FORTIFICATION OF DRINKING YOGHURT WITH BETA CAROTENE BY INCORPORATING *Daucus carota* PULP AND *Citrus sinensis* JUICE

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Summary

Beta carotene is a natural antioxidant omnipresent in most of the fruits and vegetables. The current research was carried out to enrich a dairy product; drinking yoghurt with beta carotene which is known as an excellent source of vitamin A. *Daucus carota* pulp was incorporated as the main beta carotene source and *Citrus sinensis* juice was used to enhance the sensory properties of the product. The drinking yoghurt formula was developed as 80% of yoghurt base, 10% of *Daucus carota* pulp and 10% of *Citrus sinensis* juice.The shelf life of developed product was determined as 35 days considering the absence of coliform and yeast & mold counts, variation of pH, beta carotene and antioxidant capacity respectively from 4.41±0.01 to 4.20±0.01, from 4.97±0.01 to 4.39±0.01 µg/g and from 55.24±0.01 to 38.36±0.05% and at 95% confidence level, no significant difference was there between sensory attributes throughout the shelf life according to the analysis done using Kruskal-Wallis non-parametric one-way ANOVA and Mann Whitney tests of Minitab 17 version. These results collectively suggest that the developed product can be identified as a beta carotene enriched dairy product which may encourage further studies on skin fairness effect of the developed product.

Keywords: Beta carotene, yoghurt, *Citrun sinensis*, *Daucuc carota*, Fortification

Introduction

Milk is a highly nutritious food which contains substances provide both energy and the building materials necessary for growth. Water, fat, protein and lactose are the four quantitatively dominant components of milk while the minor components are minerals, enzymes, vitamins, and dissolved gases. It satisfies consumer demand for high quality innovative dairy products. Fermentation is a value added process of milk which adds more taste, better texture and enhanced shelf life for the product. Yoghurt is also a fermented product preferred by worldwide consumers. However, there are two main types of yoghurt, set and stirred, based on the method of production and on the physical structure of the coagulum. With the innovations of dairy industry, nutritional substances such as probiotic cultures, minerals, natural and artificial fruit and vegetable flavors are incorporated to yoghurts. Drinking yoghurt which is under the category of stirred yoghurt, is now a highly consumable product in both national

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and international markets. With the developments of the dairy industry, more innovative types of drinking yoghurt are coming to the market and are in research level based on the fortification of essential nutrients for the human body. Such developments will enhance the nutritional value and also sensory properties of the plain yoghurt drink. The study was carried out in the University of Sri Jayewardenepura to develop a drinking yoghurt enriched with beta carotene by incorporating *Daucus carota (carrot)* pulp and *Citrus sinensis*(orange) juice. Carrot is mostly used vegetable in human nutrition. Carrot juice increases the total antioxidant status and decreases lipid peroxidation in adults (Potter *et al.*, 2011). It is rich in beta carotene, ascorbic acid, tocopherol and classified as vitaminized food (Bello and Wudil, 2012). Therefore, the carrot was used as the main beta carotene source and orange was added to enhance the sensory properties of the product and also as a beta carotene source. Orange is a rich source of vitamin C, flavonoids, phenolic compounds and pectins. The main flavonoids found in citrus species are hesperidine, narirutin, naringin and eriocitrin (Milind and Dev, 2012). Beta carotene pigments are naturally occurring antioxidants in plant materials. According to recent studies, a diet high in carotenoids may reduce the risk of heart attack and assist in cancer prevention (Steinmetz, 1996). Fortification is one of the best methods to deliver the benefits of natural antioxidants for humans (Gad *et al.*, 2017).

Methodology

The Raw carrot (*Daucus carota)* was peeled, washed, grated and blended with water (4:1) to prepare the carrot pulp. Orange (*Citrus sinensis*) was washed, peeled and the juice was extracted. Orange juice and carrot pulp were mixed at 1:1 ratio and pasteurized at 105°C for 1 minute for the preparation of pulp to be mixed with yoghurt. According to the usual method, the yoghurt base was prepared using standardized milk containing 3.5% fat and 8.5% MSNF. The yoghurt base was stirred while mixing with pasteurized carrot orange mix at 4:1 ratio. Prepared drinking yoghurt was filled into bottles and stored at 4°C. A preliminary experiment was conducted to select the best formulation of carrot pulp (5%,10%,15%) and yoghurt base (85%, 80%,75%) with constant percentage (10%) of orange juice. The sensory properties of three samples were evaluated using a trained sensory panel on a nine-point hedonic scale. The sample containing 10% carrot pulp, 10% orange juice and 80% yoghurt base was selected as the best after analyzing the data gathered from the sensory trial with respect to appearance, colour, taste, mouth feel, and overall acceptability using Kruskal-Wallis non-parametric one-way ANOVA and Mann Whitney test. Shelf-life of the product stored at 4°C was analyzed for 35 days. For the evaluation of shelf life, the variation of the product pH value, Coliform and Yeast & Mold counts, beta carotene content, antioxidant activity and sensory parameters with shelf life were studied. Ultra violet visible spectrophotometry and 2,2-diphenyl-1-

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picrylhydrazyl radical scavenging activity were used to measure beta carotene content and antioxidant activity respectively. The collected data were analyzed statistically using Kruskal-Wallis non-parametric one-way ANOVA and Mann Whitney tests of Minitab 17 version.

Results and Discussion

Sensory analysis

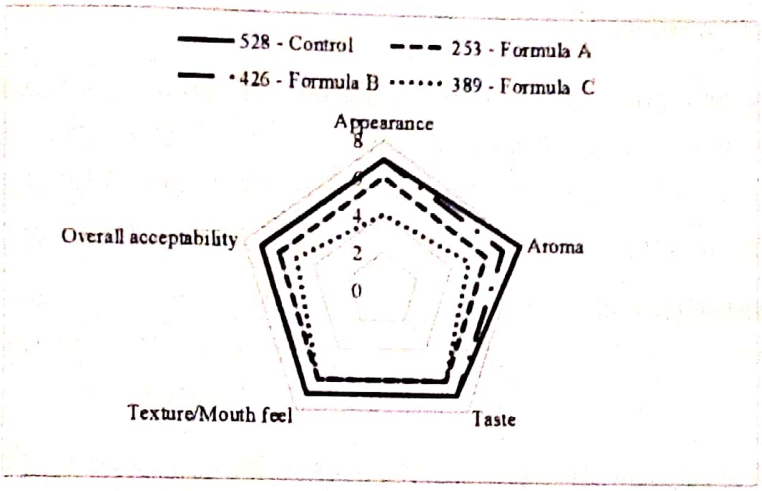

Figure 1: Graphical representation of selecting the best formula with respect to sensory attributes

This web diagram (Figure 1) shows the variation of mean values of each sensory attribute of the four drinking yoghurt samples (528 – Control, 253 – Formula A, 426 – Formula B, 389 – Formula C) according to the data collected from sensory evaluation. The mean values of each sensory attribute of Formula B are similar to the control sample except aroma. Other formulae are having lower values for sensory parameters than formula B and control. Therefore, formula B was selected as the best and subjected to product development and further analysis.

Table 1: H_{cal} values for each sensory attribute

Attribute	H_{cal} value
Appearance	32.65
Aroma	19.38
Taste	26.76
Texture/Mouthfeel	32.28
Overall Acceptability	35.77

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Null hypothesis H_0: All medians are equal (there is no significant difference between two samples under the tested attributes)

Alternative hypothesis H_1: At least one median is different (there is a significant difference between two samples under the tested attributes)

The degree of freedom of the test samples; 3 – 1 = 2

The H_{cal} values of each sensory attributes are greater than the relevant chi-square value (5.991). Therefore, according to the Kruskal Wallis test, under 0.05 level of significance, H_0 can be rejected. Which concludes that there is a significant difference in each sensory attributes of four samples.

Variation of pH Value with Storage at 4° C

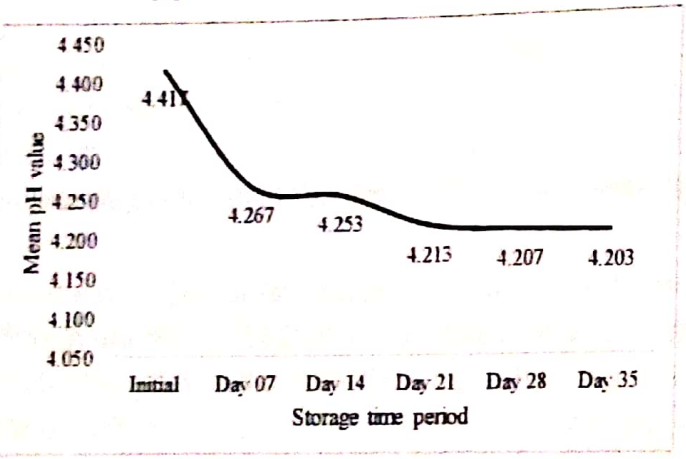

Figure 2: Variation of pH Value with Storage

Figure 2 indicates the graphical representation of the variation of pH value with storage at 4°C. The initial pH value of developed drinking yoghurt was 4.41 and reduced up to 4.20 within 35 days.

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Variation of beta Carotene Content with Storage at 4°C

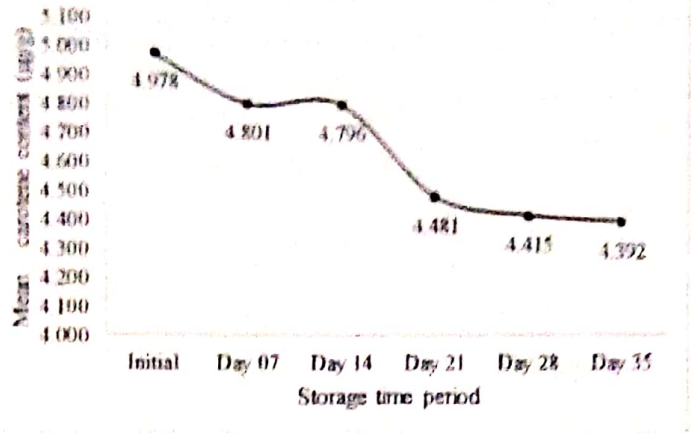

Figure 3: Variation of Beta Carotene Content with Storage

The initial beta carotene content of developed drinking yoghurt was 4.97 µg/g. After 35 days of storage at 4°C, the beta carotene content was reduced to 4.39 µg/g which is shown in figure 3.

Variation of Antioxidant activity with Storage at 4°C

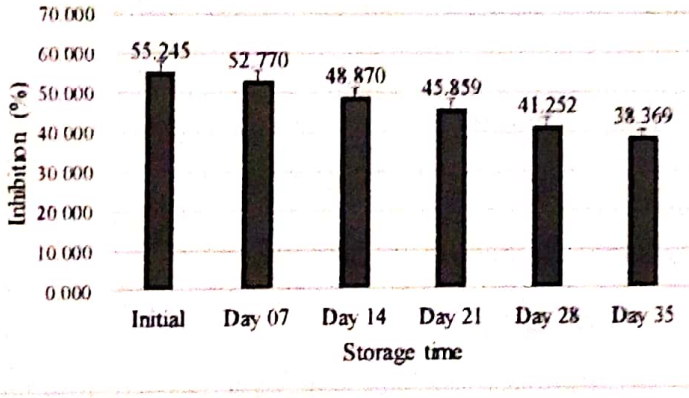

Figure 4: Variation of Antioxidant activity with Storage

The antioxidant activity of developed drinking yoghurt was reduced from 55.2% to 38.3% within 35 days of storage time at 4°C as shown in figure 4

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Microbial Analysis

The time period of storage (at 4°C)	Coliform Count		Yeast and Mold count (CFU)	
	Developed drinking yoghurt sample	Control	Developed drinking yoghurt sample	Control
Initial	Negative	Negative	0	
Day 07	Negative	Negative	0	
Day 14	Negative	Negative	0	
Day 21	Negative	Negative	0	
Day 28	Negative	Negative	0	
Day 35	Negative	Negative	0	

Table 2: Coliform, Yeast & Mold counts of the Developed Drinking Yoghurt Samples

Microbial results are indicated in table 3. Coliform counts were negative for 35 days in both developed sample and the control sample. Yeast and mold were also absent from the storage time period.

Conclusion

The drinking yoghurt; developed according to the formula of 80% of yoghurt base, 10% of carrot pulp and 10% of orange juice is a rich source of beta carotene which is 11.63 times higher than a plain yoghurt with 35 days of shelf life.

References

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