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Evaluation of phytochemical and nutritional composition of Boriavi ginger variety

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Abstract

The "*Boriavi*" variety of ginger was evaluated for its phytochemical and nutritional composition. The proximate composition was found to be 86.30 ± 0.11% moisture content (% wet basis), 2.70 ± 0.06% protein content, 0.60 ± 0.01% fat content, 1.30 ± 0.07% fiber content, 1.88 ± 0.02% ash content, and 7.20 ± 0.11% carbohydrate content. The ascorbic acid content was found to be 6.55 ± 0.26 mg per 100g, antioxidant activity was found to be 86.94 ± 0.16% by DPPH method, and total phenolic content was found to be 41.45 ± 0.17 mg GAE per 100ml. The mineral composition in fresh ginger was also evaluated in which phosphorus (10955 ± 2.00 mg kg^{-1}) was found to be the highest among all minerals.

Keywords: spice, medicinal plant, nutritional composition, antioxidant activity

Ginger (*Zingiber officinale* Roscoe) is a tropical herbaceous monocotyledonous perennial rhizome belonging to the Zingiberaceae family. It is a Southeast Asian species that has migrated to Africa and the Caribbean. It is a popular spice and a valuable cash crop in many regions throughout the world (Ajav & Ogunlade 2014). Overall ginger production throughout the globe is 3,270,762 tonnes, with an average area of 407,773 hectares. India, China, Nepal, Nigeria, and Thailand are the world's top ginger producers (FAO, 2018). Ginger was produced in India in 160.14 thousand hectares, with a production of 1118.16 thousand tonnes in the year 2018. Apart from its nutritional value, ginger as gaining popularity in the pharmaceutical, culinary, and chemical industries as a rich source of bioactive phenolics (Srinivasan, 2017). Ginger has high amount of bioactive phenolics such as gingerols, paradols, shogaols, and zingerones, which are non-volatile, pungent chemicals. The pungency of fresh ginger is due to gingerol, which is produced in the plant from phenylalanine, malonate, and hexonate (Evans *et al.*, 2009). Ginger is also commonly used in the food industry as a flavoring agent for ginger ale, candies, pastries, and cakes (Malu *et al.*, 2009).

The local variety of Ginger "*Boriavi*" was procured from a single source at Boriavi

village near Anand, Gujarat, India was used in the study. The AOAC method of oven drying was used to determine the moisture content of fresh ginger (AOAC, 2019). Crude fat was analyzed using Socsplus instrument. About 1 g sample in triplicate were weighed and then transferred to a thimble placed in a special type of fat extraction cup and then fixed on a heating mantle of the instrument's assembly. Approximately 80 mL of petroleum ether was added. The extraction was carried out at 100 °C for 60 min. Cold water (10 °C) was circulated through the condenser. After 1 h recovery of solvent was done at 180 °C for 30 min. Then the extraction cups were cooled in a desiccator and % fat content was calculated by the following formula:

$$\text{Crude fat (\%)} = \frac{\text{(Weight of flask with oil- Weight of empty flask)}}{\text{Total weight of the sample}}$$

The Kjeldhal method, as described in the AOAC (2019), was used to assess the protein content of fresh ginger. A catalyst mixture including concentrated sulphuric acid (H_2SO_4) was used to digest 5 g of material (K_2SO_4: $CuSO_4$, 1:5). A measured aliquot of digested material was distilled with excess of 40% NaOH solution and the liberated ammonia was collected in 20 mL of 2% boric acid solution. The entrapped ammonia was titrated against 0.01 N hydrochloric acid by adding 2-3 drops of mixed indicator (bromocresol green and methyl red), a light pink colour was achieved as an endpoint indicator.

The % nitrogen was calculated using following formula:

$$\text{Nitrogen (\%)} = \frac{\text{(14x9T-N)xNormality of HCL x100)}}{\text{(Wx1000)}}$$

Total crude protein (%) = Total nitrogen (%) × 6.25

Where, T = Titre value

N = Normality of HCl

14 = Atomic weight of nitrogen

W = Weight of the sample

The total ash content of fresh ginger was determined by using Rangnna's (2007) method. Fibra Plus instrument was used to estimate the crude fibre content (Pelican Equipments, Chennai). A 0.5 g of defatted material was placed in a thimble and digested with 1.25% H_2SO_4. After boiling for 60 minutes, the contents were drained. The residue was extensively cleansed until it was acid-free by using hot distilled water. The operation was repeated with 1.25% NaOH. The washing was done once again with hot distilled water to eliminate the alkali. Leftover neutral residue was dried to get a constant weight in a 105 °C oven before being burnt for 4 hours at 550 to 600 °C in a muffle furnace. The crude fibre % was calculated using Rangnna's (2007) formula. The acidity of fresh ginger was determined using the method proposed by Rangnna (2007) and expressed as a % of anhydrous citric acid.

$$\text{Tiltratable acidity (\% CA)} = \frac{\text{(0.1 N NaOHxTitration valuex0.64x100)}}{\text{(Volume of sample taken)}}$$

The dye method (2, 6-dichlorophenol-indophenol) was used to test the ascorbic acid content of fresh ginger as mentioned by Rangnna (2007) and the concentration of ascorbic acid in the sample was calculated using the following formula.

$$\text{Ascorbic acid (mg per 100 gm)} = \frac{\text{(Titration valuexDye factorxVolumex100)}}{\text{(Aliquot taken for estimationxWeight of sample)}}$$

The total sugar content of fresh ginger was determined using the Lane and Eynon method published by Rangnna (2007) and the total sugar was calculated by using the formula below.

$$\text{Total sugar (\%)} = \frac{\text{(Factor (0.052)xDilutionx100)}}{\text{(Titration valuex Weight of the sample)}}$$

The total phenols in the samples were computed and expressed in mg gallic acid equivalent (GAE) per 100 ml of sample (Thimmaiah, 1999). The gallic acid standard graph was used to assess total phenolic concentration.

The DPPH scavenging effect was measured using by formula:

$$\% \text{ inhibition} = \frac{AB-AA}{AB} \times 100$$

Where, AB = absorbance of blank

AA = absorbance of sample

Estimation of minerals was done by digesting the sample using 30 ml of diacid mixture. The contents were heated at 180-200°C until the white fumes evolved. The final volume of solution was made up to 50 ml by addition of double distilled water. The sample was analysed in ICP-OES (Inductively Coupled Plasma – Optical Emission Spectroscopy; model number 7000 DV, Perkin Elmer USA) using Winlab 32 software ver. 5.1.

$$\text{Mineral content (mg kg}^{-1}) = \frac{(\text{Reading-Blank}) \times \text{Dilution factor}}{\text{Sample weight}}$$

Where,

$$\text{Dilution factor} = \frac{\text{The final volume of diluted solution}}{\text{The volume of aliquot taken for dilution}}$$

The total soluble solids (TSS) was measured by using a digital hand refractometer (AOAC, 2012). Proximate composition is an important factor for evaluating nutritional status of any food product as it helps to study the composition. For each parameter, measurements were made in triplicate and the average values are reported. The values of moisture, protein, fat, fiber, ash, and carbohydrate content were found to be 86.30 ± 0.11 %, 2.70 ± 0.06%, 0.60 ± 0.01%, 1.30 ± 0.07%, 1.88 ± 0.02 %, and 7.20 ± 0.11%, respectively (Table 1). The results obtained were found similar to the reported values by Dhiman (2015) & Hema (2017) except the moisture content which might be due to the variety, and difference in the time gap between harvesting and analysis. The moisture content of freshly harvested ginger rhizome is reported to be 82.39% (Dhiman, 2015) & 82.86 % (Hema, 2017). The fiber content in ginger of "*Boriavi*" variety was found to be lower than other local varieties reported by Dhiman (2015) & Hema (2017). The crude fiber content of fresh ginger was reported as 1.40% (Dhiman, 2015), & 1.28% (Hema, 2017). However, the moisture content was found to be in the range of previously reported data and was found to be similar to data reported by Policegoudra & Aradhya (2007) which was 86%.

Table 1. Physico-chemical composition of ginger

Parameter	Quantity (%) (mean ± SD)
Moisture	86.30 ± 0.11
Protein	2.70 ± 0.06
Fat	0.60 ± 0.01
Fiber	1.30 ± 0.07
Ash	1.88 ± 0.02
Carbohydrate	7.20 ± 0.11
pH	6.28 ± 0.01
TSS (°Brix)	2.85 ± 0.05
Titratable acidity (% citric acid)	0.15 ± 0.01
Total sugar (%)	1.35 ± 0.02
Ascorbic acid (mg per 100 g)	6.55 ± 0.26
Antioxidant activity (%)	86.94 ± 0.16
Total phenolic content (mg GAE 100 ml^{-1})	1.45 ± 0.17

The values of chemical parameters such as titratable acidity (% citric acid), pH, and total sugar were found to be 2.85 ± 0.05 °B, 0.15 ± 0.01% citric acid, 6.28 ± 0.01, and 1.35 ± 0.02%, respectively (Table 2). The values for TSS, titratable acidity, and total sugar were found to be similar as reported by Dhiman (2015) at 3.00%, 0.16% CA, and 1.86%, respectively. The result for pH value of "*Boriavi*" variety ginger was found lower as compared to results

Table 2. Mineral composition of ginger

Mineral	Value (mg kg^{-1}) (mean ± SD)
Phosphorus (P)	10955.00 ± 2.00
Potassium (K)	9790.00 ± 0.08
Magnesium (Mg)	2495.00 ± 0.06
Sulfur (S)	1925.00 ± 0.41
Calcium (Ca)	1882.00 ± 0.05
Iron (Fe)	343.70 ± 1.20
Manganese (Mn)	62.20 ± 0.10
Zinc (Zn)	14.70 ± 1.87
Copper (Cu)	7.40 ± 0.78

reported by Dhiman (2015) and that might be due to varietal difference.

The raw ginger was also analyzed for nutritional parameters such as ascorbic acid, antioxidant activity, and total phenolic content. The values of ascorbic acid were found to be 6.55 ± 0.26 mg 100 ml^{-1}. The values were found to be slightly higher than that reported by Dhiman (2015) and found to be lower than Shirin & Prakash (2010). The values for antioxidant activity for raw ginger were found to be 86.94 ± 0.16 % by DPPH method which was found to be higher than values reported by Purnomo *et al*. (2010) & Maizura *et al*. (2011). The total phenolic content of raw ginger was found to be 41.45 ± 0.17 mg GAE 100 ml^{-1}. The values of total phenolic content of raw ginger falls between the values reported by Dhiman (2015) & Hema (2017). Fresh ginger has a total phenolic concentration of 49.81 mg 100 g^{-1} (Dhiman, 2015); & 36.28 mg 100 g^{-1} (Hema, 2017).

Fresh ginger was found to have high amount of phosphorus (10955 ± 2.00 mg kg^{-1}) followed by potassium (9790 ± 0.08 mg kg^{-1}), magnesium (2495 ± 0.60 mg kg^{-1}), sulfur (1925 ± 0.41 mg kg^{-1}), calcium (1882 ± 0.05 mg kg^{-1}), iron (343.7 ± 1.20 mg kg^{-1}), manganese (62.20 ± 0.10 mg kg^{-1}), zinc (14.70 ± 1.87 mg kg^{-1}), and copper (7.40 ± 0.78 mg kg^{-1}). Although the results of raw ginger for its proximate composition, chemical parameters, and mineral composition showed slight differences, this might be due to a variety of factors including differences in agronomic practices followed, cultivation and harvesting practices used, variety, climatic and geographical conditions and other environmental factors etc.

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