

Biochemical Analysis and Nutritive Values of a Non-major Citrus Fruit *Citrus macroptera* Mont. var. *annamensis* Tanaka (Satkora)

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Abstract

'Sat Kara', an important citrus fruit, is edible and popular among the people of greater Sylhet region of Bangladesh as well as Meghalaya and Assam of India. Quantitative biochemical analyzes were conducted to determine its nutritional values through the estimation of proximate nutrients, available major acids and minerals. Results revealed that ash and moisture content of the Satkora peels were 0.89% and 75.53% respectively. Protein, fat and carbohydrates percentage of peels were found to be 1.02%, 0.85% and 18.98% respectively. pH value for peel was 4.32 and, 2.45 for juice. Total Soluble Solid (TSS) for peel and juice was estimated to be 24.47% and 12.43% respectively. Crude fibre and energy of peel were 2.46% and 90 Kcal per 100 grams. The most important component, vitamin C (ascorbic acid), was found to be 5.58 mg / 100 g for peel and 53.07 mg / 100 g for juice. Citric acid was estimated as 4.53 mg / 100 g for peel and 55.05 mg / 100 g for juice while the values were 1.43 and 4.54, respectively, for malic acid. The respective values for mineral content from peel and juice, as determined according to the standard methods, are: Phosphate: 0.20%, 0.14%; Sodium: 3.58%, 2.57%; Potassium: 2.14%, 1.14%; Calcium: 0.19%, 0.21%; Magnesium: 0.38%, 0.26%; Copper: 0.06%, 0.07%; Zinc: 0.07%, 0.05%; Iron: 0.33%, 0.31%; Manganese: 0.13%, 0.17%.

Key words : Nutritive value, Proximate nutrients, *Citrus macroptera* Mont. var. *annamensis*.

Introduction

Citrus macroptera Mont. Var. *annamensis* Tanaka is a non-major citrus fruit under the taxonomic family *Rutaceae*. This edible fruit is popular among the people of greater Sylhet region of Bangladesh, Meghalaya and Assam of India¹. In Bangladesh, both green and mature fruits are used for flavoring curry of meat, fishes, vegetables and pulses. This fruit is a primary ingredient in the preparation of tasty 'Satkora'

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pickles. During off season, previously dried and preserved fruits can also be used in the preparation of curry. . Although the juices contain modest nutritive values they are not generally used like lemon and lime. In India, local tribes of Assam take this as traditional medicine². In addition to its culinary and medicinal importance, antioxidant activity of the crude extract of this plant has recently been reported³.

Yet there is no production statistics of Satkora in Bangladesh, the availability and sale of this fruit in different markets of Sylhet are increasing day by day. More than 90% of total supply of this fruit is from the neighboring states of India⁴. During season, from July to November, per piece of standard-size fruit is sold at Tk. 15-20 while the price varies from Tk. 70-100 during off season.

It is well established that some of the nutrients in citrus fruits promote health and provide protection against chronic diseases like cardiovascular diseases, cancer, obesity etc. for which citrus fruits and juices have long been considered as a valuable part of a healthy and nutritious diet. Though Citrus fruits are most commonly thought of as a good source of vitamin C they also contain an impressive list of other essential nutrients, including both glycemic and non-glycemic carbohydrate (sugars and fibre), potassium, folate, calcium, thiamin, niacin, vitamin B₆, phosphorus, magnesium, copper, riboflavin, pantothenic acid and a variety of phytochemicals⁵. In addition, citrus fruits contain no fat or sodium and, being a plant food, no cholesterol. The average energy value of fresh citrus fruit is also low, which can be very important for consumers who are concerned about putting on excess body weight⁵. Because of significant effect on growth, development, general health and overall survival, consumption of citrus fruits is now promoted by a host of nutritionists. This habit is also very much important for the population who need to combat micronutrient deficiencies along with problems of over-nutrition and diet-related chronic diseases⁵.

As mentioned earlier that Satkora is an exceptional fruit, its uses are limited in some regions and nutritional value is not appropriately highlighted. Moreover, only peel of the fruit is used as a flavoring agent although it is assumed that the juice of fruit has the potential to be considered as a source of vitamin C and other nutrients available in other citrus fruits. In this regard, the present study aims at determining the proximate nutrient values of the fruit along with pH, Total Soluble Solids (TSS) of both peel and juice, vitamin C, Citric acid, malic acid and other micronutrients.

Materials and Methods

Fresh Satkora samples were collected from Regional Citrus Research Station of Bangladesh Agriculture Research Institute (BARI) Jaintpur, Sylhet. Just after

harvesting, the fruits were wrapped by clean poly bag and preserved under normal freezing for further analysis. Ash content was estimated according to the methods of Joslyn⁶. Moisture was determined following the steps of Indian Council of Medical Research, National Institute of Nutrition (ICOMR, NIN)⁷. The nitrogen content of the sample was determined by Kjeldahl method as described by Association of Official Analytical Chemists (AOAC) from which values for protein were calculated by using a conversion factor of 6.25⁸. The Soxhlet method was used to determine fat content as recommended by AOAC, 1990⁹. The amount of carbohydrate was obtained by differences i.e. by subtracting the sum of average values for ash, moisture, protein and crude fat from the 100 g of dry sample. Crude fibre, the organic residues composed mostly of cellulose together with little lignin, was measured according to the procedure described by ICOMR⁷.

Energy content of fresh peel was calculated by using Atwater Factor. From the summation of these values the total metabolizable energy was calculated¹⁰. The pH was determined by a pH meter (Model- Jenway instrument, pH meter 3305, Jackson (1967). Total Soluble Solid (TSS) of juice and peel was determined by hand Refractometer. Estimation of ascorbic acid was done by spectrophotometric method¹¹. The citric and malic acid contents were estimated by following standard titration method with 0.1N NaOH and 0.1N HCl. Phosphorus was estimated by "ascorbic acid blue colour method"¹². Sodium and potassium of both peel and juice were determined by flame emission spectrophotometry (Model: Jenway, PEP7) and calcium and magnesium by EDTA titration method¹³. The copper, zinc, iron and manganese content were determined from the extract of acid digestion by Atomic Absorption Spectrometer (ASS).

Results and Discussion

The content of proximate nutrients and energy value are Table 1.

Percentage of ash present in peel was found to be 0.89%. Moisture content was estimated to be 75.53%. The concentration of protein was 1.02 g/100 g for peel and 0.75 g/100 g for juice. Carbohydrate content of peel was estimated to be 18.98 g/100g. Fat content for peel and juice was calculated to be 0.85 g/100g and 0.43 g/100 g respectively. Crude fibre was 2.46% for peel and 1.54% for juice. Energy was calculated to be approximately 90.00 kcal for peel.

Percentage of ash as previously estimated was 0.61% for California lemon, 0.78% for Valencia orange and 0.65% for Neval orange which are close to the present findings (0.89%)¹⁴. Similarly, reported values of moisture for peel were 81.62% (California

lemon), 85.05% (Valencia orange) and 75.09% (Neval orange) which are near to the estimated value (75.53%)¹⁴.

Table 1: Proximate composition and energy (Kcal) of *Citrus macroptera* Mont. var. *annamensis* Tanaka (Satkora).

Variable	Content in peel (g/100 g)	Content in juice (g/100 g)
Ash	0.89 ± 0.01	----
Moisture	75.53 ± 0.06	----
Protein	1.02 ± 0.02	0.75 ± 0.03
Carbohydrate	18.98 ± 0.32	----
Fat	0.85 ± 0.08	0.43 ± 0.04
Crude fibre	2.46 ± 0.24	1.56 ± 0.03
Energy (Kcal/100g)	90.00 ± 0.56	-----

Protein, fat, carbohydrate and energy from sweet orange were estimated to be 1.3%, 1.0%, 15.7% and 67 kcal respectively¹⁵. Because of low fat content, citrus fruits are recommended for maintaining good health. Average crude fibre of citrus species (peel) was measured 5.84-7.10% which is higher than the present findings (2.46%). Fibre has significant physiological effect as it softens stool and enhances frequent waste elimination, including bile acids, sterols and fats.

The values of pH, TSS, Vitamin C (ascorbic acid), citric acid and malic acid values are presented in Table 2.

Table 2: The pH, TSS, and organic acid content of *Citrus macroptera* Mont. var. *annamensis*.

Variable	Peel	Juice
pH	4.32 ± 0.13	2.45 ± 0.04
TSS (g%)	24.47 ± 0.13	12.43 ± 0.21
Ascorbic acid (mg/100g)	5.58 ± 0.77	53.07 ± 0.69
Citric acid (mg/100g)	4.53 ± 0.32	55.25 ± 0.32
Malic acid (mg/100g)	1.43 ± 0.05	4.54 ± 0.21

The values for pH were 4.32 for peel extract and 2.45 for juice. Total Soluble Solid (TSS) for peel and juice was estimated to be 24.47% 12.43% respectively. 4.53

mg/100g and 55.25 mg/100g of citric acid were recorded for peel and juice, respectively. Malic acid was estimated to be 1.43 mg/100g for peel and 04.54 mg/100g for juice. Karadeniz et al. found pH and TSS of lemon which are almost equal to the current values¹⁷. Citric acid is a weak acid; it is a natural preservative and also used to add an acidic or sour taste to foods and soft drinks. Next to citric acid, malic acid is also present in peel and juice. The vitamin C in the fruit juices of different species of citrus fruits varies from 25mg to 85mg/100g. We found an ascorbic acid concentration of 53 mg/100g for juice and 5.58 mg/100g for peel of Satkora.

The essential mineral content of the fruit is shown in table 3 and the presence of these minerals signifies the medicinal values of the fruit. Kwu and Emanke investigated the minerals of some citrus species and they found the average values of phosphate, sodium, potassium, calcium, and manganese at a level of 0.24%-0.4%, 0.28%-0.36%, 0.28%-1%, 2.0%-3.2% and 0.49%-0.61%, respectively which are consistent with the current findings¹⁶. The trace components (Cu, Zn, Fe and Mn) of the fruit's peel and juice are also presented in the table 3. The percentage values of Cu, Zn, Fe and Mn for peel are 0.06, 0.07, 0.33 and

Table 3: Mineral content of peel and juice of *Citrus macroptera* Mont.var.*annamensi* (dry weight basis).

Mineral	Content in peel (g %)	Content in juice (g %)
Phosphate	0.20 ± 0.01	0.14 ± 0.01
Sodium	3.58 ± 0.15	2.57 ± 0.13
Potassium	2.14 ± 0.05	1.14 ± 0.12
Calcium	0.19 ± 0.03	0.21 ± 0.03
Magnesium	0.38 ± 0.04	0.26 ± 0.03
Copper	0.06 ± 0.00	0.07 ± 0.00
Zinc	0.07 ± 0.01	0.05 ± 0.00
Iron	0.33 ± 0.06	0.31 ± 0.03
Manganese	0.13 ± 0.02	0.17 ± 0.02

0.13% and for juice are 0.07, 0.05, 0.31 and 0.17%. The results are almost same for peel and juice. The findings of Theiodossions et al. for grapefruit juice are 0.17-0.42 (Cu), 0.32-0.81 (Zn), 0.11-0.93 (Fe) and 0.04-0.82 (Mn) which are higher than the values for *Citrus macroptera*¹⁸.

Conclusion

“Satkora” is a good source of vitamin C, citric acid and minerals which have significant role for maintaining general health and for protecting body from diseases. Although the peel of *Citrus macroptera* is widely used as a flavouring agent for cooking curry and preparing pickles in certain areas of Bangladesh and India the present study reveals that the juices of the fruit also contain appreciable amount of ascorbic acid (Vitamin C) and citric acid along with other essential minerals. As juice of Sat Kara is not traditionally used in our country, initiatives are needed to be taken to promote the uses of juice directly or commercially processed as a healthy drink. Juice may also be used for producing various commercial products.

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