“EVALUATION OF SELECTED VEGETABLES OF SIKKIM HIMALAYAS FOR SOME NUTRACEUTICAL PROPERTIES”

A Thesis summary of Ph.D. Thesis
Submitted
To
Sikkim University

In Partial Fulfilment of the Requirement for the
Degree of Doctor of Philosophy

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The increased knowledge on the relationship between nutrients and health has resulted in several new products categories, such as Nutraceuticals. The word nutraceutical is a portmanteau of the words nutrient and pharmaceutical coined by Dr. DeFelice in 1989 and the product category represents a unique intersection of the pharmaceutical and food industries. Nutraceuticals are diet supplements that deliver a concentrated form of a bioactive component from a food and used with the purpose of enhancing health in dosages that sometimes exceeds that of the normal foods. The nutraceuticals can either be taken as dietary supplements or as functional foods. The dietary supplements can be in the form of liquid concentrates or capsules whereas functional foods are enriched foods which are very close to the original natural food.

The major source of biologically active substances, such as vitamins and secondary metabolites (polyphenols, carotenoids, sterols, glucosinolates, and saponins) are present in most of the vegetables. Number of studies revealed that individuals who eat five servings daily or more of fruits and vegetables have approximately half the risk of developing a wide variety of cancer types, particularly those of the gastrointestinal tract suggesting that consuming phenolic-rich fruits and vegetables increases the antioxidant capacity of the blood. Vegetables are important sources of minerals, fibre and vitamins, which provide essential nutrients for human health. Increased consumption of vegetable significantly reduces the incidence of chronic diseases, such as cancer, cardiovascular diseases and other age-related disorders. Various compounds such as polyphenols, carotenoids (pro-vitamin A), vitamins C and E (tocopherol) present in the vegetables have antioxidant and free radical scavenging activities and play a significant role in the prevention of many diseases. Polyphenols express many biological activities, such as antifungal, antibacterial, antiviral, anti-inflammatory,
anticancerous and antioxidative and therefore continued identification of vegetables with high polyphenol content is of considerable interest and importance to the scientific community due to the potential health benefits of these compounds.

Sikkim, a Himalayan state of India is known for rich biodiversity owing to varied climatic condition across the altitudinal gradient. The state is inhabited by diverse ethnic communities with about 10 hilly tribes and ethnic communities. In the Sikkim Himalaya, several varieties of locally available vegetables are commonly consumed and are considered an integral part of ethno-culture. These tribes and the ethnic communities have rich knowledge on use of indigenous vegetables as medicine. In recent decades, a resurgence of interest has focused on wild plant species for their possible nutritional and medicinal values to broaden the diversity of human diet. This is because people today are more concerned about the effects of modern agricultural technology and marketing, which only cultivate plant types that have high productivity and consequently caused massive loss of biodiversity. On the other hand, increasing research on underutilized vegetables in different regions showed that most of these wild greens have great nutritional values and antioxidant properties, which are comparable to those commercially cultivated vegetables and there has been no document on nutraceutical potential of local, indigenous or underutilized vegetables of Sikkim. So, this work envisages exploring these vegetables as potential nutraceuticals keeping in mind following objectives:-

1. To survey the knowledge of ethnic community of Sikkim about the medicinal properties of vegetables.
2. To characterize and quantify constituent phenolics of selected vegetables.
3. To elucidate nutritional and ionic profiling of selected vegetables.
4. To study the antioxidant activity of selected vegetables.
Material and methods

The present investigation entitled was carried out at Department of Horticulture, School of Life Sciences, Sikkim University, Gangtok, Sikkim during with the objective of evaluation of nutraceutical properties of some vegetables of Sikkim Himalayas which are indigenous and underutilized.

Collection and Survey:

A survey was conducted in all the four districts of Sikkim for the knowledge of traditional use of indigenous vegetables especially for their medicinal use. Collection of sample was also done during the survey for the following vegetables and samples were further subjected to different procedure depending upon the parameters to be studied.

1. *Solanum aethiopicum* L.
2. *Solanum macrocarpon* L.
3. *Capsicum annuum* var. *cerasiformae* (Dalle Khorsani)
4. *Tupistra aurantiaca* Wall. (Nakima)
5. *Nasturtium officinale* (Watercress)

Parameters for analysis:

Following parameters were estimated and analysed, as per the approved synopsis:

1. **Proximate analysis**
   i. Moisture and Dry Matter Content
   ii. Total soluble solids
   iii. Ash Content
   iv. Crude fat
   v. Crude Protein
vi. Crude Fibre  
vii. Carbohydrate  
viii. Total Starch  
ix. Total Sugar  
x. Chlorophyll A  
xi. Chlorophyll B  
xi. Total Chlorophyll  

2. **Elemental Analysis**  
   
   An Inductively Coupled Plasma Mass Spectrometry (ICPMS) will be used for the quantification of selected metals like potassium, phosphorus, sulphur, calcium, magnesium, cadmium, aluminium, cobalt, chromium, copper, iron, molybdenum, lithium, manganese, sodium, tin, strontium and zinc.

3. **Phyto-chemicals**  
   
   i. Determination of Total Phenols  
   ii. Determination of Total Flavonoid Contents  
   iii. Determination of Total Flavonols  
   iv. Determination of Ascorbic Acid  
   v. Determination of Carotene content  

4. Phenol estimation and characterization (Gallic Acid, Rutin, Catechol, Ferulic Acid and Quercetin) through HPLC.

5. **Anti-Oxidant activity**  
   
   1. DPPH Scavenging Activity  
   2. Ferric ion Reducing Antioxidant Power (FRAP Assay)  
   3. Ferrous ion chelating capacity  
   4. Phosomolybdenium Complex (PM) Assay
5. Free radical scavenging activity

6. Hydrogen Peroxide Scavenging Activity

6. Determination of fat soluble (A, D, E and K) vitamin content through HPLC.

**Statistical Analysis**

All the statistical analysis were performed with the help of JMP 11 statistical software. All the experiment was performed in completely randomized design with three replication. ANOVA was performed to know the statistical significance between the treatments. Duncan Multiple range test was also performed to determine the statistical differences between the treatments.

**Results and Discussion**

*Solanum aethiopicum, S. macrocarpon, C. annuum var. cerasiformae, N. officinale* and *Tupistra aurantiaca* are the crops, though not very commercially cultivated are consumed by the local inhabitant of the Sikkim Himalayas. All the above mentioned crops under the study were claimed to have medicinal properties as revealed from the survey. A total of 137 number of respondents were interviewed during the survey. It was revealed that about 36 local vegetables belonging to 21 families are consumed for medicinal properties. Most of the vegetables were found to be belong to cucurbitaceae, fabaceae, solanaceae and araceae family. *Tupistra aurantiaca, Solanum anguivi, Solanum macrocarpon, Cyphomandra betacea, Fagopyrum esculentum* and *Musa spp.* were reported to be used for treatment of diabetes. For lowering of blood pressure *Apium graveolens var. dulce, Solanum anguivi* and *Spinacea oleracea* were used.

*Tupistra aurantiaca* was found to have high proximate and mineral content than other vegetables under study. *Solanum aethiopicum, Solanum macrocarpon, Capsicum*
annual var. cerasiformae and Nasturtium officinale when compared to secondary data of closely related commercial species like Solanum melongena and Capsicum annuum were found to be at par for proximate and mineral content. Potassium and magnesium was found highest in Solanum aethiopicum which makes it suitable for consumption for people suffering from hypertension, high blood pressure and asthma etc. Calcium and Zinc was reported to be highest in Solanum macrocarpon and can be recommended for people suffering from osteoporosis, arthritis, night blindness and less immunity. Phosphorus, Iron, manganese, copper and molybdenum were found highest in Tupistra aurantiaca which makes it suitable for consumption for people suffering from aging problem, anaemia, muscle weakness and osteoporosis etc.

Adequate phytochemicals and phenolics were recorded in all the vegetables under study. The higher values of total phenol, flavonoids and carotene were recorded for C. annuum var. cerasiformae, flavonols for N. officinale and ascorbic acid in S. macrocarpon. Gallic acid was found highest in C. annuum var. cerasiformae, rutin, catechol, ferulic acid in N. officinale and quercetin in S. macrocarpon.

Antioxidant activity were determined by six different assays namely DPPH activity, FRAP value, ferrous ion chelating activity, phosphomolybdenum activity, hydrogen peroxide and hydroxyl ion scavenging activity. All the studied vegetables were found to be having ample antioxidant activity which makes them valuable for consumption. High DPPH and hydroxyl radical scavenging activity was found highest in C. annuum var. cerasiformae, whereas FRAP value, ferrous ion chelating activity, phosphomolybdenum activity was found highest in S. aethiopicum and hydrogen peroxide scavenging activity in Nasturtium officinale.

Fat soluble (A, D, E and K) vitamins were found in all vegetables except Vitamin D in case of S. aethiopicum and Vitamin K in case of C. annuum var cerasiformae.
Vitamin A and D content was found more in *S. aethiopicum* whereas Vitamin D in *C. annuum* var. *cerasiformae* and Vitamin E in *S. macrocarpon*.

To conclude, based on this study, *Tupistra aurantiaca* is considered rich amongst the studied vegetables for proximate and mineral content. *C. annuum* var. *cerasiformae* was found to be the rich in phytochemicals, different phenolics, vitamin and antioxidant content could be recommended to include in day to day food basket of local people and also for peoples of other than this region. Cultivation of these local vegetable not only enhance the livelihood security of the local community but also lead to the nutritional security. Growing of these vegetable at commercial scale provides ample scope for popularization of these crops and include them in food bowl locally and globally. There are much future thrust for exploring them as potential nutraceutical food.