Basically, our diet now is lower in protein, higher in fat, and lower in fibre than the diet of early humans and as a conclusion, the food we consume today is more detrimental to our health (Lewellyn-Jones, 1980). Even if
people today wanted to return to the diet of their ancestors, availability would be a problem. Many of the foods our ancestors ate simply do not exist today or exist in insufficient amounts for global distribution (Fisher and Bender, 1974). If compared to today’s food, it is clear to see that the primitive diet may have been unprocessed and free of detrimental additives and pesticides (Schwarcz and Berkoff, 2004). However, the food was far from safe because of the presence of animal parasites due to undercooking, toxins resulting from poor food storage and preparation, and the inclusion of occasional poisonous plants (Lopez-Rubio et al., 2006).

2.2 WHAT ARE NUTRIENTS?

Nutrients are substances that provide energy, contribute to body structure, and regulate biological processes (Sullivan and Carpenter, 1993). To date, approximately 45 nutrients are considered essential to human life (Carr, 2003). One of the better known is called essential nutrients. Essential nutrients have to be included in our daily diets from the food that we eat because such nutrients cannot be naturally produced by our bodies. Indeed, food also contains many non-essential substances that can be produced by the human body.

Overall, there are six groups of nutrients, which are known as carbohydrates, proteins, lipids, water, vitamins, and minerals (Mindell, 1994). Nutrients can also be classified into two main groups, which are macronutrients and micronutrients (Berdanier, 2000). In nutrition, macronutrients are those nutrients that together provide the vast majority of metabolic energy to an organism. Their requirements are measured in kilogram (kg) or gram (g) amounts. The three main macronutrients are
carbohydrate, protein and lipid (Pomeranz and Meloan, 1994). On the other hand, vitamins and minerals are classified as micronutrients. This is because they are needed in small amounts in the diet. The amounts required are expressed in milligrams (mg = 1/1,000 gram) or micrograms (μg = 1/1,000,000 gram) (Stegeman and Davis, 2005). They provide no energy, but many help to regulate the production of energy from macronutrients (FAO, 1996).

To support life and maintain health, nutrients must not only be supplied. In fact, they must be supplied in the appropriate amounts (Kubrak and Jensen, 2006). Malnutrition is a general term for the medical condition caused by an improper or insufficient diet. Malnutrition is defined as imbalanced nutritional status resulting from a dietary intake either above or below that which is optimal to meet nutritional needs (Wardlaw et al., 1992). From the term imbalanced, malnutrition can be classified into two categories, which are undernutrition and overnutrition (UN, 2004).

Undernutrition is defined as poor nutritional status resulting from a dietary intake below that which meets nutritional needs (Natow and Heslin, 2006). Starvation, the most severe form of undernutrition, is a deficiency of energy that causes poor growth, weight loss, decreased ability to do work, the inability to reproduce, and if severe enough, death. The symptoms of a single nutrient deficiency demonstrate the body functions that rely on the deficient nutrient. For example, vitamin A is necessary for vision. As a result, a deficiency interferes with vision (Eleanor and Sharon, 2002).
Overnutrition is defined as excessive nutritional status resulting from a dietary intake in excess of that which is optimal for nutritional needs (Wardlaw et al., 1992). When food is consumed, in excess of energy need, the extra is stored as body fat. Some fat is necessary to insulate the body and store energy. However, an excess of body fat, called obesity increases the risk for many chronic diseases such as high blood pressure, heart disease, and diabetes (Stanton, 1996). When excess of specific nutrients are consumed, an adverse or toxic reaction may occur. In contrast, nutrient toxicities rarely occur as a result of food consumption because the amounts of vitamins and minerals in individual foods are well below nutrient requirements. Nutrient toxicities result more frequently from the consumption of vitamin and mineral supplements than from foods (Schwarz and Berkoff, 2004).

2.2.1 Water

Water has the chemical formula H₂O, meaning that one molecule of water is composed of two hydrogen atoms and one oxygen atom (Srikiatden and Roberts, 2006). Water alone is colourless, tasteless, and odourless liquid and is often referred as the universal solvent, dissolving many types of substances in the human body, such as mineral, vitamin, amino acid, glucose, and other small molecules. Water mainly functions to deliver oxygen and nutrients to different parts of the body and remove toxins and waste from the body. Besides that, water regulates body temperature through perspiration, reduces friction between joints, facilitates movement, acts as a cushion between organs in order to protect them, and facilitates normal functions of body processes, such as metabolism (Carr, 2003; Birch et al., 1972).
Water is essential to survival. Without food, an average individual can survive for eight weeks, but a lack of water reduces survival to only a few days. In adults, 60% of the body weight is water (Eleanor and Sharon, 2002). This percentage is higher in infants and generally, decreases with age. Water is found in varying proportions in all the tissues of the body. Although the amount and distribution of body water are controlled, water cannot be stored. Intake and output must therefore be balanced to maintain homeostasis. As a fact, an average adult needs two to three litres of water a day, which is equivalent to around seven to 11 glasses of water (Zubaidah, 1992).

Most of the water in the body comes from the diet, not only as the water that we drink but also from other liquids and solid food. For instance, milk and juices are 90% water, an apple is 85% water, and roast beef is 50% water (Tull, 1997). However, other beverages, such as alcohol, coffee, tea and soda are not ideal replacement for water. This is because both alcohol and coffee react as diuretic; causing the human body to lose half of the liquid that is contained in those drinks (Mann and Truswell, 2002).

In addition to that, a small amount of water is also generated inside the body by metabolism and it varies with the types of food metabolized, but it is not enough to significantly affect body water needs. The need to consume fluid is signalled by the sensation of thirst. When body water is low, saliva secretion decreases, making the mouth dry and stimulating thirst. An increase in the concentration of dissolved particles in body fluids and a decrease in total blood volume or blood pressure are also sensed by the brain, signalling the need to drink (Carr, 2003).
REFERENCES


