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Full Length Research Paper

Food analytical evaluation of fruits and vegetables-based diets in relation to human carbohydrates

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Carbohydrates are the major nutrients of fruits and vegetables in human nutrition. Sucrose is one of the important parameters for the assessment of the commercial quality of the fruit, since consumers prefer the sweetest fruits. Results showed that fructose, glucose, sucrose contents were high in *Cordia myxa* (9.38, 12.75 and 29.09%) respectively and the starch content was high in *Alocacia indica* (60.41%). *Alocacia* has high calorie and nutritional value because it contains high carbohydrates contents (72.66%) and *Cordia* was the sweetest fruits because it contains the maximum amounts of sucrose, glucose and fructose. The TDF content was low in *Portulaca oleracia* (dried) (8 g %) and was high in *Cordia myxa* (27.7 g %). It is observed that vegetables of Portulaca, *Asparagus, Momordica* and *Eulophia* can be recommended in plant -based diets in Iran and India.

Key words: Fiber, carbohydrates, nutritional values, edible plants.

INTRODUCTION

Dietary fiber (DF) plays an important role in decreasing the risks of many disorders such as constipation, diabetes, cardiovascular diseases (CVD), diverticulosis and obesity (Bassi and Marangoni, 1984). Plant foods are the only sources of DF. All the fractions (cellulose, lignin, hemicellulose, pectins, gums and mucilages) of DF are the major constituents of plant cell wall (Bergougnoux et al., 1978) . The physiological effects of total dietary fiber (TDF), in the forms of insoluble and soluble fractions of foods, have a significant role in human nutrition (Desmaison and Adrian, 1986).

Indian diets predominantly consist of a variety of plant foods such as cereals, pulses, green leafy vegetables (GLV), roots, tubers, other vegetables, fruits, oil seeds, spices and condiments. Fruits are consumed in various forms like fresh, dried, frozen or canned (FAO, 1998). The polysaccharides comprising a major part of DF in fruits and vegetables are beneficial to healthy human volunteers, since the consumption of fiber lowers plasma cholesterol levels (Food and Nutrition Board, 2002).

Reported protective effect of fruits and vegetables against the development of stroke in men. Addition of fruits and vegetables to the regular diet of infarcted survivors resulted in a decreased mortality and subsequent infarc-tions Gopalan et al. (2000). Therefore, the dietary fiber may play a major role in determining the health and disease conditions of different population groups.

The data on DF content and its components in fruits are not available in India. The dietary reference value (DRV) for the DF has not been prescribed so far, either in India Herausgegeben (2000), or in most other countries. Some organizations suggested 10 g DF/1000 kcal as an interim recommendation (Holland et al., 1993; Kamath and Belavady, 1980), Institute of Medicine, USA recom-mended approximately 14 g TF/1000 Kcal. No systematic studies are available so far in this regard. Presently, the food composition tables give crude fiber (CF) content but not DF content of foods in India (Marlett et al., 1992). Moreover, the methodology for the determination of fiber content of foods has changed from time to time from a chemical method (Ramulu et al., 1997) to chemical and gravimetric method (Roberfroid and Selvendran, 1993).

Carbohydrates are the major nutrients of fruits and vegetables, with sucrose representing one third of total sugars (Selvendran et al., 1984). This disaccharide is one of the important parameters for the assessment of the commercial quality of the fruit, since consumers prefer the sweetest fruits.

Spiller (2001) followed Scales technique (quoted by these authors) in which the Feehling reagent is used, for

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carrying out one of the first studies on the nutritional composition of fruits, where they found a sucrose content of 5.7% in fresh matter. French investigators published a study on the nutritional composition of fruits from different varieties in their country, and found values for this disaccharide ranging from 7.6 - 16.7% of dry matter, whilst reducing sugars ranged between 4.5 and 9.6% of dry matter. These authors however do not specify the method of determination used. Singh et al. (1993) determined the content of soluble carbohydrates in Italian varieties of fruits, using chromatographic determination with antrone and obtained values then from 7.4 - 8.4% of dry matter. Other authors like Senter et al. (1994) studied sugars and nonvolatile acid contents in fruits from different varieties of fruits, using gas chromatography, and obtained values of 9.2 g of sucrose% of dry matter and traces of glucose and fructose. We want to know in this study which edible plant is suitable for food heat processing.

MATERIALS AND METHODS

Collection of samples

Eight different types of fruits and vegetables (*Alocacia indica Sch., Asparagus officinalis DC.*, *Chlorophytum comosum Linn., Cordia Myxa Roxb., Eulophia Ochreata Lindl., Momordica dioicia Roxb., Portulaca oleracia Linn. and Solanum indicum Linn.*) were purchased from were collected from various localities of Maharashtra (India) and Iran. Five wild edible plants were collected from Iran viz *Asparagus officinalis*, *Chlorophytum comosum, Codia myxa, Portulaca oleracia and Solanum indicum* were collected from Iran. Efforts made to collect these plants in flowering and fruiting conditions for the correct botanical identification. Healthy and disease free edible plant part/s selected each variety of fruit and vegetables were collected to assess the variation in their TDF, simple sugars and starch contents.

Samples preparation

Fresh fruits and vegetables were cleaned with water and external moisture wiped out with a dry cloth. The edible portion of the individual fruits was separated dried in a hot air oven at 50°C for 1 h. The dried samples were then powdered in blander for further study.

Some of the plants dried under shade so as to prevent the decomposition of chemical compounds present in them.

Chemical

Chemicals: H_2SO_4 and NaOH solutions, hydro alcoholic solution, ethanol solution at exactly, solution of acetonitrile and water, standard solutions of different sugars: sucrose, glucose and fructose.

Determination of TDF

Crude fiber is loss on ignition of dried residue remaining after digestion of sample with 1.25% (w/v) H_2SO_4 and 1.25% (w/v) NaOH solutions under specific conditions. Method is applicable to materials from which the fat can be and is extracted to obtain a workable residue, including grains, meals, flours, feeds, fibrous materials, and pet foods (Southgate et al., 1969).

Extraction of sugars using an ultrasound bath

We weighed 3 g of dry plants and introduced them in an Erlenmeyer flask of 250 ml, adding a hydro alcoholic solution at 80% (v/v), before putting the top on and introducing it in an ultrasound bath for half an hour at 60°C. Then it was centrifuged at 2500 rpm for 15 min. The supernatant, which contains the sugars of this first extraction, was transferred to a volumetric flask of 50 ml and the residue introduced in a new Erlenmeyer to carry out the second extraction in the same conditions as mentioned above. The floating material was again transferred to a flask of 50 ml which contained the previous floating material and this was diluted in an ethanol solution at exactly 80% (v/v). This solution contained the sugars from the initial samples and once filtered-filters of 0.2 m and degasified it was utilized for analysis using liquid chromatography.

Determination of sugars using advanced HPLC

Sugars are determined in the combined extracts using high-performance liquid chromatography (HPLC) with a universal evaporative light scattering detector. In the mobile phase we used a solution of acetonitrile and water in a ratio 80/20 previously filtered and degasified, like the sample. The column used was of the amino kind (Teknokroma, kromasil 100 NH_2 5 m 25 × 0.46 cm^2), thermostatized at 30°C in order to avoid fluctuations in detector responses. Working conditions were: flow rate of 1.5 ml/min, detector temperature 130°C and pressure 40 mmHg. The analyses were performed in triplicate batches (Singh et al., 1969).

Before the quantitative and qualitative determination of sugars in the sample, we prepared standard solutions of different sugars: sucrose, glucose and fructose. With those standard solutions of different sugars we made calibration lines for each one of the sugars, which were later used for assessing the concentrations corresponding to the different peaks in the chromatograms.

Statistical methods

For the statistical analysis of our sampling we have used the Windows SPSS 10.0. Comparisons were carried out at 95% confidence by application of the Anova and Dunnet Test, which establishes a comparison of means of sucrose and glucose contents between the plants varieties.

RESULTS AND DISCUSSION

Among the vegetables, the TDF content was low in *P. oleracia* (dried) (8 g %), and high in *C. myxa* (27.7 g %). The TDF contents of the fruits ranged between 23.9and 25.7 g% in *S. indicum Linn* and *C. myxa* respectively. The SDF content of vegetables ranged from 22.9 g % in *E. ochreata* to 8 g % in *P. oleracia* The TDF % was minimum in *P. oleracia* (8%) and maximum in *C. myxa* (25.7%). The TDF % was moderate in *C. comosum* (17.24%). The TDF % was high in *M. dioicia* (21.3%), *E. ochreata* (22.9%) and *S. indicum* (23.9%). The TDF % was low in *Alocacia indica* (11.05%) and was relatively high in *A. officinalis* (18.5%) (Figure 1).

Comparison of Figures 2, 3, 4 and 5 showed that fructose, glucose, sucrose contents were high in *C. myxa*

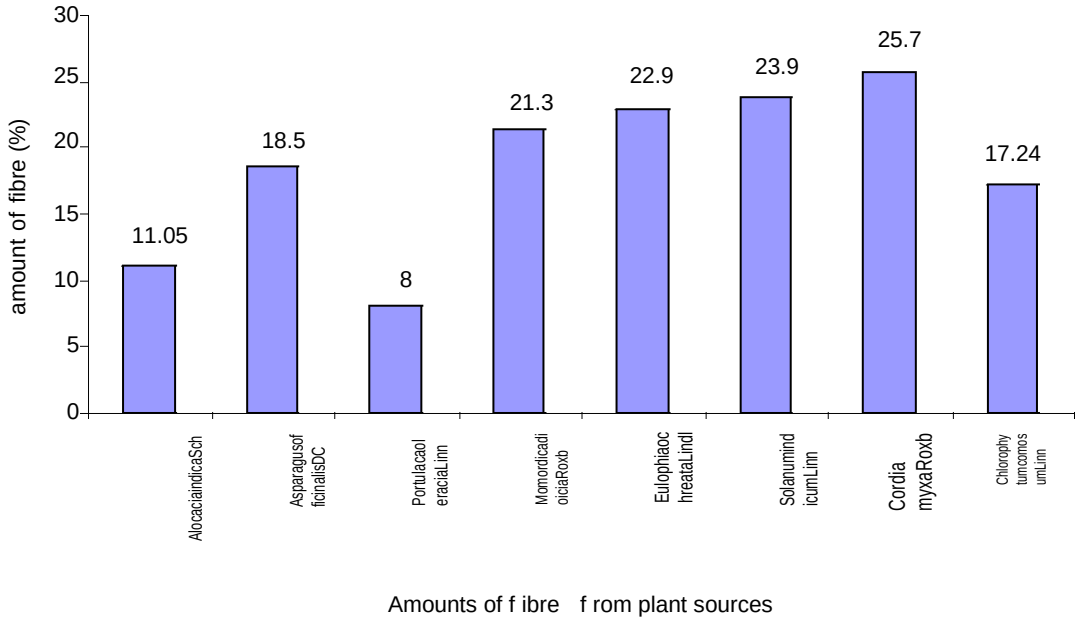

Figure 1. Fiber contents of plants sources.

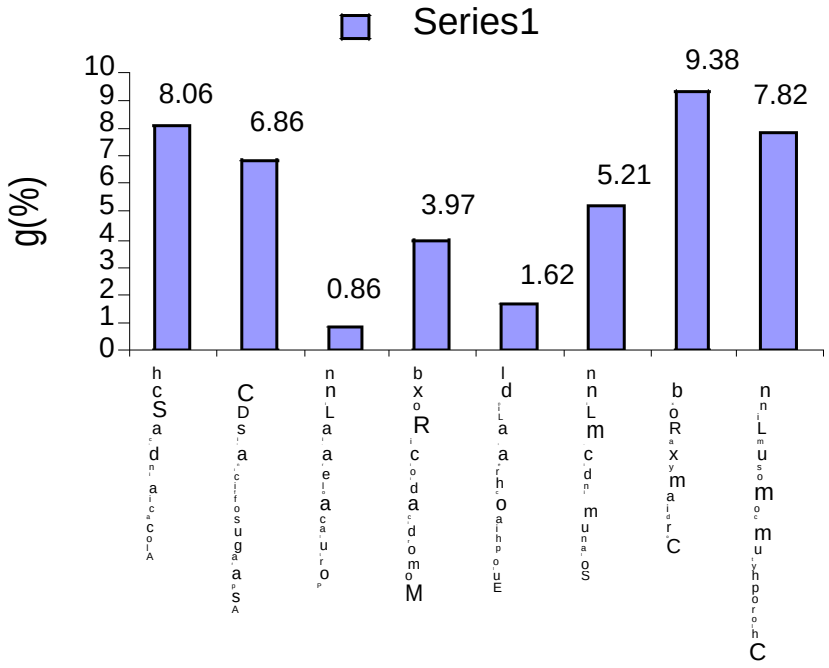

Figure 2. Fructose contents of plants (edible plant) sources.

(9.38, 12.75 and 29.09%) respectively and the starch content was high in *Alocacia indica* (60.41%) and fructose and glucose contents were low in P. *oleracia* (0.86, 0.01%) respectively and sucrose content was not detected in *A. officinalis* and *P. oleracia,* starch content was low in *C. myxa* (5.86%).

Intervarietal comparison of results showed that the sucrose variables were not significantly different between *Eulophia*, *Solanum and Asparagus*, *Portulaca* and also the glucose variables were not significantly different between *Asparagus*, *Momordica* and *Momordica, Eulophia*, and *Solanum, Chlorophytum*.

The vegetables of *Asparagus, Portulaca*, *Momordica Eulophia* and *Solanum* contain lowest content of the

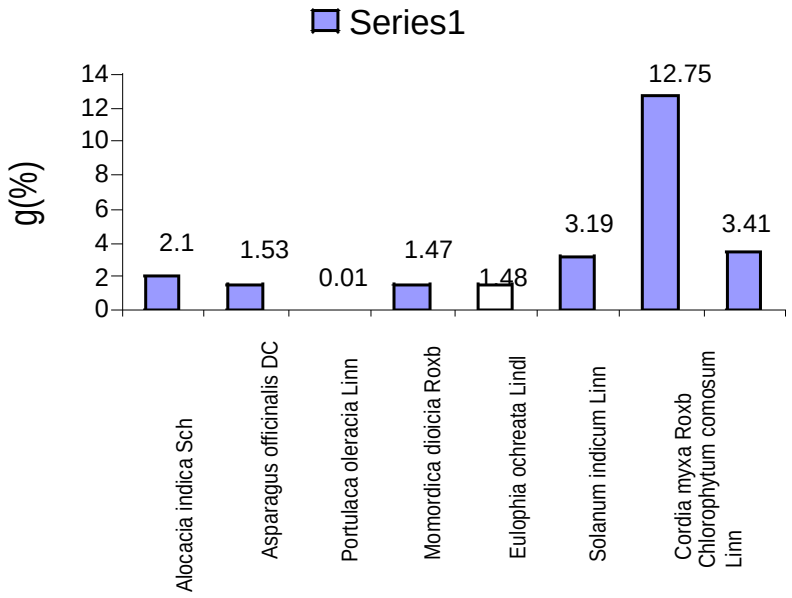

Figure 3. Glucose contents of plants (edible plants) sources

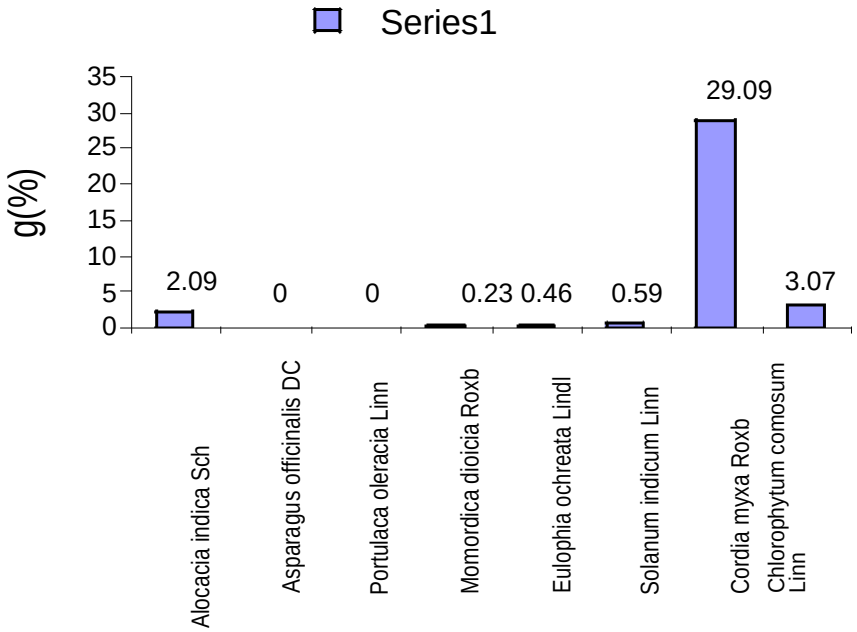

Figure 4. Sucrose contents of plants sources

disaccharide, whilst *Cordia* was the sweetest fruits.

The values of sucrose in other plants were very low, which may be due to a partial hydrolysis of sucrose.

Therefore, *Alocacia* have high calorie and nutritional value because it contains high starch and total carbohydrates contents (Figure 6).

Parmar et al. (1982), carbohydrates contents of *C. myxa* Roxb reported below: The fruit contains total sugars, 3.55 g; reducing sugars, 3.41 g; non-reducing sugars, 0.08 g, and pectin, 4.5 g; all per 100 g of the edible portion.

Duke and Ayensu (1985), carbohydrates contents of *A. officinalis DC* reported below: In grammes per 100 g stem fresh weight of food: Carbohydrate: 5 Fibre: 0.7, Carbohydres contents of *P. oleracia Linn* reported by Ezekwe et al. (1999), Leaves (Dry weight) in grammes per 100 g

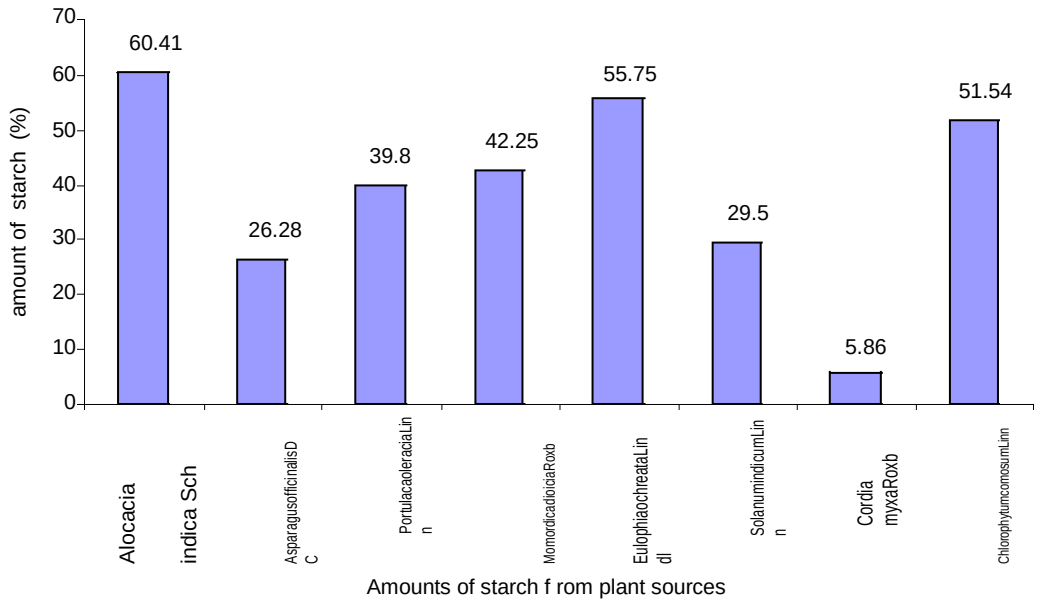

Figure 5. Starch contents of plants sources

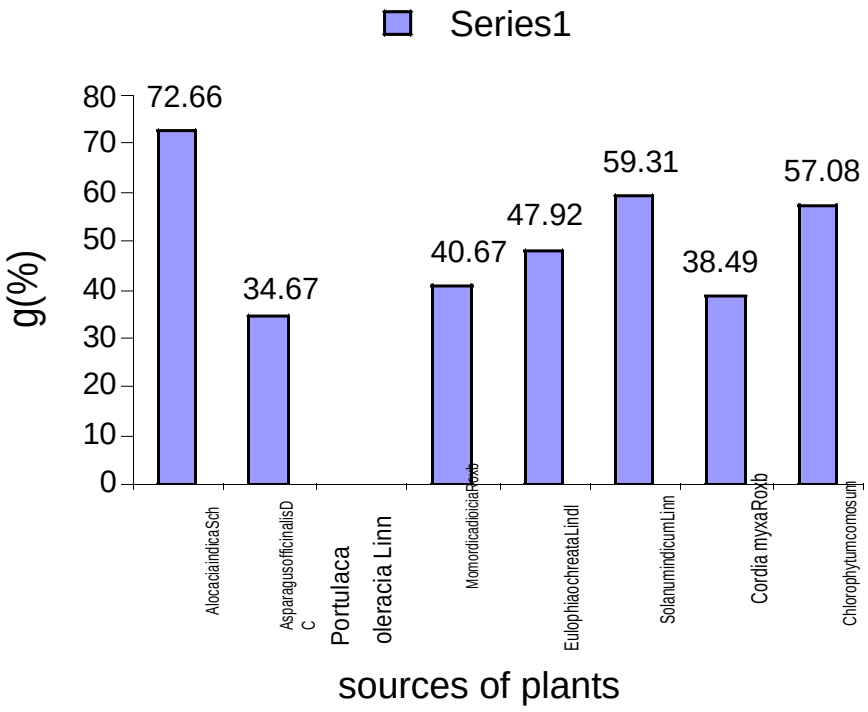

Figure 6. Total carbohydrates contents of plants (edible plants) sources.

weight of food: Carbohydrate: 50 Fibre: 11.5.

Carbohydrates contents of *C. comosum Linn* has been showed by Becker B, 1983, in below: Carbohydrates: 35 - 42%.

Comparison of obtained results from this study with other workers results showed that carbohydrates amounts of studied edible plants in this research except *Portulaca* were higher than obtained results from other workers.

It is observed the edible plants of *Portulaca, A. Momordica* and *Eulophia* are relatively good carbohydrates

sources in plant -based diets.

Conclusion

The nutrition parameters, such as water, starch and free sugars, in the edible plants studied, are in accordance with the literature data. The free sugars concentrations appear to be high in the *S. indicum*, *C*. *myxa,* and *C. comosum* plants. The starch concentration is low in the *C. myxa* plant.

Three plants, *M. dioicia*, *E. ochreata* and *P. oleracia,* are suitable for high temperature food processes, because they have very low free sugars concentrations; thereby reducing the possibility of Maillard reaction and then acrylamide formation.

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