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Characterization of chemical and antioxidant properties of Kiwi fruit

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Abstract
Actinidia deliciosa commonly known as Kiwifruit native to south Asia, is rich in many vitamins, flavonoids and minerals. Traditionally it has been used to treat various diseases like cancers, including those of the digestive system. Healthful attributes of kiwifruit are high ascorbic acid levels and polyphenols. The present study was carried out to evaluate the chemical and antioxidant characteristics of kiwi fruit.

Keywords: Antioxidant activity, Kiwi, Proximate composition

Introduction
Actinidia deliciosa commonly known as Kiwifruit, belong to the family Actinidiaceae and are distributed throughout the world, especially in eastern Asia. In India, the area under this fruit is very less, due to its exotic introduction. It has been extended to the mid-hills of Himachal Pradesh, Jammu-Kashmir and Arunachal Pradesh. Kiwifruits are normally consumed as fresh fruit (Atkinson and Macrae 2007) [4]. Ascorbic acid (Vitamin C) in fruits and vegetables is considered an important component for human nutrition.
More than 90% of the ascorbic acid in the human diet comes from fruits and vegetables (Lee and Kader, 2000) [16]. Kiwi fruit is rich in ascorbic acid and polyphenols. Ascorbic acid, as an antioxidant, is associated with a decreased risk of arteriosclerosis, cardiovascular diseases, and some forms of cancer (Harris, 1996) [10]. The polyphenolic compounds (flavonoids) also have antioxidant characteristics and can account for some benefits associated with the consumption of fruits and vegetables (Wong *et al*., 2006) [26]. Kiwifruits are used for the treatment of many different types of cancers, e.g., stomach, lung, and liver cancer (Yang 1981) [28] in traditional medicine. Some studies have shown that the extracts of kiwi fruits inhibit cancer cell growth (Song 1984) [23] and exhibit cell protection against oxidative DNA damage *in vitro* (Collins *et al*. 2001) [7]. The aim of the present study was to evaluate the chemical and nutritional characteristics of kiwi fruit.

Material and methods
Edible fresh fruit materials of *Actinidia deliciosa* were procured from the local market of Srinagar, Kashmir. The fruits were thoroughly washed, peeled, crushed and used for the physico chemical analysis. To study the total phenols and radical scavenging activity about 50gm of fresh fruits were minced and defatted using 50 ml of ethanol & distilled water at room temperature (27 °C) at an atmospheric pressure for 3 days by shaking at 100rpm /min speed. The extract was filtered, concentrated and used to determine the quantitative analysis.

Moisture content
5 gm of fruit samples were transferred in to a Petri dish and the contents were distributed evenly about 7.5 cm in diameter and to a depth of 2.5 cm. The tarred samples were air dried in an oven at 70 °C for 12 hours, kept in desiccators (to cool) and weighed at different time intervals until a constant weight was obtained. The processes were repeated until the difference in two successive weights are less than 1 mg. The difference in weight after drying and initial weight is the moisture content. Respective moisture content (%) for the samples was calculated (AOAC, 2007) [2].

Protein content

5 g of fruit samples were extracted 3 times with 50 ml of water by overnight cold percolation method. To 0.5 ml of sample, blank and standard taken in duplicate, 0.5ml of alkaline copper reagent was added, mixed and allowed to stand undisturbed for 10 minutes. Then 2 ml of phenol reagent was added to each tube; mixed immediately and placed at room temperature for 5 minutes and absorbance of samples and standard were taken at 615 nm against blank. The protein content of fruits was calculated by comparing with the standard curve **(**Raghuramulu *et al*., 2003) [20].

Fat content

5 g of fruit samples were placed in a soxhlet fitted with a condenser**.** 90 ml of petroleum ether (boiling point 40-60 °C) was taken in a 150 ml round bottom flask and boiled for 6 hours. The extract was taken in a pre- weighed conical flask and petroleum ether was evaporated on a water bath. The traces of petroleum ether were removed using a vacuum pump (AOAC, 2007) [2].

$$\text{Percentage of Fat content} = \frac{\text{Weight of petroleum ether extract}}{\text{Weight of the sample taken}} \text{ X } 100$$

Fibre

About 5 g of moisture and fat free fruit samples were weighed, added 200 ml of 0.255 N (1.25% W/V) sulphuric acid, boiled for 30 minutes and the volume was kept constant by the addition of water at frequent intervals. The mixture was filtered and the residues were washed with hot water until it was free from acid. To the filtrate then added 200ml of 1.25% sodium hydroxide and boiled for 30 minutes. The mixture was filtered and the residues were washed with hot water till it was free from alkali, followed by washing with some alcohol and ether. It was then transferred to a crucible, dried overnight at 80-100 °C and weighed (We). The crucible was heated in a muffle furnace at 60 °C for 2-3 hours. It was cooled and weighed again (Wa). The difference in the weights (We-Wa) represents the weight of fibre (Raghuramulu *et al*., 2003) [20].

$$\text{Fiber content} = \frac{[100-(\text{moisture} + \text{fat})]}{\text{Wt.of the sample taken}} \text{ X (We-Wa)}$$

Titratable acidity

Titratable acidity was determined using an automated titrimeter. Ten milliliter of clarified kiwifruit extracts were placed into a sample cup and titrated to the endpoint of pH 8.1 using 0.1 N sodium hydroxide. The results were expressed as % citric acid equivalent (AOAC, 2007) [2].

Ascorbic acid (Vit C)

Ascorbic acid was determined according to the volumetric method (Thimmaiah 1999) [24]. Ten milliliter of 4% oxalic acid was added to the standard solution of vitamin C (100µg/mL, purity ≥ 99%) and the resulting solution was titrated against 2, 6-dichloroindophenol dye until a pink colour end point was obtained and the titer value was noted as V1. Again, dried methanolic extract of each sample (500 mg) was extracted with 4% oxalic acid and volume was made to 100 mL. The filtered extract (5.0 mL) was mixed with 10 mL of 4% oxalic acid and titrated against 2, 6-dichloroindophenol dye until a pink colour end point was obtained and the titer value was noted as V2. Ascorbic acid content was calculated based on the following equation: Amount of ascorbic acid (mg/100 g sample) = 0.5 mg × V2 × 100 mL / V1 × 15 mL × Wt. of samples × 100, where V1 and V2 were the volume of the dye used to titrate vitamin C and sample extract, respectively. The result was expressed as mg ascorbic acid /100 g fresh weight (FW) of the plant material.

Total phenolic content

The total phenolic compound was extracted from 2 g of flesh tissue with 10 ml of cold 0.1 M phosphate buffer, pH 7.0 at 4 °C. Total phenolic compounds were measured using the Folin-Ciocalteu method (Keith *et al*., 1958) [15]. One ml of extract was added to 0.1 ml of Folin-Ciocalteu phenol reagent, 0.2 ml of 20% Na2CO3, and 8.7 ml distilled water. The mixture was boiled for 3 min and cooled immediately. The resulting blue complex was then measured at 660 nm. Gallic acid was utilized to plot the standard curve, and analytical results were expressed as mg Gallic acid equivalent per 100g of fresh weight (Hou *et al*., 2004 [12]; Huang *et al*., 2004 [13]).

Scavenging activity of 1, 1-diphenyl -2- picrylhydrazyl (DPPH) radical effect

The DPPH assay was done by measuring the decrease in absorbance of methanolic DPPH solution at 515 nm in the presence of the extract (Brand-Williams *et al*. 1995) [5] with some modifications. The stock solution was prepared by dissolving 24 mg DPPH with 100 mL methanol and then stored at -20 °C until further use. The working solution was obtained by mixing 10 mL stock solution with 45 mL methanol to get an absorbance of 1.17 ± 0.02 units at 515 nm. Fruit extracts (150 µL) of different cultivar were allowed to react with 2850 µL of the DPPH solution for 24 h in the dark and absorbance was taken at 515 nm. Butylated hydroxytoluene (BHT) was employed as a reference and the radical scavenging activity was calculated as a percentage of DPPH discoloration using the equation:

DPPH radical scavenging (%) = [(Acontrol – Asample)/Acontrol] × 100

Where Asample is the absorbance of the solution when the extract/reference has been added at a particular level, and Acontrol is the absorbance of the DPPH solution without addition of extract.

Results and discussion

Table 1 represents the results for moisture, protein, fat, fibre, titratable acidity, ascorbic acid, total phenols and DPPH radical scavenging activity of kiwi fruit.

Since in kiwifruit, as in all other fruit, water is the main component, a moisture content of 84.33% was reported in kiwi fruit. Lintas *et al* (1991) [17] reported a moisture content in the range of 80-87% in different varieties of Kiwi fruit. The protein content of kiwi fruit was 1.09%. Due to the high moisture content the protein content and other nutrients were quite low. Similar results were reported by Lintas *et al* (1991) [17] in different varieties of kiwi. Kiwi fruit had the fat content of 0.51%. Due to the seed and seed oil, kiwifruit has slightly more fat than other fruits. However, the total fat content is less than a gram per serving (Anonymous 1994) [1].The fibre content of kiwi fruits was 2.10%. Fibre helps in the maintenance of human health by reducing cholesterol level in the body and decreasing the risk of various cancers and improves general health (Hassan *et al*., 2009a) [11]. Yamanaka *et al* (2004) [27] reported fibre content of 2-3% in different varieties of kiwi fruit. The kiwi fruit recorded the titratable

acidity of 1.87%.

Table 1: Chemical and antioxidant properties of Kiwi fruit.

Parameter	Kiwi fruit
Moisture content (%)	84.33
Protein content (%)	1.09
Fat content (%)	0.51
Fibre (%)	2.10
Titratable acidity (%)	1.87
Ascorbic acid (mg/100gm)	62.78
Total phenols (mgGAE/100g)	937.54
DPPH scavenging activity (% inhibition)	46.41

Several studies demonstrate that consumer acceptance of kiwifruit is affected by the dry matter and the acidity levels and to maximize the consumer satisfaction, the researchers propose that the minimum quality index should be with ≥16.1% of dry matter when the titratable acidity is ≥1.2%, or with 15.1% of dry matter when the titratable acidity is <1.2% (Crisosto *et al*., 2012) [8]. However, Ramesh *et al* (2015) [21] recorded the titratable acidity in the range of 0.41-0.66% in different varieties of Kiwi. As one of the most popular fruits today, kiwifruit is characterized by a high content of vitamin C. The ascorbic acid content of kiwi fruit was 62.78mg/100gm. Kiwifruit has more ascorbic acid than fruits such as cashew apples (Assuncao and Mercadante, 2003) [3] bananas, papayas, longan, lychees, and rambutan (Wall, 2006) [25]. The current recommended dietary allowance (RDA) for ascorbic acid for adult nonsmoking men and women is 60 mg/day, based on a mean requirement of 46 mg/day to prevent scurvy (Carr and Frei, 1999) [6]. Total phenolic content of the kiwi fruit was 937.54mgGAE/100gm. A high correlation has been reported between the content of total phenols and antioxidant activity (Du *et al* 2009) [9]. The total phenols present in the kiwi fruit contribute to various beneficial effects on health. These antioxidants prevent diseases by scavenging radicals or by suppressing formation of free radicals by binding to metal ions, reducing hydrogen peroxide and quenching superoxide and singlet oxygen (Peschel *et al* 2006) [19]. Rustem *et al*. (2011) [22] reported total phenolic content ranged from 1398.6 to 1933.7 mg GAE/g in Kiwi fruits at physiological maturity and ripening period, respectively. The DPPH is a stable free radical. Antioxidants when interacting with DPPH, either transfer electrons or hydrogen atoms to the DPPH radical, thereby neutralizing it (Naik *et al*., 2003) [18]. In the present study free radical DPPH scavenging activities were 46.41%. The antioxidant defence system of the body is composed of a mixture of antioxidants. Kiwi Fruits are good sources of antioxidants that may be more effective and economical than supplements in protecting the body against oxidative damage under different conditions (Hui *et al* 2008) [14]. The radical scavenging and chelating activities are beneficial antioxidative effects against radical-associated health problems, such as cancer and coronary heart disease (Yu *et al*., 2004) [29].

Conclusion

The present investigation reveal that kiwi fruit has potential chemical constituents. The phenols and ascorbic acid content may be the potential chemo preventive and anticancer substances. The fibre content of the fruit might contribute to reduce the problems due to various diseases. Further studies are needed to quantify and determine the antioxidant properties.

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