Physico-chemical Composition and Acceptability of Newer Carrot Germplasms

Keertikumari Kasale*, Usha Malagi and K. Ramachandra Naik

Department of Food Science and Nutrition, College of Community Science, University of Agricultural Sciences, Dharwad, Karnataka, India

*Corresponding author

A B S T R A C T

Nine newly identified carrot germplasms and one local carrot variety were evaluated in terms of their physico-chemical composition and acceptability. The physical parameters viz. weight, length and diameter of the carrot germplasms ranged from 46 - 91.40 g, 11.87 – 18.48 cm and 3.11 – 4.43 cm respectively. There was no significant difference observed for circumference, volume, bulk density and phloem to xylem ratio among the carrot germplasms. All the germplasms were cylindrical in shape. The different colours were noted in the carrot germplasms i.e. yellow red in three carrot germplasms and local carrot variety, red in four germplasms, yellow green and red purple in one each of germplasms. The physico-chemical parameters viz. dry matter, TSS, pH and vitamin C content of the carrot germplasms ranged from 9.92 - 18.11 %, 5.92 – 8.44° Brix, 6.70 – 7.84 and 4.01 – 4.7 mg/100 g respectively. Germplasms viz. UHSBC64, UHSBC23-1, UHSBC44-1 had better acceptability indices in boiled and sauteed carrots. Germplasms UHSBC53, UHSBC64 and UHSBC23-1 were on par with local carrot variety with regard to physico-chemical composition and acceptability.

Introduction

Carrot is globally important vegetable crop that has a source of important nutritional compounds through their carotenoid content and add flavour and texture to many diets across the world. It is a root vegetable and is in demand throughout the year. Carrot also contains wide spectrum of other antioxidant substances, such as phenolic compounds and vitamin C, which is one of the important compounds present in vegetables. Carrots are usually orange but white, black, yellow, red and purple colour also available. Preference for carrot cultivars are not only for its nutritive value and antioxidants but also for sensory properties, physical parameters viz., shape, uniform size, bright colour and xylem phloem ratios.

Carrots can be consumed fresh or cooked, either alone or with other vegetables in the preparation of soups, curries, bhajis and pickles. They are grated and used as salads and tender roots are pickled. Carrot juice is considered as a health food. Cooking methods
like boiling, microwaving, baking and frying lead to changes in texture and nutritional properties of vegetables i.e. cooking softens the cell walls which lead to increase in the extraction of carotenoids and loss of water soluble vitamins. Sauteing is the optimum method of cooking carrot which results in highest retention and an increase in the antioxidant constituents.

Realising the nutritional importance of natural antioxidant and other bioactive compounds present in carrot and overwhelming demand of consumer, various research institutes and private seed companies started breeding to develop high yielding bright coloured carrot cultivars. In the horticulture department high yielding newer carrot varieties are grown and need to be tested for their physicochemical properties and sensory characteristics. Hence, the present study was undertaken with the objective to analyze the physico-chemical composition and acceptability of newer carrot germplasms.

**Materials and Methods**

Nine newly identified carrot germplasms viz. UHSBC51, UHSBC52, UHSBC53, UHSBC59, UHSBC64, UHSBC101, UHSBC23-1, UHSBC34-1 and UHSBC44-1 were collected from Regional Horticulture Research and Extension centre Dharwad, University of Horticulture sciences Bagalkot. One variety was taken for comparison from Dharwad local market as a control (LC).

For the physical parameters of the carrots the weight was taken using electronic balance and length and diameter were measured with the help of vernier calliper to nearest 0.01 mm. Volume was measured by using water displacement method. The cylindrical form of the root was determined using formula C = W/ π r²L where C= cylindricity; W = weight in g; L= length in cm; r = radius in cm (Silva et al. 2007). Colour of the carrots was recorded by matching with Munsell colour chart. Dry matter was determined by drying samples in 105°C until constant weight (AOAC 1998). pH was measured using pH meter and TSS by hand refractometer (Gajewski et al., 2010). Vitamin C determined by titrimetric method by using 2, 6-dichlorophenol indophenol dye (Ranganna 1986).

Acceptability was assessed by sensory evaluation method by subjecting to cooking methods viz. boiling and sautéing and they were evaluated using 9 - point hedonic scale by ten semi trained judges. The results were statistically analyzed by one way ANOVA using SPSS software.

**Results and Discussion**

The physical parameters of carrot cultivars have been presented in Table 1. The weight, length and diameter of the carrots differed significantly among the germplasms. Weight of carrots ranged from 46 – 91.40g. The highest weight was observed in the germplasm UHSBC23-1 (91.40g) and least in the germplasm UHSBC101 (46 g). The length of the carrot germplasms varied from 11.87 – 18.48cm. The highest length was observed in the local carrot variety (18.48 cm) and least in the germplasms UHSBC51 (11.87 cm). The study conducted by Saha et al. (2016) reported higher values for weight and length (129 – 165 g and 18.82 – 22.85 cm). The diameter of the carrots ranged from 3.11 – 4.43cm. The highest diameter was observed in the germplasm UHSBC23-1 (4.43 cm) and least in the germplasms UHSBC59 (3.09 cm). Study conducted by Karkeline et al., (2009) reported similar values for diameter (3.4- 4.1 cm). There was no significant difference were observed in circumference, volume and bulk density among the carrot germplasms. Circumference ranged from 9.94 – 14.08 cm. Utabo et al., (2015) reported lower values for
circumference (5 - 9.99 cm). Volume varied from 25.60 – 50.60 ml. Hailu et al., (2008) reported higher values for volume (46 – 75 ml). Bulk density varied from 1.50 – 2.56 g/ml. Lim et al., (2014) reported similar results for bulk density (1.61g/ml). The difference in the physical parameters of the present study in comparison to other studies of carrots may be due to genetic variability and growing conditions such as temperature, soil, moisture, rainfall, light intensity and day length.

The carrot roots have two different types of transport tissues: the xylem which is inner core and phloem that forms the outer cortex. Majority of the carotenoids are present in the phloem tissue. In the present study the phloem and xylem ratio of carrot germplasms are presented in the Table 2. The length of phloem and xylem ranged from 1.46 - 2.03 cm and 0.50 – 0.93cm respectively and differences in means were significant at p < 0.05 level among the carrot germplasms. The highest length of the phloem was observed in the local carrot variety, UHSBC51 and UHSBC59 (2.03cm). The highest length of xylem was observed in local carrot variety (0.93cm). Higher ratios of phloem to xylem are more desirable in carrots. The phloem and xylem ratio ranged from 2.91 – 3.20 with no significant difference among the germplasms. The values in the present study were on par with those reported by Sink et al., (2017) who noted the mean ratio of 2.1.

Apart from physical parameters of carrots external and internal root colour and shape are important quality characteristics. Carrots with bright coloured and uniform shape are preferred by the consumers. They are classified as conical (C = ≤ 0.33) or cylindrical shape (0.33 to 1). In the present study the local carrot variety had conical shape (Table 3) while all the germplasms were cylindrical in shape. The study conducted by Silva et al., (2007) reported similar cylindrical shape of carrots. The different colours were noted in the carrot germplasms i.e. yellow red in three carrot germplasms and local carrot variety, red in four germplasms, yellow green and red purple in one each of germplasms. Carotenoids and lycopene are responsible for imparting orange and red colours, chlorophyll and anthocynins are responsible for imparting green and purple colours. The study conducted by Leja et.al (2013) reported similar differences in colour of carrots.

The physicochemical characteristics of carrot germplasms viz. dry matter, TSS, pH and vitamin C are presented in the Table 4. The dry matter, TSS and pH were significant at p < 0.01 level among the carrot germplasms. The dry matter content of the carrots ranged from 9.92 - 18.11 %. The highest dry matter content was observed in the germplasm UHSBC59 (18.11%) and least in UHSBC101 (9.92%). The TSS level of the carrots ranged from 5.92 – 8.44° Brix. Highest TSS level was observed in the germplasm UHSBC34-1 (8. 44° Brix) and least in the germplasm UHSBC44-1 (5.92° Brix). Study conducted by Silva et al., (2007) reported lower values for dry matter content (12.17 – 13.63%) and higher values for TSS (9.7.0 – 10.30° Brix). The pH level of the carrot germplasms varied from 6.70 – 7.84. The highest pH level was found in the germplasm UHSBC101 (7.84) and least in the germplasm UHSBC44-1 (6.70). Gajewski et al., (2010) reported lower value for pH (6.14 – 6.27). The vitamin C content of the carrot germplasms ranged from 4.01 – 4.7 mg/100 g. There was no significant difference observed in vitamin C content among the germplasm. Study conducted by Bembem and Sadana (2014) reported lower value for vitamin C (3.02 mg/100 g). The variation in the values in the present study in comparison to other studies on carrots may be due to difference in genotypes, soil type and climatic conditions.
Table 1 Physical characteristics of carrot germplasms

| Carrot germplasms | Weight (g)       | Length (cm)   | Diameter (cm) | Circumference (cm) | Volume (ml) | Bulk density (g/ml) |
|-------------------|-----------------|---------------|---------------|--------------------|-------------|---------------------|
| LC (Control)      | 78.40 ± 24.52   | 18.48 ± 1.4   | 4.04 ± 0.41   | 13.26 ± 1.72       | 42 ± 7.38   | 1.95 ± 0.52         |
| UHSBC 51          | 60.80 ± 21.08   | 11.87 ± 0.87  | 3.11 ± 0.52   | 10.88 ± 2.52       | 28.80 ± 20.29 | 2.56 ± 1.00        |
| UHSBC 52          | 46.80 ± 14.25   | 13.84 ± 2.09  | 3.37 ± 0.50   | 14.08 ± 1.61       | 25.60 ± 14.79 | 2.06 ± 0.67        |
| UHSBC 53          | 51.80 ± 20.11   | 14.33 ± 1.84  | 3.11 ± 0.74   | 12.82 ± 2.69       | 27.20 ± 9.65 | 1.90 ± 0.21        |
| UHSBC 59          | 49.40 ± 18.51   | 13.28 ± 2.43  | 3.09 ± 0.71   | 13.24 ± 5.32       | 29 ± 19.26  | 2.00 ± 0.76        |
| UHSBC 64          | 61.40 ± 26.04   | 13.35 ± 1.35  | 3.82 ± 1.04   | 11.40 ± 2.33       | 28.80 ± 13.35 | 2.21 ± 0.40        |
| UHSBC 101         | 46.00 ± 11.59   | 13.01 ± 1.96  | 3.13 ± 0.49   | 10.50 ± 1.66       | 30.20 ± 11.71 | 1.66 ± 0.64        |
| UHSBC 23-1        | 91.40 ± 15.50   | 15.89 ± 2.66  | 4.43 ± 0.43   | 12.48 ± 2.40       | 50.60 ± 8.93 | 1.80 ± 0.10        |
| UHSBC 34-1        | 65.00 ± 24.26   | 13.27 ± 0.97  | 3.78 ± 0.71   | 10.56 ± 1.39       | 38.40 ± 16.59 | 1.72 ± 1.10        |
| UHSBC 44-1        | 53.80 ± 18.28   | 12.71 ± 1.20  | 3.29 ± 0.64   | 9.94 ± 3.78        | 36.40 ± 10.06 | 1.50 ± 0.40        |
| Mean ± SD         | 60.48 ± 0.22    | 14.00 ± 2.42  | 3.52 ± 0.74   | 11.91 ± 2.87       | 33.70 ± 14.83 | 1.94 ± 0.58        |
| F- value          | 2.70            | 5.77          | 2.63          | 1.31               | 1.61        | 1.44                |
| S. Em. ±          | 8.93            | 0.78          | 0.28          | 1.24               | 17.97       | 0.25                |
| C. D. @ 1% level  | 25.52*          | 2.25**        | 0.82*         | NS                 | NS          | NS                  |

Note: Mean ± S.D; C.D – Critical Difference; S. Em. ± Standard Error mean; * Significant at 0.05 percent level; ** Significant at 0.01 percent level; NS - Non significant; Different superscript within a column indicate significant difference at 0.05 level by DMRT
### Table 2: Phloem and xylem ratio of carrot germplasms

| Carrot germplasms | Length (cm) | Phloem (cm) | Xylem (cm) | Phloem/Xylem ratio |
|-------------------|-------------|-------------|------------|-------------------|
| LC (Control)      |             | 2.03 ± 0.15<sup>a</sup> | 0.93 ± 0.11<sup>a</sup> | 2.19 ± 0.18       |
| UHSBC 51          |             | 2.03 ± 0.20<sup>a</sup> | 0.70 ± 0.10<sup>ab</sup> | 2.95 ± 0.61       |
| UHSBC 52          |             | 1.46 ± 0.30<sup>c</sup> | 0.50 ± 0.10<sup>c</sup> | 2.93 ± 0.11       |
| UHSBC 53          |             | 1.53 ± 0.11<sup>bc</sup> | 0.63 ± 0.15<sup>c</sup> | 2.48 ± 0.42       |
| UHSBC 59          |             | 2.03 ± 0.15<sup>a</sup> | 0.66 ± 0.15<sup>c</sup> | 3.14 ± 0.65       |
| UHSBC 64          |             | 1.83 ± 0.57<sup>abc</sup> | 0.70 ± 0.26<sup>ab</sup> | 2.66 ± 0.28       |
| UHSBC 101         |             | 1.56 ± 0.11<sup>abc</sup> | 0.53 ± 0.05<sup>c</sup> | 2.96 ± 0.45       |
| UHSBC 23-1        |             | 2.00 ± 0.20<sup>ab</sup> | 0.73 ± 0.05<sup>ab</sup> | 2.73 ± 0.35       |
| UHSBC 34-1        |             | 1.83 ± 0.15<sup>abc</sup> | 0.70 ± 0.10<sup>ab</sup> | 2.63 ± 0.17       |
| UHSBC 44-1        |             | 1.80 ± 0.10<sup>abc</sup> | 0.56 ± 0.05<sup>c</sup> | 3.20 ± 0.38       |
| Mean ± SD         |             | 1.81 ± 0.29 | 0.66 ± 0.16 | 2.79 ± 0.44       |
| F- value          |             | 2.38 | 2.65 | 1.77 |
| S. Em. ±          |             | 0.14 | 0.07 | 0.23 |
| C. D. @ 1% level  |             | 0.42* | 0.22* | NS |

Note: Mean ± S.D; C.D – Critical Difference; S. Em. ± Standard Error mean; * Significant at 0.05 percent level; NS-Non significant; Different superscript within a column indicate significant difference at 0.05 level by DMRT
### Table 3: Shape and Colour of Carrot Germplasms

| Carrot Germplasms | Cylindrical Form  
C = \frac{W}{\pi r^2} \text{ L (g/cm}^3\text{)} | Shape   | Colour Root/Phloem | Colour Xylem |
|------------------|---------------------------------|---------|-------------------|--------------|
| LC (Control)     | 0.31 ± 0.03^c                   | Conical | Yellow red        | Light yellow red |
| UHSBC 51         | 0.66 ± 0.11^a                   | Cylindrical | Red            | Yellow       |
| UHSBC 52         | 0.38 ± 0.13^bc                  | Cylindrical | Yellow red      | Yellow       |
| UHSBC 53         | 0.48 ± 0.11^b                   | Cylindrical | Red            | Yellow red   |
| UHSBC 59         | 0.51 ± 0.11^b                   | Cylindrical | Green yellow    | Dark yellow green |
| UHSBC 64         | 0.39 ± 0.01^bc                  | Cylindrical | Red            | Yellow red   |
| UHSBC 101        | 0.47 ± 0.12^b                   | Cylindrical | Red            | Yellow red   |
| UHSBC 23-1       | 0.38 ± 0.12^bc                  | Cylindrical | Yellow red      | Light yellow red |
| UHSBC 34-1       | 0.42 ± 0.03^bc                  | Cylindrical | Yellow red      | Light yellow red |
| UHSBC 44-1       | 0.49 ± 0.07^b                   | Cylindrical | Red purple     | Yellow red   |
| Mean ± SD        | 0.45 ± 0.12                     |          |                  |              |
| F- value         | 4.21                            |          |                  |              |
| S. Em. ±        | 0.12                            |          |                  |              |
| C. D. @ 1% level| 0.04**                          |          |                  |              |

Note: Mean ± S.D; C.D – Critical Difference; S. Em. ± Standard Error mean; ** Significant at 0.01 percent level; Different superscript within a column indicate significant difference at 0.05 level by DMRT.
Table 4 Physicochemical characteristics of carrot germplasms

| Carrot Germplams | Dry matter (%) | TSS (°Brix) | pH       | Vitamin C (mg/100g) |
|------------------|----------------|-------------|----------|---------------------|
| LC (Control)     | 10.94 ± 0.16<sup>de</sup> | 6.92 ± 0.13<sup>e</sup> | 7.12 ± 0.08<sup>d</sup> | 4.53 ± 0.44 |
| UHSBC 51         | 11.12 ± 0.41<sup>de</sup> | 7.92 ± 0.13<sup>c</sup> | 6.86 ± 0.05<sup>ef</sup> | 4.28 ± 0.45 |
| UHSBC 52         | 11.27 ± 0.27<sup>de</sup> | 7.96 ± 0.11<sup>c</sup> | 7.22 ± 0.08<sup>cd</sup> | 4.7 ± 0.46 |
| UHSBC 53         | 12.80 ± 0.68<sup>c</sup> | 8.14 ± 0.11<sup>b</sup> | 7.34 ± 0.11<sup>b</sup> | 4.01 ± 0.008 |
| UHSBC 59         | 18.11 ± 0.11<sup>a</sup> | 7.30 ± 0.22<sup>d</sup> | 7.24 ± 0.13<sup>bc</sup> | 4.29 ± 0.46 |
| UHSBC 64         | 15.93 ± 0.18<sup>b</sup> | 6.34 ± 0.15<sup>f</sup> | 6.90 ± 0.07<sup>e</sup> | 4.01 ± 0.007 |
| UHSBC 101        | 9.92 ± 0.88<sup>f</sup> | 6.82 ± 0.08<sup>e</sup> | 7.84 ± 0.05<sup>a</sup> | 4.54 ± 0.46 |
| UHSBC 23-1       | 10.76 ± 0.18<sup>e</sup> | 6.34 ± 0.08<sup>f</sup> | 6.76 ± 0.05<sup>fg</sup> | 4.27 ± 0.44 |
| UHSBC 34-1       | 11.07 ± 0.11<sup>de</sup> | 8.44 ± 0.15<sup>a</sup> | 6.94 ± 0.05<sup>e</sup> | 4.26 ± 0.46 |
| UHSBC 44-1       | 11.62 ± 0.31<sup>d</sup> | 5.92 ± 0.13<sup>g</sup> | 6.70 ± 0.07<sup>g</sup> | 4.53 ± 0.45 |
| Mean ± SD        | 12.35 ± 2.54   | 7.21 ± 0.84  | 7.09 ± 0.33 | 4.30 ± 0.38 |
| F- value         | 119.97         | 202.91       | 86.05     | 0.66               |
| S. Em. ±         | 0.23           | 0.06         | 0.014     | 0.23               |
| C. D. @ 1% level | 0.70<sup>**</sup> | 0.17<sup>**</sup> | 0.04<sup>**</sup> | NS                 |

Note: Mean ± S.D; C.D – Critical Difference; S. Em. ± Standard Error mean; ** Significant at 0.01 percent level; Different superscript within a column indicate significant difference at 0.05 level by DMRT.
Table 5 Sensory scores of boiled carrot germplasms

| Carrot germplams | Appearance | Colour | Flavour | Taste | Texture | Overall acceptability | Acceptability index |
|------------------|------------|--------|---------|-------|---------|-----------------------|---------------------|
| LC (Control)     | 8.60 ± 0.51<sup>a</sup> | 8.60 ± 0.51<sup>a</sup> | 8.20 ± 0.42<sup>a</sup> | 8.00 ± 0.66<sup>a</sup> | 8.20 ± 0.42<sup>a</sup> | 8.40 ± 0.51<sup>a</sup> | 92.59               |
| UHSBC 51         | 6.80 ± 0.78<sup>d</sup> | 7.10 ± 0.73<sup>bd</sup> | 6.70 ± 0.67<sup>bcd</sup> | 6.90 ± 0.87<sup>bc</sup> | 7.30 ± 0.82<sup>b</sup> | 6.80 ± 0.63<sup>bc</sup> | 77.03               |
| UHSBC 52         | 7.20 ± 0.78<sup>cd</sup> | 7.40 ± 0.69<sup>bcd</sup> | 6.60 ± 0.69<sup>cd</sup> | 6.50 ± 0.52<sup>c</sup> | 7.10 ± 0.99<sup>b</sup> | 6.90 ± 0.73<sup>bc</sup> | 77.22               |
| UHSBC 53         | 7.40 ± 0.96<sup>bcd</sup> | 7.60 ± 0.84<sup>bc</sup> | 7.00 ± 0.66<sup>bcd</sup> | 6.80 ± 0.42<sup>bc</sup> | 7.20 ± 0.78<sup>b</sup> | 7.20 ± 0.63<sup>bc</sup> | 80.00               |
| UHSBC 59         | 6.90 ± 0.73<sup>cd</sup> | 7.00 ± 0.81<sup>bd</sup> | 6.50 ± 0.70<sup>d</sup> | 6.30 ± 0.48<sup>c</sup> | 6.30 ± 0.48<sup>c</sup> | 6.60 ± 0.84<sup>c</sup> | 73.33               |
| UHSBC 64         | 8.00 ± 0.47<sup>ab</sup> | 8.00 ± 0.47<sup>b</sup> | 7.30 ± 0.82<sup>bc</sup> | 7.00 ± 0.81<sup>bc</sup> | 7.40 ± 0.96<sup>b</sup> | 7.40 ± 0.84<sup>b</sup> | 83.51               |
| UHSBC 101        | 7.60 ± 0.69<sup>bc</sup> | 7.50 ± 0.70<sup>bc</sup> | 6.77 ± 0.83<sup>bcd</sup> | 6.90 ± 0.87<sup>bc</sup> | 7.30 ± 0.67<sup>b</sup> | 7.10 ± 0.73<sup>bc</sup> | 80.18               |
| UHSBC 23-1       | 7.00 ± 0.66<sup>cd</sup> | 7.20 ± 0.63<sup>bd</sup> | 7.10 ± 0.73<sup>bcd</sup> | 7.00 ± 0.66<sup>bc</sup> | 7.20 ± 0.78<sup>b</sup> | 7.10 ± 0.71<sup>bc</sup> | 78.88               |
| UHSBC 34-1       | 7.10 ± 0.56<sup>cd</sup> | 7.10 ± 0.56<sup>bd</sup> | 6.90 ± 0.73<sup>bcd</sup> | 6.80 ± 0.63<sup>bc</sup> | 7.00 ± 0.66<sup>b</sup> | 7.10 ± 0.72<sup>bc</sup> | 77.77               |
| UHSBC 44-1       | 6.90 ± 0.56<sup>cd</sup> | 6.90 ± 0.50<sup>d</sup> | 7.40 ± 0.69<sup>b</sup> | 7.30 ± 0.82<sup>b</sup> | 7.40 ± 0.69<sup>b</sup> | 7.30 ± 0.67<sup>bc</sup> | 80.00               |
| Mean ± SD        | 7.35 ± 0.85 | 7.44 ± 0.80 | 7.06 ± 0.82 | 6.95 ± 0.79 | 7.24 ± 0.84 | 7.19 ± 0.82 | - |
| F- value         | 6.87 | 6.16 | 4.95 | 4.35 | 3.82 | 4.16 | - |
| S. Em. ±         | 0.21 | 0.20 | 0.22 | 0.21 | 0.23 | 0.22 | - |
| C. D. @ 1% level | 0.60** | 0.58** | 0.62** | 0.61** | 0.66** | 0.63** | - |

Note: Mean ± S.D; C.D – Critical Difference; S. Em. ± Standard Error mean; ** Significant at 0.01 percent level; Different superscript within a column indicate significant difference at 0.05 level by DMRT
Table 6: Sensory scores of sauted carrot germplasms

| Carrot germplams | Appearance   | Colour          | Flavour | Taste           | Texture       | Overall acceptability | Acceptability index |
|------------------|--------------|-----------------|---------|-----------------|---------------|-----------------------|---------------------|
| LC (Control)     | 8.00 ± 0.66<sup>a</sup> | 7.60 ± 0.84<sup>a</sup> | 7.50 ± 0.70 | 7.70 ± 0.48<sup>a</sup> | 7.80 ± 0.42<sup>a</sup> | 7.80 ± 0.42<sup>a</sup> | 85.95               |
| UHSBC 51         | 6.90 ± 0.73<sup>bc</sup> | 6.90 ± 0.87<sup>bcd</sup> | 6.90 ± 0.73 | 7.30 ± 0.48<sup>abc</sup> | 7.30 ± 0.48<sup>abc</sup> | 7.00 ± 0.66<sup>b</sup> | 78.33               |
| UHSBC 52         | 6.80 ± 0.63<sup>bc</sup> | 6.70 ± 0.67<sup>cd</sup> | 6.60 ± 0.96 | 6.80 ± 0.91<sup>bc</sup> | 6.70 ± 0.94<sup>c</sup> | 6.90 ± 0.99<sup>b</sup> | 75.00               |
| UHSBC 53         | 6.70 ± 0.84<sup>c</sup> | 6.60 ± 0.69<sup>d</sup> | 6.70 ± 0.82 | 6.70 ± 0.69<sup>c</sup> | 6.70 ± 0.82<sup>c</sup> | 6.70 ± 0.82<sup>b</sup> | 74.88               |
| UHSBC 59         | 6.60 ± 0.82<sup>c</sup> | 6.50 ± 0.70<sup>d</sup> | 6.80 ± 0.78 | 6.60 ± 0.67<sup>c</sup> | 6.60 ± 0.48<sup>c</sup> | 6.60 ± 0.82<sup>b</sup> | 73.25               |
| UHSBC 64         | 7.50 ± 0.84<sup>ab</sup> | 7.60 ± 0.69<sup>a</sup> | 6.90 ± 0.73 | 7.00 ± 0.81<sup>abc</sup> | 7.40 ± 0.81<sup>bc</sup> | 7.30 ± 0.94<sup>ab</sup> | 80.18               |
| UHSBC 101        | 7.30 ± 0.82<sup>abc</sup> | 7.60 ± 0.51<sup>a</sup> | 7.20 ± 0.63 | 7.50 ± 0.70<sup>ab</sup> | 7.30 ± 0.67<sup>abc</sup> | 7.20 ± 0.67<sup>ab</sup> | 81.85               |
| UHSBC 23-1       | 7.30 ± 0.67<sup>abc</sup> | 7.40 ± 0.51<sup>ab</sup> | 7.20 ± 0.78 | 7.10 ± 0.87<sup>abc</sup> | 7.20 ± 0.91<sup>abc</sup> | 7.30 ± 0.67<sup>ab</sup> | 80.55               |
| UHSBC 34-1       | 7.10 ± 0.87<sup>bc</sup> | 7.00 ± 0.66<sup>abcd</sup> | 7.10 ± 0.87 | 7.20 ± 0.87<sup>abc</sup> | 7.10 ± 0.87<sup>abc</sup> | 7.00 ± 0.81<sup>b</sup> | 78.51               |
| UHSBC 44-1       | 7.10 ± 0.56<sup>bc</sup> | 7.30 ± 0.48<sup>abc</sup> | 7.30 ± 0.67 | 7.10 ± 0.56<sup>abc</sup> | 7.50 ± 0.70<sup>bc</sup> | 7.40 ± 0.69<sup>ab</sup> | 80.92               |
| Mean ± SD        | 7.13 ± 0.82  | 7.12 ± 0.76     | 7.02 ± 0.79 | 7.09 ± 0.76     | 7.13 ± 0.78     | 7.14 ± 0.80           | -                   |
| F-value          | 3.70         | 4.07<sup>***</sup> | 1.34     | 2.25            | 2.48           | 1.9                  | -                   |
| S. Em. ±         | 0.23         | 0.21            | 0.24     | 0.22            | 0.23           | 0.24                 | -                   |
| C. D. @ 1% level | 0.67<sup>**</sup> | 0.60<sup>**</sup> | NS       | 0.64<sup>*</sup> | 0.65<sup>**</sup> | 0.68<sup>**</sup> | -                   |

Note: Mean ± S.D; C.D – Critical Difference; S. Em. ± Standard Error mean; * Significant at 0.05 percent level; ** Significant at 0.01 percent level; NS- Non significant; Different superscript within a column indicate significant difference at 0.05 level by DMRT
Sensory characteristics of carrots was evaluated by subjecting to different cooking methods viz., boiling and sautéing. Acceptability of boiled and sautéed carrot germplasms are presented in Table 5. There was significant difference observed in the mean values for appearance, colour, flavour, taste, texture and over all acceptability of boiled and sautéed carrot germplasms. Sensory scores for overall acceptability of boiled and sautéed carrot germplasms ranged from 6.60 – 8.40 and 6.60 – 7.80 respectively. Germplasms viz. UHSBC64, UHSBC23-1 and UHSBC44-1 had high acceptability index in boiled and sautéed carrots. However, germplasm UHSBC53 had higher scores only in boiled form and germplasm UHSBC101 had higher scores after sautéing. Acceptability of carrots is affected by appearance, colour, taste, flavour and texture. Germplasms UHSBC64 had higher scores for appearance and colour and germplasms UHSBC44-1 has got higher scores for flavour, taste and texture in boiled and sautéed form. But germplasm UHSBC59 had lower scores for appearance, flavour, taste and texture in boiled and sautéed carrot germplasms because of its yellow green colour and hard texture (Table 6). The differences noted in the appearance, colour, taste, flavour, texture and over all acceptability of boiled and sautéed carrot germplasms may be attributed to genetic variability, physico-chemical properties and phenolic compounds present in the carrots.

The study on physico-chemical composition and acceptability of newer carrot germplasms showed that germplasms UHSBC53, UHSBC64 and UHSBC23-1 were on par with local carrot variety and best in terms of physico-chemical composition and sensory characters.

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