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Original article

## Whey-carrot based functional beverage: Development and storage study

Bindu Naik<sup>c</sup>, Deepika Kohli<sup>a</sup>, Nidhi Walter<sup>b</sup>, Arun Kumar Gupta<sup>c</sup>, Sadhna Mishra<sup>d</sup>,  
Javed Masood Khan<sup>e</sup>, Per Erik Joakim Saris<sup>f,\*</sup>, Mohammad Irfan<sup>g</sup>, Sarvesh Rustagi<sup>h</sup>, Vijay Kumar<sup>i,\*</sup>

<sup>a</sup> Department of Food Technology, Vignan's Foundation for Science, Technology & Research (Deemed to be University), Vadlamudi, Guntur-522213, Andhra Pradesh, India

<sup>b</sup> Department of Food Science and Technology, Doon Group of Colleges, Selaqui, Uttarakhand 248011, India

<sup>c</sup> Department of Food Science and Technology, Graphic Era (Deemed to be University), Dehradun 248002, Uttarakhand, India

<sup>d</sup> Faculty of Agricultural Sciences, GLA University, Mathura, UP, India

<sup>e</sup> Department of Food Science and Nutrition, Faculty of Food and Agricultural Sciences, King Saud University, 2460, Riyadh 11451, Saudi Arabia

<sup>f</sup> Department of Microbiology, Faculty of Agriculture and Forestry, University of Helsinki, Finland

<sup>g</sup> Plant Biology Section, School of Integrative Plant Science, Cornell University Ithaca, NY, USA

<sup>h</sup> Department of Food Technology, UCALS, Uttaranchal University, Dehradun, Uttarakhand, India

<sup>i</sup> Himalayan School of Biosciences, Swami Rama Himalayan University, Jolly Grant, Dehradun, Uttarakhand 248016, India



### ARTICLE INFO

#### Article history:

Received 20 March 2023

Revised 30 May 2023

Accepted 15 June 2023

Available online 21 June 2023

#### Keywords:

Carrot

Whey

Functional beverage

Shelf life

Storage

### ABSTRACT

The current study was designed to prepare whey-carrot-based functional beverages and to study the effect on physicochemical properties during the 28-day storage period. Different ratios of whey and carrot juice were selected for the preparation of the six formulations, out of which based on the sensory acceptance only three were selected for further storage studies (sample 1 = 45:55, sample 2 = 50:50, and sample 3 = 55:45 of carrot juice to whey ratio). During 28 days of storage, the developed beverage samples revealed a significant increase in reducing sugars, total phenolic content, and acidity. The pH, sweetness, and acceptance percentage of the beverage were found to be decreased with the storage period. It was also found that there is no change in the properties of the beverage storage with and without the preservative. It was revealed that beverage with less proportion of carrot juice is more acceptable quality. The results also suggest that whey can be used with fruit and vegetable to create the whey-based beverage.

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### 1. Introduction

People today are more concerned with their health, which has led to an increase in awareness of functional foods (Kohli et al., 2019). In recent years, a variety of unique functional food products have been created; of them, over 40% are dairy products, and the main functional beverages are those made with milk whey. In addition to being delicious, fruit and milk-based beverages are gaining popularity these days because of their nutritious value (Ahmed et al., 2023). Whey, a valuable byproduct liquid from the cheese business, is made when milk proteins precipitate. Additionally, numerous techniques have been investigated over time to trans-

form massive amounts of whey into food-grade goods. This is because only roughly 60% of the whey obtained globally is utilized to make products and the remaining is discarded as waste or fed to cattle (Arsić et al., 2018). Furthermore, due to the existing environmental restrictions, it is required to treat the whey before disposal, which is a challenging task for industries and a cost-consuming process. Alternatively, whey has a range of nutrients, such as protein (serum albumin, immunoglobulins,  $\beta$ -lactoglobulin,  $\alpha$ -lactalbumin), vitamins (thiamine, and riboflavin), phosphorus, magnesium, and calcium. Additionally, whey proteins are fast proteins because of their ability to quickly deliver nourishment to muscles. It also has protective and curative nature against different diseases such as liver complaints, anemia, jaundice, arthritis, and gonorrhoea (Begum et al., 2019). This makes milk whey to be a good functional food, so its utilization in the food chain is a more reasonable and economical method than discarding.

The carrot (*Daucus carota*) is one of the widely used vegetables. It is a good source of nutrients like carbohydrates, minerals, and vitamins as well as therapeutic compounds such as carotenoids (potent antioxidants). It helps to fulfil vitamin A deficiency, diminish cholesterol, lower the risk of arteriosclerosis, purification of blood,

\* Corresponding authors.

E-mail addresses: [per.saris@helsinki.fi](mailto:per.saris@helsinki.fi) (P.E.J. Saris), [vijaykumar@srhu.edu.in](mailto:vijaykumar@srhu.edu.in) (V. Kumar).

Peer review under responsibility of King Saud University.



Production and hosting by Elsevier

<https://doi.org/10.1016/j.jksus.2023.102775>

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and constipation, prevention of the appearance of colon cancer, and combat diarrhea (Sharma et al., 2012). Ginger (*Zingiber officinale* Rosc.) belongs to Family *Zingiberaceae*, whose rhizomes are used as a spice. It is a good source of minerals (iron, calcium, and phosphorous), and vitamins (thiamine, riboflavin, niacin, and vitamin C). Its pungency is due to gingerol. It has anticoagulant, anti-inflammatory, anti-fungal, antiseptic, and antioxidant properties. It helps to relieve cramps and tension, stimulate digestion, and absorption, relieve constipation and flatulence, and reduces nausea and vomiting. Some constituents of ginger inhibit the growth of some colon bacteria like *Proteus* species, *Escherichia coli*, *Streptococci*, *Staphylococci*, and *Salmonella* (Shukla and Singh, 2007). A few researchers investigated whey-fruit-based beverages such as probiotics (Dinkçi et al., 2023), ovine (Nedanovska et al., 2022), pineapple (Islam et al., 2021), grape (Barros et al., 2021), orange (Oliveira et al., 2022; Vieira et al., 2020), and strawberry (Souza et al., 2019).

The current study aims to formulate a whey-carrot-based functional beverage with various proportions of whey and carrot juice with a constant portion of ginger extract and sugar. The study also investigated the physicochemical properties and sensory attributes of formulated beverages for the storage life of 28 days at  $7.0 \pm 1.0$  °C.

## 2. Materials and methods

### 2.1. Material

Milk, carrot, ginger, and sugar were procured from the local market of Dehradun. The carrot and ginger were selected based on the visual inspection and these were then cleaned and washed to remove foreign matter and adhesive debris.

### 2.2. Method

#### 2.2.1. Preparation of protein whey

Whey was produced by the procedure explained by Chavan et al. (2015) with few changes. The pasteurized double-toned milk (1.5% Fat, 9.0% SNF) was heated to 80 °C for 10 min. with continuous stirring and coagulated at 72 °C by adding 1% citric acid. It was then cooled and filtered using a muslin cloth to separate coagulated casein i.e., paneer and whey. The whey was then stored at  $7.0 \pm 1.0$  °C for further usage.

#### 2.2.2. Preparation of carrot juice

The carrot juice was prepared by the extraction method. The peel was removed from the washed carrot and it was chopped into pieces to facilitate the extraction of juice by using the juicer. The juice was then filtered by using a muslin cloth to remove the suspended particles. It was then stored at  $7.0 \pm 1.0$  °C for further usage.

#### 2.2.3. Preparation of ginger extract

The ginger was washed thoroughly, and the peel was removed using a knife. The ginger was then chopped into small pieces to extract the juice from the juicer. The juice was then filtered and stored at  $7.0 \pm 1.0$  °C for further usage.

#### 2.2.4. Preparation of whey carrot based RTS beverage

The whey-carrot-based functional beverage was produced by the procedure explained by Baljeet et al. (2013) with few modifications. The whey, carrot juice, ginger extract, and sugar were properly mixed in the different ratios mentioned in Table 1. The obtained mixture was preheated at 45 °C, which is then filled in the pre-sterilized bottles, sealed, and pasteurized at 90 °C for 15 min. The bottles were then cooled at room temperature and stored at  $7.0 \pm 1.0$  °C for further analysis.

### 2.2.5. Physico-chemical properties

The pH, total soluble solids, moisture content, and ash content was determined by the method explained by Ranganna (1986). The fat content and protein content was determined by method described by Ranganna, (1986). The titrable acidity, reducing sugar, total phenolic content, antioxidant and sedimentation for the beverage, was determined by the method explained by Gad et al. (2013) and Kumar et al., (2019). The acceptance percentage of the beverage was also determined.

### 2.2.6. Sensory evaluation

The sensory evaluation was done for all the prepared beverages by using the rating given by panel members.

### 2.2.7. Storage analysis

The beverage samples were stored with and without the addition of preservatives and analyzed for their physicochemical properties, and sensory properties such as pH, TSS, titrable acidity, sweetness, reducing sugar, total phenolic content, and % acceptance at intervals of 7 days for 28 days.

### 2.2.8. Statistical analysis

The statistical analysis was performed in Origin 6.0 (Origin Lab Corporation, USA). The values in the graphs are the mean of triplicates  $\pm$  standard deviation. The bar indicates the standard deviation.

## 3. Result and discussion

The whey-carrot-based functional beverages were prepared by using different concentrations of whey and carrot juice. After the sensory evaluation of the all mixtures the three blends were found to be acceptable, i.e.,  $S_3$  (45:55),  $S_4$  (50:50), and  $S_5$  (55:45), which will be further represented as  $T_1$ ,  $T_2$ , and  $T_3$ , respectively and which are shown in Fig. 1. Therefore, only these mentioned combinations were only analyzed further for physicochemical properties throughout the storage time.

### 3.1. Physicochemical analysis of whey, carrot, and formulations

The physicochemical properties of the different formulations of whey and carrot juice are shown in Table 2. It was found that the carrot juice has high pH, TSS, ash content, reducing sugar, antioxidant content, TPC, and sedimentation rate compared to the whey. It can also be observed from Table 2, as the concentration of carrot juice increases in the functional beverage, all the above-mentioned parameters also significantly increase as the carrot juice contains more reducing sugar, total phenolic content, and antioxidant. Similar results were obtained by Zaman et al. (2023), in which by increasing the sugarcane juice concentration the value of these parameters was also found to be increased. The sedimentation rate was found to be highest for the sample with the lowest carrot juice concentration.

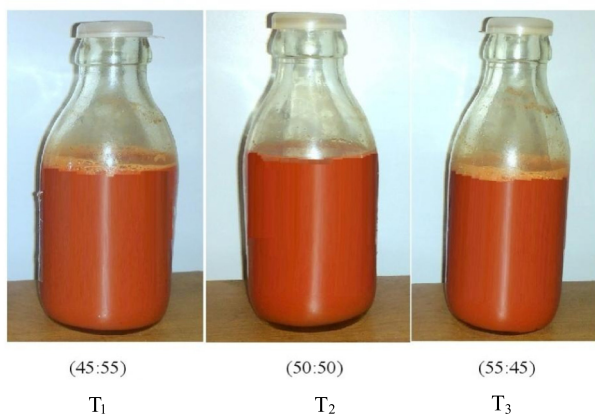
### 3.2. Storage studies of functional beverage

#### 3.2.1. pH

The changes in pH during the 28 days of storage of whey-carrot-based mixed beverages with and without the preservatives are demonstrated in Fig. 2. During the storage, the pH value of samples doesn't vary significantly ( $p > 0.05$ ) for the beverage stored with and without preservatives, but it is significantly different ( $p < 0.05$ ) for different formulations of the beverage due to different concentrations of whey and carrot juice. The pH of whey-carrot-based functional beverage was noted as  $T_1$  ( $5.51 \pm 0.004$ – $5.4 \pm 0.001$ ),

**Table 1**  
Different ratios of whey-carrot-based beverage.

Samples	Ingredients			
	Carrot juice (%)	Whey (%)	Sugar (%)	Ginger extract (%)
S <sub>1</sub>	25	75	3	0.75
S <sub>2</sub>	35	65	3	0.75
S <sub>3</sub>	45	55	3	0.75
S <sub>4</sub>	50	50	3	0.75
S <sub>5</sub>	55	45	3	0.75
S <sub>6</sub>	60	40	3	0.75



**Fig. 1.** Selected blends for the analysis throughout the storage time.

T<sub>2</sub> (6.09 ± 0.002–5.97 ± 0.004), and T<sub>3</sub> (6.54 ± 0.003–6.42 ± 0.002) for the samples with and without preservative. Due to an increase in the titratable acidity values of the beverage, which is inversely related to pH, the mixture’s pH reduced significantly (*p* < 0.05) during the storage. The produced whey-carrot mixed beverages have a pH value in agreement with the results of Chavan et al. (2015), which reported a significant decline in pH after 30 days of storage. Similarly, Ahmed et al. (2023) observed a decrease in pH after 25 days of storage, which may be due to the generation of amino and organic acids during the storage.

**3.2.2. TSS**

The total soluble solid is different in the different samples, but it doesn’t significantly (*p* > 0.05) vary with the storage time from 0 to 28 days (Fig. 3). It was found to be high for the samples containing a high amount of carrot juice and a low amount of whey. This result showed consistency with the previous research done by Pandey and Ojha (2020). The other researcher reported an increase in TSS of the whey-based fruit beverage during the storage of 30 days (Alane et al., 2017).

**Table 2**  
Physicochemical parameters of whey, carrot, and formulations.

Parameters	Whey	Carrot juice	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>
Ph	5.64	6.73	5.51	6.09	6.54
TSS	5.63	7.7	12	12.5	13
Titrable Acidity (%)	0.39	0.128	0.036	0.018	0.018
Moisture (wb%)	94.9	92.7	88.2	90.1	89.4
Ash (%)	11.8	14.4	6.79	7.83	7.45
Fat (%)	0.32	0.1	0.42	0.37	0.32
Protein	0.0297	0.0293	0.02167	0.0353	0.0277
Reducing Sugar (mg/ml)	18.15	27.94	29.9	42.4	47.2
Antioxidant (mg/ml)	2.14	2.42	0.77	0.89	0.99
Total Phenol Content (mg/ml)	0.158	0.336	0.280	0.320	0.360
Sedimentation rate (%)	0.74%	2.08%	4.75%	4.32%	3.89%

**3.2.3. Titrable acidity (TA)**

The effect of the proportion of whey and carrot juice and the storage time on the acidity of the beverage is demonstrated in Fig. 4. During the storage, the acidity of samples doesn’t vary significantly (*p* > 0.05) for the beverage stored with and without preservatives, but it is significantly different (*p* < 0.05) for different formulations of the beverage due to different concentrations of whey and carrot juice. The acidity was found to be increased during the storage period. According to the findings of the study, the acidity significantly increased from 0.037 ± 0.001 to 0.054 ± 0.002 for formulation 1, 0.018 ± 0.002 to 0.036 ± 0.003 for formulation 2, and 0.017 ± 0.002 to 0.038 ± 0.001 for formulation 3 after 28 days of storage period with and without the preservatives. Moreover, the proportion of whey and carrot juice shows significant changes in acidity. The possible reason for the increase in acidity might be that lactose and protein are converted into lactic acid and amino acids (Purkiewicz and Pietrzak-Fiećko, 2021). Similar inverse relation of acidity and pH was observed by Yadav et al. (2010), who employed acid whey produced by the acid coagulation of milk. They found that the acidity rises after 20 days of storage from 0.40 to 0.50. Similarly, Oliveira et al. (2022) observed an increase in acidity during 21 days of storage of orange juice whey drink.

**3.2.4. Sweetness**

The sweetness change with the change in the proportion of carrot juice and whey and the storage time is shown in Fig. 5. It was found that their no significant (*p* > 0.05) changes in the sweetness of the beverages stored with and without the preservative. During the storage of 28 days, the sweetness of the whey-carrot beverage was found to be decreased significantly (*p* < 0.05) from 32.7 ± 0.1 to 22.1 ± 0.2 for sample 1, 70 ± 0.3 to 35 ± 0.2 for sample 2, and 76.4 ± 0.2 to 34.2 ± 0.1 for sample 3 for both the samples stored with and without preservatives. Additionally, there was no change in the sweetness of the sample till the 14th day of storage, but after that, the sweetness starts decreasing. Colaric et al. (2005) concluded that the sweetness of fruits and fruit juices is influenced by the amount of acid and sugar to acid ratio. In continuation, the decreasing trend of sweetness in the prepared beverages during storage may increase the acidity of the samples.

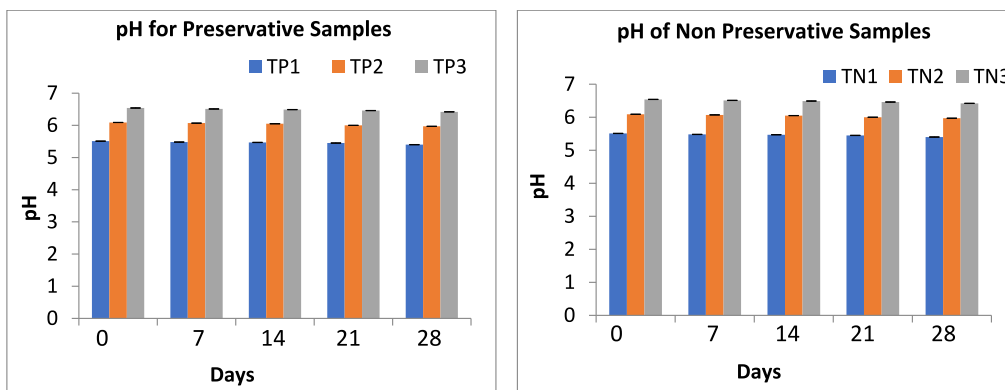


Fig. 2. pH changes of beverage during storage with and without preservative.

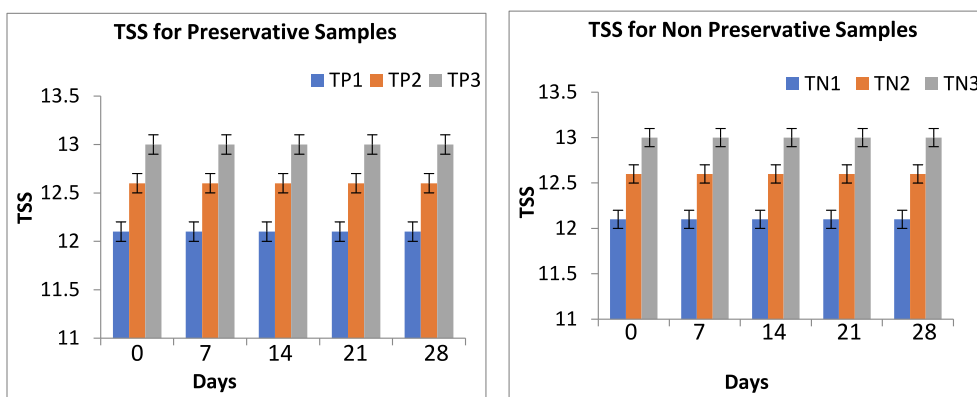


Fig. 3. TSS changes of beverage during the storage with and without preservative.

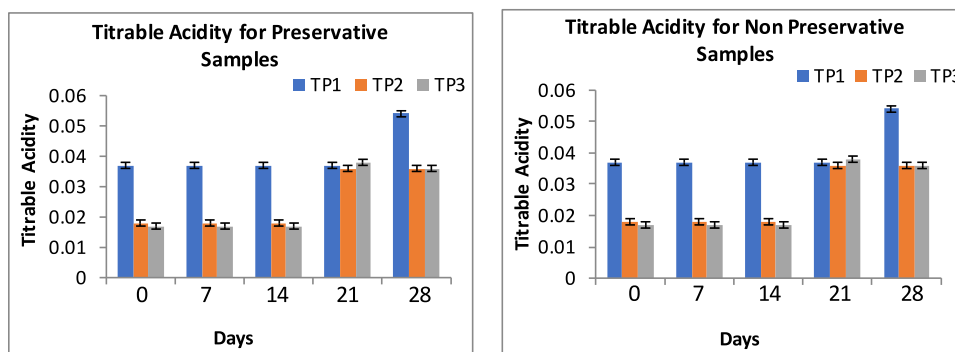


Fig. 4. Acidity changes in beverage during storage with and without preservatives.

3.2.5. Reducing sugar (RS)

The changes in RS with storage time and proportion of carrot juice and whey stored with and without the preservative are shown in Fig. 6. It was found that the RS significantly ( $p < 0.05$ ) varies for the samples stored with and without the preservative. During the storage of the 28 days of the whey-carrot-based functional beverage, the RS was found to be changed from  $29.1 \pm 0.15$  to  $63.1 \pm 0.1$ ,  $42.7 \pm 0.35$  to  $47.5 \pm 0.3$ , and  $47.2 \pm 0.35$  to  $39.8 \pm 0.2$  for sample 1, sample 2, and sample 3, respectively for the samples with preservatives. For the sample stored without preservatives, it was found to be changed from  $22.7 \pm 0.4$  to  $59.8 \pm 0.4$  for sample 1,  $39.7 \pm 0.3$  to  $37.8 \pm 0.4$  for sample 2, and  $43.9 \pm 0.2$  to  $38.6 \pm 0.3$  for sample 3. The highest RS was observed in sample 3 with a high concentration of carrot juice. It was also observed that the reducing

sugar first increases till the 7th and 14th day of the storage and after that it starts decreasing. During the storage, the increase in the RS content may be due to the inversion of non-reducing sugar to reducing the sugar by the acids present in the whey-carrot-based beverage (Bhardwaj and Pandey, 2011). Pandey and Ojha (2020) found that reducing sugar increased with the storage period of whey-mango-based beverages. On the other hand, Barwal et al. (2005), observed a decrease in reducing the sugar of bitter gourd beverages.

3.2.6. Total phenol content (TPC)

Fig. 7 represents the changes in TPC of whey-carrot-based beverages during storage with and without preservatives. The TPC of the prepared beverage significantly varied ( $p < 0.05$ ) for the beverage

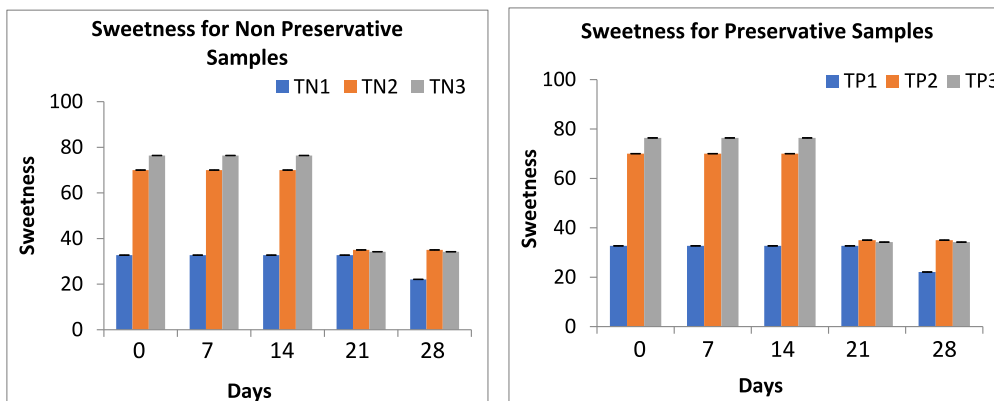


Fig. 5. Sweetness changes in beverage during storage with and without preservatives.

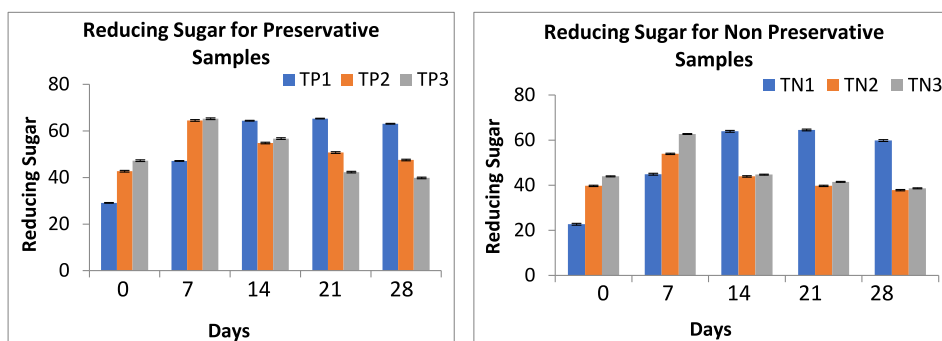


Fig. 6. Reducing sugar changes in beverages during storage with and without preservatives.

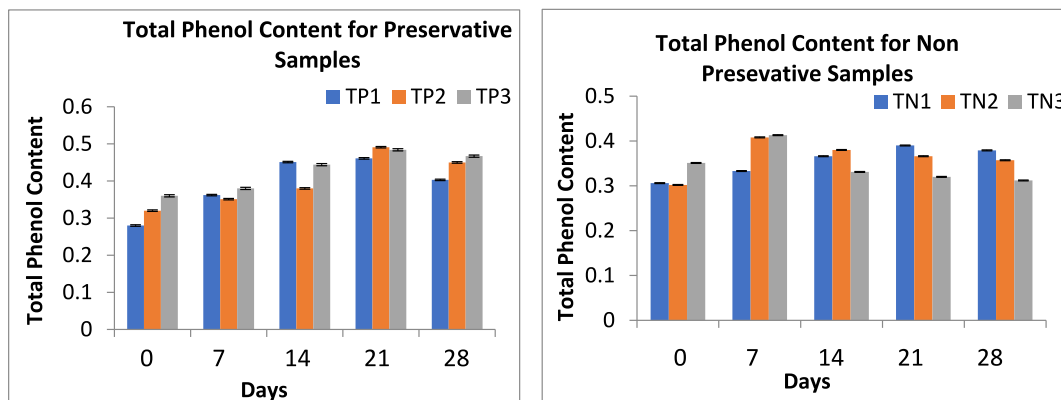


Fig. 7. Total phenolic content in beverage during storage with and without preservatives.

storage with and without the preservatives. During the storage, it was found to be changed from  $0.28 \pm 0.002$  to  $0.403 \pm 0.003$  for sample 1,  $0.32 \pm 0.002$  to  $0.45 \pm 0.001$  for sample 2, and  $0.36 \pm 0.003$  to  $0.467 \pm 0.003$  for sample 3 for beverages stored with preservatives. For the sample stored without preservatives, it was found to be changed from  $0.306 \pm 0.001$  to  $0.379 \pm 0.001$ ,  $0.302 \pm 0.001$  to  $0.357 \pm 0.002$ , and  $0.351 \pm 0.001$  to  $0.312 \pm 0.003$  for sample 1, sample 2, and sample 3, respectively for the beverages stored without preservatives. The result also showed that there is an increase in TPC during the 21st day of storage, while it gradually decreased on the 28th day of storage. These findings are supported

by the other different studies done on sugarcane (Zaman et al., 2023) and carbonated soft drinks (Tireki, 2021).

### 3.2.7. Percent acceptance (PA)

Fig. 8 represents the PA of the whey-carrot-based functional beverage during the 28 days of storage with and without the preservative. It was found that there is decreasing trend in the acceptance percentage of the beverage with the increase in the storage days. The highest acceptance was found for the samples with the low amount of carrot juice i.e., sample 1. There is not much difference in the acceptance percentage of the beverage

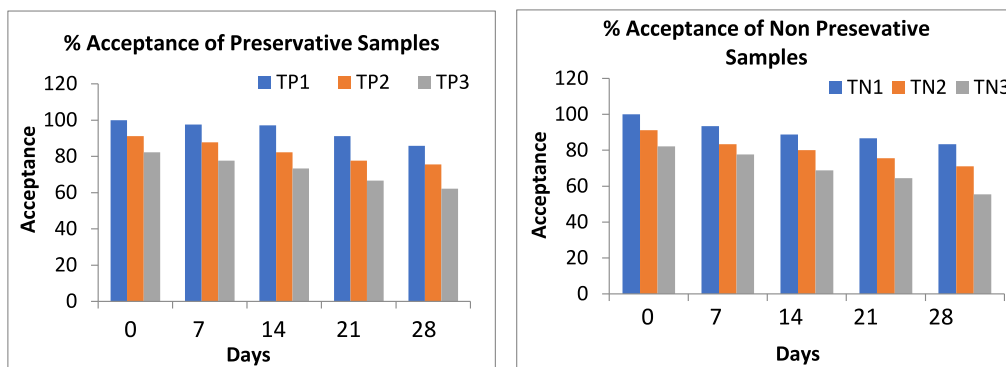


Fig. 8. Percent acceptance of beverage during storage with and without preservative.

stored with and without the preservative. The decreasing trend in acceptance percentage during the storage is may due to various chemical changes during the storage of the product.

#### 4. Conclusion

The results of the study recommend that adding fruits and vegetables to whey supplements could be a viable alternative for creating nutritious beverages with the best sensory qualities and can be recommended for consumption. It can be hypothesized that the whey-carrot-based beverage could be a fascinating product for beverage industries by giving the benefits of bioactive elements present in both fruit and whey. Therefore, to use this beverage at a commercial scale, more research on shelf life, optimizing process conditions, quality improvement using stabilizer and packaging, and a clinical trial is required for benefits to human health.

#### Funding

Authors are grateful to the Researchers Supporting Project number (RSP2023R360), King Saud University, Riyadh, Saudi Arabia. Authors are also thankful to University of Helsinki, Finland for open access support.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

#### Acknowledgments

Authors are grateful to the Researchers Supporting Project number (RSP2023R360), King Saud University, Riyadh, Saudi Arabia and University of Helsinki, Finland for open access support.

#### Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jksus.2023.102775>.

#### References

Ahmed, T., Sabuz, A.A., Mohaldar, A., Fardows, H.M.S., Inbaraj, B.S., Sharma, M., Rana, M.R., Sridhar, K., 2023. Development of novel Whey-mango based mixed beverage: effect of storage on physicochemical, microbiological, and sensory analysis. *Foods* 12 (2), 237.

Alane, D., Raut, N., Kamble, D.B., Bhotmange, M., 2017. Studies on preparation and storage stability of whey based mango herbal beverage. *Int. J. Chem. Stud.* 5 (3), 237–241.

Arsić, S., Bulatović, M., Zarić, D., Kokeza, G., Subić, J., Rakin, M., 2018. Functional fermented whey carrot beverage—qualitative, nutritive and techno-economic analysis. *Rom. Biotechnol. Lett.* 23 (2), 13496–13504.

Baljeet, S.Y., Ritika, B.Y., Sarita, R., 2013. Studies on development and storage of whey-based pineapple (*Ananas comosus*) and bottle gourd (*Lagenaria siceraria*) mixed herbal beverage. *Int. Food Res. J.* 20 (2), 607–612.

Barros, C.P., Grom, L.C., Guimarães, J.T., Balthazar, C.F., Rocha, R.S., Silva, R., Almada, C.N., Pimentel, T.C., Venancio, E.L., Junior, I.C., Maciel, P.M.C., Freitas, M.Q., Esmerino, E.A., Silva, M.C., Maria Carmela, K.H., Duarte, M.C.K.H., Sant'Ana, A.S., Cruz, A.G., 2021. Paraprobiotic obtained by ohmic heating added in whey-grape juice drink is effective to control postprandial glycemia in healthy adults. *Food Res. Int.* 140, 109905.

Barwal, V.S., Singh, T.K., Alkesh, 2005. Studies on processing and development of ready-to-serve drink from bittergourd fruit. *J. Food Sci. Technol.-Mysore* 42 (3), 217–220.

Begum, T., Islam, Z., Siddiki, M.S.R., Habib, R., Rashid, H.-U., 2019. Preparation of fermented beverage from whey-based watermelon (*Citrullus lanatus*) juice. *Asian J. Dairy Food Res.* 38 (4), 301–306.

Bhardwaj, R.L., Pandey, S., 2011. Juice blends—a way of utilization of under-utilized fruits, vegetables, and spices: a review. *Crit. Rev. Food Sci. Nutr.* 51 (6), 563–570.

Chavan, R.S., Nalawade, T., Kumar, A., 2015. Studies on the development of whey based mango beverage. *Food Dairy Technol.* 3, 1–6.

Colaric, M., Veberic, R., Stampar, F., Hudina, M., 2005. Evaluation of peach and nectarine fruit quality and correlations between sensory and chemical attributes. *J. Sci. Food Agric.* 85 (15), 2611–2616.

Dinkçi, N., Akdeniz, V., Akalin, A.S., 2023. Probiotic Whey-based beverages from cow, sheep and goat milk: antioxidant activity, culture viability, amino acid contents. *Foods* 12 (3), 610.

Gad, A.S., Emam, W.H., Mohamed, G.F., Sayd, A.F., 2013. Utilization whey in production of functional healthy beverage\* whey-mango beverages. *American J. Food Technol.* 8 (3), 133–148.

Islam, M.Z., Tabassum, S., Harun-ur-Rashid, M.d., Vegarud, G.E., Alam, M.S., Islam, M.A., 2021. Development of probiotic beverage using whey and pineapple (*Ananas comosus*) juice: Sensory and physico-chemical properties and probiotic survivability during in-vitro gastrointestinal digestion. *J. Agric. Food Res.* 4, 100144.

Kohli, D., Kumar, A., Kumar, S., Upadhyay, S., 2019. Waste utilization of amla pomace and germinated finger millets for value addition of biscuits. *Current Research in Nutrition and Food Science Journal* 7 (1), 272–279. <https://doi.org/10.12944/CRNFSJ.7.1.27>.

Kumar, S., Singh, I., Kohli, D., Joshi, J., Mishra, R., 2019. Waste pomelo (*Citrus maxima*) peels—a natural source of antioxidant and its utilization in peanut oil for suppressing the development of rancidity. *Curr. Res. Nutr. Food Sci. J.* 7 (3), 800–806.

Nedanovska, E., Jakopović, K.L., Daniloski, D., Vaskoska, R., Vasiljevic, T., Barukčić, I., 2022. Effect of storage time on the microbial, physicochemical and sensory characteristics of ovine whey-based fruit beverages. *Int. J. Food Sci. Technol.* 57 (8), 5388–5398.

Oliveira, G.A.R., Guimarães, J.T., Ramos, G.L.P.A., Esmerino, E.A., Pimentel, T.C., Neto, R.P.C., Tavares, M.I.B., Sobral, L.A., Souto, F., Freitas, M.Q., Costa, L.E.O., Cruz, A.G., 2022. Benefits of thermosonication in orange juice whey drink processing. *Innov. Food Sci. Emerg. Technol.* 75, 102876.

Pandey, S., Ojha, P., 2020. Preparation and quality evaluation of mango based whey beverage. *J. Food Sci. Technol. Nepal* 12 (12), 59–61.

Purkiewicz, A., Pietrzak-Fiećko, R., 2021. Antioxidant properties of fruit and vegetable whey beverages and fruit and vegetable mousses. *Molecules* 26 (11), 3126.

Ranganna, S., 1986. Handbook of analysis and quality control for fruit and vegetable products. Tata McGraw-Hill Education.

Sharma, K.D., Karki, S., Thakur, N.S., Attri, S., 2012. Chemical composition, functional properties and processing of carrot—a review. *J. Food Sci. Technol.* 49 (1), 22–32.

Shukla, Y., Singh, M., 2007. Cancer preventive properties of ginger: a brief review. *Food Chem. Toxicol.* 45 (5), 683–690.

Souza, F.P., Balthazar, C.F., Guimarães, J.T., Pimentel, T.C., Esmerino, E.A., Freitas, M. Q., Raices, R.S.L., Silva, M.C., Cruz, A.G., 2019. The addition of xylooligosaccharide in strawberry-flavored whey beverage. *Lwt* 109, 118–122.

- Tireki, S., 2021. A review on packed non-alcoholic beverages: Ingredients, production, trends and future opportunities for functional product development. *Trends Food Sci. Technol.* 112, 442–454.
- Vieira, A.H., Balthazar, C.F., Rocha, R.S., Silva, R., Guimaraes, J.T., Pagani, M.M., Pimentel, T.C., Esmerino, E.A., Silva, M.C., Tonon, R.V., Cabral, L.M., Freitas, M.Q., Cruz, A.G., 2020. The free listing task for describing the sensory profiling of dairy foods: a case study with microfiltered goat whey orange juice beverage. *J. Sensory Stud.* 35 (5), e12594.
- Yadav, R.B., Yadav, B.S., Kalia, N., 2010. Development and storage studies on whey-based banana herbal (*Mentha arvensis*) beverage. *Am. J. Food Technol.* 5 (2), 121–129.
- Zaman, Q.U., Sahar, A., Sameen, A., Ahmad, M.H., Muhammad, N., Huma, N., Afzal, M. F., Khalid, W., Al-Farga, A., 2023. Development and storage stability of Whey sugarcane based functional beverage. *Int. J. Food Properties* 26 (1), 752–763.