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Full Length Research Paper

Ficus racemosa bark: Nutrient composition, physicochemical properties and its utilization as nutra tea

Faiyaz Ahmed[1]*, Mysore Ramaswamy Asha[2], Asna Urooj[1] and Kodangala Keshava Bhat[2]

[1]Department of Studies in Food Science and Nutrition, University of Mysore, Mysore - 570 006, India.
[2]Sensory Science Department, Central Food Technological Research Institute (CFTRI), Mysore - 570 020, India.

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The present study reports, the nutrient composition, physicochemical properties and utilization potential of *Ficus racemosa* stem bark as an ingredient in tea, a popular non alcoholic beverage. The bark was found to be a good source of dietary fiber, minerals, sugars and phenolic compounds. On dry basis, the total dietary fiber content was 20.5% of which major portion was contributed by insoluble dietary fiber (13.6%). Potassium was the most abundant mineral (11975 ppm) followed by chloride (7475 ppm) and calcium (1729 ppm). The bark was also a good source of other minerals and trace elements such as phosphorus and iron, zinc, magnesium, respectively. Further, the bark powder was used as an ingredient in the preparation of tea and the bark incorporated tea (nutra tea) was found to contain significantly higher amounts of phenolic compounds compared to control tea ($p \leq 0.05$). Sensory analysis of the nutra tea indicated no perceptible off-taste or off-aroma and the overall quality was similar to that of control and was acceptable in terms of all sensory attributes. The results suggest that the bark could be effectively used in the preparation of tea to derive its beneficial effects particularly attributable to those of phenolics.

Key words: *Ficus racemosa*, Nutra tea, total phenolics, AAS, sensory analysis.

INTRODUCTION

Ficus racemosa Linn (Moraceae) is an evergreen, moderate to large sized spreading, lactiferous, deciduous tree, without much prominent aerial roots found throughout greater part of India in moist localities and is often cultivated in villages for its edible fruit (Anonymous, 1952). Different parts of *F. racemosa* are traditionally used as fodder, edible and ceremonial (Manandhar, 1972). All parts of this plant (leaves, fruits, bark, latex, and sap of the root) are medicinally important in the traditional system of medicine in India. The leaves powdered and mixed with honey is given in bilious infections (Kirtikar and Basu, 1975). Fruits are a good remedy for visceral obstruction and also useful in regulating diarrhea and constipation (Vihari, 1995). The astringent nature of the bark has been employed as a mouth wash in spongy gum and also internally in dysentery, menorrhagia and haemoptysis (Chopra et al., 1958). The bark is antiseptic, antipyretic and vermicidal, and the decoction of bark is used in the treatment of various skin diseases, ulcers and diabetes. It is also used as a poultice in inflammatory swellings/boils and regarded to be effective in the treatment of piles, dysentry, asthma, gonorrhea, gleet, menorrhagia, leucorrhea, hemoptysis and urinary diseases (Anonymous, 1952; Kirtikar and Basu, 1975; Nadkarni et al., 1976).

Apart from the usage in traditional medicine, scientific studies indicate *F. racemosa* to posses various biological effects such as hepatoprotective (Mandal et al., 1999), chemopreventive (Khan and Sultana, 2005), antidiabetic (Rao et al., 2002), anti inflammatory (Mandal et al., 2000), antipyretic (Rao et al., 2002b), antitussive (Rao et al., 2003) and antidiuretic (Ratnasooriya et al., 2003). The bark has also been evaluated for cytotoxic effects using 1BR3, Hep G2, HL-60 cell lines and found to be safe and less toxic than aspirin, a commonly consumed anti-inflammatory drug (Li et al., 2004).

Tea is the world's most popular non alcoholic beverage

*Corresponding author. E-mail: fayaz_ahmed09@yahoo.co.in. Fax: +91-821-2419632.

and a richest natural source of antioxidants. The health benefits of tea, in particular its potential to promote heart health, are mainly attributed to its flavonoid content/ composition (Rice-Evans et al., 1996). Since, current literature suggests *F. racemosa* bark to possess strong antioxidant effect (Veerapur et al., 2007) and in recent years, plants/herbs are being employed in the development of natural antioxidant formulations for food, cosmetic and other pharmaceutical applications (Dillard and German, 2003). The present study was planned to explore the possibility of using *F. racemosa* bark as an ingredient in tea preparation with a view to promote its consumption. In addition, the nutrient profile and the physicochemical properties of the bark were also studied. Furthermore, this is the first report on the nutrient profile and the utilization potential of *F. racemosa* bark.

MATERIALS AND METHODS

Plant material

F. racemosa stem bark was collected from three places (Mukkadahally, Kalana Hundi and Halepura) of Chamarajanagar district, Karnataka State, India and the voucher specimen (BOT-001/2008) was deposited at the herbarium of Department of Studies in Botany, University of Mysore, Mysore, India. The bark was cut into small pieces, dried in a hot air oven (50°C), powdered, passed through 60 mesh sieve (BS) and stored in an air tight container at 4°C till further use.

Proximate composition

The moisture, protein, fat and ash contents were determined using the standard AOAC methods of analysis (AOAC, 1984; AOAC, 1986). Dietary fiber content was determined by the method of Asp et al., (1983) Vitamin C was determined by indophenol dye method (Freed, 1996).

Elemental composition

Two grams of the bark powder was taken in a silica crucible and then subjected to dry ashing in a muffle furnace set at 550°C. The resultant ash was dissolved in 5 ml of $HNO_3/HCl/H_2O$ (1:2:3 v/v/v) followed by heating on a hot plate at boiling temperature of the solution until brown fumes disappeared. 5 ml of deionized water was added to the contents of the crucible and the mixture was heated until a colorless solution was obtained. The colorless solution was filtered into a 100 ml volumetric flask using Whatman no. 42 filter paper and the volume was made upto the mark with de-ionized water. The concentrations of the following elements Ca, Mg, Mn, Zn, Fe, Al, Hg, Cu, Cr, Ni, Ar, Pb and Co were determined by Atomic absorption spectroscopy (GBC Avanta, GmbH, Germany), having initially prepared a standard curve for each element under investigation. The concentration of each element was expressed in ppm. Sodium and potassium concentrations were determined using flame photometer (Systronics 129, India) while, phosphorous was analyzed by AOAC standard method (AOAC, 1984; AOAC, 1986).

Estimation of total phenolics

The total phenolics (TP) content was estimated according to Folin Ciocalteu micro method (Slinkard and Singleton, 1977). Briefly, the tea decoction (20 µL) was mixed with distilled water (1.58 mL) and Folin Ciocalteu reagent (100 µL) followed by the addition of Na_2Co_3 (20%, 200 µL), after 1 min and before 8 min. Subsequently, the mixture was incubated at 40°C for 30 min and the absorbance was read at 760 nm. Gallic acid was used as standard for calibration curve and the TP content is expressed as gallic acid equivalents (GAE).

Functional properties

The bulk density of the sample was determined by the method described by Narayana and Narasinga (1984). Briefly, three grams of the sample was filled into a 10 ml measuring cylinder, gently taped over a rubber mat, volume occupied was noted in ml and expressed as g/cc. The water absorption capacity was determined by the method of Beuchat (1977). Briefly, one gram of the sample was transferred into 15 mL centrifuge tube. 5 ml of distilled water was added and mixed well with a glass rod. The tubes are allowed to stand for 30 min, centrifuged at 3000 ×g (20 min) and the supernatant was drained into a measuring cylinder. Amount of water absorbed by the sample is calculated and expressed as g/g.

Swelling power and solubility

A weighed amount of sample with known moisture content was mixed with a measured volume of distilled water and heated at varying temperatures of 55, 65, 75, 85 and 95°C respectively in a temperature controlled water bath for 30 min with intermittent stirring. After heating, the slurry was centrifuged (3000 g; 20 min) and supernatant was drawn off and evaporated to dryness on steam bath to obtain a measure of the dissolved solids. The sediment flour obtained after centrifugation was weighed to get the weight of the swollen flour particles. The values were expressed as percentages of total dissolved solids (solubility) and total swollen flour particles (swelling power) with respect to the weight of the flour sample used (Schoch, 1964).

Product development (Nutra Tea)

The formulation of Nutra tea is given in Table 1. Briefly, to 125 mL of boiling water, a mixture of coarsely powdered tea leaves (3 g - Red label; Brook bond, India) and *F. racemosa* bark powder (3.3 g - 100 mesh BS) was added, boiled over low flame (3 min), removed from fire and kept covered for 5 min. It was strained through muslin cloth fitted into a tea strainer. To the collected decoction, 25 mL of freshly boiled milk and sugar/aspartame were added and mixed well. The samples were maintained at 60 - 65°C and served to the panelist for sensory evaluation. The collected decoction was also analyzed for TP content.

Sensory analysis

Samples were served hot (60 - 65°C) in containers coded with three digit random numbers, to the panelists. Plain water and bland biscuits were served as palate cleansers, along with the samples. Sensory analysis of tea samples was carried out in "Sensory Booths" under white fluorescent light, with the booth area maintained at a temperature of 20 ± 2°C and RH 50 ± 5%. Descriptors for the quality of tea were generated by 'Free choice profiling' and suitable ones were listed on the score card developed.

Sensory analysis of the tour samples of Nutra-tea was carried out by a trained panel of 10 members. "Quantitative Descriptive Analysis" (QDA) method was employed for this purpose, using a

Table 1. Composition of Nutra tea samples. S1 (control- not contained the bark powder and contained sugar), S2 (experimental- contained the bark powder and sugar), S3 (control- not contained the bark powder and contained aspartame) and S4 (experimental- contained aspartame and bark powder).

Sample	Water (ml)	Tea leaves (g)	Bark powder (g)	Milk (ml)	Sugar (g)	Aspartame (mg)
S1	125	3.0	0.0	25	6.0	0.0
S2	125	3.0	3.3	25	6.0	0.0
S3	125	3.0	0.0	25	0.0	200
S4	125	3.0	3.3	25	0.0	200

Table 2. Average concentration of nutrients (±SD) of *F. racemosa* bark on fresh and dry basis.

Nutrients	Fresh basis (%)	Dry basis (%)	Poplar bark dry basis (%)*
Moisture	65.0 ± 0.23	7.6 ± 0.15	ND
Protein	1.48 ± 0.15	3.9 ± 0.39[b]	2.2[a]
Fat	0.95 ± 0.08	2.5 ± 0.21[a]	5.8[b]
Total Ash	5.52 ± 0.04	14.5 ± 0.09[b]	2.68[a]
Starch	2.70 ± 0.06	7.0 ± 0.15	ND**
Total Sugars	5.70 ± 0.06	15.0 ± 0.15	ND**
SDF	2.60 ± 0.02	6.9 ± 0.06	ND**
IDF	5.17 ± 0.02	13.6 ± 0.06	ND**
TDF	5.52 ± 0.04	20.5 ± 0.12[a]	53.7[b]
Vitamin C (mg)	23.47 ± .060	61.7 ± 1.56	ND**

*Literature value; ND**: Not determined. [a,b] - Different letters indicate statistical differences ($p \leq 0.05$) between fresh basis, dry basis and popular back.

scale of 0 - 15 cm. This scale was anchored at 1.25 cm on either end as 'Low' and 'High' representing 'Recognition Threshold' and 'Saturation threshold' respectively.

Panelist were asked to mark the perceived intensity of each attribute listed on the score card by drawing a vertical line on the scale and writing the code number. The scores for each attribute for a given sample were tabulated, representing the judgment of individual panelists. Finally, mean value was taken for each attribute of a sample, representing the panel's verdict about the sensory quality of the product. This is represented graphically as "Sensory Profile"

Statistical analysis

All the values are mean ± SD of triplicates determinations of three replicates. The data was analyzed by ANOVA followed by Tukey's multiple comparisons test for significant differences using SPSS 14.0 software and the graphs were plotted using Origin 6.1 software. The values were considered significant at $p \leq 0.05$.

RESULTS AND DISCUSSION

Proximate composition

The proximate composition of the *F. racemosa* bark is presented in Table 2. On fresh basis, the moisture content of the bark was relatively high (65%) while, it was relatively low (7.6%) on dry basis. Although the bark contained high total dietary fiber (20.5%) it was comparably lower than that of poplar bark, which contained 53% of crude fiber (Enzmann et al., 1969). A major proportion of the total dietary fiber was insoluble dietary fiber (13.6%) and about 6.9% was soluble dietary fiber. The total starch content was low (7%) while, the bark contained exceptionally amounts of high total sugars (15%). The protein content was 3.9 g% which is comparatively higher than that of poplar bark (Enzmann et al., 1969). The lipid content was found to be 2.5% which also contained petroleum ether soluble phytochemical components including phytosterols such as β-sitosterol and triterpinoids such as β-amyrin and lupeol acetate (Rahman et al., 1994). Hence, the value obtained may not be true representation of the fat content of the bark.

Elemental composition

The mineral composition of the bark is shown in Table 3. It is observed that potassium was the most abundant mineral present in the bark followed by chloride and calcium. The bark was a good source of iron, magnesium, phosphorous as well as trace elements such as manganese, nickel, chromium, zinc and copper. However, the bark contained significantly less ($p \leq 0.01$) sodium in proportion to potassium. The trace elements

Table 3. Concentration of mineral elements (±SD) in the bark of *F. racemosa* (dry basis).

Mineral elements	Concentration (ppm)
Calcium	1729.3 ± 13.02
Iron	159.2 ± 2.03
Magnesium	196.2 ± 4.63
Phosphorous	443 ± 8.98
Zinc	0.49
Manganese	1.9 ± 0.14
Nickel	1.9 ± 0.14
Cadmium	ND
Chromium	0.38
Copper	5.2 ± 0.15
Lead	0.017 ± 0.003
Sodium	255 ± 42.03
Potassium	11975 ± 537.74
Chloride	7475 ± 263
Aluminum	ND
Cobalt	ND
Arsenic	ND
Mercury	ND

*ND: Not detected.

such as cadmium, aluminum, cobalt, mercury and arsenic were not detected.

Total phenolics

The concentration of TP was estimated in the tea decoction and expressed in gallic acid equivalents (Figure 1). Nutra tea (both with sugar and with aspartame) was found to contain significantly higher ($p \leq 0.05$) amounts of phenolic compounds than the control tea (both with sugar and with aspartame) indicating its usefulness in counteracting free radical induced oxidative damage within the body as phenolics are reported to scavenge free radicals, thus protecting the cells from oxidative damage (Chin Yuan, 2006).

Functional properties

The bulk density of the sample was 0.5 g/cm^3 implying that, it might have packaging disadvantages as less weight would be packaged in a specific volume of a container. It is also reported that the physical properties such as bulk density, water absorption capacity, oil absorption capacity, gelation capacity, swelling index and viscosity could be influenced by the drying temperature in the course of processing (Oyenuga, 1968). The water absorption capacity of the sample was 3.0 g/g which depends on starch and protein concentration coupled with the particle size (Bolade et al., 2002). The sample with smaller particle size will have more surface area and higher sample-water interaction resulting in higher water holding capacity than the sample with bigger particle size. The water holding capacity of plant polysaccharides is determined by their chemical and structural properties and also by the pH and osmolality of the surrounding fluids (Anderson and Chen, 1979).

Swelling power and solubility

The swelling power and solubility of *F. racemosa* bark powder is shown in Figure 2. Swelling power ranged between 3.9 - 4.23%. No considerable swelling occurred over the range of temperature (55 - 95°C) and did not differ significantly. The swelling power of any powder depends largely on the starch content and it provides evidence of non-covalent bonding between starch molecules. Factors like amylase-amylopectin ratio, chain length and molecular weight distribution, degree/length of branching and conformation determine the degree of swelling and solubility (Rickard et al., 1991). Most polysaccharides swell in the presence of water to form gels. pectins, gums, mucilages and storage polysaccharides have high affinities for water, while hemicelluloses and celluloses bind water to a limited extent (Anderson and Chen, 1979). Hence lower swelling power of the sample

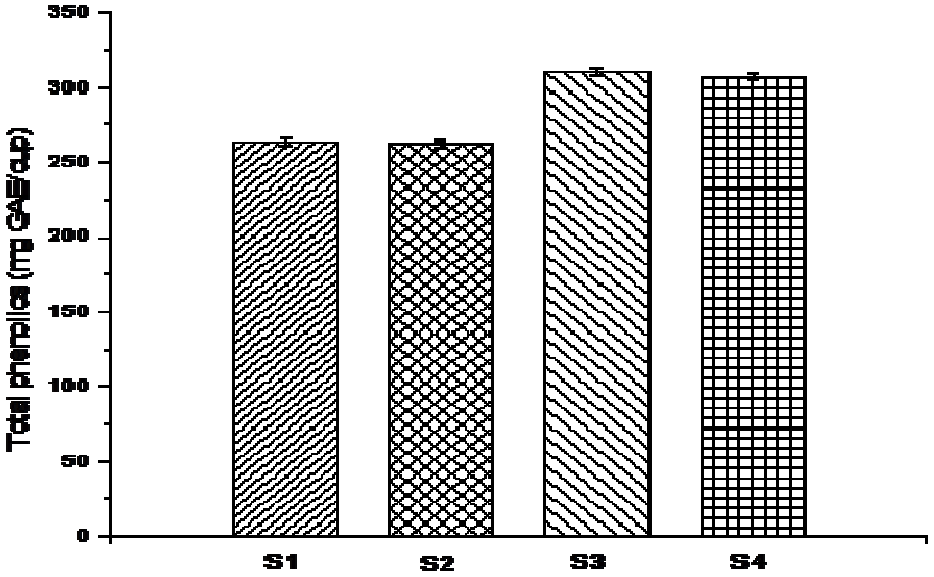

Figure 1. Concentration of total phenolics (±SD) in the tea samples. (control- not contained the bark powder and contained sugar), S2 (experimental- contained the bark powder and sugar), S3 (control- not contained the bark powder and contained aspartame) and S4 (experimental- contained aspartame and bark powder).

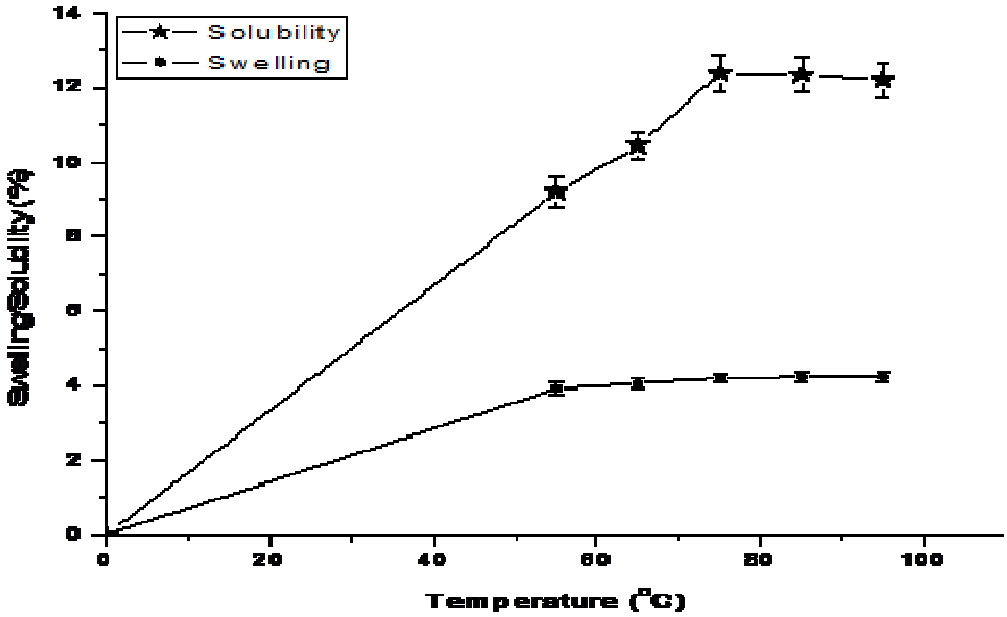

Figure 2. Swelling power and solubility (±SD) of *Ficus racemosa* bark powder.

could be attributed for its low starch content (7%).

Solubility depends on a number of factors such as source, inter-associative forces, swelling power, presence of other components etc (Bolade et al., 2002). The solubility of the bark powder being a function of temperature revealed that the sample had an initial solubility of 9.3% - 9.5% at 55 - 65°C, which increased to 12.2% at 75°C. However, no further increase in solubility was observed at 85 and 95°C.

Sensory analysis

Results of sensory analysis are presented in Figure 3. The

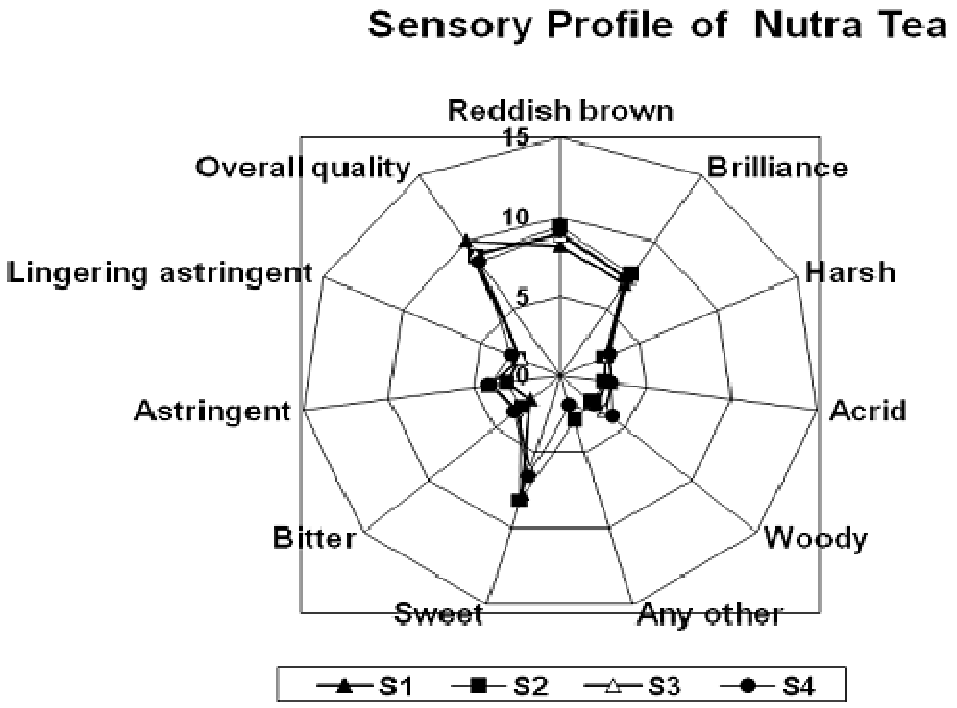

Figure 3. Sensory profile of Nutra tea samples. S1 (control- not contained the bark powder and contained sugar), S2 (experimental- contained the bark powder and sugar), S3 (control- not contained the bark powder and contained aspartame) and S4 (experimental- contained aspartame and bark powder).

The results indicated that S2 and S4 were slightly darker in color compared to S1 and S3. The trend of ratings for brilliance, harsh, acrid and woody notes was similar in all the four samples. However, compared to S1 and S2, sweetness was perceived to be significantly less ($p \leq 0.05$) in S3 and S4 where aspartame was used as sweetener instead of sugar. Bitterness and astringency were rated slightly higher in these two samples but this did not affect their overall quality, which was above 8.5. There was no perceptible off-taste or off-aroma in the experimental samples S2 and S4, with overall quality rated at 9.1 and 8.5 respectively. This indicated that the samples containing the *F. racemosa* bark powder extract were acceptable.

Conclusion

The present investigation has revealed that the *F. racemosa* bark is an excellent source of minerals particularly traces elements and total phenolics as well. The results demonstrate that *F. racemosa* bark could be effectively used in the preparation of tea without influencing sensory attributes as reflected by the sensory studies. Nutra tea could serve as a source of natural phenolics thus providing health benefits. Nevertheless, more work needs to be carried out in order to bring out the commercial usage of *F. racemosa* bark as an ingredient in tea.

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