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Studies on physical, chemical and mineral evaluation of fresh carrot (*Daucus carota*)

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Abstract
The present investigation was carried out to study the physical and chemical composition of fresh carrot. Results obtained indicated that color of carrot was red in colour, the mean length, width, thickness, arithmetic mean diameter, geometric mean diameter, surface area, sphericity, aspect ratio, mass, of the carrot were 15.4, 2.86, 2.76, 7.049, 4.954 cm, 77.58 cm^2, 0.32%, 0.18, 72.74 gm respectively. Further, chemical and mineral composition was reported and results showed that the moisture content 86 percent, fat 0.27 percent carbohydrate 10.3 percent, protein 1.0 percent, ash 1.20 percent and crude fibre 1.23 percent. Calcium content of carrot was found to be highest 80 mg/100gm than rest of other minerals; phosphorus 54.1 mg/100gm magnesium 9.0 mg/100gm and iron 2.23 mg/100gm. Finally, it can be concluded from the obtained results that fresh carrot was high in nutrients that makes it potential source for value addition in food commercialization.

Keywords: Physical properties, carrot, proximate composition, beta- carotene, minerals

Introduction
Carrot is a popular cool season crop grown throughout India. It is used as raw as well as cooked form. It is made in to pickles. Gajar halwa is delicious dish. The preservation methods such as dehydration, canning, and pickling can be successfully adopted to preserve carrot for off-season. Dehydrated carrot in the form of grating can be used in the preparation of halwa, discs made in to chips. Dehydration is one of the important methods of value addition of vegetables to make them available during the off-season.

China is the major carrot producing country in the world. The area under carrot in India is 22,538 ha with an annual production of 4.14 lakh tons (Thamburaj and Singh 2005) [22] with Uttar Pradesh, Assam, Karnataka, Andhra Pradesh, Punjab and Haryana being the major producing States. In recent years, the consumption of carrot and its products have increased steadily due to their recognition as an important source of natural antioxidants besides, anticancer activity of β-carotene being a precursor of vitamin A (Dreosti 1993) [6] and (Speizer *et al.,* 1999) [19].

Carrots (*Daucus carota*) are among the most popular root vegetables and have been identified as the main dietary sources of carotenoids (O'Neill *et al.,* 2001) [16]. Carrot is the diverse coloured crop grown annually for the edible purpose belonging to *Apiaceae* (previously *Umbelliferae*) family grown throughout the world. The cultivation of the crop is favoured during the months of September to November in tropical and subtropical regions whereas the temperate conditions offer a wide option of cultivation throughout the year. The crop needs a cool temperature for the production of seeds. Carrot is the lonely coloured root crop with different types of pigments in the form of carotenoids and flavonoids that impart antioxidant properties in addition to colour (Rodriguez-Amaya 2001) [17].

Fruits and vegetables are an important part of our diet. They provide, not only the major dietary fibre component of food, but also a range of micronutrients, including minerals, vitamins and antioxidant compounds, such as carotenoids and polyphenols (Augspole *et al.*, 2014) [3]. Carrot is one of the most important vegetables in the world; its bioactive constituents may be beneficial to a vast number of consumers. It is rich in pro-healthy antioxidants both of lipophilic (carotenoids) and hydrophilic (phenolic compounds) characters (Hager and Howard 2006) [9].

Carrots are noted for their rich antioxidants, especially β-carotene. In recent years, worldwide consumption of carrots has been steadily increasing because of their nutritional benefits. Carrots have potentially beneficial health effects, anti-carcinogenic, antioxidant, and immune

boosting properties, as well as the pro-vitamin activity of some carotenoids (Fiedor and Burda 2014) [7] and (Tanaka *et al.,* 2012) [21].

Carrots are processed into products such as canned, dehydrated, juice, beverages, candy, preserves, intermediate moisture products and halwa (Kalra *et al.,* 1987) [14]. Carrot candy or preserve can be prepared by covering small whole carrots or slices of carrots with sugar or heavy sugar syrup so that total soluble solids content increases to 70–75°B (Beerh *et al*., 1984) [4]. Carrots have been processed to obtain intermediate moisture foods containing about 55% moisture (Jayaraman and Dasgupta 1978) [13], (Bhatia and Mudhar 1982) [5] and (Sethi and Anand 1982) [18].

Materials and Methods

The fresh carrot were obtained from local village market, Parbhani. The proposed research was carried out in Department of Food Engineering, College of Food Technology, VNMKV, Parbhani.

Physical properties of fresh carrot

Different physical properties such as Length, Width, Thickness, Mass, arithmetic mean diameter, mean geometric mean diameter, surface area, sphericity, and Aspect ratio were measured by using Vernier calliper and electronic weighing balance.

To measure physical properties, 100 samples of carrot were selected randomly. Dimensions of the carrot (their length (*L*), width (*W*), and thickness (*T*)) were measured using a DC-515, Taiwan digital caliper with the precision of 0.01 mm. Then, the geometric mean diameter, arithmetic mean diameter, and sphericity were calculated through Equations 1, 2, and 3.

$$D_g = 3\sqrt{LWT} \quad (1)$$

$$D_a = \frac{L + W + T}{3} \quad (2)$$

$$Ø = \frac{D_g}{L} \quad (3)$$

D_g is the geometric mean diameter, D_a is the arithmetic mean diameter and Ø is the sphericity of the carrot. The surface area (*S*) and the aspect ratio (R_a) of the carrot were obtained through Equations 4 and 5.

$$S = \pi D_g^2 \quad (4)$$

$$R_a = \frac{W}{L} \quad (5)$$

Proximate composition of fresh carrot

Proximate Analysis

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) [2] method as following:

$$\% \text{ Moisture content} = \frac{\text{Loss in weight}}{\text{Weight of sample}} \times 100$$

Fat

AOAC (2005) [2] 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) [2] method. Percentage of nitrogen and protein calculated by the following equation:

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

Where, Ts = Titre volume of the sample (ml), TB = Titre volume of Blank (ml), 0.014= M eq. wt. of N_2.

$$\% \text{ Protein} = \text{Nitrogen} \times 6.25$$

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) [2].

Ash

Drying the sample at 100 ^{0}C and charned over an electric heater. It was then ash in muffle furnace at 550 ^{0}C for 5 hrs. By AOAC (2005) [2]. It was calculated using the following formula:

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

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

Beta-carotene

The beta-carotene content was estimated following the procedure of (Srivastava and Kumar 1994 a) [20].

Result and Discussion

Physical properties of fresh carrot

Different physical properties such as colour, length, width, thickness, mass, arithmetic mean diameter, mean geometric mean diameter, surface area, sphericity, Aspect ratio of fresh carrot were evaluated and results obtained are presented in Table 1.

Table 1: Physical properties of carrot

Physical Parameters	Observation
Colour	Red
Length (cm)	15.4
Width (cm)	2.86
Thickness (cm)	2.76
Arithmetic mean diameter (cm)	7.049
Geometric mean diameter (cm)	4.954
Surface area (cm^2)	77.58
Sphericity (%)	0.32
Aspect ratio	0.18
Weight (gm)	72.74

*Each value represents the average of three determinations

The physical characteristics of fresh carrot were observed to be reddish in colour. the mean length, width, thickness, arithmetic mean diameter, geometric mean diameter, surface area, sphericity, aspect ratio, mass, of the carrot were 15.4, 2.86, 2.76, 7.049, 4.954 cm, 77.58 cm^2, 0.32%, 0.18, 72.74 gm respectively. In similar research, Jahanbakhshi (2018) [11], (Jaliliantabar *et al.*, 2011) [12], (Karaj and Muller 2010) [15] and (Akar and Aydin 2005) [1] has discussed and stressed upon the importance of these properties.

Chemical properties of fresh carrot

Data pertaining to various chemical properties like moisture, fat, carbohydrates, protein, ash, and crude fiber were investigated and results obtained are depicted in Table 2

Table 2: Chemical composition of fresh carrot

Chemical Parameters	Mean Value*
Moisture (%)	86.0 ± 0.23
Total Fat (%)	0.27 ± 0.13
Total carbohydrates	10.3 ± 0.10
Total Protein (%)	1.00 ±0.07
Ash	1.20 ± 0.01
Crude Fiber	1.23 ± 0.03
Beta-carotenes (mg/100 g)	5.33 ± 0.14

*Each value represents the average of three determinations

The data in the above table showed that the moisture content 86 per cent, fat 0.27 per cent carbohydrate 10.3 per cent, protein 1.0, ash 1.20 and crude fiber 1.23 respectively. Similar results were obtained by (Holland *et al.*, 1991) [10] and (Gopalan *et al.*, 1991) [8]

Mineral composition of fresh carrot

The results given with respect to various minerals such as Ca, P, Mg and Fe were determined and accordingly results presented in Table 3.

Table 3: Mineral content in fresh carrot

Minerals	Average value (mg/100g)
Calcium	80.0
Phosphorus	54.1
Magnesium	9.00
Iron	2.23

*Each value is an average of three determinations

The table 3 showed that the calcium content of carrot was found to be highest 80 mg than the rest of other minerals; phosphorus 54.1 magnesium 9.0 and iron 2.23. Similar results were obtained by (Gopalan *et al.*, 1991) [8].

Conclusion

Overall it can be concluded that the importance of studying physical properties are considered as the basic data in designing the machinery and equipment used during the harvesting and in the post harvesting operations. Importance of these properties in determining the size of the machines particularly that of the separation, transfer, and sorting equipment. Finally, it can be concluded from the results that fresh carrot is highly nutritious and make it potentially useful in preparation and value addition of food products. Carrots are processed into products such as canned, dehydrated, juice, beverages, candy, preserves, intermediate moisture products and halwa.

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