FORMULATION OF SYMBIOTIC ICE CREAM FROM COTTONSEED MILK

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ABSTRACT

A wholesome and adaptable dairy substitute, cottonseed milk is becoming more and more popular in Tamil Nadu as a locally produced, sustainable product. This novel milk alternative has several advantages for the environment over traditional dairy milk production techniques because it is made from the leftovers of cotton farming. Cottonseed milk is lactose-free and so provides a rich food profile that includes vital vitamins, minerals, and protein. This study explores the utilization of cotton seed extracted milk for the production of symbiotic ice cream with enhanced nutritional value. Beyond its nutritional advantages, cottonseed milk may be used in a variety of culinary applications due to its creamy texture and mild flavour. Its adaptability is endless, since it can be used to improve everything from savoury meals to baked products, smoothies, and even coffee. Because of its adaptability, it's a desirable choice for people who want to try plant-based substitutes without sacrificing flavour or texture. These materials are selected for their ability to provide prebiotic fiber and probiotic cultures, promoting gut health and overall well-being. Through systematic experimentation and analysis, the resulting ice cream product demonstrates substantial nutritional improvements compared to conventional varieties. The advent of cottonseed milk offers a viable response to the growing need for sustainable food options. It not only boosts local agriculture but also lessens the ecological imprint associated with regular dairy operations. This project aims to set the stage for a more sustainable future for the food business in Tamil Nadu by promoting accessibility and education.

Keyword : - *Cottonseed milk, Ice cream, Plant-based, Sustainable, Symbiotic*

1. Introduction

The demand for nutritious and sustainable food options continues to grow as consumers become increasingly health-conscious and environmentally aware. In response to this trend, our project focuses on the development of ice cream made from cotton seed extracted milk, presenting a novel approach to both agricultural by-product utilization and frozen dessert production. Cotton seeds, often overlooked as a by-product of the textile industry, possess untapped potential as a rich source of proteins, fats, and other nutrients. By extracting milk from these seeds and employing a process of homogenization, we aim to create a smooth and creamy base for our ice cream formulation. Furthermore, the incorporation of symbiotic materials adds functional benefits, promoting gut health and overall well-being.

Through meticulous experimentation and formulation adjustments, our objective is to produce ice cream that not only delights the palate but also delivers significant nutritional value. This project not only contributes to the diversification of food sources but also aligns with the principles of sustainability by utilizing agricultural by-products to create value-added products. Ultimately, our endeavor seeks to offer consumers a delicious and nutritious alternative in the realm of frozen desserts while simultaneously addressing environmental and agricultural challenges. Cotton seed milk, manufactured from the seeds of the cotton plant, is a dairy-free substitute for regular cow's milk. It is a great source of protein, calcium, and other vital elements, with a creamy and nutty flavor. For people who are lactose intolerant, vegan, or just trying to cut back on their intake of animal products, cotton seed milk is a fantastic substitute. It may be substituted for cow's milk in several recipes, such as those for smoothies, porridge, and baked goods. Cotton seed milk is prepared by soaking the seeds, blending them with water, then straining them to get rid of any solids. The resultant milk has a little nutty flavor that goes well with both savory and sweet foods. It is smooth and creamy. All things considered, cotton seed milk is a delightful and nourishing substitute for conventional dairy milk that will delight your palate and provide you with all the vital nutrients your body needs. Try it now to experience the silky sweetness of cottonseed milk.

2. OBJETIVES AND METHODOLOGY

The four Main objectives for the preparation of symbiotic cream from cotton seed milk are Study on the toxicity of cottonseed, Removal of gossypol toxicity from cottonseed, Formulation and optimization of ice cream from cottonseed milk and Incorporation of symbiotic culture in the cottonseed ice cream

1. Study on the toxicity of cottonseed: A by-product of the manufacture of cotton is cottonseed, which is the seed of the cotton plant (Gossypium spp.). Cottonseed has been used historically for several uses, such as being an industrial and culinary oil source and an element in animal feed. On the other hand, if ingested in excessive amounts, several of the substances it contains may be hazardous to both humans and animals. Gossypol and cyclopropenoid fatty acids are the main hazardous ingredients in cottonseed. For example, gossypol can lead to difficulties with reproduction and other health in animals.
2. Removal of gossypol toxicity from cottonseed: The main goal is to come up with methods that will successfully bring cottonseed's gossypol content down to levels that are safe for both human and animal consumption. This entails investigating several physical, chemical, and biological methods to neutralize or remove gossypol with the least amount of negative impacts on seed quality.Preserving Nutritional Quality: It is essential to make sure that cottonseed's nutritional content is not jeopardized by gossypol removal techniques. The goal is to create methods that specifically target gossypol while leaving the vital nutrients—protein, lipids, vitamins, and minerals—in the seed unaltered.Optimization of Extraction Procedures: Research activities aim to maximize the efficiency of gossypol removal by optimizing extraction procedures while reducing energy usage, processing time, and environmental effects. The goal is to create scalable, affordable methods that may be used in the industrial setting.
3. .Formulation and optimization of ice cream from cottonseed milk: The study aims to develop ice cream using cottonseed milk as a nutritious and sustainable alternative to traditional dairy milk. The goal is to create a nutrient-rich product that enhances the nutritional profile of ice cream compared to conventional dairy-based options. The research also focuses on optimizing the formulation to achieve desirable sensory attributes, such as taste, texture, and mouthfeel, to create a creamy, appealing ice cream that rivals or exceeds traditional dairy ice cream. Cottonseed milk is being used in ice cream production to create an allergen-free and vegan-friendly option, thereby expanding market accessibility and catering to diverse dietary preferences. This also contributes to sustainability byrepurposing by-products from the cotton industry. The aim is to create a cost-effective and scalable ice cream using cottonseed milk, meeting consumer expectations for taste, texture, and nutritional value. Research will assess acceptability, identify barriers, and refine the formulation to meet market demands. Researchers aim to showcase the feasibility and potential benefits of using cottonseed milk as a sustainable, nutritious, and delicious alternative to traditional dairy ice cream.

4. Incorporation of symbiotic culture in the cottonseed ice cream: By integrating probiotics and prebiotics into a delectable frozen treat, symbiotics are added to ice cream recipes to improve gut health and nutritional value. The research aims to improve digestive health by developing ice cream products with probiotic bacteria and prebiotic fibers and to increase dietary fiber intake in ice cream. Symbiotic ice cream aims to balance functional benefits with sensory attributes like taste, texture, and mouthfeel while maintaining creamy texture and flavor. Research assesses product acceptability, flavor preferences, and market viability through sensory evaluations and consumer studies.

2.1 Methodology

2.1.1 Extraction of cottonseed milk

Cotton plants are harvested for their seeds, which are then gathered for additional processing. To get rid of any dirt, debris, or contaminants, the cotton seeds are cleansed. To reduce their size, the cleaned cotton seeds are crushed. A mill or grinder is then used to process the crushed cotton seeds into a fine powder. To make a thick paste, water is combined with powdered cotton seed powder. To separate the liquid portion (cotton seed milk) from the solid particles, the paste is strained through a small mesh or cloth. To extract as much milk as possible, more pressure is applied to the strained liquid. To get rid of any last traces of contaminants, the extracted cotton seed milk is then put through a fine filter. To assure the safety of the filtered cotton seed milk for eating, it is heated to a certain temperature, and any hazardous bacteria are killed. After being pasteurized, the cotton seed milk is put into containers for distribution and storage. Before the finished product is made available for sale to customers, it is tested for consistency, taste, and quality**.**

2.1.2 Chemical analysis of cottonseed milk

The solvent utilised in fat extraction is petroleum ether. The flask is first gently heated as part of the extraction procedure. After rising into the condenser and vaporising, the solvent condenses and drips onto the sample within the thimble. The fat in the sample is dissolved by the solvent and returned to the flask. The Soxhlet device runs in an endless loop. The solvent re-evaporates when it approaches the flask, leaving the fat behind. Once the fat has been fully extracted, the solvent is recycled to the thimble and the procedure is repeated. Dry the fat that was extracted to get rid of any leftover solvent. The bulk of the fat is then ascertained by weighing it.

2.1.3 Moisture analysis of cottonseed milk

The moisture analysis was conducted by cleaning and thoroughly drying the weighing dishes. Weigh each empty dish individually and record their weights. Ensure the homogeneity of the cottonseed milk sample before transferring a portion onto a pre-weighed dish using a spatula or scoop. Record the total weight of the sample and dish together. Set the oven to a temperature typically between 105°C and 110°C and place the dish with the sample in the oven. Allow the sample to dry until its weight stabilizes, which may take several hours depending on moisture levels and drying conditions. Once dried, remove the dish from the oven and let it cool to room temperature in a desiccator. Finally, weigh the dry sample and dish together, recording the final weight for analysis.

Calculation:

Initial weight of the sample = 100

Final weight of dried sample = 88

Moisture content =

$$= \left(\frac{\text{Initial weight of sample} - \text{Final weight of dried sample}}{\text{Initial weight of sample}}\right) \times 100$$

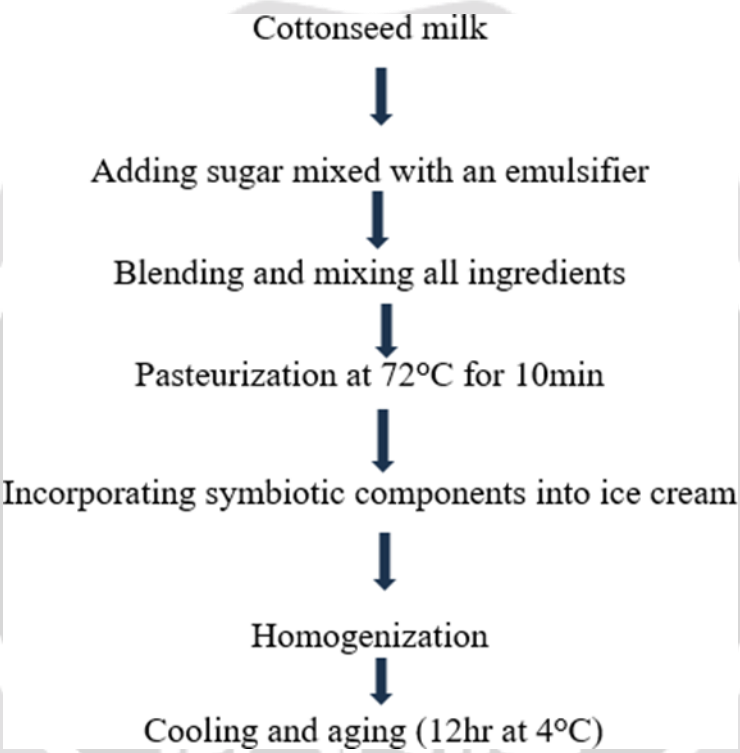
$100-88\div100 * 100 = 12\%$

2.2 Formulation of ice cream using cottonseed milk

The cottonseed milk base was prepared by heating cottonseed milk over medium heat in a saucepan. Once the sugar was fully dissolved, it was mixed in. Vanilla essence, if opted for, was added and thoroughly mixed into the mixture. Subsequently, the mixture was allowed to cool until it reached room temperature**.**

2.2.1 Incorporation of symbiotic elements

Once the cottonseed milk combination cooled, probiotic yoghurt and prebiotic syrup were added and mixed together. Thorough stirring was advised to guarantee that the probiotics and prebiotics were evenly distributed throughout the mixture. The mixture was then transferred to a shallow container and put in the freezer. To achieve a smooth texture during the freezing process, the liquid was mixed often every thirty minutes to prevent the production of huge ice crystals. The ice cream was ready to serve after it reached the right consistency. The following ingredients were used sugar, an emulsifier, probiotic (Lactobacillus acidophilus), prebiotic (Fructooligosaccharides), and cottonseed milk



Flowchart of formulation of cottonseed symbiotic ice cream

2.3 Preservation and storage

When properly packaged in polypropylene (PP) or high-density polyethylene (HDPE) containers and chilled, ice cream has an impressive shelf life of 15 to 20 days. This extended duration of freshness ensures product quality and enhances consumer convenience. HDPE containers serve as a great barrier against moisture and external pollutants, preserving the integrity of the product. Refrigerated products are kept at a temperature of approximately -18°C (0°F) to avoid oxidation and microbial growth, both of which can degrade the product's quality.prepped, the wet and dry components are brought together for mixing Following mixing comes a one-hour kneading stage. This step is essential for developing the gluten structure within the dough, which ultimately impacts the bread's elasticity and texture. After kneading, the dough enters a proofing stage, lasting two hours, where it rises comfortably in a mold. Finally, The risen dough is baked in a preheated oven at 170 degrees Celsius for 45 minutes. Once baked through, the product is allowed to cool before being packaged, ready to be enjoyed. This flowchart provides a concise overview of the key steps involved in transforming basic ingredients into a delicious baked good

3. PROPOSED WORK MODULES AND ANALYSIS

The research aims to improve gut health and nutritional value by incorporating probiotics and prebiotics into cottonseed ice cream. The goal is to enhance the nutritional profile by fortifying it with vitamins, minerals, and bioactive compounds derived from probiotics and prebiotics. The research also aims to increase dietary fiber intake by incorporating prebiotics, which support digestive health. The research also aims to ensure probiotic viability and stability by selecting resistant strains and developing strategies for environmental stress protection. The goal is to balance functional benefits with sensory attributes while maintaining creamy texture and flavor.

3.1 Ingredients Selection

3.1.1 Methodology

The initial phase of our project involved the selection of plant-based under-utilized raw material which possess protein, fiber and anti-oxidants and have taste to similar to that of ice- creams made from animal sources.

3.1.2 Findings

After extensive research and analysis, we selected cottonseed, prebiotics (Fructooligosaccharides) and probiotics (Lactobacillus acidophilus) to enhance the nutritional properties, and sugar for sweetener as our core ingredients.

3.1.3 Extraction of cottonseed milk

Cottonseed milk is a product of the extraction process of cotton plants. The process involves harvesting the seeds, cleaning them, crushing them, grinding them into a fine powder, mixing them with water to create a paste, straining the liquid portion, pressing more pressure to extract more milk, filtering the milk to remove contaminants, pasteurizing it to ensure safety, and packaging it for distribution and storage. Quality control is then conducted before the finished product is sold to customers, ensuring consistency, taste, and quality. The process involves several steps to ensure the safety and quality of the final product. The process ensures the safety and quality of the final product. Optimization of Fenugreek Powder Addition for Baking Wheat Bread The purpose of this experiment is to determine the ideal amount of fenugreek powder to add to wheat bread in order to achieve the greatest baking outcomes.

3.2 Incorporation of symbiotic compounds

The symbiotic ice cream was prepared by heating cottonseed milk over medium heat, dissolving sugar, and add vanilla essence. Allow it to cool to room temperature. Add prebiotic syrup and probiotic yogurt, stirring to distribute probiotics and prebiotics evenly. Pour the mixture into an ice cream machine and process until creamy, following the manufacturer's directions. If not, freeze it in a shallow container and stir every thirty minutes until the desired consistency is reached.

3.3Shelf-life studies

Ice cream has an exceptional shelf life of 15-20 days when it is correctly packaged in containers made of polypropylene (PP) or high-density polyethylene (HDPE) and refrigerated. This prolonged freshness period guarantees product quality and improves consumer convenience. HDPE containers protect the integrity of the product by acting as an excellent barrier against moisture and outside pollutants. The temperature under refrigeration, which is normally kept at roughly -18°C (0°F), further prevents oxidation and microbiological growth, both of which can lower the quality of the product.

Symbiotic icecream

3.4 Result and Discussion

The ice cream prepared from cottonseeds possesses anti-oxidant properties and contains higher protein, fat and fiber compared to ice cream made from diary sources. The key findings are the developed product contained 8.52% of protein, 14.2% of fat, 2.38% of fiber and 12% of moisture.

3.4.1 Extraction of cottonseed milk

The cleaned cottonseeds were crushed using a high-speed blender. The seeds were efficiently ground into a fine powder by this apparatus, which made it easier for the milk to come out during the extraction procedure. After that, the waste was gathered separately and the milk was squeezed out. The extraction process yielded an average of 2.5 millilitres of milk for every 10 grams of cotton seeds processed. Additionally, approximately 7.5 grams of extracted seed waste were generated for every 10 grams of cotton seeds processed. These results indicate a linear relationship between the quantity of cotton seeds processed and both the milk yield and the extracted seed waste, highlighting the efficiency and potential scalability of the extraction process.

Quantity of cottonseed (g)	Milk obtained (ml)	Extracted seed waste (g)
10	2.5	7.5
30	7.5	22.5
50	12.5	37.5
100	25	75
250	62.5	187.5

Yield of cottonseed milk obtained

3.4.2 Fat analysis of symbiotic cottonseed ice-cream

The cottonseed ice cream samples were found to have an average fat content of 14.2% and a fat content ranging from 8% to 15%. These results suggest that the fat content of cottonseed ice cream is moderate and on par with several commercial dairy-based ice cream variations.

3.4.3 Protein analysis of symbiotic cottonseed ice-cream

The cottonseed ice cream samples were found to have the protein content of 8.52%. The findings reveal cotton seed milk to be a rich source of protein, with levels comparable to or even surpassing those found in traditional dairy milk.

3.4.4 Comparison of nutrition content of conventional ice cream with symbiotic cottonseed ice cream

In a comprehensive nutritional comparison between the symbiotic cottonseed ice cream substitute and conventional dairy ice cream, several key differences and similarities emerge. The cottonseed ice cream offers a protein content of 8.52%, relatively higher than that of dairy ice cream, which typically range from 4% to 6% with some variability based on texture. However, in terms of fat, the cottonseed ice cream is also notably higher, compared to the 14.2% fat content of ice cream made from cow's milk which contains 10-12%.

Nutrients	Traditional ice cream (in %)	Symbiotic cottonseed ice cream (in %)
Protein	12-13	8.52
Fat	9-10	14.2
Fiber	<0.5	2.38
Carbohydrates	23.2	21.28
Ash	0.85	0.89

Nutritional comparison of symbiotic cottonseed ice-creamand traditional ice cream

3.4.5 Sensory analysis

The sensory analysis was conducted with 9 members based on a 5-point hedonic scale. The appearance and texture was acceptable. It did not have texture of ice-cream and also the appearance was not appealing. The overall acceptability of the product was acceptable because of the taste and aroma.

Appearance	Extremely attractive	Moderately attractive	Attractive/ matches photo	Unappetizing	Unattractive
Taste	Tasted great	Flavourful	Acceptable	Off flavour	Flavour didn't appealto me
Texture	Wonderful texture	Good texture	Acceptable texture	Off texture	Inappropriate
Aroma	Wonderful aroma	Appealing aroma	Acceptable aroma	Aroma is not appealing	Unappetizing aroma
Overall acceptability	Extremely attractive	Moderately attractive	Acceptable/ matches photo	Unappetizing	Unattractive

Sensory analysis of symbiotic ice-cream

3.4.6 Shelf-life studies

The shelf-life studies were conducted using humidity chamber under controlled humidity (55.5%) and temperature. The provided data represents a comprehensive analysis of various parameters of a product, likely an ice-cream, over a span of 28 days. At a temperature of -18℃ in terms of nutritional composition and sensory attributes, the sample is expected to be stable stable up to 20-30 days. When stored at atmospheric conditions (>28℃), the product showed major changes in sensory attributes and started to melt within 15 minutes of time. Thus we conclude that the symbiotic cottonseed ice cream was stable for 20 days under proper storage conditions.

PARAMETERS	**DAY-1**	**DAY-7**	**DAY-14**	**DAY-21**	**DAY-28**
Protein %	12.0±0.2	11.8±0.1	11.78±0.1	11.72±0.0	11.70±0.1
Fat %	6.58±0.4	6.56±0.1	6.55±0.0	6.52±0.1	6.52±0.1
Fibre %	2.86±0.1	2.85±0.1	2.48±0.1	2.42±0.1	2.38±0.1
Ash %	0.15±0.01	0.15±0.02	0.14±0.01	0.14±0.02	0.138±0.0
Appearance	6.26±0.8	6.24±1.0	6.24±1.0	6.20±01.8	6.17±0.9
Colour	15.67 ± 1.5^{a}	15.60 ± 1.5^{a}	15.58 ± 1.5^{a}	15.58 ± 1.5^{a}	15.50 ± 1.0^{a}
	35.52 ± 1.5^{L}	35.50 ± 1.5^{L}	35.42 ± 1.5^{L}	35.36 ± 1.5^{L}	35.32 ± 1.5^{L}
	35.83 ± 1.5^{b}	35.78 ± 1.5^{b}	35.76 ± 1.5^{b}	35.70 ± 1.5^{a}	35.64 ± 1.5^{b}
Odour	6.62±1.2	6.58±1.0	6.54±1.0	6.48±1.2	6.31±1.0
Flavour	5.93±0.3	5.91±0.5	5.8±1.0	5.78±1.0	5.75±1.0
Texture	6.73±1.5	6.62±1.0	6.59±1.0	6.31±1.5	5.59±1.0

Shelf-life analysis

3.5 Comparative study and analysis:

Symbiotic cottonseed ice cream	**Ice cream made from dairy milk**	**Symbiotic vegan icecream**
INGREDIENTS: • Cotton seed milk • Vannila essence • Prebiotic (Fructooligosaccharides) • Probiotic (*Lactobacillus acidophilus*) • Sugar • Stabilizer (401) STORAGE TEMPERATURE: -18℃ COST = ₹62.5 (125 ml) 	INGREDIENTS: • Milk Solids • Cane sugar • Stabilizer (401, 407) • Emulsifier (E322, 401) STORAGE TEMPERATURE: -18℃ COST = ₹40-45 (125ml) 	INGREDIENTS: • Skim Milk Powder • Polydextrose • Probiotic starter culture • Fruit puree • Prebiotic culture • Natural colour (E140) • Added flavours • Erythritol • E412, E433, E415,E407 STORAGE TEMPERATURE: -18℃ COST = ₹135 (125 ml) 

4. CONCLUSIONS

Though it is a symbiotic ice cream, the sensory attributes were not satisfactory. The texture and appearance should be enhanced. Through careful mixing and regulated processing methods, we have created a novel cottonseed symbiotic ice cream and is intended to be an affordable vegan alternative to ice cream made from dairy products. With 21.28 gram of carbohydrates,2.38 grams of soluble fiber, and 8.52 grams of protein and 14.2g of fat.

Symbiotic cottonseed ice cream

5. ACKNOWLEDGEMENT

We would like to enunciate heartfelt thanks to our esteemed Chairman Dr. S.V. Balasubramaniam, Trustee Dr. M. P. Vijayakumar, and the respected Principal Dr. C. Palanisamy for providing excellent facilities and support during the course of study in this institute.

We are grateful to Mr. Gowrishankar L, Head of the Department, Department of Food technology for his valuable suggestions to carry out the project work successfully

We wish to express our sincere thanks to Faculty guide ,Ms. Pidathala Sahitya, Assistant Professor, Department of Food technology, for his constructive ideas, inspirations, encouragement, excellent guidance, and much needed technical support extended to complete our project

We would like to thank our friends, faculty and non-teaching staff who have directly and indirectly contributed to the success of this project.

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