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# Studies on physical and chemical composition of Broccoli (*Brassica oleracea* L.)

**Wadmare VB, Gadhe KS and Joshi MM**

**Abstract**
In this present investigation, study was carried out to determine physical and chemical composition of Broccoli (*Brassica oleracea* L.). The freshly harvested broccoli selected for evaluation of physical, chemical and mineral composition. Results obtained showed that color of broccoli was green, length was 111.14 mm, longest diameter was 144 mm and mean weight was observed to be 308.83 g. Further chemical and mineral composition was reported and results showed that moisture content found to be 86.36 %, carbohydrate 5.59 %, protein 4.89 %, Fat 0.37%. The mineral composition of broccoli showed iron 0.7 mg, zinc 0.4mg, calcium 47 mg and phosphorous 66 mg/100g respectively.

**Keywords:** Broccoli, *Brassica oleracea*, physical properties, chemical properties

## Introduction
Broccoli scientifically known as "*Brassica oleracea* L.*"*, a cruciferous green leaf cole vegetable; is one such promising underexploited plant. This plant is native of Italy, but can be successfully grown in our country. It is a source of valuable nutrients Vitamin A, C & riboflavin. It is also high in iron and calcium and is a non-fattening food and possesses various medicinal properties as well broccoli has large flower heads, usually green in color, arranged in a tree-like fashion on branches sprouting from a thick, edible stalk. The mass of flower heads is surrounded by leaves. Broccoli, most closely resembles cauliflower, which is a different cultivar of the same species (Mishra and Mukherjee, 2012) [7].
Broccoli also contains the compound "glucoraphanin", which can be processed into an anti-cancer compound "sulforaphane", though the benefits of broccoli are greatly reduced if the vegetable is boiled. Broccoli is also an excellent source of "indole-3-carbinol", a chemical which boosts DNA repair in cells and appears to block the growth of cancer cells. Broccoli has a chemical component called "indole-3- carbinol" that can combat breast cancer by converting a cancer-promoting estrogen into a more protective variety (Phillip, 2011) [9].
Fresh broccoli is exceptionally rich source of Vitamin C. Calcium content in broccoli is equivalent to that in the milk (47mg/100gm.). It is also a good source of minerals like-calcium, manganese, iron, magnesium, selenium, zinc and phosphorus. In addition to that this vegetable is also good source of electrolytes (Mishra and Mukharjee, 2012) [7].
A cross-over clinical trial was undertaken to compare the bioavailability and tolerability of sulforaphane from two of broccoli sprout-derived beverages: one glucoraphanin-rich (GRR) and the other sulforaphane-rich (SFR). Bioavailability was substantially greater with the SFR (mean = 70%) than with GRR (mean = 5%) beverages. Glucoraphanin in broccoli is converted to sulforaphane either by plant myrosinases, or if the plant myrosinases have been denatured by cooking, by bacterial myrosinases in the human colon **(**Patricia *et al.*, 2011) [8].
As broccoli can be consumed both as fresh and processed food, it is regarded as a dual use vegetable. Typically, broccoli is processed as dried or frozen for retail sale, or canned for instant soup. Broccoli is generally grown for processing under contract between growers and processors, although processors often purchase raw broccoli when fresh market prices are low. By the booming number of health-conscious consumers, who prefer salad, side dish, entrée component, or a nutritious dietary supplement, broccoli offers great advantage and hence enhances its share of the market (Boriss and Brunke, 2005) [2].

## Materials and Methods
The present investigation was carried out in Department of Food Process Technology with

collaboration of Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV, Parbhani during year 2017-18.

**Materials**

**Raw materials**

Fresh broccoli was obtained from vegetable scheme of Horticulture Department of V.N.M.K.V., Parbhani. 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 Process Technology.

**Methods**

**Physico-chemical properties**

Physical properties such as longest diameter, length, mean weight, shape and proximate analysis.

**Longest Diameter**

Longest diameter of broccoli was measured by vernier caliper (digital) which shows readings in millimeter. Broccoli curd was positioned between the two jaws of vernier caliper and fixed with help of sliding jaw. The determinations were done in triplicate and the results were expressed as the average value.

**Length**

Length of broccoli was measured by vernier caliper. Broccoli was placed in between jaws such that it will measure the distance from stalk end to the curd end. The determinations were done in triplicate and the results were expressed as the average value.

**Mean weight**

Mean weight of broccoli was determined by digital weighing balance. The final reading obtained was a mean of three readings.

**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) [1] 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 determine 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 550° 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

**Physico-chemical properties of broccoli powder**

**Bulk density**

5 gm of broccoli powder is poured in measuring cylinder and volume occupied is recorded.

$$\text{Bulk density} = \frac{\text{weight of sample}}{\text{Volume of sample}}$$

**Rehydration capacity**

The rehydration capacity (RC) was used as a quality parameter of the dried broccoli particles, which expressed the ability of dried material to absorb water and regain weight. Rehydration capacity measurement were performed by immersing a weighed amount (0.5 g) of dried samples into water bath filled with distilled water at 95°C for 10 min. Each sample was then taken out and blotted with the paper towels gently in order to eliminate the surface water. These rehydrated samples were reweighed quickly afterwards. The rehydration capacity, which describes the percentage of water gained by the sample, was calculated as the sample weight ratio after and before the rehydration as follows (Maskan, 2001) [6].

$$\text{Rehydration Capacity (RC)} = \frac{Wr}{Wd}$$

Where, *Wr* is the weight of rehydrated sample,
*Wd* is the weight of dried sample.
All samples were measured in triplicates.

**Colour measurent**

Color is one of main attributes, along with texture, that characterizes the freshness of most vegetables (Rico *et al*., 2007) [10]. The browning issue of dried broccoli cannot be ignored, thus we need to evaluate the color change during the drying process. A measurement of tri-stimulus color co-

ordinates is widely used as a quality indicator for monitoring of color changes during food processing (Koca *et al*., 2007) [4]. The measurement was fulfilled by a chroma meter (CR-300X, Minolta Camera Co. Ltd., Japan) with a 5 mm diameter measuring area was used for surface color measurements (Li *et al*., 2011) [5].

Colour of broccoli powder was determined by hunter colourimeter. Color parameters on the CIE Lab scale include: L* (brightness), a* (redness), and b* (yellowness). The criterion established by the International Commission on Illumination (CIE) was applied (Hutchings, 2003). In addition chroma and hue angle were calculated from the values for L*, a* and b* value and used to describe the color change during drying. The saturation index or chroma indicates color saturation and is proportional to its intensity. The hue angle is another parameter frequently used to characterize color in food products.

## Results and Discussion

Broccoli florets were crushed and evaluated for various physicochemical properties are presented as follows:

### Physical properties

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

**Table 1:** Physical properties of Broccoli

| Physical parameters | Average value |
|---|---|
| Longest diameter | 144.00 mm |
| Length | 111.14 mm |
| Meant weight | 308.83 gm |
| Shape | Unequal irregular |
| Colour | Green |

*Each value is average of three determinations

The physical properties of broccoli were measured and results reported that longest diameter was found 144.00 mm, length 111.14 mm, mean weight 308.83 gm, unequal irregular in shape and colour was green.

### Chemical properties and mineral composition of Broccoli

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 Broccoli

| Nutrients | Average Value |
|---|---|
| Moisture | 86.36% |
| Fat | 0.37±0.01% |
| Protein | 4.98±0.02% |
| Carbohydrate | 5.59±0.12% |
| Dietary fibre | 89.53±0.20% |
| Ash | 1.3±0.2% |

Results given in the table. 2 indicated that the moisture content was 86.36%, fat 0.37%, protein 4.98%, carbohydrates 5.59%, crude fiber 89.53%, and ash 1.3%. The results found to be similar with book of Nutritive Value of Indian foods revised and updated by (Santhi P. *et al*., 2016) [11].

**Table 3**: Mineral composition of lime juice

| Minerals | Average value mg/100g |
|---|---|
| Iron | 0.7 |
| Zinc | 0.4 |
| Calcium | 47 |
| Phosphorous | 66 |

The mineral composition of broccoli were analyzed and results revealed that iron was 0.7, zinc 0.4, calcium 47 and phosphorous 66 mg/100gm) respectively. Results reported are in close agreement with the data reported by (USDA (United States Department of Agriculture) National Nutrient Database for Standard Reference, 2015) [12].

### Physico-chemical properties of broccoli powder

Broccoli was washed, crushed and dried at 50 °C for 4.5 hr by sundrying and cabinet drying method. Physico-chemical properties of obtained powder was determined such as bulk density, rehydration capacity and colour.

**Table 4:** Physico-chemical properties of broccoli powder

| Parameter | Sundried broccoli powder | Cabinet dried broccoli powder |
|---|---|---|
| Bulk density | 0.96 gm/ml | 0.92 gm/ ml |
| Rehydration capacity | 6.22 | 6.29 |

### Colour

**Table 5:** Colour measurement of broccoli powder

| | Colour parameters | | | | |
|---|---|---|---|---|---|
| **Drying method** | **+L** | **-a** | **+b** | **C** | **H** |
| Fresh Broccoli | 56.45 ± 1.89 | 13.93 ± 0.65 | 24.25 ± 1.47 | 27.97 ± 1.60 | 60.12 ± 0.46 |
| Sundrying | 54.36 ± 1.08 | 6.79 ± 0.61 | 26.70 ± 1.28 | 26.30 ± 0.41 | 69.89 ± 0.52 |
| Cabinet drying | 53.36 ± 3.41 | 7.37 ± 0.97 | 25.89 ± 2.35 | 26.36 ± 2.29 | 71.39 ± 2.42 |

Bulk density of sundried broccoli powder was 0.96 gm/ml and that of cabinet dried was 0.92 gm/ml. Rehydration capacity of sundried broccoli powder was 6.22 and that of cabinet dried was 6.29. The colour measurement of sundried and cabinet dried broccoli powder was as shown in table 5. The results reported are in close agreement with data reported by (Maskan, 2001) [6] and (Hutchings, 2003) [3].

## Conclusion

In the present investigation it could be finally concluded that broccoli is good source of protein, carbohydrate and dietary fiber. Broccoli is good source of calcium. The cabinet dried broccoli powder shows higher rehydration capacity (6.29) over sundried broccoli powder. The colour of cabinet dried (at 50°C) broccoli powder was better than that of sundried broccoli powder. The broccoli is excellent source of health beneficiary nutrients which makes it potential source for exploration and value addition in food products.

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