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Studies on physical and chemical composition of beetroot (*Beta vulgaris* L.)

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Abstract
The present study was carried out to analyze physical and chemical composition of beetroot (*Beta vulgaris* L.). The freshly harvested beetroot selected for evaluation of different physicochemical and mineral composition. Results obtained indicated that colour of beetroot was deep reddish in colour, length was 7.06 cm, diameter was 4.03 cm and mass of beetroot was observed to be 178 g. Further, chemical and mineral composition was reported and results showed that moisture content was found to be 85.56 percent, carbohydrate 9.05 percent, Protein 1.41 percent, fat 0.21 percent and betalain content of beetroot was recorded to be 291mg/100g. The other parameters such as acidity and pH of beetroot juice were indicated 0.8 percent and 6.13 respectively. The mineral composition of beetroot showed copper 0.064, manganese 0.22, zinc 0.20 and iron 1.107 mg/100g respectively.

Keywords: Betalain, *Beta vulgaris*, physical properties and chemical properties

Introduction
Beet root, scientifically known as *Beta vulgaris* is one of the well known plants belonging to Chenopodiaceae family includes approximately 1400 species divided into 105 genera. It makes an excellent dietary supplement being not only rich in minerals, nutrients and vitamins but also has unique phytoconstituents, which have several medicinal properties Several parts of this plant are used in medicinal system such as anti-oxidant, anti-depressant anti-microbial, anti-fungal, anti-inflammatory, diuretic, expectorant and carminative. It is one of the natural food which boosts the energy in athletes as it has one of the highest nitrates and sugar contents plant (Lee C.H. 2005) [9].

Beetroot is grown for food uses (pickles, salad, juice) rather than for sugar production. In contrast to other fruits, the main sugar in beetroot is sucrose with only small amounts of glucose and fructose (Bavec *et al.* 2010) [3] Because fructose reduces human exercise capacity, a low fructose and a high sucrose content is preferable, for example, in sports drinks (Murray *et al*., 1989) [11].

The intense red color of beetroots derives from high concentrations of betalains, a group of phenolic secondary plant metabolites. Betalains are used as natural colorants by the food industry, but have also received increasing attention due to possible health benefits in humans, especially their antioxidant and anti-inflammatory activities (Georgiev *et al*., 2010; Zielinska-Przyjemska *et al*., 2009) [6, 16]. Other benefits include increased resistance to the oxidation of low-density lipoproteins (Tesoriere *et al*., 2003) [14], and chemo-preventive effects (Zhang *et al*., 2013) [15]. The betalains that are mainly found in beetroot are betacyanins and betaxanthins (Gandia-Herrero *et al*., 2010) [5]. Apart from betalains, small amounts of hydroxycinnamic acids such as gallic, syringic, and caffeic acids and flavonoids have been identified (Kazimierczak *et al*., 2014) [8].

Beetroot has excellent physiological properties. Its macro- and micronutrient content is remarkable and its vitamin content is high. Its vitamin A and C content is substantial and its vitamin B is outstanding. Vitamin B1 (thiamine), vitamin B2 (riboavin), and vitamin B3 (niacin) can be found in most root vegetables with dark green leaf, such as in beetroot. Beetroots play a vital role due to their remarkable folate content. Folic acid helps to prevent cancer and in cooperation with vitamin B contributes to the proper functioning of the nervous system (Tak_acsn_e, 2002) [10]. The beetroot (*Beta vulgaris*) being an alkaline food with pH from 7.5 to 8.0 has been acclaimed for its health benefits, in particular for its disease fighting antioxidant potential, significant amount of vitamin C and vitamins B1, B2, niacin, B6, B12 whilst the leaves are an excellent source of vitamin A. The juice of beetroot is also consumed

as a natural remedy for sexual weakness and to expel kidney and bladder stones. The claimed therapeutic use of beetroot includes its antitumor, carminative, emmenagogue and hemostatic and renal protective properties and is a potential herb used in cardiovascular conditions. Beetroot is known to be a powerful antioxidant. (Dambalkar *et al.* 2015) [4].

Materials and Methods

The present investigation was carried out in Department of Food Engineering with collaboration of Department of Food Science and Technology and Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV, Parbhani during year 2017-18.

Materials

Raw materials

Fresh beetroots were obtained from the local village area of the Parbhani region. The experiments were generally performed immediately after procurement.

Chemicals and glasswares

The chemicals of analytical grade and glasswares required during investigation were used in the department of Food Engineering.

Methods

Physico-chemical properties

Physical properties such as titrable acidity, pH, sugar, proximate analysis.

pH: The pH of the beetroot juice was determined using digital pH meter. Twenty (20ml) of the juice was transferred into a beaker and the pH was determined after the meter was calibrated using standard buffer of pH 4.0 and 7.0, sufficient time was allowed for stabilization before readings were taken.

Total soluble solid (TSS)

The TSS content of juice was determined with the help of Erma hand refractometer of 0-32 range in duplicate (A.O.A.C., 2005) [1]. The sugar content percentage (soluble sugar) was read from the scale of the refractometer when held close to the eye.

Titratable acidity

The titratable acidity was determined by the procedure as reported by Ranganna (1986) [13].

Reducing sugar: The reducing sugars were estimated by the volumetric method as reported by Ranganna (1986) [13].

Total sugar: Total sugars were determined by volumetric method as reported by Ranganna (1986) [13].

Proximate composition

Different chemical properties of samples were analysed for moisture content, ash, fat, protein and total carbohydrate. All the determinations were done in triplicate and the results were expressed as the average value.

Moisture content

Moisture content was determined adopting AOAC (2005) method as following:

$$\% \text{ moisture} = \frac{\text{Wt. of fresh sample} - \text{Wt. of dry sample}}{\text{Weight of fresh sample}} \times 100$$

Fat

AOAC (2005) [1] method using Soxhlet apparatus was used to determined crude fat content of the sample. The percent of crude fat was expressed as follows:

$$\% \text{ Crude Fat} = \frac{\text{Weight of dried ether soluble material}}{\text{Weight of sample}} \times 100$$

Protein

Protein content was determined using AOAC (2005) [1] method. Percentage of nitrogen and protein calculated by the following equation:

$$\% \text{ Nitrogen} = \frac{\text{TS - TB} \times \text{Normality of acid} \times 0.014}{\text{Weight of sample}} \times 100$$

Where, Ts = Titre volume of the sample (ml), TB = Titre volume of Blank (ml), 0.014= M eq. of N2.

% Protein = Nitrogen × 6.25

Total carbohydrate

Total carbohydrate content of the samples was determined as total carbohydrate by difference that is by subtracting the measured protein, fat, ash and moisture from 100 phenol sulphuric acid method as given by AOAC (2005) [1].

Ash

Drying the sample at 100 ℃ and charned over an electric heater. It was then ashed in muffle furnace at 5500 C for 5 hrs by AOAC (2005) [1]. It was calculated using the following formula:

$$\% \text{ Ash content} = \frac{\text{AW}}{\text{IW}} \times 100$$

Where, AW = Weight of Ash and IW= Initial weight of dry matter

Results and Discussion

The extracted beetroot juice were evaluated for various physicochemical properties are presented as follows:

Physical properties

The data pertaining to various physical properties like mass, length, colour, diameter, shape, edible index and waste index were determined and the average values are presented in table 1.

Table 1: Physical properties of beetroot

Physical parameters	Average value
Mass	178gm
Length	7.06 cm
Colour	Deep reddish
Diameter	4.03cm
Shape	Round
Edible index	88.24%
Waste index	11.75%

*Each value is average of three determinations

The physical properties of beetroot were measured and results reported that mass was found 178 (g), length 7.06 cm,

diameter 4.03cm, round in shape. Properties like edible index and waste index was noted as 88.24 and 11.75% respectively.

Chemical properties and mineral composition of beetroot

The data pertaining to various chemical and mineral composition such as moisture, fat, carbohydrates, protein, ash and crude fiber were determined and results obtained are illustrated in Table. 2 and Table. 3

Table 2: Proximate composition of beetroot

Nutrients	Average Value
Moisture	85.56%
Fat	0.21±0.01%
Protein	1.04±0.02%
Carbohydrate	9.05±0.12%
Dietary fibre	2.2±0.21%
Ash	1.18±0.2%

Results given in the table. 2 indicated that the moisture content was 85.56%, fat 0.21%, protein 1.04%, carbohydrates 9.05%, crude fiber 2.2%, and ash 1.18%. The results found to be similar with (Odoh and Okoro 2013) [12]

Table 3: Mineral composition of beetroot

Minerals	Average value mg/100g
Iron	1.107±0.29
Zinc	0.207±1.25
Copper	0.064±0.49
Mangnese	0.228±1.82

The mineral composition of beetroot were analyzed and results revealed that iron was 1.107, copper 0.064, manganese 0.228 and zinc 0.207(mg/100g) respectively. Results reported are in close agreement with (Odoh and Okoro 2013) [12].

Table 4: Chemical properties of beetroot

Chemical parameters	Average value
TSS	7.9±1.5
P^H	6.01±0.04
Titrable acidity	0.89±0.031
Betalain (mg/100g)	291±140

The chemical composition of beetroot were analyzed and results revealed that TSS was 7.9, pH 6.01, acidity was 0.89. The betalain content of beetroot observed to be 291 mg/100g respectively. Results reported are in close agreement with (Kale *et al*. 2018, Attia *et al.* 2013) [7, 2].

Conclusion

It could be finally concluded that beetroot is good source of protein, carbohydrate and dietary fiber. Beetroot is good source of mineral iron. The beetroot is good source of betalain, which makes it potential source for exploration and value addition in food products in combination with various fruits.

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