Nutritional evaluation of five selected tubers of Kanyakumari District, India

[1]F. Vargila, [2]Dr. C. Josephine Priyatharshini
[1]Research Scholar, [2]Assistant Professor
[1]Department of Zoology, Holy Cross College, Nagercoil.
[1]Manonmaniam Sundaranar University, Tirunelveli, Tamilnadu, India.

Abstract - Eating balanced diet is essential for good health and wellfare. Tubers provide the chief nutrients like carbohydrate, protein and fat for the proper function of our body. In this study, biochemical and nutritive value of five commonly available tubers of Kanyakumari district such as Solanum tuberosum, Ipomoea batatas, Colocasia esculenta, Plectranthus rotundifolius and Borassus flabellifer were analysed. The results revealed that, the tubers contain rich amount of carbohydrate, protein and lipid. Among all, the amount of protein is high in C. esculenta, carbohydrate in S. tuberosum and lipid in B. flabellifer. Also the tubers have good amount of minerals like nitrogen, phosphorous and potash. The analysis showed that, the amount of nitrogen is high in P. rotundifolius, phosphorous and potash in Ipomoea batatas. pH of the tubers are seems to be slightly alkaline ranging from 7.6 to 7.7. Thus it can be concluded that tubers are staple food and have immense potential as functional foods.

Index Terms - Borassus flabellifer, Colocasia esculenta, Ipomoea batatas, Solanum tuberosum and Plectranthus rotundifolius.

Introduction

Tubers provide a substantial part of the world's food supply and are also an important source of animal feed and processed products for human consumption and industrial use. The contribution of tubers to the energy supply in different population varies with the country; the relative importance of these tubers is evident through their annual global production which is approximately 836 million tones. A number of species and varieties are consumed but *Solanum tuberosum* and *Ipomoea batatas* consist of 90% global production of tubers (Faostat, 2013).

Solanum tuberosum (Potato) is the most important tuber crop in terms of production, accounting for about 45 % of the total world production of all tuber crops (Messer, 2000). *Ipomoea batatus* (Sweet potato) is a dicotyledonous species with tubers derived from swollen roots (Walter *et al*., 1984). Taro is the generic name for four related species of the family Araceae (aroids). *Colocasia esculenta* (taro), in which the corms are eaten, and *Alocasia macrorhiza* (giant taro) in which the edible part is the thickened underground stem (Pollock, 2000). *Plectranthus rotundifolius or Solenostemon rotundifolius,* commonly known as native or country potato in Africa and called "Chinese potato" is a perennial herbaceous plant of the mint family (Lamiaceae) native to tropical Africa (National Research Council, 2006). *Borassus flabellifer* is commonly known as doub palm, palmyra palm, tala palm, toddy palm or wine palm.

The bioavailability of minerals from plant tissues depends on their chemical form and the presence of promoter substances and anti-nutrients (White and Broadley, 2009). Potato tubers have high concentrations of promoter substances such as ascorbate, b-carotene, protein cysteine and various organic and amino acids that enhance the absorption of essential micronutrients (White et al., 2009). The historic use and importance of tubers can explain the reason for its significant implications in human health (Wagner et al., 1985) and healthcare needs (Pritha et al., 2015).

The systematic screening of plant species with the purpose of discovering new bioactive compounds is a routine activity in many laboratories (Parekh et al., 2006). Food fortification and supplementation through intervention programs have long been used to combat nutrient deficiency problems. Use of food-based approaches to combat micronutrient malnutrition is more likely to be sustainable. Researchers aim at investigating the nutritional quality of commonly consumed foods for possible improvement. This study investigated the biochemical and nutrient composition of five tuber varieties common in Kanyakumari District.

Materials and methods

Collection of tubers

The fully mature tubers of *Solanum tuberosum, Ipomoea batatas, Colocasia esculenta, Plectranthus rotundifolius* and *Borassus flabellifer* were collected from Kanyakumari District, Tamilnadu, India. The tubers were washed thoroughly until it is free from soil then cut into small pieces and dried at room temperature. The dried tubers were manually ground to fine powder and used for the biochemical analysis.

Biochemical analysis

Protein, carbohydrate and lipids were quantified by following the methods of Lowry et al. (1951), Seiffer et al. (1951) and Folch et al. (1975) respectively. The minerals were assessed following the procedure of Nithya et al. (2011). pH was determined by using pH meter.

Solanum tuberosum

Ipomoea batatas

Colocasia esculenta

Plectranthus rotundifolius

Borassus flabellifer

Results

The amount of carbohydrate and protein is higher in the tubers compared to lipid content. Amount of carbohydrate is very high in *S. tuberosum* and the amount of protein is very high in *I. batatas* (Table- 1). The carbohydrate content is high in all tubers except *C. esculenta*, *P. rotundifolius* and *B. flabellifer*.

The minerals like nitrogen, phosphorous and potash were determined in five tubers and the results showed that, the amount of nitrogen was higher in *P. rotundifolius* and phosphorous and potash in *Ipomoea batatas* (Table 2). pH of the tubers are ranging from 7.6 to 7.7 and thus the results revealed that the tubers are slightly alkali in nature (Table 3).

Discussion

In unsatisfactory environments, several tubers from underground carbohydrate structures to allow survival and renewed dynamic growth when suitable conditions return. The biochemical analysis performed during the current study confirmed that the tubers are rich source of carbohydrate and proteins. Carbohydrates are widely prevalent in the plant kingdom, comprising the mono, di, oligo and polysaccharides (Dash et al., 2017). The carbohydrates produced by plants are an important source of energy for animals. Carbohydrates, proteins and lipids also fulfill other needs by helping in the synthesizing of other chemicals and providing structure for cells within the body (Kroll, 2017).

The import of minerals into these storage structures has suggested for the successive growth of the plant and also for man when he depend on these structures as major foodstuffs. Patterns of cumulate in potato tubers for each mineral will depend on an interacting set of factors, including the developmental anatomy of the tuber, phloem and xylem loading and unloading, movement across the periderm and mechanisms for transport and sequestration within the tuber. The patterns of mineral transport in tubers are also likely to be dynamic during tuber storage, given that tubers mature, break dormancy and sprout during storage and prior to the next growing season (Nithya et al., 2011). In this study the amount of minerals in five dried tubers were determined and the results revealed that, a good amount of minerals are present in all the tubers.

Potassium plays an important role in translocation and storage of assimilates, osmoregulation, cation-anion balance and enzyme activation (Marschner, 1995; White and Karley, 2010). Tubers are considered to be relatively high in potassium (White et al., 2009). Macklon and De Kock (1967) showed a positive correlation between potassium and citric acid within the tuber. This makes some root crops particularly valuable in the diet of patients with high blood pressure. In such cases the high potassium to nitrogen and phosphorous may be an additional benefit (Meneely and Battarblee, 1976). However, high potassium foods are usually omitted in the diet of people with renal failure (McCay et al., 1975). From this suggestion, the above said tubers are rich in potassium and it is required for starch synthesis (Forster and Beringer, 1983).

Tamme et al. (2006) who also recorded a higher content of nitrogen in the tubers grown in traditional farming. It is the result of the content of nitrogen in the fertilizers that had been used. As an addition, manure causes the improvement of the content of humus in soil. It causes improvement of the amount and availability of food ingredients for plants. Investigating the content of nitrogen in tubers commercially available from traditional farming (Tamme et al., 2006) is important. Phosphorus has various effects on tuber quality, since it functions in cell division and synthesis and storage of starch in the tubers (Houghland, 1960), phosphorous can increase the size and percentage of dry matter (DM) (indicated by specific gravity) of the tubers (Freeman et al., 1960; Rosen et al., 2014). From the results it can be concluded that, the tubers has trace amount of nitrogen and phosphorous and used for fertilization.

The optimum pH range commonly reported for tubers is ranging from 5.5 to 7.5 (Smith, 1940), with higher pH levels causing significant yield reductions in some cases (Odland and Albritton, 1950) and little effect in others (Blodgett and Cowan, 1935). Blodgett and Cowan (1935) also noted little impact of increasing soil pH through to 9.0, but yields declined rapidly at higher pH levels.

Roots and tubers are important diet components for humans and add variety to it. In addition to the main role as an energy contributor, they provide a number of desirable nutritional and health benefits such as antioxidative, hypoglycemic, hypocholesterolemic, antimicrobial, and immune-modulatory activities. A variety of foods can be prepared using tubers and type and usage vary with the country and region. Tubers may serve as functional foods and nutraceutical ingredients to attenuate non-communicable chronic diseases and to maintain wellness (Chandrasekara and Josheph Kumar, 2016). The present study confirms that the tuber contains important nutrients and some required macro and micro nutrient necessary for human and animals.

Table 1: **Biochemical content of tubers**

Name of the tuber	Carbohydrate mg%	Protein mg%	Lipid mg%
Solanum tuberosum	35.6 ± 0.471	5.6 ± 0.47	0.016 ± 0.004
Ipomoea batatas	27 ± 0.816	151 ± 0.81	0.006 ± 0.004
Colocasia esculenta	8.6 ± 0.47	70.6 ± 0.94	0.006 ± 0.004
Plectranthus rotundifolius	11 ± 0.81	31.6 ± 1.24	0.006 ± 0.004
Borassus flabellifer	7.6 ± 0.47	140.3 ± 0.47	0.006 ± 0.004

Values are Mean ± S.E. of three observations

Table 2: **Quantitative analysis of Minerals in tubers**

Tubers	Total Nitrogen (5g/kg)	Total Phosphorous (5g/kg)	Total Potash (5g/kg)
Solanum tuberosum	1.05	0.51	2.05
Ipomoea batatas	0.86	0.86	2.35
Colocasia esculenta	1.21	0.56	1.96
Plectranthus rotundifolius	1.28	0.70	1.83
Borassus flabellifer	1.05	0.50	1.79

Values represent the average of three observations

Table 3: **pH of five tubers**

Tubers	pH
Solanum tuberosum	7.7
Ipomoea batatas	7.6
Colocasia esculenta	7.7
Plectranthus rotundifolius	7.7
Borassus flabellifer	7.7

Values represent the average of three observations

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