Assessment of storage stability of essential oil enriched flavoured milk

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Abstract Health conscious consumers are more concerned about adverse effects of synthetic preservatives in food. So as an alternative, natural preservatives like plant essential oil components having antimicrobial activity against pathogenic and spoilage microorganisms can be used in food products. No study exists on flavoured milk enriched with plant derived essential oil component. So in the present study, essential oil enriched flavoured milk (eugenol and trans-cinnamaldehyde enriched) were assessed for stability during refrigerated storage. Level of essential oil components were standardized for preparation of flavoured milk. Storage studies revealed that essential oil enriched flavoured milk with increased antioxidant activity of the product, ultimately enhances the shelf life of the product. Thus, the essential oil enriched flavoured milk is proved as a value added product with enhanced food safety and health attributes as well as it would protect the health of consumers vis-à-vis health of the nation.

Keywords : Essential oil, eugenol, trans-cinnamaldehyde, flavoured milk

Introduction

Milk is an important source for maintaining good health, bone development, and providing nutrients to the growing children. It is also one of the main sources of protein in certain populations. However, the shelf life of fluid milk products is sometimes limited because of the processing conditions, shipping and extreme conditions during storage in unfavourable environments. Conventional food processing operations (e.g. drying, UHT treatment, blanching, canning, etc.) adversely affect the overall quality of food like, destroying some vitamins and pigments, and denaturation of some protein (Bermúdez-Aguirre et al., 2010). So, in recent years, considerable effort has been made to find natural antimicrobials that can inhibit bacterial and fungal growth in foods in order to improve quality and shelf-life. Further, consumers have become concerned about the safety of synthetic preservatives used in food. As a result, there is an increasing demand for natural products that can serve as alternative food preservatives.

The plant bioactive components of essential oils are well known for their potential antimicrobial activity to control food borne pathogenic and spoilage microflora (Bajpai et al., 2008). In this regard, applications of plant essential oils (PEOs), being potent antimicrobials, can be a good strategy to control or inhibit those food borne pathogenic and spoilage bacteria in milk and dairy products with better consumer acceptability (Abeywickrama et al., 2004). Plant essential oils (PEOs) components can be extracted from various parts of the plants by steam distillation and solvent extraction methods. (Burt, 2004) There are about three thousand PEOs with potent biological efficacy which have been commercialized (Van de Braak and Leijten, 1999). The antimicrobial or other biological activities of PEOs are directly correlated to the presence of their bioactive volatile components (Mahmoud and Croteau, 2002). Among several plant-derived compounds, polyphenolic compounds have great structural diversity and variations in chemical composition, and thus differ in their antibacterial effectiveness against pathogenic microorganisms (Stojkovic et al., 2013).

Trans-cinnamaldehyde is a major component of bark extract of cinnamon and eugenol, the principal chemical component of clove oil from Eugenia aromatica have been long known for their antibacterial effects (Hemaiswarya et al., 2009). They are
also known as generally recognized as safe (GRAS) by the FDA, and has been approved for use in foods. The U. S. Flavoring Extract Manufacturers’ Association has reported that trans-cinnamaldehyde and eugenol exhibit a wide margin of safety between conservative estimates of intake without any observed adverse effective levels, from sub chronic and chronic studies (Adams et al., 2004). The present study was aimed to optimize the minimum bactericidal concentrations of two essential oil components to prepare essential oil enriched flavoured milk having better shelf life and good bioactivity.

Materials and Methods

Trans-cinnamaldehyde (99%), eugenol (99%), ABTS* [(2, 2’-azinobis (3-ethylbenzothiazoline-6-sulphonic acid)] and tween-80 (Sigma Aldrich Pvt. Ltd., Bangalore, India), Folin-Ciocalteu’s reagent (Merk, Germany) were used in the study.

Preparation of essential oil enriched flavoured milk

Standardized milk (Fat= 1.5%, SNF=9%) was collected from Experimental Dairy, NDRI, Karnal. Trans-cinnamaldehyde and eugenol (essential oil component) were selected for preparation of essential oil enriched flavoured milk on the basis of better sensory quality and good biological activities. Essential oil enriched flavoured milk was prepared according to the flow diagram (Figure 1). Since EOs are lipophilic component hence they are not easily soluble in milk. To improve solubility of trans-cinnamaldehyde and eugenol, tween80 @ 0.1 % was added after pasteurization. In control samples only sugar (@5%) and colour (0.008mg/lit) were added.

Sensory evaluation

Sensory evaluation of the product was done by a panel of 5 judges who were asked to grade enriched milk for any change in colour and appearance, odour, taste and mouthfeel compared to control. Score card based on 9 point Hedonic scale was used.

Storage Study

Flavoured milk samples were stored in sterile plastic bottles and stored at refrigeration temperature (4-7°C) for 7 days for shelf-life studies. Each sample bottle was used and discarded after analysis. Microbiological and physicochemical characteristics (Total viable count, colour, pH, titratable acidity, and alcohol stability) were studied at 0,3,5 and 7th days.

Total Viable Count

For enumeration of total viable bacteria in prepared product, standard plate count was done as per the procedure described in BIS: 11. SP: (Part XI) - 1981 at 0,3,5 and 7th days.

Colour

Changes in colour of the EOs enriched flavoured milks were measured using a Colourflex (Hunterlab, Reston, Virginia, USA) equipment coupled with the universal software (Version 8.10). The readings are expressed in the form of scale values (L, a and b) in which "L", indicates whiteness in values ranging from 0 (white) to 100 (black), "a", measures degree of greenness with negative values and redness with positive values and "b", values indicates degree of blueness (positive) to yellowness (negative). Using the below formula Total color differences (ΔE) were calculated. Essential oil enriched milk samples were pasteurized (63°C/30 min) and stored under refrigerated conditions (4-7°C) After 2h, milk samples were brought to room temperature and colour measurements were performed.
pH

pH was determined by direct immersion of electrode in the EO enriched flavoured milk samples with a pH-meter (Cyberscan, Eutech instruments, Singapore). The pH meter was calibrated previously with three standards (pH 4, 7 and 9.2). Each sample was measured in triplicate.

Titratable Acidity

Titratable acidity was determined by titrating 10 ml of sample with 0.1 N NaOH to the phenolphthalein end point.

Titratable acidity (%LA) = 9 x N1 x V1/ N2

Ethanol Stability

The ethanol stability of equal volume of milk samples with aqueous dilution of ethanol (10 to 100% at 2.5% increments) were mixed in a Petri dish and subjectively examined for appearance of flocculation of protein. The concentration of ethanol at which sample has shown no flocculation was recorded as ethanol stable.

Absolute Viscosity

Kinematic viscosity of samples at 27ºC was measured with an Ostwald’s U tube viscometer. The density of sample set at 27ºC was analyzed using pycnometer. The experiment was conducted in thermostatically controlled water bath to maintain the temperature exactly at 27ºC. Absolute viscosity was calculated according to equation:

Absolute viscosity = Kinematic viscosity x density

Antioxidant Activity

Free radical scavenging activity of the essential oil enriched flavoured milk was determined by ABTS method given by Hernandez-Ledesma et al. (2005).

Total phenolic content

Total phenolic content of samples were analyzed by Folin-Ciocalteu’s method given by Zheng and Wang (2001).

Statistical analysis

The results were expressed as mean ± standard error of mean. Significance was tested by employing analysis of variance (ANOVA) and comparison between means was made by critical difference (C.D.) value. T-test was used to compare between two samples. For computation of data, software application programme like Microsoft Excel and PRISM were used.

Results and Discussion

Sensory Evaluation

After preparation, products were judged for their sensory attributes and were studied up to 7 days during storage at 4-7ºC. The overall sensory score obtained for TC enriched flavoured milk was 32.1 as compared to 38.8 of control milk (Table 1) whereas for eugenol enriched flavoured milk it was 34.7 as compared to 40.3 obtained for control milk (Table 2). Statistically (t-test) control and essential enriched flavoured milk samples showed non-significant difference (p<0.05) in terms of colour, appearance, taste, mouthfeel, odour and overall acceptability.

Storage study

Milk samples supplemented with EOs along with control samples were stored at refrigerated temperature (4-7ºC) temp for 7 days. All milk samples viz, control milk, trans-cinnamaldehyde and eugenol enriched flavoured milk were regularly evaluated and results are presented here under.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Effect of essential oil (trans-cinnamaldehyde) enrichment on sensory quality flavoured milk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum score</td>
</tr>
<tr>
<td>Colour and appearance</td>
<td>9</td>
</tr>
<tr>
<td>Odour</td>
<td>9</td>
</tr>
<tr>
<td>Taste</td>
<td>9</td>
</tr>
<tr>
<td>Mouthfeel</td>
<td>9</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>9</td>
</tr>
<tr>
<td>Total Score</td>
<td>45</td>
</tr>
</tbody>
</table>

Data are presented as mean± SEM (n=5)

a-b-c means with same superscript in columns do not vary significantly (P< 0.05) from each other.
Change in Total Bacterial count during storage

On statistical analysis of trans-cinnamaldehyde, eugenol enriched milk and corresponding control milk are presented in table 3. On 0 and 3rd day, there was significant (P>0.05) difference between control and enriched flavoured milk in total viable count as compared to 5th and 7th day of storage in all the samples analysed. As per BIS specifications (1981), the standard plate count should not exceed 50,000 cfu/ml. The prepared enriched flavoured milk showed (Table 3) the total viable count within the normal range. There was no increase in bacterial count even during storage periods which might be due to the antimicrobial activity of essential oil components which correlated with the report of Alves (2004) who opined that anthraquinones isolated from the exudate of Aloe vera have shown wide antimicrobial activity.

Effect of enrichment on colour profile of milk

Colour is an important criterion while enriching light colour foods with EOs. Colour of control and enriched milks were determined by Hunter Lab Coordinates. The colour measured with colourflex was described in terms of L* value (lightness), a* value (red-green) and b* value (yellow-blue). Colourflex reading for control and enriched milks are represented in Table 4 and 5. Enrichment of milk with trans-cinnamaldehyde and eugenol slightly affected the colour profile of milk. There was slight decrease in whiteness or increase in "L" value of milk after enrichment ("L" value was 77.21 and 78.76 for control and TC whereas 83.01 and 83.09 for control and eugenol respectively). Similarly, "a" value (which shows intensity of greenness) was -8.9 and -8.76 for control and eugenol enriched milk, whereas 3.21 and 4.76 for control and TC enriched milk respectively. "b" value (which shows intensity of yellowness) was 17.25 and 15.03 for control and TC enriched milk, whereas 24.55 and 24.36 for control and eugenol enriched milk respectively. In present findings, there was a change with regard to greenness, yellowness and redness.

ΔE values for 0, 3rd, 4th and 7th day were also calculated. The observations indicated no significant differences were observed upto 7th day for both the samples.

Change in pH during storage

pH profiles of trans-cinnamaldehyde, eugenol enriched milk and corresponding control milk are presented in Table 6. On 0 and 3rd day pH of all milk samples i.e. control, eugenol and trans-cinnamaldehyde enriched milk did not show any significant (p<0.05) change. On 5th and 7th day of storage, pH of Trans-cinnamaldehyde and eugenol enriched milk was slightly lower but not significant (p< 0.05). The pH of control milk kept on decreasing throughout the storage of 7 days however, magnitude of decrease in pH of enriched milk and control milk was comparable throughout the duration of storage.

Table 2 Effect of essential oil (eugenol) enrichment on sensory quality flavoured milk

<table>
<thead>
<tr>
<th>Maximum score</th>
<th>Control</th>
<th>Eugenol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour and appearance</td>
<td>9</td>
<td>8.1±0.33a</td>
</tr>
<tr>
<td>Odour</td>
<td>9</td>
<td>8.30±0.20a</td>
</tr>
<tr>
<td>Taste</td>
<td>9</td>
<td>8.1±0.33a</td>
</tr>
<tr>
<td>Mouthfeel</td>
<td>9</td>
<td>7.9±0.40a</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>9</td>
<td>7.9±0.24a</td>
</tr>
<tr>
<td>Total Score</td>
<td>45</td>
<td>40.3</td>
</tr>
</tbody>
</table>

Data are presented as mean± SEM (n=5)
a-b-c means with same superscript in columns do not vary significantly (P< 0.05) from each other.

Table 3 Effect of essential oil enrichment on Total Viable Count (log 10 cfu/ml) of flavoured milk

<table>
<thead>
<tr>
<th>Storage Time(Days)</th>
<th>0</th>
<th>3</th>
<th>5</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk variants</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>4.31±0.018 Aa</td>
<td>4.87±0.018 Aa</td>
<td>5.03±0.013 Aa</td>
<td>5.15±0.013 Aa</td>
</tr>
<tr>
<td>TC enriched milk</td>
<td>4.27±0.020 Aa</td>
<td>4.34±0.013 Aa</td>
<td>4.35±0.014 Aa</td>
<td>4.37±0.039 Bb</td>
</tr>
<tr>
<td>Eugenol enriched milk</td>
<td>4.30±0.011 Aa</td>
<td>4.35±0.014 Aa</td>
<td>4.36±0.012 Bb</td>
<td>4.39±0.018 Bb</td>
</tr>
</tbody>
</table>

Data are presented as mean± SEM (n=3)
a-b-c Means with same superscript in rows do not vary significantly (P< 0.05) from each other.
A-B-C Means with same superscript in columns do not vary significantly (P< 0.05) from each other.
Table 4  Effect of trans-cinnamaldehyde enrichment on colour profile of flavoured milk during storages at 4-7°C

<table>
<thead>
<tr>
<th>Storage period (day)</th>
<th>Milk variants</th>
<th>L, a, b values</th>
<th>ΔE = 3.12</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Control</td>
<td>L</td>
<td>ΔL</td>
</tr>
<tr>
<td></td>
<td>Trans-cinnamaldehyde enriched milk</td>
<td>L</td>
<td>ΔL</td>
</tr>
<tr>
<td>0</td>
<td>Control</td>
<td>77.21</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Trans-cinnamaldehyde enriched milk</td>
<td>78.76</td>
<td>1.55</td>
</tr>
<tr>
<td>3</td>
<td>Control</td>
<td>77.18</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Trans-cinnamaldehyde enriched milk</td>
<td>78.70</td>
<td>1.52</td>
</tr>
<tr>
<td>5</td>
<td>Control</td>
<td>77.20</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Trans-cinnamaldehyde enriched milk</td>
<td>78.68</td>
<td>1.48</td>
</tr>
<tr>
<td>7</td>
<td>Control</td>
<td>77.26</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Trans-cinnamaldehyde enriched milk</td>
<td>78.72</td>
<td>1.46</td>
</tr>
</tbody>
</table>

Table 5  Effect of eugenol enrichment on colour profile of flavoured milk during storages at 4-7°C

<table>
<thead>
<tr>
<th>Storage period (day)</th>
<th>Milk variants</th>
<th>L, a, b values</th>
<th>ΔE = 0.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Control</td>
<td>L</td>
<td>ΔL</td>
</tr>
<tr>
<td></td>
<td>Eugenol</td>
<td>L</td>
<td>ΔL</td>
</tr>
<tr>
<td>0</td>
<td>Control</td>
<td>83.01</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Eugenol</td>
<td>83.09</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Control</td>
<td>83.03</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Eugenol</td>
<td>83.07</td>
<td>0.06</td>
</tr>
<tr>
<td>5</td>
<td>Control</td>
<td>83.00</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Eugenol</td>
<td>83.07</td>
<td>0.07</td>
</tr>
<tr>
<td>7</td>
<td>Control</td>
<td>83.04</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Eugenol</td>
<td>83.09</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Table 6  Changes in pH profile of EOs enriched milk during storages at 4-7°C

<table>
<thead>
<tr>
<th>Storage Time(Days)</th>
<th>Milk variants</th>
<th>Control</th>
<th>Trans-cinnamaldehyde enriched milk</th>
<th>Eugenol enriched milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>6.76± 0.03bc</td>
<td>6.76± 0.03bc</td>
<td>6.66± 0.03aa</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>6.76± 0.03bc</td>
<td>6.73± 0.03ba</td>
<td>6.66± 0.03aa</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>6.73± 0.03ba</td>
<td>6.72± 0.03ba</td>
<td>6.66± 0.03aa</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>6.7± 0.03aA</td>
<td>6.7± 0.03aA</td>
<td>6.65± 0.05aA</td>
</tr>
</tbody>
</table>

Data are presented as mean± SEM (n=3)
A-B-C Means with same superscript in columns do not vary significantly (P<0.05) from each other.

Changes in titratable acidity during storage

The changes in titratable acidity (% LA) of control as well as Trans-cinnamaldehyde, eugenol enriched milk during storage are represented in table 7. Acidity of control milk increase significantly (p<0.05) on 5th and 7th day of refrigerated storage whereas trans-cinnamaldehyde and eugenol enriched milk showed non-significant change (p<0.05) on 5th and 7th day.
of refrigerated storage.

Effect of enrichment on viscosity during storage

Viscosity of Trans-cinnamaldehyde, eugenol enriched and control milk was measured at 27°C using OSWALD’S U- tube viscometer and the results were shown in table 8. There was non- significant effect of enrichment (p<0.05) with trans-cinnamaldehyde and eugenol on viscosity of milk. There are no reports available regarding the impact of addition of Trans-cinnamaldehyde, eugenol on viscosity of milk. No significant difference (p<0.5) on viscosity were observed up to 7th day of storage.

Table 7 Changes in Titratable acidity of milk during storage at 4-7°C

<table>
<thead>
<tr>
<th>Storage Time(Days)</th>
<th>0</th>
<th>3</th>
<th>5</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk variants</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0.14</td>
<td>0.14</td>
<td>0.16</td>
<td>0.18</td>
</tr>
<tr>
<td>±0.003aA</td>
<td>±0.003aA</td>
<td>±0.005bB</td>
<td>±0.006cC</td>
<td></td>
</tr>
<tr>
<td>Trans-cinnamaldehyde enriched milk</td>
<td>0.14</td>
<td>0.14</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>±0.003aA</td>
<td>±0.003aA</td>
<td>±0.016aB</td>
<td>±0.003bB</td>
<td></td>
</tr>
<tr>
<td>Eugenol enriched milk</td>
<td>0.14</td>
<td>0.14</td>
<td>0.15</td>
<td>0.16</td>
</tr>
<tr>
<td>±0.003aA</td>
<td>±0.003aA</td>
<td>±0.005bB</td>
<td>±0.003bB</td>
<td></td>
</tr>
</tbody>
</table>

Data are presented as mean± SEM (n=3)

a-b-c Means with same superscript in rows do not vary significantly (P< 0.05) from each other.

A-B-C Means with same superscript in columns do not vary significantly (P< 0.05) from each other.

Effect of enrichment on alcohol stability

The alcohol (ethanol) stability test has been used as a simple indicator of milk freshness and suitability for UHT processing. Milk should be stable in 74% alcohol to be suitable for UHT treatment. Effect of trans-cinnamaldehyde and eugenol enrichment has been recorded in table 9. All enriched milk samples did not coagulate on addition of ethanol (74%) i.e. all samples were alcohol negative indicating that the enriched milk had good heat stability and can be used for manufacturing ultra high treated dairy products. No significant difference (p<0.5) was observed upto 7th day of refrigerated storage.

Table 8 Changes in absolute viscosity of Eos enriched flavoured milk during storages at 4-7°C

<table>
<thead>
<tr>
<th>Sample</th>
<th>0</th>
<th>3</th>
<th>5</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Storage Period (Days)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Absolute viscosity (Cp)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control milk</td>
<td>1.421 ±0.001aA</td>
<td>1.421 ±0.001aA</td>
<td>1.422 ±0.001aA</td>
<td>1.421 ±0.001aA</td>
</tr>
<tr>
<td>Trans-cinnamaldehyde enriched milk</td>
<td>1.421 ±0.001aA</td>
<td>1.422 ±0.001aA</td>
<td>1.422 ±0.001aA</td>
<td>1.421 ±0.001aA</td>
</tr>
<tr>
<td>Eugenol enriched milk</td>
<td>1.423 ±0.001aA</td>
<td>1.423 ±0.001aA</td>
<td>1.421 ±0.001aA</td>
<td>1.422 ±0.001aA</td>
</tr>
</tbody>
</table>

Data are presented as mean± SEM (n=3)

a-b Means with same superscript in rows do not vary significantly (P< 0.05) from each other.

A-B-C Means with same superscript in columns do not vary significantly (P< 0.05) from each other.

Table 9 Effect of essential oil enrichment on alcohol stability of flavoured milk

<table>
<thead>
<tr>
<th>Sample</th>
<th>Storage period (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Alcohol test</td>
<td></td>
</tr>
<tr>
<td>Control milk</td>
<td>Negative</td>
</tr>
<tr>
<td>Trans-cinnamaldehyde enriched milk</td>
<td>Negative</td>
</tr>
<tr>
<td>Eugenol enriched milk</td>
<td>Negative</td>
</tr>
</tbody>
</table>
**Table 10 Antioxidant activity of Essential oil enriched flavoured milk**

<table>
<thead>
<tr>
<th>Sample</th>
<th>% inhibition</th>
<th>TEAC*/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trans- Cinnamaldehyde enriched milk</td>
<td>10.19</td>
<td>0.1495</td>
</tr>
<tr>
<td>Eugenol enriched flavoured milk</td>
<td>62.47</td>
<td>1.2860</td>
</tr>
</tbody>
</table>

*μM Trolox/ml of milk (TEAC= Trolox Equivalent Antioxidant Capacity)

**Antioxidant activity (ABTS method)**

Antioxidants are used to preserve food products by acting as sacrificial oxidants, thus retarding rancidity or discolouration that may have occurred as a result of oxidation. Phenolic compounds, in addition to their antimicrobial properties, are known to have antioxidant ability because of their role as free radical scavengers. The antioxidant activity of Trans-Cinnamaldehyde and Eugenol flavoured milk were i.e. 0.1495 and 1.2860 μM of trolox/ml of milk respectively (Table 10).

**Total polyphenol content**

The total phenolic content of Trans-Cinnamaldehyde and Eugenol flavoured milk were 12.28 and 45.66 μg of Gallic Acid Equivalent (GAE)/ml of milk respectively. According to the results eugenol enriched flavoured milk was found rich in antioxidant activity as well as total phenolic content than that of trans-cinnamaldehyde enriched milk. It is because more concentration of eugenol (23.8mM) was added than trans-cinnamaldehyde (60.8mM) when preparing flavoured milk. But the organoleptic quality of the product was not much affected due the higher concentration. Even eugenol enriched flavoured milk showed better sensory quality than trans-cinnamaldehyde enriched flavoured milk. Thus, the essential oil enriched flavoured milk is proved a value added product with enhanced food safety and health attributes as well as it would protect the health of consumers and reduce the economic loss.

**Conclusions**

Essential oil enrichment of flavoured milk is a natural method to extend the shelf life of milk with enhanced bioactivity. Phenolic compounds are present in essential oils are responsible for its high antioxidant activity. Hence it can be used as preservative to prevent the spoilage of milk and products and thereby enhancing the shelf life without influencing the properties of the milk products. In today’s world people are looking for natural preservative, in this context essential oils are best alternative to meet the markets demand. However, the strong odour of essential oil limits its use to directly add in to the food. In order to prevent the modification of organoleptic properties of food product, it's recommended to add a small concentration of essential oils to the products. It has been reported that combined methods of application of the EOs with other methods such as hurdle technology and modified-atmosphere packaging improve the flavour and increase shelf life of food products. The use of plant extracts and essential oils in consumer goods is expected to increase in the future due to the fact that volatile oils can be considered as a natural alternative to synthetic food preservatives and could be used to enhance food safety and shelf life.

**References**


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