Optimization and shelf life extension of flax seed milk paneer by hurdle technology

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Abstract: Flax seed milk paneer is a new product developed with the target of providing a nutritional supplement of omega 3 fatty acids to the vegetarian population. Various magnitudes of flax seed milk and standardised milk were used and coagulated using three different coagulants citric acid (2%), ascorbic acid (2%), and tartaric acid (4%). Based on sensory and textural analysis the best blend was nominated for further studies and analysis. Hurdle technology was applied to the prepared flax seed milk paneer. The hurdles adopted comprised of Water activity (aw), pH, and preservative. Water activity was reduced from 0.99 to 0.95 at 28.5°C and pH values decreased from 5.6 to 5.1. The product was packed in polyethene bags, sealed and stored under refrigerated conditions at 5°C. The sensory scores decreased on storage but the keeping quality and nutritional values of the product did not show considerable conditions.

Keywords: Flax Seed Milk, Paneer, Omega 3 Fatty Acids, Hurdle Technology, Water Activity, Sensory Analysis

I. Introduction

Flax seed is the richest plant source of omega 3 fatty acids. It is an emerging functional food because of its rich contents of α linolenic acid, lignans and fiber. It can contribute to the reduction of several diseases such as diabetes mellitus, atherosclerosis and cancer. Flax seed has a very healthy fatty acid profile with high concentrations of PUFA (73%). (Flax Canada 2015).

Paneer is one of the important Indian traditional heat and acid coagulated product widely used as a vegetarian delicacy (Venkateshaiah 2003). Flax seed milk incorporated paneer will be a promising supplement of omega 3 fatty acids to the vegetarian population. The higher moisture content of this product makes it more to faster spoilage resulting in limited shelf life. Each hurdle like aw, pH and the use of preservatives like delvoacid, sorbic acid, hydrogen peroxide may help to extend shelf life (Rao 2000). When used in combination at an optimum level without affecting the product quality hurdle technology concept may enhance the shelf life of the product (Leistner 1994).

Present study was done on formulation of flax seed milk paneer and application of hurdle technology to the optimized product for shelf life enhancement.

1.1. Need for the Study

Flaxseed provides one of the richest non-animals sources of omega-3 fatty acids making it ideal for vegetarians. Hence, the aim of the project is to develop flaxseed milk paneer with increased shelf life by using hurdle technology.

1.2. Objectives

- To optimize flaxseed milk paneer.
- To study the physiochemical, textural, microbial and sensory characteristics of the product.
- To increase the shelf life of the product by application of hurdle technology.

II. Materials & Methods

2.1. Extraction of Flax Seed Milk

Flax seed (Linumusitatissimum) were procured from a local super market (Nilgris at Urapakkam). Flax seed milk is extracted by a three step process. The seeds are soaked in hot water at 45°C for 20 minutes to remove the anti-nutritional factors present. The soaked seeds were ground to a fluid consistency using ice cold water at 5°C (500ml of water for 100 gm of seeds). The milk was filtered from the extract by using a muslin cloth.
Table 2.1. Proportions for 1 litre milk:

<table>
<thead>
<tr>
<th>Standardised Milk</th>
<th>Flax Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>900 ml</td>
<td>100ml</td>
</tr>
<tr>
<td>800 ml</td>
<td>200ml</td>
</tr>
<tr>
<td>700 ml</td>
<td>300ml</td>
</tr>
<tr>
<td>600 ml</td>
<td>400ml</td>
</tr>
<tr>
<td>500 ml</td>
<td>500ml</td>
</tr>
</tbody>
</table>

2.2. Preparation of Flax Seed Milk Paneer and Application of Hurdle Technology

Milk and flax milk were taken in the proportions as mentioned in Table 2.1. The mixture was heated to 98°C with stirring to facilitate uniform mixture. When the temperature drops between 87°C - 90°C the coagulant was added with intermittent stirring till end point was indicated by clear whey solution. Three different coagulants at different strengths were used – citric acid 2%, ascorbic acid 2% and tartaric acid 4%. After coagulation the curds were passed through muslin cloth to drain off the whey and the curds are transferred to the paneer press lined with a muslin cloth subjected to pressing for 20 minutes to obtain a compact block of paneer. Immediately after pressing the paneer is transferred into cold water at 5°C and kept as it is for 45 minutes. The paneer is then cut into small cubes to be utilized for further studies.

Table 2.2. Textural analyzer settings and parameters:

<table>
<thead>
<tr>
<th>Mode</th>
<th>Measure force in compression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option</td>
<td>Return to start</td>
</tr>
<tr>
<td>Pre-Test Speed</td>
<td>1.5 mm/s</td>
</tr>
<tr>
<td>Test Speed</td>
<td>2.0 mm/s</td>
</tr>
<tr>
<td>Post-Test Speed</td>
<td>10.0mm/s</td>
</tr>
<tr>
<td>Distance</td>
<td>5 mm</td>
</tr>
<tr>
<td>Trigger Type</td>
<td>Auto 2.5g</td>
</tr>
<tr>
<td>Data acquisition rate</td>
<td>400pps</td>
</tr>
</tbody>
</table>

Textural analysis to check the firmness of the samples were done using Texture AnalyserHDi from Stable Microsystems. Table 2.2 shows the texture analyser settings and parameters. Sensory analysis was done using a 9 point hedonic scale. Based on textural and sensory analysis the best variant was selected and was used for further analysis.

2.3. Water Activity and pH

Water activity and pH were reduced by dipping paneer cubes of 1 cm in stainless steel vessels containing 1 litre of 3% NaCl and 0.1% Citric Acid solution for diffusion at refrigerated conditions at 7°C for 12 hours. After diffusion paneer cubes were taken out and kept on wire gaze for 30 mins to facilitate drainage. Potassium sorbate (0.1%) was used as a preservative (Thakral et al 1990). The water activity and pH reduced paneer was packed in the packaging material (PE) and stored at refrigerated conditions.

2.4. Analytical Methods

Paneer samples were analysed for moisture, fat, protein, pH, ash as per ISI (1981 b). Water activity was measured by using Aqua lab V2.3 water activity meter. pH was determined by using digital pH meter as per the procedure followed by ISI. The paneer samples were analysed for standard plate count (SPC), Yeast and molds, coliforms (ISI 1981a).
III. Results and Discussion

3.1. Standardisation of Flax Seed Milk Paneer
For the standardisation of flax seed milk paneer, the following parameters are mandatory to be considered. The parameters are proportion of flax seed milk, coagulant used, concentration of hurdles used for shelf life extension.

Table 3.1. Proportions for Flaxseed Milk Paneer

<table>
<thead>
<tr>
<th>Sample</th>
<th>Proportions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>90% Milk + 10% Flaxmilk</td>
</tr>
<tr>
<td>Sample 2</td>
<td>80% Milk + 20% Flaxmilk</td>
</tr>
<tr>
<td>Sample 3</td>
<td>70% Milk + 30% Flaxmilk</td>
</tr>
</tbody>
</table>

Based on proportion and type of coagulant:

3.1.1. Comparison of Sensory Analysis of Citric Acid Variables

Fig. 3.1. Sensory analysis of the proportions coagulated with 2% Citric Acid
3.1.2. Texture Analysis of Citric Acid Coagulated Flax Seed Milk Paneer Variables

Fig. 3.2. Citric Acid Control

Fig. 3.3. Sample 1
Discussion: Comparing the sensory and textural analysis of the different proportions, Sample 2 has parameters which are equivalent to the control paneer sample. Hence, Sample 2 will be carried for further trials.

3.1.3. Comparison of Sensory Analysis of Ascorbic Acid Variables

![Graph showing comparison of sensory analysis of ascorbic acid variables](Fig3.6)
3.1.4. Texture Analysis of Ascorbic Acid Coagulated Flax Seed Milk Paneer Variables

**Fig. 3.7. Ascorbic Acid Control**

**Fig. 3.8. Sample 1**
Discussion: It was observed that there was considerable difference between the three samples and the control sample in the sensory analysis due to poor appearance and lack of proper texture. Texture analysis shows wide variation in terms of firmness of the product.

3.1.5. Comparison of Sensory Analysis of Tartaric Acid Variables

![Figure 3.11. Sensory analysis of the proportions coagulated with 4% Tartaric Acid](image)
3.1.6. Texture Analysis of Tartaric Acid Coagulated Flax Seed Milk Paneer Variables

Fig. 3.12. Tartaric Acid Control

Fig. 3.13. Sample 1
Discussion: On comparing the results of texture analysis, it is evident that samples coagulated with tartaric acid were hard and hence not preferred in the sensory analysis by the panel members.

Inference: On comparing the sensory analysis values in Figures 3.1, 3.5, 3.10 it can be concluded that the most preferred sample was Citric acid coagulated Sample 2. Texture analysis report of Citric Acid coagulated Sample 2 also showed that it was
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3.2. Effect of 3% NaCl on Flax Seed Milk Paneer

Fig. 3.16. Changes in water activity due to the effect of diffusion of 3% NaCl

Discussion: The prepared flaxseed milk paneer was soaked in 3% NaCl solution and kept at 5°C for 10 hours diffusion. NaCl is a good humectant and it binds to the free water molecules and thereby brings about a reduction in the water activity from 0.99 to 0.951 at 28.5°C. Reduction in water activity is believed to inhibit the growth of spoilage microorganisms and thereby aid in shelf life extension of the product. Higher concentrations of NaCl may reduce the water activity to considerable levels but it may impart a salty flavour to the product and was rejected in sensory analysis and hence 3% is considered the optimum concentration (Thippeswamy et al. 2011).

3.3. Effect of 0.1% Citric Acid on Flax Seed Milk Paneer

Fig. 3.17. Changes in pH due to the effect of diffusion of 0.1% CA

Discussion: pH is found to decrease from 5.65 to 5.1 when paneer was diffused in 0.1% Citric Acid solution at 5°C for 10 hours diffusion. At this level, Citric Acid did not impart a sour acid taste and was within acceptable limits. (Jayaraj Rao and Patil 1999). Reduction in pH also inhibited microbial growth. The samples thus prepared from application of hurdle technology were stored up to 20 days at refrigerated conditions. Microbial analysis was done for the samples at the 20th day.

3.4. Comparison of Sensory Analysis of the Product at the 1st and 20th Day

Fig. 3.18. Sensory analysis on 1st and 20th day

sfirmness of 2.5 N which shows very negligible variation when compared with the control sample. Hence Sample 2 was selected and carried out for application of hurdle Technology.
3.5. Comparison of Texture Analysis of the Product at the 1st and 20th Day

Discussion: Colour and appearance scores of the flax seed milk paneer at the 20th day were lower compared to the product at the 1st day due to turning of colour of paneer to dull white probably due to the scattering of light by the moistened droplets on the surface. Though the scores reduced, the colour and appearance was within acceptable levels. Diffusion of NaCl increases palatability up to certain levels but due to the salty flavour, the scores slightly decreased but may not be objectionable because the product will be used in other recipes causing dilution of salt content. The body and texture scores of NaCl diffused paneer decreased possibly due to the softening and dissolving effect of salt on the proteins in paneer. Comparing the texture analysis graphs Fig: 4.18 & 4.19, a slight decrease in firmness is observed on storage up to 20 days.
3.6 Physico chemical and rheological Analysis:

### Table 3.2. Physico-chemical and rheological characteristics of flaxseed milk paneer per 100g

<table>
<thead>
<tr>
<th>Component/Characteristic</th>
<th>Content</th>
<th>Sensory characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Carbohydrate</td>
<td>28.5g</td>
<td>Color: Creamy white</td>
</tr>
<tr>
<td>Fat</td>
<td>35.97g</td>
<td>Appearance: Rubbery surface</td>
</tr>
<tr>
<td>Protein</td>
<td>16.4g</td>
<td>Body: Uniform and soft</td>
</tr>
<tr>
<td>Moisture</td>
<td>56.54%</td>
<td>Texture: Solid and slightly chewy</td>
</tr>
<tr>
<td>pH</td>
<td>5.1</td>
<td>Flavor: Milky</td>
</tr>
<tr>
<td>Ash</td>
<td>1.15g</td>
<td></td>
</tr>
<tr>
<td>Yield from 1 litre</td>
<td>536g</td>
<td></td>
</tr>
<tr>
<td>Firmness</td>
<td>2412N</td>
<td></td>
</tr>
<tr>
<td>Springiness</td>
<td>36.11</td>
<td></td>
</tr>
</tbody>
</table>

3.6. Microbial Analysis

**Discussion:** In the total plate count of the paneer sample, the bacterial count was shown as $8 \times 10^3$ cfu/gram. Surprisingly, single colony morphology was seen in the paneer sample. No fungal species were observed in the paneer sample.

### IV. Summary and Conclusion

Paneer is an indigenous dairy product. It is an unaged, acid-set, non-melting farmer cheese or curd cheese made by curdling heated milk with lemon juice, vinegar or other food acid, followed by draining the curds in muslin or cheesecloth and the whey is pressed out by applying pressure. The resulting paneer is dippe...
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dinchilled water for 2–3 hours to give it a good texture and appearance. It represents one of the soft varieties of cheese.

Omega-3 fatty acids are not available to the vegetarian population by natural intake but only through supplements. The efaFugu project aims to incorporate flaxseed, the richest non-animal source of omega-3 fatty acids, into paneer, which serves as a delicacy in the vegetarian cuisine.

In this study, flaxseed milk paneer was prepared. The methods of preparation and the parameters were optimized. The proportion of mixed milk and flaxseed milk that gave better results was 800 ml and 200 ml, respectively. This proportion was selected because it offered high sensory scores and textural characteristics. The hurdles app lied for extending shelf life were reduced pH, reduced water activity, and use of preservative. This was achieved by diffusion of the product with 0.1% citric Acid, 3% NaCl solution, and 0.1% potassium sorbate. The water activity reduced from 0.99 to 0.95 at 28°C and pH values were decreased to 5.1 from 5.6. The product was packed in polyethylene bags, sealed, and stored for 20 days in refrigerated conditions at a temperature of 5°C. The samples on the 20th day were subjected to sensory, textural, and microbiological analysis, and results were acceptable. Slightly decreased sensory values and negligible differences in textural properties were observed. Bacterial growth within the permissible load of 10³ cfu/gram was present. No yeast and mold growth was observed.

This product was considered as an acceptable alternative with 80:20 ratio of milk:flax milk, coagulated by using 2% citric acid. The softest proportion for commercial manufacture of flaxseed milk paneer and its shelf life can be extended up to 2 days by use of hurdle technology.

References


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