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### Standardization and sensory evaluation of sterilized carrot-based flavoured milk drink

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#### Abstract

The growing demand for functional dairy beverages has encouraged the incorporation of nutrient-rich plant ingredients into milk-based products. Carrot (*Daucus carota* L.) is an excellent source of  $\beta$ -carotene, dietary fiber, vitamins, minerals, and antioxidant compounds that contribute to human health and help reduce the risk of several chronic diseases. Recent studies have highlighted the importance of carotenoid-rich foods in promoting eye health, cardiovascular health, and antioxidant protection. Carrots are also widely utilized in the development of value-added food products because of their attractive colour, flavour, and bioactive composition.

In the present investigation, sterilized carrot-based flavoured milk was developed using carrot juice at different incorporation levels (10, 20, and 30%). The products were evaluated for physicochemical characteristics, sensory quality, and storage stability under ambient conditions. Sensory evaluation was conducted using a 9-point hedonic scale. Among all treatments, flavoured milk containing 20% carrot juice and 15% sugar received the highest overall acceptability score. The product remained acceptable during 28 days of storage at room temperature with only minor changes in quality attributes. The findings indicate that carrot can be successfully incorporated into sterilized flavoured milk to produce a nutritious and consumer-acceptable functional dairy beverage enriched with natural carotenoids and antioxidants.

**Keywords:** Carrot juice, flavoured milk, sterilization, sensory quality, physicochemical characteristics, carotenoids, functional dairy beverage

#### Introduction

Milk is considered one of the most complete and balanced foods due to its rich composition of proteins, fats, carbohydrates, vitamins, and minerals. In recent years, consumer demand has shifted toward functional dairy products that not only provide nutrition but also offer additional health benefits. Flavoured milk is a popular dairy beverage because of its pleasant taste, high nutritional value, and potential as a carrier of bioactive ingredients (Daryani *et al.*, 2024) [4].

Carrot (*Daucus carota* L.) is an important root vegetable widely consumed throughout the world. It is recognized as a rich source of  $\beta$ -carotene, dietary fibre, vitamins, minerals, and several phytochemicals with antioxidant activity. Carrots contain significant amounts of carotenoids, including  $\alpha$ -carotene and  $\beta$ -carotene, which act as precursors of vitamin A and contribute to the prevention of vitamin A deficiency (Motegaonkar *et al.*, 2024) [7]. Carrot also contains phenolic compounds and other bioactive constituents that contribute to its nutraceutical properties (Bas, 2024) [2].

Regular consumption of carotenoid-rich foods has been associated with improved eye health, enhanced immune response, reduced oxidative stress, and decreased risk of cardiovascular diseases and certain cancers. Carotenoids function as powerful antioxidants that protect cells against oxidative damage and support overall health (Bas, 2024;

Ikram *et al.*, 2024) [2, 6]. Recent studies have also reported that carrot-derived bioactive compounds contribute to improved nutritional quality and consumer acceptance when incorporated into food products (Ikram *et al.*, 2024) [6].

The utilization of carrot in dairy products offers an attractive approach to developing value-added functional beverages with enhanced nutritional and sensory characteristics. The natural orange colour, pleasant flavour, and health-promoting compounds present in carrot make it a suitable ingredient for flavoured milk preparation. Furthermore, sterilization can extend the shelf life of flavoured milk while maintaining product safety and quality during storage.

Therefore, the present investigation was undertaken to develop and standardize sterilized carrot-based flavoured milk using different levels of carrot juice and to evaluate its physicochemical characteristics, sensory quality, and storage stability.

#### Materials and Methods

##### Raw Materials

Fresh cow milk was procured from a private dairy farm located near the College of Dairy Technology, Raipur, Chhattisgarh. Fully matured, healthy, and defect-free carrots (*Daucus carota* L.) along with food-grade cane sugar were purchased from the local market of Raipur. All raw materials were transported under hygienic conditions and used immediately for product preparation.

### Preparation of Carrot Juice

Fresh carrots were thoroughly washed under running water to remove adhering dirt and impurities, followed by peeling and trimming. For carrot juice preparation, peeled carrots were cut into small pieces and processed using a sanitized fruit and vegetable juicer. The extracted juice was filtered through a double-layer muslin cloth to remove coarse fibrous materials and obtain a uniform juice.

### Preparation of Sterilized Carrot-Based Flavoured Milk

The manufacturing process of carrot-based flavoured milk is illustrated in Figure 1. The milk was analyzed for fat, total solids (TS), solids-not-fat (SNF), and titratable acidity before processing. Carrot juice or shredded carrot was incorporated at three levels, namely 10, 20, and 30 per cent (w/w) of milk. Six treatment combinations were prepared. The required quantities of milk, carrot juice/shredded carrot, and sugar (15%) were accurately weighed and blended thoroughly at approximately 60 °C to ensure uniform mixing.

The prepared flavoured milk was filled into pre-sterilized glass bottles and sealed using a crown-capping machine. Sterilization was carried out at 108–111 °C for 25–30 min, followed by rapid cooling to room temperature. The sterilized bottles were labelled and stored under ambient conditions for evaluating shelf-life characteristics at 7-day intervals. Similar processing conditions for vegetable-enriched dairy beverages have been reported by Motegaonkar *et al.* (2024)<sup>[7]</sup> and Pop *et al.* (2024)<sup>[9]</sup>.

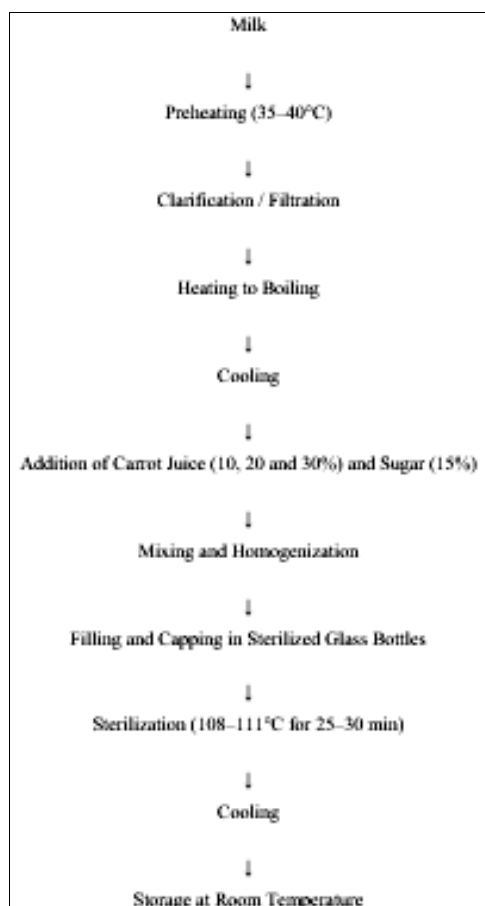


**Fig 1:** Flow Diagram for Preparation of Sterilized Carrot-Based Flavoured Milk

### Analytical Methods

The raw milk and prepared flavoured milk samples were analyzed for physicochemical characteristics. Fat content was determined by the Gerber method, total solids by the gravimetric method, and titratable acidity by standard titration procedures following BIS specifications (BIS, 2022)<sup>[3]</sup>. The pH of samples was measured using a calibrated digital pH meter at 25°C, while total soluble solids (TSS) were determined using a hand refractometer and expressed as °Brix according to AOAC (2023)<sup>[1]</sup> procedures.

### Sensory Evaluation

Fresh and stored samples of carrot-based flavoured milk were subjected to sensory evaluation by a panel of six trained judges. The samples were evaluated for colour and appearance, flavour, sweetness, mouthfeel, and overall acceptability using a nine-point hedonic scale, where 9 represented "like extremely" and 1 represented "dislike extremely." Sensory evaluation was conducted at 7-day intervals throughout the storage period under controlled conditions.

### Statistical Analysis

The experimental data obtained during the study were subjected to statistical analysis using a Randomized Block Design (RBD). Analysis of variance (ANOVA) was performed to determine the significance of treatment effects and storage periods. Differences among treatment means were tested at the 5% level of significance ( $p < 0.05$ ) following standard statistical procedures.

### Results and Discussion

#### Physicochemical Characteristics of Fresh Carrot-Based Flavoured Milk

The physicochemical characteristics of fresh carrot-based flavoured milk prepared with different levels of carrot juice and shredded carrot are presented in Table 1.

**Table 1:** Physicochemical characteristics of fresh carrot-based flavoured milk

| Treatment                  | Fat (%) | Acidity (%) | pH  | TSS (°Brix) | Total Solids (%) |
|----------------------------|---------|-------------|-----|-------------|------------------|
| T <sub>1</sub> (Juice 10%) | 4.10    | 0.14        | 6.5 | 21.50       | 25.71            |
| T <sub>2</sub> (Juice 20%) | 3.90    | 0.14        | 6.4 | 21.50       | 25.71            |
| T <sub>3</sub> (Juice 30%) | 3.60    | 0.14        | 6.4 | 21.00       | 25.72            |

Values represent the mean of three observations.

The fat content of the flavoured milk samples decreased slightly with increasing levels of carrot incorporation. This reduction may be attributed to the dilution effect caused by the addition of carrot juice or shredded carrot to milk. Similar observations have been reported in vegetable-enriched dairy beverages where incorporation of plant materials reduced the relative fat content of the final product (Pop *et al.*, 2024)<sup>[9]</sup>.

Titratable acidity remained constant (0.14%) across all treatments, indicating that carrot incorporation did not significantly influence the acidity of fresh flavoured milk. The pH values ranged from 6.3 to 6.5, which are within the normal range reported for flavoured milk beverages. A slight decrease in pH with increasing carrot concentration

may be attributed to the presence of naturally occurring organic acids in carrots. Similar findings were reported by Motegaonkar *et al.* (2024) [7], who observed minor variations in pH following carrot incorporation into value-added food products.

Total soluble solids (TSS) values ranged from 21.0 to 21.5 °Brix. The results indicated no appreciable differences among treatments because identical sugar levels were used in all formulations. Likewise, total solids content remained

relatively stable among treatments, ranging from 24.85 to 25.72%. The absence of substantial variation suggests that the levels of carrot incorporation used in the study did not markedly affect the total solids content of the product.

**Sensory Evaluation of Fresh Carrot-Based Flavoured Milk**

The sensory scores of flavoured milk prepared with different levels of carrot juice are presented in Table 2.

**Table 2:** Effect of carrot concentration on sensory characteristics of fresh flavoured milk

| S. No. | Carrot Concentration | Sensory Characteristics |           |                 |            |                       |
|--------|----------------------|-------------------------|-----------|-----------------|------------|-----------------------|
|        |                      | Colour & Appearance     | Flavour   |                 | Mouth feel | Overall Acceptability |
|        |                      |                         | Sweetness | Overall flavour |            |                       |
| 1      | T <sub>1</sub>       | 6.66                    | 7.17      | 7.17            | 7.33       | 7.17                  |
| 2      | T <sub>2</sub>       | 7.17                    | 6.66      | 7.66            | 7.33       | 7.83                  |
| 3      | T <sub>3</sub>       | 7.33                    | 7.50      | 7.33            | 7.83       | 7.67                  |

Values represent the mean of three observations.

The sensory evaluation revealed significant differences among treatments for colour and appearance, flavour, mouthfeel, sweetness, and overall acceptability. The treatments, T<sub>2</sub> (20% carrot juice) obtained the highest overall acceptability score (7.83), followed by T<sub>3</sub> (7.67) and T<sub>1</sub> (7.17). The superior acceptability of T<sub>2</sub> may be attributed to the optimum balance between carrot flavour, colour intensity, sweetness, and milk solids.

The findings indicate that moderate incorporation of carrot enhances sensory quality, whereas excessive addition may negatively affect flavour balance and texture. Similar trends have been reported in studies on vegetable-fortified dairy beverages where optimum levels of plant ingredients improved sensory acceptability, while higher concentrations resulted in lower consumer preference (Ikram *et al.*, 2024) [6].

**Effect of Storage on Overall Acceptability**

The overall acceptability scores of fresh samples ranged from 6.83 to 7.83. Among all treatments, T<sub>2</sub> recorded the highest score (7.83), indicating maximum consumer preference. After 28 days of storage at room temperature, the corresponding scores decreased to 5.33–6.50, demonstrating a gradual decline in sensory quality during storage.

The reduction in overall acceptability during storage may be attributed to slight flavour deterioration, changes in colour stability, and physicochemical modifications occurring during prolonged storage. Similar decreases in sensory scores during storage have been reported for fortified dairy beverages and vegetable-based milk products (Pop *et al.*, 2024) [9].

Statistical analysis revealed that both treatment effect and storage period had a significant ( $p < 0.05$ ) influence on overall acceptability. However, the interaction between treatment and storage period was found to be non-significant, indicating that all treatments exhibited a similar pattern of sensory decline during storage. Nevertheless, T<sub>2</sub> maintained the highest acceptability throughout the storage period, suggesting that incorporation of 20% carrot juice was the most suitable formulation for the preparation of sterilized carrot-based flavoured milk.

Overall, the results demonstrate that carrot juice can be

successfully incorporated into flavoured milk to improve nutritional value and sensory quality without adversely affecting physicochemical characteristics. The formulation containing 20% carrot juice and 15% sugar was found to be the most acceptable and remained organoleptically acceptable during 28 days of storage under ambient conditions.

**Conclusion**

The present study demonstrated the successful development and standardization of sterilized carrot-based flavoured milk using different levels of carrot juice and shredded carrot. The incorporation of carrot did not adversely affect the physicochemical properties of the product, as the values of acidity, pH, total soluble solids, and total solids remained within acceptable limits. Sensory evaluation revealed significant differences among the treatments, with the formulation containing 20% carrot juice and 15% sugar (T<sub>2</sub>) receiving the highest overall acceptability score due to its desirable colour, flavour, sweetness, and mouthfeel.

A gradual decline in sensory scores was observed during storage; however, all products remained acceptable for up to 28 days under ambient conditions. Statistical analysis indicated that both treatment and storage period significantly influenced the overall acceptability of the product, while their interaction was found to be non-significant.

Based on the results obtained, it can be concluded that carrot juice can be effectively utilized in the preparation of sterilized flavoured milk to enhance its nutritional quality, sensory characteristics, and consumer acceptability. Among all treatments, the formulation containing 20% carrot juice was found to be the most suitable and can be recommended for commercial production of carrot-based flavoured milk.

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