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Development and characterisation of blended carrot (*Daucus carota* L.) juice

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ABSTRACT

The present investigation was designed and evaluated during the Rabi season (October–December 2021-22). Different combinations of carrot juices were blended with varied amounts of pineapple and orange juices, and natural ingredients were prepared. Obtained analytical outcomes were put to statistical analysis using Factorial Completely Randomised Design (FCRD), wherein three replicates of treatments were comprised for 27 trials consisting of three carrot variables (carrot 60%, carrot 70%, and carrot 80%), three factors of fruits (no fruit, pineapple, and orange), and furthermore, three aspects of flavour (no flavour, ginger, and mint). In a nutshell, treatment T_8 (carrot juice 60% + orange juice 35% + ginger juice 5%) was observed to be highly acceptable as per the sensory evaluation score, followed by T_7 (carrot juice 60% + orange juice 40%). Both the samples, *i.e.*, T_7 (carrot juice 60 % + orange juice 40 %) and T_8 (carrot juice 60 % + orange juice 35 % + ginger juice 5 %), were accepted by panellists and were further tested for physicochemical, energy, and nutritional attributes.

1. Introduction

The carrot (*Daucus carota* L.) is considered the most popular known vegetable crop grown all over the world, and it belongs to the family *Apiaceae* (*Umblifereae).* Furthermore, it is one of the most common cold-season vegetables for human nutrition, is rich in dietary carotenoids (β-carotene), and exhibits an adequate number of metabolic regulators (vitamins and minerals). This is the reason why it is subjected to minimal processing and is popularly used as a beverage (Walde *et al*., 1992; Demir *et al*., 2004). Generally, the most consumed edible part of this vegetable is a taproot, which possesses an appreciable number of dietary fibres, has a laxative effect, prevents digestive disorders and constipation, and facilitates the absorption of nutrients. The juice of carrots produces high nutritive contents, fibres, carbohydrates, and vitamin A derived from its α-carotene and β-carotene content (Abdel *et al*., 2006). Moreover, the vitamins present in carrots help to promote growth for visual light, improve eyesight, and moisturise and hydrate the skin (Ochulor *et al*., 2013).

Orange (*Citrus cinensis*) is a typical kind of fruit that belongs to the family *Rutaceae,* consisting of chromosome number 2n=18. It is well known for its various components, such as flavour, vitamin C, and natural antioxidants (Campos *et al*., 2010). The juice of oranges maintains its popularity as it is marketed, recognised, and accepted worldwide. For instance, the physiological benefits of drinking orange juice include a reduction in oxidative damage to DNA and an increase in levels of antioxidants in plasma (Moller *et al*., 2004).

Similarly, pineapple (*Ananas comosus* L.) belongs to the family *Bromeliaceous* and is considered popular among non-citrus tropical and sub-tropical fruits due to its flavour and also for maintaining the balance between sugars and acids. The total production of pineapple across India is

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approximately 1.53 million tonnes (APEDA, 2013).

Ginger, scientifically known as *Zingiber officinale*, belongs to the family *Zingiberaceae* and has been considered a spice for the past 2000 years, meant for flavouring distinct foods and beverages, too. It is loaded with lists of functional features *viz,* fibre, ash, numerous antioxidants such as β-carotene, ascorbic acid, alkaloids, polyphenols like flavonoids, flavones, glycosides and rutin (Nile & Park, 2015). *Mentha arvensis*, also known as mint (from Greek mintha), is from the family *Lamiaceae*, with nearly 13 to 18 species existing. It possesses various derived chemical compounds that exhibit numerous properties that promote health, prevent diseases, and are anti-oxidating in nature (Anne & Juri, 2001).

Juices are marked for their thirst-quenching and immune-modulating properties, which promote health and longevity through the availability of vitamins, minerals, phenolics, and dietary fibres. Currently, awareness regarding healthier diets is advancing, so the consumption of juices is higher for the sake of nutrition (Singh et al., 2021). That's why they have adopted them as a substitute for other food products. Also, the increasing perils of ongoing modern life bring out diseases like diabetes, high blood pressure, fatigue, and various types of cancer, which align humankind to uptake rational nutrition (Poornima et al., 2021). Eventually, the demand for nutrition will be satisfied by nutritional juice and drinks made from fruits with great taste (Suad & Eman, 2008).

The present study highlights the scope of carrot juice blending with natural and health-promoting ingredients with the motive of providing a nutritionally loaded and palatable juice option to provide the vitamins and fibres available in soluble form.

2. Materials and Methods

The current study was carried out at the Department of Agriculture, Mata Gujri College, Fatehgarh Sahib, during the rabi season, 2021–22. The experiment was laid out in a factorial completely randomised design (FCRD) with three replications and comprising twenty-seven treatment combinations for 100 ml of juice with three different factors (Tables 1 and 2).

Table 1. Details of factors selected and their coded format for blend development

TREATMENT DETAILS					
factor-a (carrot)		***factor-b (fruits)***		***factor-c (flavouring agent)***	
C_1	Carrot (60 %)	P_0	No Fruit	F_0	No Flavour
C_2	Carrot (70 %)	P_1	Pineapple	F_1	Ginger (5 %)
C_3	Carrot (80 %)	P_2	Orange	F_2	Mint (5 %)

Table 2. Details of treatment and their levels in coded format for blend preparation

Treatment	Treatment Combinations
T_1	$C_1P_0F_0$ - Carrot Juice (60 %) + No Fruit + No Flavour
T_2	$C_1P_0F_1$ - Carrot Juice (60 %) + No Fruit + Ginger Juice (5 %)
T_3	$C_1P_0F_2$- Carrot Juice (60 %) + No Fruit + Mint Juice (5 %)
T_4	$C_1P_1F_0$- Carrot Juice (60 %) + Pineapple Juice (40 %) + No Flavour
T_5	$C_1P_1F_1$- Carrot Juice (60 %) + Pineapple Juice (35 %) + Ginger Juice (5 %)
T_6	$C_1P_1F_2$- Carrot Juice (60 %) + Pineapple Juice (35 %) + Mint Juice (5 %)
T_7	$C_1P_2F_0$- Carrot Juice (60 %) + Orange Juice (40 %) + No Flavour
T_8	$C_1P_2F_1$- Carrot Juice (60 %) + Orange Juice (35 %) + Ginger Juice (5 %)
T_9	$C_1P_2F_2$- Carrot Juice (60 %) + Orange Juice (35 %) + Mint Juice (5 %)
T_{10}	$C_2P_0F_0$- Carrot Juice (70 %) + No Fruit + No Flavour
T_{11}	$C_2P_0F_1$- Carrot Juice (70 %) + No Fruit + Ginger Juice (5 %)
T_{12}	$C_2P_0F_2$- Carrot Juice (70 %) + No Fruit + Mint Juice (5 %)
T_{13}	$C_2P_1F_0$- Carrot Juice (70 %) + Pineapple Juice (30 %) + No Flavour
T_{14}	$C_2P_1F_1$- Carrot Juice (70 %) + Pineapple Juice (25 %) + Ginger Juice (5 %)
T_{15}	$C_2P_1F_2$- Carrot Juice (70 %) + Pineapple Juice (25 %) + Mint Juice (5 %)
T_{16}	$C_2P_2F_0$- Carrot Juice (70 %) + Orange Juice (30 %) + No Flavour
T_{17}	$C_2P_2F_1$- Carrot Juice (70 %) + Orange Juice (25 %) + Ginger Juice (5 %)

T_{18}	$C_2P_2F_2$- Carrot Juice (70 %) + Orange Juice (25 %) + Mint Juice (5 %)
T_{19}	$C_3P_0F_0$- Carrot Juice (80 %) + No Fruit + No Flavour
T_{20}	$C_3P_0F_1$- Carrot Juice (80 %) + No Fruit + Ginger Juice (5 %)
T_{21}	$C_3P_0F_2$- Carrot Juice (80 %) + No Fruit + Mint Juice (5 %)
T_{22}	$C_3P_1F_0$- Carrot Juice (80 %) + Pineapple Juice (20 %) + No Flavour
T_{23}	$C_3P_1F_1$- Carrot Juice (80 %) + Pineapple Juice (15 %) + Ginger Juice (5 %)
T_{24}	$C_3P_1F_2$- Carrot Juice (80 %) + Pineapple Juice (15 %) + Mint Juice (5 %)
T_{25}	$C_3P_2F_0$-Carrot Juice (80 %) + Orange Juice (20 %) + No Flavour
T_{26}	$C_3P_2F_1$- Carrot Juice (80 %) + Orange Juice (15 %) + Ginger Juice (5 %)
T_{27}	$C_3P_2F_2$- Carrot Juice (80 %) + Orange Juice (15%) + Mint Juice (5 %)

Whereas, in T_1, T_2, T_3, T_{10}, T_{11}, T_{12}, T_{19}, T_{20}, and T_{21}, the remaining concentration was distilled water.

Experimentation was initiated with the selection of good-quality fruits and vegetables. Peeling, cutting, and extraction of juice were done with the sample. Blending was carried out at different proportions, and straining of the blended sample was carried out to remove fruit and vegetable debris. After filtration, the product was filled in glass bottles, and thereafter, pasteurisation was carried out at 75 °C for 15 minutes (Chaudhary & Mishra, 2016) (Figure 1).

Selection of raw materials and ingredients

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Cleaning and Washing

↓

Peeling

↓

Cutting

↓

Extraction of juice

↓

Blending

↓

Straining and Filtration

↓

In-bottle Pasteurisation

↓

Cooling (4˚C)

↓

Refrigeration storage

Figure 1. Flow chart for juice blend development

2.1 Physico-chemical characterisation

Different carrot samples were assessed for pH, TSS (total soluble solids), titratable acidity, vitamin A (retinol), vitamin C (ascorbic acid), and total sugar content. Titratable acidity, vitamin A, vitamin C, and total sugars were calculated by following the processes given by Ranganna (1986), whereas pH was measured with the help of the pH metre (4320 DPH-2 Atago Digital Waterproof pH metre), Kingwood, United States, and TSS was calculated in degree Brix (°Brix) using the PR-32 Portable Refractometer, Advanced Research Instrument Company, New Delhi, India. The vitamin-C content of blended juice was determined by performing the 2,6-dichlorophenolindophenol method (Ranganna, 1986), in which the dye solution is reduced by vitamin-C to a light pink colour while the appearance of a light pink colour denotes the end point of the titration. Then, the titer value was noted, and the content of vitamin C was measured by using the formula as follows:

$$\text{Vitamin C (mg/100g)} = \frac{\text{Dye factor} \times \text{Titer} \times \text{Volume made up (ml)}}{\text{Aliquot taken (ml)} \times \text{Volume of sample (ml)}} \times 100$$

2.2 Proximate Characterisation

With the help of AOAC (2016), the content of moisture, ash, crude fibre, crude protein, and carbohydrates in the samples in percentage formulation (%) was calculated, whereas the content of protein was measured by performing the Micro-Kjeldahl method. Total carbohydrate content (%) was calculated by the factorial method (AOAC, 2016) as follows:

Carbohydrates % = 100- Crude fat% + Crude protein% + Crude Fibre% + Ash%).

Whereas crude fibre was measured with the help of the automatic fibre plus apparatus, in which a sample (1g) that had no fats was placed in a glass crucible; this crucible was attached to the extraction unit, and from the top of the extraction unit, a 1.25% sulfuric acid solution was poured for digestion for about half an hour. After completion of digestion, draining out of this acid was done, and washing of the sample was done using distilled water. Following that, the sample was taken out of the crucible and dried overnight at

110 °C. Then, the sample was placed in a desiccator for cooling. Weight was noted down, and crude fat was calculated by using the formula as follows:

$$\text{Crude fibre\%} = \frac{(\text{Initial weight of crucible with sample - Final weight of crucible after drying}) \times 100}{\text{Weight of sample}}$$

2.3 Sensory characterisation

The carrot-blended juice was subjected to sensory evaluation using a group of 10 semi-trained panellists. Sensory evaluation was carried out using a nine-point hedonic scale (9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, and 1 = dislike extremely). The sample juices were served to the individual panellists in clear glasses. Also, water was served to the panellists to rinse their mouths after each evaluation in the well-lit evaluation room. The blended juice was rated for various characters by each panellist based on its external appearance, colour, taste, flavour, and overall acceptability.

3. Results and Discussion

3.1. Physico-chemical Characterisation

3.1.1. pH

The data pertaining to the pH of sample juices with respect to the individual effects of carrot juice, added fruit, and added flavour has been presented in Table 3. According to the data, carrot juice (C_3–70%) revealed the highest pH value (4.96), whereas the minimum pH (4.30) was reported in (C_1–60%). In addition to this, in the added fruit sample, the highest pH of 5.55 was reported in P_0 (no fruit), while the minimum pH (4.18) was recorded in P_1 (pineapple). But in the case of added flavour, the maximum pH (4.75) resulted in F_1 (ginger), and the minimum pH (4.72) was recorded in F_2 (mint) (Sanchez-Moreno *et al*., 2006).

Furthermore, the data associated with pH for interactions between two characters *viz.* C×P (carrot × fruit), P×F (fruit × flavour), and C×F (carrot × flavour) have been exhibited in Table 3. For C×P (carrot × fruit), the maximum pH (5.72) was observed in C_2P_0 (carrot 70%, no fruit), while the lowest pH (3.32) was reported in C_1P_2 (carrot 60%, orange). Whereas, in the case of P×F (fruit × flavour), the maximum pH (5.58) was recorded in P_0F_0 (no fruit, no flavour). Among C×F (carrot × flavour), the highest value of pH (4.98) was revealed in C_3F_1 (carrot 80%, ginger), and the lowest value of pH (4.29) was reported in both C_1F_0 (carrot 60%, no flavour) and C_1F_2 (carrot 60%, ginger).

The data interpretation of pH has been presented in Table 3. The highest pH value (5.75) was reported in sample T_1 (carrot juice 60%). However, the lowest pH value (3.30) was observed in T_7 (carrot 60% + orange 35% + ginger 5%). Manna *et al*. (2017) revealed that if pH decreases, acidic content increases, which further results in an increase of vitamin C in the juice blends. Eventually, pH decreases with the addition of pineapple as well as orange juice.

3.1.2 Vitamin A (mg/100 ml)

The individual effect of carrot juice content, along with added fruit and added flavour, on the basis of vitamin A is displayed in Table 3. Among the carrot juice, (C_3–80%) revealed the highest vitamin A (4.27 mg/100 ml), whereas the lowest vitamin A (3.18 mg/100 ml) was reported in (C_1–60%). In addition to this, with the addition of the fruit sample, the highest vitamin A content (3.73 mg/100 ml) was depicted in P_1 (pineapple), while the lowest vitamin A content (3.70 mg/100 ml) was depicted in P_2 (orange). However, in the case of flavours, the maximum vitamin A content (3.76 mg/100 ml) was observed in F_0 (no flavour), and the minimum vitamin A content (3.68 mg/100 ml) was recorded in F_1 (ginger), and the explanation for the higher content of the vitamin A sample was demonstrated as it must have the higher β-carotene content that is present in carrot (Aderinola & Abaire, 2019).

The data associated with vitamin A for interactions between two characters has been presented in Table 3. For C×P (carrot × fruit), the maximum vitamin A (4.33 mg/100 ml) was observed in C_3P_0 (carrot juice 80% with no fruit), while the minimum vitamin A (3.16 mg/100 ml) was found in C_1P_0 (carrot 60% with no fruit). Moreover, in the case of P×F (fruit × flavour), the highest vitamin A content (3.82 mg/100 ml) was observed in P_1F_0 (pineapple, no flavour), whereas the lowest vitamin A content (3.66 mg/100 ml) was observed in P_0F_1 (no fruit, ginger). Among C×F (carrot × flavour), the highest vitamin A (4.37 mg/100 ml) was revealed by C_3F_0 (carrot 80%, no flavour), and the lowest vitamin A (3.17 mg/100 ml) was found in both C_1F_1 (carrot 60%, ginger) and C_1F_2 (carrot 60%, mint). The data interpretation of vitamin A is demonstrated in Table 3, with the statistical analysis of significant associations among them. The highest content of vitamin A (4.44 mg/100 ml) was reported in sample T_{19} (carrot juice 80%), whereas the lowest value of vitamin A (3.12 mg/100 ml) was obtained in sample T_1 (carrot 60%) because vitamin A content varies in different samples due to variability in the composition of blended samples. It was concluded that the vitamin A content increases with an increase in the carrot juice concentration in the blends, as carrots are a rich source of carotenoids (precursors of vitamin A) (Nicolle *et al*., 2013).

3.1.3 Vitamin C (mg/100 ml)

The data depicting the effects on carrot juice along with the addition of distinct kinds of fruits and flavours with respect to vitamin C content has been exhibited in Table 3, and it was recapitulated that among carrot juice, (C_1-60 %) showed the highest value of vitamin C say (22.31 mg/100ml) while the lowest vitamin C (16.34 mg/100 ml) was recorded in (C_3-80 %). On the other hand, in the case of added fruit, sample P_2 (orange) exhibited maximum vitamin C (28.04 mg/100 ml), whereas the minimum vitamin C (5.02 mg/100 ml) was reported in P_0 (no fruit). In the case of flavour addition, the highest vitamin C (19.76 mg/100 ml) was observed in F_0 (no flavour), and the lowest vitamin C (18.88 mg/100 ml) was found in F_2 (mint) because this amount of mint leaves is not able to bring the significant change in vitamin C instead of that it adds flavour to the juice blend.

The data interpretation of vitamin C for interactions among two characters *viz*. C×P (carrot × fruit), P×F (fruit × flavour) and C×F (carrot × flavour) have been shown in Table 4. For C×P (carrot × fruit), the maximum vitamin C (34.96 mg/100 ml) was found in C_1P_2 (carrot 60 %, orange), while minimum vitamin C (4.80 mg/100 ml) was recorded in C_1P_0 (carrot 60 %, no fruit). In the case of P×F (fruit × flavour), the utmost vitamin C (29.00 mg/100 ml) was observed in P_2F_0 (orange, no flavour), whereas the lowest content (4.99) was found in P_0F_0 (no fruit, no flavour) Among C×F (carrot × flavour), the maximum vitamin C (22.87 mg/100 ml) was recorded in C_1F_0 (carrot juice 60 %, no flavour) and the minimum vitamin C (15.97 mg/100 ml) was found in C_3F_2 (carrot 80 %, mint) which is illustrated as vitamin C content in blended juice increases with addition of pineapple and orange juice (Zeeshan *et al*., 2018).

The data interpretation of vitamin C content in different juice samples of blended carrot juice has been shown in Table 5 and reveals a non-significant statistical association. The highest vitamin C (35.90 mg/100 ml) was reported in sample T_7 (carrot juice 60 % + orange juice 40 %). However, the minimum vitamin C (4.74 mg/100 ml) was observed in sample T_1 (carrot 60 %), which is due to the addition of fruit juice. The results corresponded with the findings of Imitiyaz and Singh (2018), Bhardwaj and Mukerjee (2010), Hussein *et al*. (2017), Khan *et al*. (2018) and Jan and Masih (2012).

3.2 Proximate Characterisation

3.2.1 Crude fiber (%)

The content of crude fibre concerning the effect of carrot juice with added fruit and flavour has been represented in Table 3, and it was concluded that the carrot juice (C_3-80 %) showed the highest crude fibre content (2.29 %) while the least crude fibre (1.93 %) was observed in (C_1-60 %). On the other hand, added fruit sample P_2 (orange) exhibited maximum crude fibre content (2.29 %) and the minimum crude fibre content (1.92 %) was recorded in P_0 (no fruit). Among the added flavour, the maximum crude fibre (2.15 %) was observed for F_0 (no flavour), whereas the minimum crude fibre (2.09 %) was observed for F_2 (mint).

The data evaluates the crude fibre content for interactions between two characters, *viz*. C×P (carrot × fruit), P×F (fruit × flavour), and C×F (carrot × flavour) have been showed in Table 4. For C×P (carrot × fruit), the maximum crude fibre (2.33 %) was observed in C_2P_2 (carrot 70 %, orange) while minimum crude fibre (1.51 %) was observed in C_1P_0 (carrot 60 %, no fruit). In the case of P×F (fruit × flavour), the highest crude fibre (2.36 %) was revealed in P_2F_0 (pineapple, no flavour) and the lowest crude fibre content (1.99 %) was revealed in P_0F_2 (no fruit, no flavour). Among C×F (carrot × flavour), the highest value of crude fibre (2.30 %) was recorded in both C_3F_0 (carrot 80 %, no flavour) and C_1F_1 (carrot 60 %, ginger), whereas the minimum crude fibre (1.91 %) was recorded in both C_1F_1 (carrot 60 %, ginger) and C_1F_2 (carrot 60 %, mint).

The data shown in Table 5 depicts crude fibre content in different juice blends and reveals a non-significant association. The highest crude fibre content (2.45 %) was recorded in sample T_{16} (carrot 70 % + orange 30 %), whereas the minimal crude fibre (1.49 %) was found in sample T_1 (carrot 60 %). The result regarding the presence of the highest crude fibre among different juice blends was supported by the findings of Razzaq *et al*. (2020) in carrot blended juice.

3.2.2 Crude protein (%)

The individual effect of carrot juice, added fruit and added flavour with respect to crude protein has been presented in Table 3. The carrot juice (C_3-80 %) revealed the maximum crude protein, say 0.82 %, and the lowest crude protein (0.65 %) was revealed by (C_1-60 %). In the case of added fruit, the highest crude protein content (0.79 %) was found in P_2 (orange), while the lowest crude protein content (0.68 %) was found in P_0 (no fruit). Among added flavours, the maximum crude protein (0.74 %) was present in both F_0 (no flavour) and F_2 (mint), and the minimum crude protein (0.73 %) was present in F_1 (ginger).

The data related to interactions between two factors *viz*. C×P (carrot × fruit), P×F (fruit × flavour) and C×F (carrot × flavour) have been exhibited in Table 4. The interaction among C×P (carrot × fruit) shows the maximum crude protein (0.87 %) was observed in C_3P_2 (carrot 80 %, orange) while the lowest value of crude protein (0.55 %) was observed in C_1P_0 (carrot 60 %, no fruit). Among P×F (fruit × flavour), the highest crude protein (0.81 %) was found in P_2F_2 (orange, mint) and the lowest crude protein (0.68 %) was found in both P_0F_0 (no fruit, no flavour) and P_0F_2 (no fruit, mint). Moreover, for C×F (carrot × flavour), the utmost crude protein (0.83 %) was recorded in C_3F_2 (carrot 80 %, mint) and the lowest crude protein (0.65 %) was recorded in both C_1F_0 (carrot 60 %, no flavour) and C_1F_2 (carrot 60 %, mint) because the former blend contains high proportion of carrot juice which eventually gives rise to the total content of crude protein and here, mint leaves aids digestion and acts as flavouring agent.

The crude protein content present in different samples has been exhibited in Table 5. The highest crude protein (0.88 %) was observed in sample T_{27} (carrot 80% + orange 15% + mint 5 %), and the lowest value of crude protein (0.54 %) was observed in sample T_1 (carrot 60 %). The similar results were also revealed by Banigo *et al.* (2015).

3.2.3 Carbohydrates (%)

Carbohydrates provide the energy herein; the blended juices also contain an appreciable amount of carbohydrates and, therefore, serve as an energetic and nourishing drink (Olalude *et al.* (2015). The data related to carbohydrates revealing individual effects of carrot juice, added fruit, and added flavour had been exhibited in Table 3. The carrot juice (C_1-60 %) revealed the highest value of carbohydrates (8.39%), whereas the minimum carbohydrate (8.25 %) was reported in (C_3-80%). In addition to this, the added fruit sample P_2 (orange) exhibited maximum carbohydrate content (8.89%), while the minimum carbohydrate content (7.95 %) was recorded in P_0 (no fruit). In the case of added flavour, the maximum carbohydrate value (8.34 %) was observed for F_2 (mint), whereas the minimum carbohydrate (8.33 %) was observed in both F_0 (no flavour) and F_1 (ginger).

The data associated with carbohydrates for interactions between two characters *viz*. C×P (carrot × fruit), P×F (fruit × flavour) and C×F (carrot × flavour) have been given in Table 4. For C×P (carrot × fruit), the maximum carbohydrate (9.26 %) was observed in C_1P_2 (carrot 60 %, orange) and the minimum carbohydrate (7.85 %) was observed in C_1P_0 (carrot 60 %, no fruit). Whereas, in the case of P×F (fruit × flavour), the highest value carbohydrate (8.94 %) was found in P_2F_0 (orange, no flavour) and the lowest carbohydrate value (7.92 %) was found in P_0F_0 (no fruit, no flavour). Among C×F (carrot × flavour), the maximum value of carbohydrate (8.41 %) was revealed in C_1F_0 (carrot 60 %, no flavour) and the minimum value of carbohydrate (8.23 %) was revealed in C_3F_0 (carrot 80 %, no flavour).

The data presented in Table 5 depicted carbohydrate content in different samples of blended juice of carrot. The maximum carbohydrate content (9.32 %) was recorded in sample T_7 (carrot 60 % + orange 40 %); however, the lower value of carbohydrate (7.84 %) was found in sample T_1 (carrot 60 %). The Brix explains this to the Acid ratio; the sugar level minimises in the T_1 sample while the carbohydrate proportion is elevated in the T_7 sample. The current results are in accordance with Banigo *et al.* (2015).

3.3 Sensory Characterisation

Sensory analysis was carried out using a 9-point Hedonic Scale by five semi-trained panellists from an institute. The acceptability of the blended juice was evaluated on the basis of colour and appearance, aroma and flavour, mouthfeel and overall acceptability, as shown in Table 6.

3.3.1 Colour and appearance

Colour and appearance are considered the most important characteristics for the evaluation of blended juice, and rejection of the juice sample is directly proportional to the physical appearance of the juice, which is due to the pigments present (Aderinola & Abaire, 2019). From the results, it was concluded that the maximum score of 8.2 for T_8 (carrot juice 60 % + orange juice 35 % + ginger 5 %) was found in accordance with colour and appearance, while the minimum score was 6.3 which was observed for T_3 (carrot 60 % + mint 5 %). The colour of the juice is imparted by different phytochemicals, such as carotenoids, which impart colour; therefore, juice blended with carrot juice is highly acceptable. Similar findings were found by Rani *et al.* (2020) and Aderinola and Abaire (2019).

3.3.2 Aroma and flavour

The preference for aroma and flavour depends upon the choice and taste of the person, and it differs significantly. The maximum score was gained by the combination of carrot juice and orange juice, say T_8 (carrot juice 60 % + orange juice 35 % + ginger 5 %) with the value of 8.6, while the minimum score (6.3) was observed in T_2 (carrot 60 % + ginger 5 %). Similarly, Afreen *et al.* (2016), Raza *et al.* (2014), Manna *et al.* (2017), and Okwori *et al.* revealed that the blended juice of vegetables and fruit has higher acceptability.

3.3.3 Mouthfeel

Mouthfeel is affected by the physico-chemical characteristics present in the juices (Ullah *et al.*, 2015). The maximum score was recorded in T_8 (carrot juice 60 % + orange juice 35 % + ginger juice 5 %), which was 7.9, as most people like the taste of carrot and orange juice. However, the minimum score was recorded in T_2 (carrot 60 % + ginger 5 %) with a value of 6.4. Onyekwelu (2017), Bhardwaj and Mukerjee (2011), Afreen *et al.* (2016) and Raza *et al.* (2014) also concluded that the blends with orange juice are found good in accordance with sensory attributes.

3.3.4 *Overall acceptability*

Overall acceptability indicates the overall sensory evaluation by considering the overall acceptance of all the sensory attributes. The overall acceptability of blended juice was higher due to the presence of a higher proportion of vitamin C (Akusu *et al*., 2016). The present finding reveals that the treatment T_8 (carrot juice 60 % + orange juice 35 % + ginger juice 5 %) was observed with the highest score (8.7) in all sensory attributes, whereas the lowest overall acceptability (6.6) was reported in T_2 (carrot 60 % + ginger 5 %) this happened as of Brix to Acid ratio, the likeness preference is more towards with the addition of orange juice in the considered juice blend which in turn enhance the overall acceptability characteristics of blended juice. Some similar results were also revealed by El-Dakak *et al*. (2016), Rani *et al*. (2020), Sharma *et al*. (2016) and Zeeshan and Saleem (2018) in carrot blended juice with orange.

Table 3. Effect of individual factors of carrot, fruits and flavours on physicochemical and proximate composition of blended juice

Parameter / Treatment	Physico-chemical characterisation			Proximate Characterisation		
	pH	**Vitamin A**	**Vitamin C**	**Crude Fiber**	**Crude Protein**	**Carbohydrates**
Carrot						
C_1	4.30	3.18	22.31	1.93	0.65	8.39
C_2	4.93	3.71	18.99	2.13	0.75	8.36
C_3	4.96	4.24	16.34	2.29	0.82	8.25
SEm(±)	0.02	0.02	0.14	0.02	0.01	0.01
$CD_{(0.01)}$	0.06	0.05	0.36	0.05	0.02	0.04
Fruit						
P_0	5.55	3.70	5.02	1.92	0.68	7.95
P_1	4.18	3.73	24.58	2.13	0.74	8.16
P_2	4.46	3.70	28.04	2.29	0.79	8.89
SEm(±)	0.02	0.02	0.14	0.02	0.01	0.01
$CD_{(0.01)}$	0.06	NS	0.36	0.05	0.02	0.04
Flavour						
F_0	4.73	3.75	19.76	2.15	0.74	8.33
F_1	4.75	3.68	19.01	2.10	0.73	8.33
F_2	4.72	3.70	18.88	2.09	0.74	8.34
SEm(±)	0.02	0.02	0.14	0.02	0.01	0.01
$CD_{(0.01)}$	NS	0.05	0.36	0.05	NS	NS

Whereas, C_1 = Carrot juice 60 %, C_2 = Carrot juice 70 %, C_3 = Carrot juice 80 %;
P_0 = No fruit, P_1 = Pineapple juice, P_2 = Orange juice;
F_0 = No flavour, F_1 = Ginger juice 5 %, F_2 = Mint juice 5 %
NS = Non-Significant, CD= Critical Difference, SEm =Standard Error of mean

Table 4. Effect of interaction between carrot × fruit, fruit × flavour and carrot × flavour on physico-chemical and proximate characterisation.

Parameter / Treatment	Physico-chemical Characterisation			Proximate Characterisation		
	pH	**Vitamin A**	**Vitamin C**	**Crude Fiber**	**Crude Protein**	**Carbohydrate**
C×P						
C_1P_0	5.67	3.16	4.80	1.51	0.55	7.85
C_1P_1	3.93	3.18	27.17	2.05	0.70	8.07
C_1P_2	3.32	3.19	34.96	2.22	0.71	9.26
C_2P_0	5.72	3.67	5.02	2.01	0.73	7.94
C_2P_1	4.11	3.76	24.16	2.04	0.71	8.18

C_2P_2	5.00	3.70	27.80	2.33	0.79	8.95
C_3P_0	5.27	4.26	5.24	2.24	0.78	8.06
C_3P_1	4.52	4.26	22.40	2.31	0.80	8.23
C_3P_2	5.09	4.21	21.37	2.32	0.87	8.45
SEm(±)	0.04	0.03	0.24	0.02	0.01	0.02
$CD_{(0.01)}$	0.11	NS	0.63	0.05	0.03	0.07
P×F						
P_0F_0	5.58	3.74	4.99	1.92	0.68	7.92
P_0F_1	5.55	3.66	5.05	1.93	0.69	7.96
P_0F_2	5.54	3.68	5.03	1.91	0.68	7.97
P_1F_0	4.13	3.82	25.29	2.17	0.75	8.14
P_1F_1	4.22	3.68	24.37	2.10	0.73	8.17
P_1F_2	4.20	3.70	24.08	2.13	0.74	8.18
P_2F_0	4.47	3.68	29.00	2.36	0.79	8.94
P_2F_1	4.48	3.69	27.60	2.27	0.79	8.87
P_2F_2	4.45	3.73	27.54	2.24	0.81	8.85
SEm(±)	0.04	0.03	0.24	0.02	0.01	0.02
$CD_{(0.01)}$	NS	0.08	0.63	NS	NS	0.07
C×F						
C_1F_0	4.29	3.18	22.87	1.96	0.65	8.41
C_1F_1	4.32	3.17	22.18	1.91	0.66	8.40
C_1F_2	4.29	3.17	21.90	1.91	0.65	8.38
C_2F_0	4.95	3.72	19.48	2.18	0.76	8.37
C_2F_1	4.94	3.67	18.71	2.11	0.73	8.35
C_2F_2	4.94	3.73	18.79	2.09	0.75	8.36
C_3F_0	4.94	4.33	16.92	2.30	0.81	8.23
C_3F_1	4.98	4.19	16.13	2.28	0.81	8.25
C_3F_2	4.96	4.21	15.97	2.29	0.83	8.27
SEm(±)	0.04	0.03	0.24	0.02	0.01	0.02
$CD_{(0.01)}$	NS	NS	NS	0.05	NS	NS

Table 5. Physico-chemical and Proximate characterisation in different samples of carrot blended juice.

Parameter / Treatment	Physico-chemical Characterisation			Proximate Characterisation		
	pH	**Vitamin A**	**Vitamin C**	**Crude Fiber**	**Crude Protein**	**Carbohydrate**
$T_1(C_1P_0F_0)$	5.75	3.12	4.74	1.49	0.54	7.84
$T_2(C_1P_0F_1)$	5.67	3.19	4.84	1.53	0.56	7.86
$T_3(C_1P_0F_2)$	5.58	3.16	4.83	1.51	0.55	7.85
$T_4(C_1P_1F_0)$	3.83	3.20	27.97	2.11	0.70	8.06
$T_5(C_1P_1F_1)$	3.98	3.17	27.08	2.00	0.69	8.09
$T_6(C_1P_1F_2)$	3.97	3.18	26.48	2.05	0.70	8.08
$T_7(C_1P_2F_0)$	3.30	3.22	35.90	2.29	0.71	9.32
$T_8(C_1P_2F_1)$	3.32	3.16	34.61	2.21	0.72	9.24
$T_9(C_1P_2F_2)$	3.33	3.17	34.38	2.17	0.70	9.21
$T_{10}(C_2P_0F_0)$	5.72	3.66	5.02	2.04	0.75	7.89
$T_{11}(C_2P_0F_1)$	5.70	3.66	5.04	2.01	0.72	7.95
$T_{12}(C_2P_0F_2)$	5.74	3.68	4.99	1.99	0.71	7.98
$T_{13}(C_2P_1F_0)$	4.09	3.88	24.70	2.07	0.73	8.16

$T_{14}(C_2P_1F_1)$	4.12	3.67	23.88	2.02	0.70	8.17
$T_{15}(C_2P_1F_2)$	4.08	3.71	23.92	2.01	0.71	8.20
$T_{16}(C_2P_2F_0)$	5.03	3.62	28.74	2.45	0.78	9.05
$T_{17}(C_2P_2F_1)$	4.98	3.69	27.21	2.29	0.77	8.92
$T_{18}(C_2P_2F_2)$	4.91	3.79	27.45	2.26	0.83	8.88
$T_{19}(C_3P_0F_0)$	5.28	4.44	5.20	2.23	0.76	8.03
$T_{20}(C_3P_0F_1)$	5.26	4.21	5.26	2.25	0.78	8.07
$T_{21}(C_3P_0F_2)$	5.28	4.21	5.27	2.24	0.78	8.09
$T_{22}(C_3P_1F_0)$	4.47	4.36	23.20	2.33	0.81	8.21
$T_{23}(C_3P_1F_1)$	4.56	4.20	22.16	2.28	0.79	8.24
$T_{24}(C_3P_1F_2)$	4.53	4.20	21.84	2.32	0.81	8.26
$T_{25}(C_3P_2F_0)$	5.08	4.19	22.35	2.36	0.86	8.44
$T_{26}(C_3P_2F_1)$	5.12	4.23	20.99	2.31	0.87	8.45
$T_{27}(C_3P_2F_2)$	5.07	4.21	20.78	2.30	0.88	8.46
SEm(±)	0.07	0.06	0.41	0.03	0.02	0.04
$CD_{(0.01)}$	NS	0.17	NS	NS	NS	NS

Table 6. Sensory evaluation of the juice samples of carrot blended juice (on the basis of Hedonic Scale).

Treatments	**Colour & Appearance**	**Aroma & Flavour**	**Mouthfeel**	**Overall acceptability**
T_1 ($C_1P_0F_0$)	6.8	6.9	6.5	6.9
T_2 ($C_1P_0F_1$)	6.6	6.3	6.4	6.6
T_3 ($C_1P_0F_2$)	6.3	6.5	7.0	7.0
T_4 ($C_1P_1F_0$)	6.5	6.9	6.8	7.2
T_5 ($C_1P_1F_1$)	6.9	6.5	6.6	6.9
T_6 ($C_1P_1F_2$)	6.4	6.6	6.8	7.2
T_7 ($C_1P_2F_0$)	7.6	8.1	7.7	8.1
T_8 ($C_1P_2F_1$)	8.2	8.6	7.9	8.7
T_9 ($C_1P_2F_2$)	7.4	7.3	7.7	7.3
T_{10} ($C_2P_0F_0$)	6.6	6.6	6.7	7.3
T_{11} ($C_2P_0F_1$)	7.1	7.1	7.2	7.2
T_{12} ($C_2P_0F_2$)	6.4	6.6	6.7	6.9
T_{13} ($C_2P_1F_0$)	6.9	6.9	7.0	7.2
T_{14} ($C_2P_1F_1$)	7.4	7.2	7.4	7.7
T_{15} ($C_2P_1F_2$)	7.1	7.1	7.2	7.5
T_{16} ($C_2P_2F_0$)	6.9	7.2	7.2	7.9
T_{17} ($C_2P_2F_1$)	7.1	7.1	7.5	7.2
T_{18} ($C_2P_2F_2$)	7.2	7.2	7.3	7.7
T_{19} ($C_3P_0F_0$)	7.4	7.2	7.0	7.6
T_{20} ($C_3P_0F_1$)	7.1	7.2	6.9	7.5
T_{21} ($C_3P_0F_2$)	7.3	7.4	7.3	7.8
T_{22} ($C_3P_1F_0$)	7.4	7.2	7.2	7.5
T_{23} ($C_3P_1F_1$)	7.3	7.3	7.4	7.7
T_{24} ($C_3P_1F_2$)	7.1	7.1	6.8	7.3
T_{25} ($C_3P_2F_0$)	7.5	7.4	7.4	7.7
T_{26} ($C_3P_2F_1$)	7.3	7.3	7.5	7.7
T_{27} ($C_3P_2F_2$)	7.4	7.2	7.4	7.4
SEm(±)	0.27	0.23	0.27	0.22
$CD_{(0.01)}$	0.78	0.65	0.78	0.62

4. Conclusion

From the present investigation, it was concluded that T_8 (Carrot juice @ 60 % + Orange juice @ 35 % + Ginger juice @ 5 ml) behaved very well as far as the sensory likeness was concerned; it was followed by T_7 (Carrot juice @ 60 % + Orange juice 40 %). Both the samples T_7 (Carrot juice @ 60 % + Orange juice 40 %) and T_8 (Carrot juice @ 60 % + Orange juice @ 35 % + Ginger juice @ 5 %) were found to be good with respect to physicochemical, energetic and nutritional attributes. Along with that, T_7 (Carrot juice @ 60 % + Orange juice 40 %) and T_8 (Carrot juice @ 60 % + Orange juice @ 35 % + Ginger juice @ 5 ml) were found with the highest proportion of vitamin C (35.90 and 34.61 mg/ 100mg respectively) and carbohydrates (9.32 and 9.24 % respectively) and also, the competitive proportion of crude fibre (2.29 and 2.21 % respectively) and crude protein (0.71 and 0.72 % respectively) among the 27 treatments. Eventually, T_7 (Carrot juice @ 60 % + Orange juice 40 %) and T_8 (Carrot juice @ 60 % + Orange juice @ 35 % + Ginger juice @ 5 ml) were found to be best suited for mankind in terms of all the essential aspects.

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