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Analysis of Physiochemical Properties and Antioxidant Profile of Selected Vegetables

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Abstract—*Vegetables are the major functional foods because they are the main sources of nutraceuticals such as vitamins, minerals and phenolic compounds.. Vegetables are part of daily diet and have good amount of vitamin, mineral and polyphenols etc. They contain high concentration of numerous redox-active antioxidants such as polyphenols, carotenoids and ascorbic acid etc. Objective– 1) To analyze the physiochemical parameters of some selected vegetables i.e. bitter gourd (Momordica charantia), jack fruit (Artocarpus heterophyllus), red cabbage (Brassica oleracea), broccoli (Brassica olerace), turnip (Brassica rapa) and parwal Chosanthes dioica). 2) To analyze the antioxidant capacity of selected vegetable on the basis of total ascorbic acid content DPPH radicals scavenging activity, and ferric radical antioxidant power assay (FRAP). 3) To analyze the total phenolic content and total tannin content of some selected vegetables. Material and method – All selected vegetables were collected from local market of Dist. Allahabad of Uttar Pradesh, India. The physicochemical properties were assessed in terms of moisture, pH, acidity (percent (%) citric acid), colour, total soluble solids (TSS), and total titarable acidity (TTA) while, the anit-oxidative property was determined by using the total polyphenol content (TPC), tannin content, beta carotene, DPPH and FRAP methods. Result- There were remarkable changes present in physicochemical parameters in all the selected vegetables. A good correlation was found between TPC and percent antioxidant activity (r^2= 0.854). Beta carotene content was found high in broccoli (2.18 µg/100mg) followed by parwal (1.42 µg/100gm) and turnip (0.63 µg/100mg). Conclusion - The aim of this study is to determine the antioxidant profile of vegetables so that people understand the importance of vegetables in body. So it can be concluded that these vegetables are good for health and should consumed daily.*

Keyword*: Antioxidant, vegetables*

1. INTRODUCTION

Vegetables are important sources of protective foods, which are highly beneficial for the maintenance of good health and prevention of diseases. These are rich in antioxidant that helps in lowering incidence of degenerative disease, inflammation, brain dysfunction and acceleration of the aging process. Vegetables and fruits contain high concentration of numerous redox-active antioxidants such as polyphenols, carotenoids and ascorbic acid etc. These contain not only the nutritional antioxidants but also a great quantity of non-nutritional antioxidants, such as polyphenol compounds. Many studies have indicated that a frequent intake of vegetables, such as broccoli, cauliflower, leaf mustard, cabbage, Chinese broccoli and turnip, could protect against cancer. Red cabbage belongs to the planate kingdom and Brassicaceae family. Its leaves are dark red/ purple because of anthocyanins. Bitter gourd originated in India, and it was carried to China in the 14th century. Bitter gourd is the immature pod vegetable, popular in many Asian countries. Jack fruit belong to planate kingdom, moraceae family. Jack fruit *(Artocarpus heterophyllus*) is a species of tree in the *Artocarpus* genus of moraceae family. Broccoli is a plant in the cabbage family, whose large flower head is used as a vegetable. The red cabbage (*Brassica oleracea* var. *capitata* f. *rubra*) is a sort of cabbage, also known as purple cabbage. It helps to lower cholesterol level because it's part of the cruciferous family of vegetables. The rich red colour of red cabbage is due to its concentration of anthocyanins polyphenols. Red cabbage is packed with fiber, vitamin K, vitamin B6, potassium and manganese, and also contains thiamine, riboflavin, calcium, iron, and magnesium. The turnip or white turnip (Brassica rapa subsp. *rapa*) is a root vegetable commonly grown in temperate climates worldwide. Parwal is often called green potato. It is a good source of carbohydrates, vitamin A, and vitamin C. It also contains major nutrients and trace elements (magnesium, potassium, copper and chlorine). They scavenge radicals by inhibiting initiation and breaking chain propagation or suppressing formatting of free radicals and singlet oxygen. It is well known that natural antioxidants extracted from herbs and spices (rosemary, oregano, thyme, etc.) have high antioxidant activity and are used in many food applications.

2. MATERIAL & METHOD:

Vegetables: The selected vegetables (red cabbage, broccoli, turnip, parwal, bitter gourd and jack fruit) are brought from the local market of Allahabad and stored in refrigerator.

Chemicals: All chemicals used for the chemical analysis were AR/GR grading.

1. Estimation of Moisture[1]:

Moisture was estimated by Oven drying method. Weighed sample (approx 2 g) (W2) on pre-weighed petriplate (W1) were kept in an oven for drying at 60º C for 5 hrs. The samples were cooled in airtight desiccators to prevent moisture loss or gain from the environment. Drying was considered complete when readings of two consecutive weighing recorded at an interval of an hour did not vary by more than 5 mg. Moisture content was calculated by subtracting the dried weight from the sample weight and was expressed as percentage.

$$\%\text{Moisture} = \frac{\text{Loss in weight}}{\text{Weight of sample}} \times 100$$

2. Estimation of Sugars[1]:

The content of reducing sugars and total sugars was estimated by Lane and Eynon method (1923) as described by.

Preparation and standardization of Fehling's solution:

Fehling's solution was prepared fresh by adding Fehling's solution A in Fehling's solution B in equal amount with constant stirring and the content was filtered through What man filter paper No. 2. Ten milliliter of Fehling's solution was titrated against standard dextrose solution of concentration 2.5 mg/ml using methylene blue as an indicator solution.

Preparation of sample:

To prepare sample, 10 ml of the sample juice was transferred to a 100 ml beaker and the content was neutralized by adding 0.1 N NaOH using phenolphthalein as an indicator solution. It was added with about 50 ml of distilled water and the content was heated to boil. Thereafter, it was transferred to a 250 ml volumetric flask using several washings with distilled water. Two milliliter of 45 per cent neutral lead acetate was added, stirred and allowed to stand for 10 minutes. It was using 22 per cent solution of potassium oxalate solution and the volume was made up to mark with distilled water. The content was filtered through Whatman filter paper No. 1.

Reducing sugars:

The prepared sample was titrated with freshly prepared and pre-standardized Fehling's solution using methylene blue as an indicator solution. The content of reducing sugar was calculated as follows.

% Reducing Sugars = Fehling's factor x Dilution x 100 / Titer x Volume of sample

Fehling's factor was determined by titrating standard sugar solution (2.5 mg dextrose/ ml) against Fehling's solution.

Total sugars:

Twenty five milliliter of the prepared sample filtrate was taken in a 100 ml volumetric flask and 5 ml of HCl (1+1) was added. This was kept for 24 hours at the ambient temperature for the hydrolysis of non-reducing sugars to the reducing ones. Thereafter, the content was neutralized with 1N NaOH and made up to 100 ml with distilled water. It was titrated against freshly prepared and pre-standardized Fehling's solution as described above. The following formula was used to calculate the per cent total sugars.

% Total Sugars = Fehling's factor x Dilution x 100 / Titer x Volume of sample

Non-reducing sugars:

The content of non-reducing sugars was calculated by the formula given below:

%, Non-reducing sugars = 0.95 x (%, Total sugars – %, Reducing sugars)

Results were expressed as per cent of reducing, non-reducing and total sugars on the basis of juice.

3. Ascorbic acid[1]:

Ascorbic acid was determined by the usual titration method using 2, 6-dichlorophenol indo-phenol solution.

Procedure: Ten to twenty ml sample juice was added with an equal amount of meta-phosphoric acid solution (3%). The content was filtered through a Whatman filter paper No. 1. It was titrated against dye solution till the appearance of pink colour. Dye was standardized with freshly prepared standard ascorbic acid solution (0.1 mg/ml) prepared in 3 % meta-phosphoric acid solution. It was expressed as mg of ascorbic acid present in 100 ml of the sample.

Ascorbic acid in the beverage samples was determined by the same method but 0.1 ml concentrated HCl and 1 ml of formaldehyde solution was added to the aliquots before titration.

4. Estimation of pH[1]:

pH of the fruit juice was determined by a digital pH meter (LI 120/LI 610, Elico

5. Estimation of Total soluble solids:

The total soluble solids content of juice and beverage samples was determined by using Hand Refract meters (Erma, Japan) of different range (0-32 and 30-60 per cent) at room temperature. Refract meter was set at zero with distilled water before recording TSS values of the samples. The reading was corrected to 20^{o}C and the value was expressed as per cent TSS.

6. Lab Value:

Tri stimulus colour: Tri stimulus colour in terms of Hunter L, a, b values was measured using X-Rite spectrophotometer (USA) using D-65 illuminate and 10o observer. 'L' value

represents lightness, 'a' value shows redness-greenness and 'b' value indicates blueness-yellowness of the samples.

7. Estimation of Acidity[1]:

The percent acid in the sample determine by titrating against standard base (IS 13844; 2003). **Procedure:** Take 10 ml of the sample in a 50 ml volumetric flask and make up the volume by adding distilled water. Take 5 ml of aliquot of sample prepared and titrate it with 1N NAOH solution using few drops of 1% phenolphthalein as indicator.

Percent Total Acid = (Titer value × normality of alkali × vol. made up × eq. wt. of acid × 100) / (Aliquot taken for titration × volume made up × 1000

7. Total Polyphenol Content[2]

Samples (0.3 ml, triplicate) were introduced into test tubes followed by 1.5 ml of Folin-Ciocalteu's reagent (diluted 10 times with water) and 1.2 ml of sodium carbonate (7.5%w/v). Total phenol contents were expressed in Gallic acid equivalents (mg per 100 g fresh vegetable).

Dilute Folin-Ciocalteau phenol reagent 10% (volume fraction):

Use a pipette, transferred 10 ml of Folin-Ciocalteau reagent to a 100 ml volumetric flask. Diluted up to the mark with distilled water and mixed.

Sodium carbonate solution, 7.5 % (mass concentration):

Weight 7.5 gm of anhydrous sodium carbonate (Na_2CO_3) into 100 ml volumetric flask. Added sufficient warm distilled water to half fill the flask. Swirled and dissolved the sodium carbonate, cooled to room temperature, diluted to the mark with distilled water and mixed.

Blank solution: Similar procedure was adopted for preparation of blank where sample was replaced by distilled water. Taken 1 ml of sample extracted. 5 ml of Folin-Ciocalteau reagent was added. 4 ml of Na_2CO_3 added within 3-8 minutes. The test tubes was covered with the help of brown paper or aluminum foil and allowed to stand for 30 minutes. Absorbance was taken at 765 nm.

Total Polyphenol Content was calculated by following formula: -

$$\text{TPC} = \frac{(\text{Sample OD} - \text{Intercept value}) \times \text{Sample extraction volume} \times 100}{\text{Slope} \times \text{mass in gm of test sample} \times 10{,}000 \times \text{wt. in dry matter}}$$

8. Antioxidant Activity

The percent (%) antioxidant activity of vegetable was determined by DPPH method.

Preparation of control sample: -Took 150 µl of DPPH solution and added 3 ml of pure methanol in it.

Preparation of DPPH solution: 4.3 mg of DPPH was dissolved in 3.3 ml of methanol. It was protected from light by covering the test tube.

Blank: Pure methanol was used as blank solution.

Procedure: The free radical scavenging activity of the vegetable extracts was measured by measuring the decrease in absorbance of methanolic DPPH solution at 517 nm in the presence of the extract. The initial concentration of DPPH was 0.1 mm and the reading was taken after allowing the solution to stand for 30 min. In cases where the absorbance decreased too much (when the solution turned yellow) before the 30 min period, the sample was appropriately diluted. The amount of sample extracted into 1 ml solution necessary to decrease by 50% the initial DPPH concentration was derived from the % disappearance vs. concentration plot. (Concentration here means mg of fruit extracted into 1 ml solution.) The results are also expressed as ascorbic acid equivalent antioxidant capacity (AEAC) using either one of the following equations where

% Antioxidant = (A control – A sample) /A control*100%

9. Ascorbic acid content (AOAC):

The AAC was determined by the iodine titration method or the RP-HPLC method: Waters C-18 column (3.9-150 mm, 5 lm particle sizes), mobile phase 5% acetic acid, flow-rate 0.5 ml/min and 254 nm detection wavelength. Both methods gave similar results to within 5%.

10. Determination of Ferric Reducing Antioxidant Power (FRAP):

The antioxidant capacity of each sample was estimated according to adapted procedure of Benzie and Strain (1996) with some modifications. FRAP reagent was prepared as using 300 mm acetate buffer, pH 3.6 (3.1 g sodium acetate rehydrate, plus 16-mL glacial acetic acid made up to 1 l with distilled water); 10 mm TPTZ (2,4,6-tri (2-pyridyl), in 40 mm HCl; and 20 mm $FeCl_3.6H_2O$ in the ratio of 10:1:1 to give the working reagent. FRAP reagent, 3,900 µl, prepared freshly and warmed at 37°C, was mixed with 100 µl test sample, standards, or extraction solvent as reagent blank. After 30 min the absorbance was measured at 595 nm wavelength. The result was expressed as milligrams of equivalents per 100 g of fresh sample (mg TE/g of FW).

3. RESULTS AND DISCUSSION

In red cabbage moisture (%) was (87.3±1.27), acidity (%) (0.385±0.007), pH (5.96±0.360), pectin (%) (0.55±0.212),ascorbic acid (mg/100gm) (123.75±0.353), TSS 4. In broccoli moisture (%) was (89.4±0.282), pH (6.22±0.07), pectin (%) (0.475±0.035), acidity (%) (1.855±0.0912). ascorbic acid (mg/100gm) (89.4±0.282), TSS (9). In turnip moisture (%) was (42.75±0.353), pH (7.61±0.007), pectin (%) (0.012±0.113), acidity acid (%) (1.13±0.69), ascorbic acid (mg/100gm) (42.75±0.353) and TSS value is (6). In jack fruit

moisture (%) (63±2.83), pH (6.195±0.134), pectin (%) (2.2±0.424), acidity (%) (0.59±0.099), ascorbic acid (mg/100gm) (14.25±0.353) and TSS value is (3). In Bitter gourd moisture (%) (71.25±0.35), pH (4.004±0.035), pectin (%) (0.315±0.049), acidity (%) (0.435±0.106), ascorbic acid (mg/100gm) (87.65±0.353) and TSS value is (4), in parwal moisture (%) was (93±0.28), pH (6.19±0.098), pectin (%) (0.35±0.070), acidity (%) (0.32±0.11), ascorbic acid (mg/100gm) (29.5±0.707) and TSS value is (6).

The analysis of antioxidant activity has been done through 5 different methods DDPH, FRAP, TPC, ferric reducing power and β-carotene content. The values had been found between 76.89 ± 1.159 to 88.06 ± 0.3639. The highest DPPH value was found in broccoli and shown almost similar value in red cabbage and jack fruit. The value has been found in the range of 2.352 ± 0.0959 to 4.282 ± 0.1056 and highest value found in bitter gourd. The values range from 0.37±0.03 to 1.68±0.0042. Beta carotene estimation has been done through the method given in **Rangana 1986**, and values are found in between range of 0.34 ± 0.13 to 2.18 ± 0.04, and the result shown that broccoli has the highest beta content value.

4. CONCLUSION

Vegetables are good for health and they have special role in nutrition. Vegetables are part of daily diet and have good amount of vitamins, minerals and polyphenols etc. Vegetables and fruits contain high concentration of numerous redox-active antioxidants such as polyphenols, carotenoids and ascorbic acid etc. Vegetables are important sources of protective foods, which are highly beneficial for the maintenance of good health and prevention of diseases. Vegetables contain not only the nutritional antioxidants but also a great quantity of non-nutritional antioxidants, such as polyphenols compounds. Due high polyphenol content, good moisture, ascorbic acid content these vegetables are very good daily consumption.

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