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Development of Carrot – Ginger Whey Beverage

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ABSTRACT: The current investigation was carried out for the standardization of carrot extract, ginger oleoresin and whey protein concentrate (WPC) for the development of functional beverage. Different formulations of ginger oleoresin, carrot extract and WPC were evaluated based on sensory scores. Eight different combinations of ginger oleoresin were incorporated into the carrot extract and WPC solution, considering ginger oleoresin as a flavour-enhancing ingredient for the beverage. The major constraint of the study was the homogenisation of the ginger oleoresin uniformly despite its characteristic. The concentration of ginger oleoresin used were 0.25%, 0.5%, 1%, 1.25%, 1.5%, 1.75%, and 2% in carrot extract incorporated with 50% of WPC solution and control was fixed as a beverage without the addition of ginger oleoresin. The beverage was standardised based on sensory scores. The colour, taste, flavour, appearance and overall acceptability of the beverage were analysed on the 9-point hedonic scale by the 15 semi-trained panel members. The proximate and physiochemical analysis such as TSS, protein, fat, acidity, pH, ash content, moisture content, etc were determined by standard procedure. The data obtained from the sensory evaluation, physiochemical and proximate analysis were computed and analysed statistically. Among the various combinations 1% ginger oleoresin in carrot extract incorporated with 50% of the WPC solution showed the highest overall acceptability based on the sensory scores. The pH, TSS, acidity, specific gravity, ash content, moisture content, carotenoid and gingerol content was estimated for the optimized sample by statistical methods and inferred for the characteristic properties of the carrot- ginger whey beverage. Carrot – ginger-based whey beverage could be an ideal functional beverage besides being delicious and refreshing it is highly nutritious and could be recommended for large-scale production in industries as a functional beverage.

Key words: Carrot, Ginger oleoresin, Whey protein concentrate, functional beverage, beverage standardisation.

INTRODUCTION

As people pay more attention to the pursuit of health, the functional food market seems to be in a long-term and sustainable development trend with fermented fruit and vegetable beverages will occupy a large share of the functional food market. With the advancement and development of technology and the increase of consumer interest in functional foods, the prospect of functional beverages is more promising than ever. Its potential to promoting-health will likely be continuously and substantially revealed in the next few years (Tang *et al.,* 2022).

With the improvement of living standards and well-being, consumers pay more and more attention to the quality requirements of fresh fruits and vegetables. Therefore, it is urgent to find new technologies for the preservation and processing of fresh fruits and vegetables Fruit and vegetable-based beverages are very useful to consumers, especially those who are strictly vegetarian, lactose intolerant, and hypercholesterolemic (Tang *et al.,* 2022).

Carrot based whey beverages could be an ideal functional drink. Whey is a valuable by product obtained in dairy industries during the manufacture of cheese, paneer, shrikhand etc. which is always considered of less value. Whey drinks can functionally stabilise the osmolar system of the body efficiently and have a thirst-quenching effect. Whey protein concentrate and Whey protein isolate are by products of Whey which is incorporated as a major ingredient in many health and energy drinks. Whey protein concentrate (WPC) adds to increased amount of protein content to our diet.

Carrot (*Daucus carota* L.) is an important vegetable because of its large yield per unit area throughout the world and its increasing importance as human food. Vegetables are said to have health benefits because they include antioxidant substances such vitamin C,

carotenoids, and phenolic compounds. Products made from carrots have significant positive health effects due to their high levels of carotenoids, some of which, like -carotene, also support vitamin A activity. They also serve as scavengers of free radicals. Vitamin C has been reported to prevent free-radical-induced damage to DNA quenching oxidants, thus, acting as antioxidants (Kapoor and Aggarwal 2014).

Ginger, scientifically known as Zingiber officinale, a member of the *Zingiberaceae* family, is a popular spice and herb that is also used medicinally for treating various diseases (Yeh *et al.,* 2014). It has several medical and flavouring benefits in addition to having significant social, economic, and industrial significance. Ginger is used in various forms for its therapeutic and nutritional value such as oleoresin, essential oil, ginger extracts, powders etc.

Oleoresin is more desirable than the fresh or dried spices because of its complete flavour, consistency, and measurable nature. Many bioactive compounds of ginger such as phenolic compounds, terpenes, polysaccharides, lipids and organic compounds have processed multiple biological activities like antioxidant activity, anticancer, anti-diabetic, anti-inflammatory, antimicrobial activity.

Many attempts have been carried out regarding the utilization of whey in the production of various food and dairy products yet any areas are still to be explored. Utilisation of whey as energy or a health drink is a prominent choice as a functional beverage (Naik *et al.,* 2009). Whey being nutritious, easily available and economical can be used to prepare a value added product such as fruits and vegetables blended beverages.

Various functional beverages were developed using carrot and ginger enriched with flavour and nutritional value. Carrot and ginger were blended with other fruits like pineapple, berries, apple, amla etc for development of beverages and other functional foods such as pineapple carrot-ginger beverage, whey drink, herbal lassi etc (Zeeshan *et al.,* 2018; Jaspreet *et al.,* 2015; Maji *et al.,* 2016).

Till date no studies have been reported on the utilization of whey protein concentrate blended with carrot extract and ginger oleoresin for the development into a functional beverage. Development of carrot – ginger whey beverage which can be used as a health based energy drink in functional beverages having increased functional properties. With this background a study has been proposed to develop a functional whey beverage with carrot and ginger oleoresin.

MATERIALS AND METHODS

The present investigation was carried out in Department of Food Process Engineering in College of Food and Dairy Technology, TANUVAS, Chennai -52.

Procurement of material. Whey protein concentrate was purchased from the market located in Chennai and it was used as wall material for microencapsulation. It was stored in airtight container and kept in a cool and dry place for protection from light and other deteriorative reactions.Fresh carrot was purchased from the local vegetable market located in Redhills, Chennai – 600052. Ginger oleoresin was purchased from Synthite Industries Private Limited, located in Kolenchery, Kerala – 682311 which was of export quality standards. It was packed and stored in airtight aluminium lined container and kept in a cool and dry place for protection from light and other deteriorative reactions.

Procedure. Fresh carrot was peeled and washed using water. Carrot extract was obtained using blender and filled in sterilised PET bottles and stored at 4ºC until further use. In the blends prepared concentration of whey protein concentrate and carrot extract was maintained constant whereas the concentration of ginger oleoresin was varied. The prepared whey beverage was then filled in PET bottles which were cleaned and sterilised in boiling water to destroy the spoilage microorganisms and pathogens. The bottles were then stored at refrigerated condition for sensory and physio chemical analysis.

Extraction of carrot extract. The fresh raw carrots purchased from the local market were subjected to washing with sterile water and the washed carrots were peeled. Before extraction the peeled carrots were kept for surface drying. The extraction was done by using a blender without the addition of water. The resultant carrot extract with no water and only fresh raw filtered carrot extract was stored in PET bottles at 4°Cuntil further use. The characteristic properties of the prepared carrot extract were analysed according to the standard procedures.

Experimental design. Preliminary studies for the standardisation were performed, which included fixing the range of percent of ginger oleoresin for the beverage. Because of the prominent characteristics of oleoresin different formulations were tried based on literatures (Harimurti *et al.,* 2011; Ahad *et al.,* 2021; Setyaningsih *et al.,* 2020). In reference to the preliminary studies eight different combinations of ginger oleoresin were incorporated into the carrot extract and WPC solution, considering ginger oleoresin as a flavour-enhancing ingredient for the beverage.

The concentration of ginger oleoresin used were 0.25%, 0.5%, 1%, 1.25%, 1.5%, 1.75%, and 2% in 100ml carrot extract incorporated with 50% of WPC solution and controlwas fixed as a beverage without the addition of ginger oleoresin. Table 1 shows the combination and concentration of each trial.

Table 1: Experimental trials for standardisation of carrot-ginger whey beverage.

Trial	Ginger oleoresin (%)	Carrot (ml)	WPC (%)
WT1	0.25	100	50
WT2	0.5	100	50
WT3	0.75	100	50
WT4	1	100	50
WT5	1.25	100	50
WT6	1.5	100	50
WT7	1.75	100	50
WT8	2	100	50
WT9	Control	100	50

Standardisation of the carrot – ginger whey beverage. The standardisation of the prepared beverage was done by evaluating the sensory scores. The standardised beverage combination was subjected to proximate and physiochemical analysis for determining the quality characteristics of the carrot – ginger whey beverage quantitatively.

Sensory analysis. A total of 9 trials inclusive of control (i.e., WT1 – WT9) was investigated for the sensory analysis. The beverage was standardised by sensory scores obtained based on various sensory attributes. The colour, taste, flavour, appearance and overall acceptability of the beverage were analysed on the 9-point hedonic scale by the 15 semi-trained panel members. The recorded data was then statistically analysed using IBM SPSS® 20.0 for Windows® software in accordance with Snedecor and Cochran's usualtechnique (2004). The analysis of variance (ANOVA) was done to see if there was any significant influence on the analytical values.

Analysis of the standardised beverage

Proximate analysis

Moisture. Moisture content was determined by the gravimetric method as described in AOAC, 2000). A dry, empty and clean petri dish was weighed. Two grams of the sample was weighed accurately and transferred to the petri-dish. The dishes were kept in the oven at 100 ± 2 °C for 5 h for drying. They were then transferred to desiccators to cool for 30 min. and then weighed accurately. The moisture content was calculated as under:

$$\text{Moisture content (\% wb)} = \frac{W_1\text{-}W_2}{W_1\text{-}W} \times 100 \quad (1)$$

where,
W - Weight of empty petridish (g),
W_1- Weight of petridish with sample (g),
W_2 - Weight of petridish with dried sample (g).

Acidity. By titrating with 0.1N NaOH solution, the acidity of the sample was determined by titrating a known quantity of the sample with 0.1 N NaOH and using phenolphthalein as an indicator, the titratable acidity, which was expressed as a percentage of acetic acid, was discovered (AOAC, 2000).

Estimation of Protein. According (AOAC, 2000) the crude protein as calculated by calculating the percentage of nitrogen using Kjeldahl's method and converting it to crude protein by multiplying by a factor of 6.25 (Pearson, 1976).

$$\text{N}(\%) = \frac{(\text{TV}.\text{BV}) * (\text{Normality of acid} * 14.01 * 100)}{\text{W} * 1000} \quad (2)$$

$$\text{Total Protein} = (\%)\ \text{Nitrogen} * 100 \quad (3)$$

where,
TV = Titre value
BV = Blank value
W = Weight of the sample (g)
N = Nitrogen (%)

Total Ash content. A known weight of 5 g of the sample was taken in the dish and it was ignited at 550 ± 10°C in a muffle furnace until grey ash results. The dish was cooled in a desiccator and weighed. This process of heating, cooling and weighing was repeated for 30 minutes, until the difference between two successive weights was less than 1 mg. The total ash content was calculated using Eqn. (4) (AOAC, 2000).

$$\text{Ash (\%)} = \frac{(\text{A} - \text{B})}{\text{A}} \times 100 \quad (4)$$

where,
A = Weight of test portion, g
B = Weight loss on ashing, g

Estimation of Fat

The total fat was estimated by Rose-Gottlieb method as per (AOAC, 2000).

$$\text{Fat content (\%)} = \frac{(\text{W2} - \text{W1})}{\text{W}} \times 100 \quad (5)$$

where,
W = Sample weight, g
W1 = Initial weight of the beaker, g
W2 = Final weight of the beaker, g

Estimation of Fibre. Crude fibre was determined by standard method of (AOAC, 2000) using FibreTron fibre analyser.

$$\text{Crude fibre (\%)} = \frac{\text{W1-W2}}{\text{W}} \times 100 \quad (6)$$

where,
W= Weight of the sample (g)
W_1=Weight of the crucible with residue after drying (g)
W_2= Weight of crucible with residue after ashing (g)

Total Carbohydrate. Carbohydrate content was calculated by difference method recommended by (AOAC, 2000) methods using the following formula:

Total carbohydrate (%) = 100 – (crude protein +crude fat + ash + crude fibre + moisture) (7)

Energy. The energy value was calculated by factorial method (Yaméogo *et al.,* 2011) using the given formula.

Energy (Kcal)=(4 ×Protein)+ (9 ×Fat)+ (4 ×Carbohydrate) (8)

Physiochemical properties of carrot ginger whey beverage. The following physiochemical properties of

the carrot extract and ginger oleoresin were studied and statistically analysed. The pH, TSS, Specific gravity, scavenging activity (%), Total carotenoid (%), Gingerol content (%) was analysed.

Estimation of pH. The pH of the sample was measured using a digital pH meter according to the method of (AOAC, 2000).

Total Soluble Solids. The total soluble solids of the beverage were measured by using refractometer in the range of (Make: Erma) 58 to 92°Brix (AOAC, 2000).

Specific gravity. Specific gravity of the standardised carrot-ginger whey beverage was analysed according to the method of (IUPAC, 1995).

DPPH free radical scavenging activity. The method recommended by Luo *et al.* (2009) was used to measure the DPPH free radical scavenging activity. Each sample was combined with 2 ml of an ethanolic solution containing 1 mM DPPH before being diluted to a different concentration in ethanol. After aggressively shaking the mixture, it was permitted to stand in the dark for 30 minutes. At 517 nm, the absorbance was measured. By using ethanol as the sample's replacement, the absorbance of the control was attained. DPPH radical scavenging activity of the sample was calculated as follows:

$$\text{DPPH radical scavenging activity } (\%) = \left[1 - \left(\frac{A_{sample}}{A_{control}}\right) \times 100\right] \quad (9)$$

Carotenoids. The method recommended by Sharma and Bhat (2021) was used to determine the number of total carotenoids in the carrot-ginger whey beverage. For the purpose of estimating TCC, 3 g of the extracts were precisely weighed in falcon tubes, and 10 mL of cyclohexane were then added for the remaining volume. Using a spectrophotometer set to 470 nm, the absorbance value (A) of these samples was determined. The total carotenoids were calculated by using Eq. 10

$$C = \frac{A \times 10^6}{2000 \times 100 \times d} \quad (10)$$

where,

C is the content of total carotenoids in mg/kg of oil and 'd' is the thickness of the spectrophotometer cell (1 cm).

Gingerol content. Gas chromatography (Agilent: GC: 8890 Triple Quad GCMS), equipped with Mass spectrometry Detector was used for detection of gingerol content in the carrot-ginger whey beverage. The oven Temperature was programmed from 60°C (isothermal for 2.0 min), with an increase of 25°C/min, to 310°C isothermal for 11.0 min. A split injection was used for sample introduction and the split ratio was set to 1:10. The helium carrier gas was set to 1.2 ml/minute flow rate (constant flow mode). The mass spectrometer operating in electron ionization (EI) mode with TSS-2000 software was used for analysis. Electron impact mode was at 70 eV. The ionization temperature was at 280°C. Electronic ionization from 35 to 700 m/z. (Touré *et al.,* 2011; Fernandes *et al.,* 2014).

RESULTS AND DISCUSSION

Experimental design. The beverage was prepared according to the combinations and standardised by conducting sensory analysis. Based on the standardisation the treatment combination was further subjected to physiochemical and proximate analysis. The results of the following observations is given in the table below. The analysis of variance (ANOVA) was done to see if there was any significant difference on the analytical values.

Sensory analysis. The sensory score obtained was statistically analysed for the standardisation of the carrot-ginger whey beverage. the 9-treatment combination WT1 – WT9 had significant difference between the treatments for appearance, colour, taste, flavour. The treatment WT4 with 1% ginger oleoresin, 100 ml of carrot extract and 50% of whey protein concentrate was found to have the maximum acceptability and differed significantly ($P<0.05$) among the panel members for appearance, colour, taste and flavour of the beverage. The corresponding mean values of the standardised treatment for WT4 were obtained as 8.00±0.000, 7.20±0.175, 7.45±0.163 and 7.12±0.133 for appearance, colour, flavour and taste respectively. The treatment WT4 was chosen as the standardised combination for further course of investigation. The results of the sensory scores are evaluated as given in Table 2 and Fig. 1.

Table 2: Sensory scores for the standardisation of carrot – ginger whey beverage (Mean ± SE)[@].

Treatments	Appearance	Colour	Flavour	Taste
WT0	7.50±0.000^{g}	7.00±0.000^{g}	7.20±0.000^{g}	7.00±0.000^{f}
WT1	7.00±0.195^{e}	6.47±0.165^{e}	6.07±0.118^{e}	5.93±0.067^{d}
WT2	7.53±0.133^{f}	6.93±0.118^{f}	6.53±0.133^{f}	6.93±0.118^{f}
WT3	7.33±0.187^{ef}	6.80±0.145^{f}	6.07±0.118^{e}	6.27±0.153^{e}
WT4	8.00±0.000^{h}	7.20±0.175^{h}	7.45±0.163^{h}	7.12±0.133^{g}
WT5	6.00±0.000^{c}	4.47±0.165^{c}	3.47±0.133^{c}	3.00±0.000^{b}
WT6	6.53±0.133^{d}	6.00±0.000^{d}	5.40±0.131^{d}	5.47±0.133^{c}
WT7	4.33±0.126^{b}	3.00±0.000^{b}	3.00±0.000^{b}	2.00±0.000^{a}
WT8	2.47±0.133^{a}	2.00±0.000^{a}	2.00±0.000^{a}	2.00±0.000^{a}
F Value	250.875**	330.014**	335.620**	604.883**

Values are expressed as mean ± SE (n = 15).
NS – Non Significant (P>0.05)
** Highly significant (P ≤ 0.01)
Different superscript in a column (small letters) differ significantly

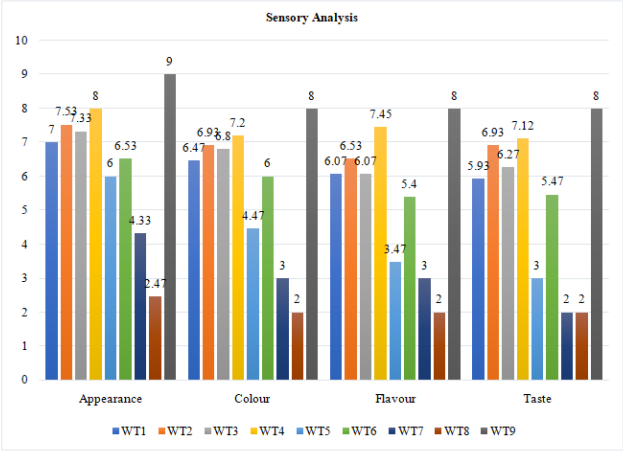

Fig. 1. Sensory analysis of the carrot – ginger whey beverage.

Physiochemical properties of standardised beverage. The physicochemical properties of the standardised beverage were measured and recorded. pH, TSS, acidity, fat, fibre, protein, ash, viscosity, moisture content, specific gravity, scavenging activity, gingerol and carotenoid content were analysed and the results are given in Table 3. The formulated beverages neither contain any artificial flavouring, colouring nor any chemical preservatives.

Proximate analysis. The TSS, pH, acidity in carrot – ginger whey beverage was 12.3 ± 0.0152, 6.5 ± 0.0159, 0.325 ± 0.0184 respectively. The carrot-ginger based whey beverage was found to have protein content of 36.5 ± 0.0159, fat value of 1.12 ± 0.0165, fibre content of 0.986 ± 0.0177 and the ash content was 2.58 ± 0.0159. The pH, TSS, acidity, specific gravity and ash content of the whey-based mango herbal beverage as studied by Kamble *et al.* (2017) was found to be 4.62, 15, 0.23, 1.04 and 1.001 respectively. They concluded that whey-based beverage proved to be highly rich in nutrients and had the maximum acceptable sensory characteristic proving it an effective healthy beverage (Yadav *et al.,* 2010) developed whey-based banana herbal beverage which was standardised based on sensory scores and the physiochemical parameters such as pH of 5.7, TSS of 13.87 °Brix, Titrable acidity in the range of 0.38 - 0.50 for the sample combinations observed during storage.

Based on the protein, fat, fibre values of the beverage the carbohydrate and energy values were obtained as 6.853 %, 55.816 respectively. The high energy value indicates the fact that the prepared beverage has sufficient energy value. The results are also justified by (Aderinola and Abaire 2019) for the research on nutritional composition and antioxidant activity of carrot cucumber juice where the fibre, ash content, fat and protein of the beverage were found to be 1.96%, 0.83%, 2.89%, 1.7%, 2.3 - 3.99 respectively.

Table 3: Proximate characteristics of standardised carrot – ginger whey beverage (Mean ± SE).

Proximate characteristics	Carrot- ginger whey beverage
pH	6.5 ± 0.0159
TSS (°Brix)	12.3 ± 0.0152
Acidity (%)	0.325 ± 0.0184
Fat (%)	1.12 ± 0.0165
Fibre (%)	0.986 ± 0.0177
Protein (%)	36.5 ± 0.0159
Ash (%)	2.58 ± 0.0159
Carbohydrate (g/100g)	5.733 ± 0.0159
Energy (Kcal)	51.336 ± 0.0152

Physiochemical analysis. The physiochemical analysis of the standardised carrot – ginger whey beverage is presented in Table 4. The moisture content of the standardised carrot – ginger whey beverage was found to be 85% (wet basis). The specific gravity of the carrot-ginger whey beverage was found to be 1.034 ± 0.0159. The DPPH scavenging activity of the carrot – ginger whey beverage was 23.29% which is due to the antioxidant properties present in carrot extract and ginger oleoresin used for the preparation of beverage.

The carotenoid content of 11.43 % was obtained by the analysis and because of the addition of ginger oleoresin it was evaluated for the percent of gingerol content which was found to be 10.65% for the prepared whey-based carrot – ginger beverage which were in agreement with thesis who reported the gingerol content in ginger oleoresin as 11.5%. The results was in agreement with (Kamble *et al.,* 2017) who studied the moisture, acidity and other physiochemical properties of whey based mango herbal beverage, the beverage had an moisture content of about 84.605% with a specific gravity of 1.04. Also as reported by Aderinola and Abaire (2019) carrot cucumber juice et al the moisture content of the carrot cucumber juice was found to be 83.03%. The Scavenging activity and total carotenoid of was found to be 23.83% 13.35 10.62 for carrot-ginger juice as studied by Kapoor and Aggarwal (2014).

Table 4: Physiochemical properties of standardised carrot – ginger whey beverage (Mean±SE).

Physiochemical properties	Carrot- ginger whey beverage
Moisture content (% w.b)	85 ± 0.0177
Viscosity (cp)	430 ± 0.0152
Specific gravity	1.034 ± 0.0159
Scavenging activity (%)	23.29 ± 0.0184
Gingerol content (%)	10.65 ± 0.0159
Total carotenoid (%)	11.43 ± 0.0152

CONCLUSIONS

Development and standardisation of functional beverage by using carrot extract, ginger oleoresin and whey protein concentrate was the objective of this study. The beverage prepared from various combinations were assessed by sensory analysis and the standardised combination was determined as WT4. The pH, acidity, viscosity, moisture content, gingerol and carotenoid content etc, were evaluated for the qualitative and quantitative evaluation of the beverage. The results were in accordance with the researches earlier conducted for similar type of beverage preparations. The resultant carrot – ginger whey beverage was found to be a better alternative as a healthy functional beverage when compared to the beverage prepared with the same raw materials individually. Henceforth this study confirms the fact that carrot ginger whey beverage can be healthy alternative among the various other functional beverages. Carrot – ginger-based whey beverage could be an ideal functional beverage besides being delicious and refreshing it is highly nutritious and could be recommended for large-scale production in industries as a functional beverage.

FUTURE SCOPE

Implication of antioxidant rich ingredients like ginger oleoresin and carrots with superior protein content with whey protein concentrate in the development of beverage and further studies by spray drying technology to develop as a functional powder. The industries focusing on functional foods and functional beverages a study and development of products like this would be benchmark.

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Conflict of Interest. None.

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