Development of Value – Added Chocolate Flavoured Sweetened Condensed Milk

Mahendran G R[1], Santhosh S[2], Sujitha M[3], Thiruppavai J[4]
[1,2,3,4] *Sri Shakti Institute of engineering and technology*

***Abstract*—Sweetened condensed milk (SCM) is a concentrated dairy product widely used in desserts, beverages, and confectionery due to its rich taste, creamy texture, and extended shelf life. The present study focuses on the development of chocolate flavoured sweetened condensed milk as a value-added dairy product with improved sensory appeal and consumer acceptability. The product was prepared by concentrating standardized milk with the addition of sugar under controlled heating conditions to achieve the desired total solids and viscosity. Chocolate ingredients such as cocoa powder and cocoa mass were incorporated to impart chocolate flavour, colour, and enhanced mouthfeel. Several formulation trials were carried out by varying the levels of chocolate ingredients to obtain an optimum balance of sweetness, flavour intensity, colour, and consistency. The developed samples were evaluated for sensory attributes including colour, flavour, texture, sweetness, and overall acceptability, along with basic physicochemical characteristics such as viscosity and consistency. The optimized formulation showed desirable chocolate flavour, smooth creamy texture, appealing brown colour, and suitable thickness comparable to commercial sweetened condensed milk products. The incorporation of cocoa ingredients significantly improved the flavour profile while maintaining the characteristic body of condensed milk. The developed product demonstrates good potential as a value-added dairy product and can be effectively used in various food applications such as desserts, bakery products, beverages, and confectionery preparations. The study highlights the possibility of diversifying traditional dairy products by incorporating popular flavours like chocolate to meet evolving consumer preferences and expand product opportunities in the dairy industry.**

***Index Terms*—Chocolate flavoured sweetened condensed milk, cocoa powder, cocoa mass, product development, sensory evaluation, viscosity.**

I. INTRODUCTION

Milk and milk products play an important role in human nutrition, as milk contains all the necessary nutrients, such as proteins, fats, carbohydrates, vitamins, and minerals, in large quantities. Milk and milk products are consumed all over the world, as they have high nutritional value and are used as ingredients to prepare various food products. Among all milk products, sweetened condensed milk (SCM) is the most commonly used concentrated milk product in the food industry. Sweetened condensed milk is prepared by removing water from milk, as it acts as a preservative, and adding sugar to it. The sugar content in SCM inhibits the growth of microbes, thus increasing its shelf life.

Sweetened condensed milk is recognized for its thick texture, flavor, and creamy feel. Therefore, it can be used in different food products. Sweetened condensed milk is used to make desserts, confectionery products, bakery products, beverages, and traditional sweets. In many countries, it is considered to be one of the main components of products such as cakes, candies, milk-based desserts, coffee drinks, and ice creams. The method of preparation of sweetened condensed milk involves standardization of milk, addition of sugar, heating to concentrate it, and then cooling it to get the desired consistency and total solids. Sweetened condensed milk is considered to have a long shelf life and is thus considered to be an important dairy product The growing demand for value-added and flavored dairy products due to the need for variety and sensory experiences of food products. Flavored dairy products are gaining popularity due to the enhanced taste and sensory experiences of the product for a wider range of consumers. Among the various flavors used for food products, chocolate flavor is one of the most

sought-after due to its taste and aroma and its acceptance by all age groups of the population.

Chocolate is derived from the cocoa bean, which is extracted from the cacao plant. The bean is then processed through various operations to derive other cocoa products for use in the food industry. The major cocoa products include the cocoa bean, cocoa mass, cocoa butter, and powder. The cocoa bean is the raw form of the seed of the cacao fruit. The bean is then processed through the operations of fermentation and roasting before it is ground to form the cocoa mass. The cocoa mass is the major component of the processed products derived from the cocoa bean. It comprises the cocoa solids and the cocoa butter. The cocoa mass is the component of the processed products that provides the rich taste and texture. The cocoa powder is derived from the cocoa mass by removing the cocoa butter before grinding the solid particles to a finer powder. The cocoa powder is one of the major cocoa products derived for use as a flavoring agent due to its rich taste and color.

Moreover, the product may be effectively used in the baking of products like cakes, cookies, brownies, and pastries, which may impart the required sweetness and chocolate flavor as well as the texture and moisture content to the final product. Furthermore, the product may be effectively used as a topping for products like desserts, ice cream, pancakes, and may even be added as an ingredient in milkshakes and beverages.

However, the development of chocolate flavoured sweetened condensed milk involves the formulation and processing of the product. The addition of cocoa powder and cocoa masses may affect the viscosity, sweetness, color, and texture of the product. Therefore, the formulation of the product should be optimized by varying the proportion of milk, sugar, and chocolate to obtain the desired quality characteristics of the product. The addition of value-added products will create interest among the consumers and provide more market opportunities along with the utilization of milk in developing value-added products. The present study involves the formulation and development of chocolate flavoured sweetened condensed milk by adding cocoa powder and cocoa masses to concentrated sweetened milk and evaluating the sensory and quality characteristics of the product to obtain the best formulation.

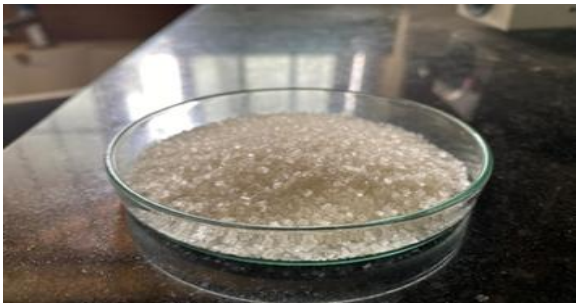
II. MATERIALS AND METHODOLOGY

Milk

Milk is the main component that is used as the base in the preparation of chocolate flavored sweetened condensed milk. Milk is the main source of nutrients such as proteins, fats, carbohydrates, and minerals. The nutrients play a crucial role in enhancing the texture and flavor of the milk. Milk is also the main source of the base of the formulation. Fresh whole milk is normally used to ensure quality and flavor

.

Sugar



Sugar is another important component of sweetened condensed milk. The main function of adding sugar is to impart sweetness to the milk. At the same time, it acts as a natural preservative. The high concentration of sugar in the milk reduces the water activity of the milk. This is helpful in preventing the growth of microorganisms. In chocolate flavoured condensed milk, the addition of sugar is to counteract the bitter taste of cocoa powder and cocoa mass. The addition of sugar also contributes to the texture and shine of the final product**.**

Cocoa Powder

Cocoa powder is used to give the condensed milk its characteristic taste, smell, and dark brown color. Cocoa powder contains cocoa solids that give the milk

its characteristic taste and make it more attractive to the consumer. In this project, cocoa powder is used as the main ingredient for giving the condensed milk its characteristic taste for making chocolate-flavored sweetened condensed milk. However, cocoa powder should be well mixed in the condensed milk to prevent settling during storage. The addition of cocoa powder in this project gives value to regular condensed milk by transforming it into a chocolate product**.**

Cocoa Mass

Cocoa mass, also known as cocoa liquor, is a mixture of cocoa solids and cocoa butter. The addition of cocoa butter is beneficial in enriching the chocolate taste and texture of the chocolate condensed milk. The addition of cocoa mass is beneficial in increasing the flavor of chocolate in comparison to cocoa powder. In this project, cocoa mass is added along with cocoa powder to increase the flavor of the product. It adds to the texture and richness of chocolate in the final product

Lactose

On the other hand, lactose is the natural sugar found in milk and is crucial in the control of crystallization during the concentration of milk. The proper control of lactose crystallization ensures that the texture of sweetened condensed milk is smooth. The formation of large crystals of lactose may cause the milk to have a grainy texture. Therefore, it is undesirable. In this project, lactose ensures that the chocolate flavoured condensed milk has the desired texture and smoothness. Lactose also adds to the composition of the milk

Stabilizer (Carrageenan)

Carrageenan is a natural hydrocolloid extracted from red seaweed and commonly used as a stabilizer in dairy products. In chocolate flavoured sweetened condensed milk, carrageenan helps maintain uniform dispersion of cocoa particles throughout the product. It prevents sedimentation of cocoa powder and improves the viscosity and stability of the mixture. The stabilizer also enhances the smooth texture and consistency of the condensed milk during storage. Therefore, carrageenan plays an important role in maintaining the quality and stability of the chocolate condensed milk developed in this project.

FORMULATION

SNO	COMPONENT	UNITS	TRIAL 1	TRIAL 2	TRIAL 3	TRIAL 4	TRIAL 5
1	Milk	ml	60ml	58ml	56ml	55ml	58ml
2	Sugar	g	35g	35g	35g	38g	35g
3	Cocoa Powder	g	4g	6g	2g	4g	3g
4	Cocoa Mass	g	-	-	5g	2g	3g
5	Lactose	g	0.5g	0.5g	0.7g	0.7g	0.5g
6	Stabilizer	g	0.3g	0.3g	0.3g	0.3g	0.3g

III. METHODOLOGY

Raw Material Inspection

All the raw materials used in the processing of chocolate flavored sweetened condensed milk have been inspected before processing. Fresh whole milk was inspected based on acidity, odor, and freshness before processing. The sugar was inspected based on the flow and the absence of impurities and contaminants in the sugar. Cocoa powder was inspected based on the color and the absence of lumps and moisture content before processing. Cocoa mass was inspected based on the freshness, absence of rancid odor, and texture before processing. Lactose and the stabilizer were inspected based on the food-grade quality before processing

Milk Standardization

Fresh whole milk was standardized to meet the desired fat and solids-not-fat content. This ensures the consistency of product quality. The standardization of milk is vital in ensuring the right balance of milk constituents for the manufacture of sweetened condensed milk. The standardized milk was filtered and then placed in a stainless steel processing vessel. The milk was preheated to about 60°C, which would ensure proper mixing of the ingredients and enhance the solubility of sugar in the next step. Preheating also aids in the stability of milk proteins.

Sugar Incorporation

Sugar was slowly added to the preheated milk and stirred continuously to ensure even distribution and prevent the formation of lumps in the milk. Adequate stirring was done to ensure the sugar was dissolved in the milk mixture. The mixture was then heated further and taken to a temperature of 85–90°C to ensure the sugar is fully dissolved in the milk and the microorganisms are killed in the mixture. The sugar not only provides the milk product with the necessary sweetness but also ensures the product is preserved due to the low water content in the milk, which is a consequence of the addition of sugar in the milk product. The high sugar concentration is one of the main reasons why sweetened condensed milk is stable.

Cocoa Preparation and Addition

Cocoa powder was initially sifted to remove lumps and provide a uniform particle size. The cocoa powder was then mixed with a small amount of milk to form a smooth paste. This is to prevent lumps from forming when mixing the cocoa powder with other ingredients. The cocoa mass was melted to a smooth blend at a temperature of about 45-50 degrees Celsius. Both the cocoa slurry and melted cocoa mass were slowly added to the milk-sugar mixture. Proper mixing was maintained to obtain a uniform particle size of cocoa and to obtain chocolate flavor, aroma, and color in the chocolate

Homogenization

This mixture was homogenized through the use of a two-stage homogenizer to ensure that the fat globules and cocoa particles were homogeneously distributed within the milk. The homogenization of the milk ensures that the fat globules are of smaller size. This ensures that the emulsion is stable and that there is no separation of fat. Homogenization also ensures that the cocoa particles are homogeneously distributed within the milk. The homogenization of this milk ensures that it has a smooth texture and creamy feel. The homogenization of this milk is important in ensuring that it is stable

Vacuum Concentration

The homogenized mixture was then placed in a vacuum evaporator for concentration. The concentration process was done at a temperature range of 55–65°C, which is a reduced pressure that enables the water content in the mixture to evaporate at a low temperature. The process protects the milk proteins and the chocolate from heat damage. At this stage, the water content in the mixture is reduced, thus increasing the total solids in the mixture and making it thick. The process continued until the mixture had the required thickness and total soluble solids content, which is characteristic of sweetened condensed milk.

Cooling

After this, the product was allowed to cool down gradually to a temperature range of 35–40°C while constant stirring was maintained. Cooling is an important step as it ensures that no large crystals of lactose form, as this can result in a grainy texture in the product. Stirring is done to ensure that all parts of the product are exposed to the same temperature. This ensures that the product has a smooth and glossy finish.

Filling and Storage

The prepared chocolate flavoured sweetened condensed milk was filled into clean and sterilized containers under hygienic conditions. The containers were properly sealed to prevent contamination and moisture absorption. Proper packaging helps maintain product quality and extends shelf life. The packaged samples were stored under suitable conditions for further physicochemical analysis and sensory evaluation. Storage stability was monitored to ensure that the product maintained its desired texture, flavor, and consistency

IV. RESULTS AND DISCUSSION

TRIAL: 1

The control sample prepared without cocoa incorporation showed typical characteristics of sweetened condensed milk. The product exhibited a light cream color with smooth and uniform consistency. The viscosity was comparatively lower (4800 cP) and the product had a mild sweet taste with no chocolate flavour. The pH (6.45) and moisture content (27.8%) were slightly higher, indicating lower concentration. Overall, the control sample showed good quality and served as a standard for comparison.

TRIAL: 2

The product prepared with initial cocoa incorporation showed noticeable changes compared to the control sample. The colour became slightly light brown and chocolate flavour was mildly developed. The viscosity increased to 5600 cP, indicating better thickness. Moisture content reduced slightly (27.0%) and total solids increased. The product showed improved taste and appearance but chocolate intensity was still moderate.

TRIAL: 3

Further increase in cocoa concentration resulted in enhanced chocolate colour and flavour. The product exhibited a uniform brown colour with improved body and texture. The viscosity increased to 6800 cP, indicating better consistency. The pH decreased to 6.32 and moisture content reduced to 26.5%, improving stability. The product showed balanced sweetness and chocolate taste with good overall acceptability.

TRIAL: 4

The product showed a darker chocolate colour with strong flavour development. The viscosity reached the highest value (8500 cP), resulting in a very thick consistency. Although the product had rich flavour and improved texture, slight over-thickening was observed. The moisture content further decreased (26.3%) and total solids increased. The product was acceptable but slightly less desirable due to excessive thickness.

TRIAL: 5 (FINAL TRIAL)

The optimized formulation showed the best combination of physicochemical and sensory properties. The product exhibited an attractive chocolate brown colour, smooth texture, and desirable consistency (7200 cP). The pH (6.30) and moisture content (26.3%) were within acceptable limits, indicating good stability. The chocolate flavour was well balanced with sweetness, and no defects were observed. Overall, Trial 5 was found to be the most acceptable formulation with improved quality, stability, and consumer acceptability.

Evaluation of Physicochemical and Functional Properties

PARAMTERS	TRIAL 1	TRIAL 2	TRIAL 3	TRIAL 4	TRIAL 5
pH	6.45	6.38	6.32	6.30	6.30
Moisture(%)	27.8	27.0	26.5	26.3	26.3
Fat(%)	8.0	8.0	8.8	9.2	8.7
Brix	72.1	73.0	73.5	74.0	73.8
Viscosity(cP)	4800	5600	6800	8500	7200
Ash Content	0.70	0.75	0.82	0.90	0.92
Titratable Acidity	0.18	0.20	0.22	0.24	0.25
Water Activity	0.87	0.85	0.83	0.82	0.80
Total Plate Count(CFU/g)	2.5×10^2	2.3×10^2	2.2×10^2	2.1×10^2	2.0×10^2

Ph

The pH of the developed Chocolate Flavoured Sweetened Condensed Milk showed a decreasing trend from 6.45 in Trial 1 to 6.30 in Trial 5. The slight reduction in pH in the final trial may be attributed to the concentration process and incorporation of cocoa ingredients. The final pH value of 6.30 indicates good stability and suitability for storage without affecting product quality.

MOISTURE CONTENT

The moisture content decreased gradually from 27.8% in Trial 1 to 26.3% in Trial 5. This reduction is due to the concentration of milk solids during processing. The lower moisture content in the final product contributes to improved shelf life by reducing microbial growth and enhancing product stability.

FAT CONTENT

The fat content varied across trials, ranging from 8.0% to 9.2%, and was recorded as 8.7% in Trial 5. The slight variation is due to formulation adjustments and cocoa incorporation. The final fat content provides desirable richness and contributes to improved texture and mouthfeel of the product.

Total Soluble Solids (°Brix)

The °Brix value increased from 72.1 in Trial 1 to 73.8 in Trial 5, indicating higher total solids in the final product. This increase is due to sugar addition and evaporation during processing. The higher °Brix value enhances sweetness, body, and shelf stability of the condensed milk.

Viscosity

The viscosity increased significantly from 4800 cP in Trial 1 to 7200 cP in Trial 5, with a peak at Trial 4. The final viscosity indicates a thick and smooth consistency, which is desirable for condensed milk. The increase is mainly due to higher total solids and cocoa incorporation.

Ash Content

The ash content increased from 0.70% in Trial 1 to 0.92% in Trial 5, indicating higher mineral content in the final product. This increase is attributed to cocoa ingredients, which contribute essential minerals. The final value confirms improved nutritional quality.

Titratable Acidity

The titratable acidity increased gradually from 0.18% to 0.25% (as lactic acid) across the trials. The final value of 0.25% is within acceptable limits and contributes to improved flavour and microbial stability of the product.

Water Activity (aw)

The water activity decreased from 0.87 in Trial 1 to 0.80 in Trial 5. This reduction is due to increased sugar concentration and total solids, which bind free water. The lower water activity in the final product indicates better shelf stability and reduced risk of microbial growth.

Total Plate Count (TPC)

The total plate count decreased from 2.5×10^2 CFU/g in Trial 1 to 2.0×10^2 CFU/g in Trial 5. The lower microbial load in the final product indicates good hygienic processing conditions and improved microbial safety, making the product suitable for consumption and storage

REFERENCE

[1] Walstra, P., Wouters, J. T. M., & Geurts, T. J. (2006). Dairy science and technology (2nd ed.). CRC Press.
[2] Deeth, H. C., & Lewis, M. J. (2017). High temperature processing of milk and milk products. John Wiley & Sons.
[3] Fox, P. F., & McSweeney, P. L. H. (2015). Dairy chemistry and biochemistry. Springer.
[4] Codex Alimentarius Commission. (2018). Standard for sweetened condensed milk (CODEX STAN 282-1971). FAO/WHO.
[5] Goff, H. D., & Hill, A. R. (2013). Chemistry and physics of dairy products. In Advanced dairy chemistry (Vol. 1). Springer.
[6] Patel, R. S., & Patel, A. A. (2019). Effect of sugar concentration on physicochemical properties of sweetened condensed milk. Journal of Dairy Science, 102(4), 3025–3034.
[7] Kumar, P., & Rai, D. C. (2020). Development and quality evaluation of flavoured condensed milk. International Journal of Dairy Technology, 73(2), 345–352.

[8] Singh, G., & Prasad, S. (2020). Physicochemical and sensory evaluation of chocolate flavoured dairy products. Journal of Food Science and Technology, 57(6), 2105–2112.
[9] Yadav, R. B., & Yadav, B. S. (2021). Effect of cocoa powder incorporation on quality characteristics of dairy products. LWT – Food Science and Technology, 140, 110801.
[10] Sharma, V., & Singh, R. (2021). Development of chocolate enriched milk products and their sensory evaluation. Journal of Dairy Research, 88(3), 295–301.
[11] Khan, M. A., & Khan, M. S. (2021). Influence of processing conditions on viscosity and stability of sweetened condensed milk. Journal of Food Processing and Preservation, 45(5), e15345.
[12] Patel, H. A., & Shah, N. P. (2022). Physicochemical properties and shelf stability of sweetened condensed milk. Dairy Science & Technology, 102(1), 85–98.
[13] Jaiswal, A. K., & Gupta, R. (2022). Functional properties of cocoa and its application in dairy products. Food Chemistry, 368, 130847.
[14] Mehta, B. M., & Darji, V. B. (2022). Technology of sweetened condensed milk manufacture. Indian Journal of Dairy Science, 75(2), 123–130.
[15] Ali, M., & Kumar, S. (2022). Development and evaluation of chocolate flavoured dairy beverages. Journal of Food Science and Nutrition, 10(4), 150–158.
[16] Singh, A., & Kumar, P. (2023). Effect of cocoa incorporation on sensory and rheological properties of dairy products. Journal of Texture Studies, 54(3), e12890.
[17] Reddy, S. Y., & Reddy, P. V. (2023). Quality evaluation of flavoured condensed milk during storage. International Journal of Dairy Technology, 76(1), 112–120.
[18] Das, S., & Das, M. (2023). Impact of sugar and heat treatment on stability of condensed milk products. LWT – Food Science and Technology, 173, 114278.
[19] Gupta, A., & Sharma, H. K. (2023). Rheological behaviour of sweetened condensed milk with flavour incorporation. Journal of Food Engineering, 341, 111345.
[20] Nair, R., & Menon, R. (2024). Development of value-added chocolate dairy products and their quality assessment. Journal of Dairy Science and Technology, 103(2), 145–154.
[21] Verma, S., & Singh, D. (2024). Effect of cocoa solids on physicochemical properties of dairy formulations. Food Bioscience, 58, 103210.
[22] Joshi, N., & Patel, M. (2024). Shelf-life evaluation of flavoured sweetened condensed milk. Journal of Food Processing and Preservation, 48(3), e17654.
[23] Chatterjee, S., & Roy, D. (2024). Application of cocoa in dairy systems: A review. Comprehensive Reviews in Food Science and Food Safety, 23(1), 412–430.
[24] Hassan, A., & Ahmed, Z. (2025). Development and sensory evaluation of chocolate flavoured condensed milk. International Journal of Food Science, 2025, 458712.
[25] Kumar, V., & Singh, P. (2025). Optimization of processing parameters for flavoured sweetened condensed milk. Journal of Food Quality, 2025, 612345