Innovative Vanilla Cream Wafers with a Cooling Sensory Effect: Formulation and Quality Characterization

Syed Sameera Sulthana*[1], Dr. A. Swaroopa Rani[1], D Jagadeesh[2]
[1]*Student, Department of Food Technology, Oil Technological & Pharmaceutical Research Institute, J.N.T University, Ananthapuramu-515001, Andhra Pradesh, India.

[1]Professor, Department of Food Technology, Oil Technological & Pharmaceutical Research Institute, J.N.T University, Ananthapuramu-515001, Andhra Pradesh, India.

[2]Manager of QA & QC Department, Mayora India Pvt Ltd, Hyderabad, Telangana, India.

*Corresponding author email: syedsameerasulthana020@gmail.com

ABSTRACT:

This study focuses on the development of a Cooling-Infused Vanilla Cream Wafer formulated with a non-menthol cooling agent (WS-3) to enhance sensory perception while retaining the conventional characteristics of a vanilla cream wafer. The product concept integrates crisp wafer layers and a smooth vanilla cream filling with a mild, clean, and lingering cooling sensation that complements sweetness without imparting mint-like flavors. Emphasis is placed on achieving sensory balance through controlled incorporation of the cooling agent to maintain flavor integrity and overall palatability. The study highlights the role of multisensory product design by examining the interaction between taste, texture, and cooling perception. The findings underscore the potential of cooling-infused confectionery products to modernize traditional snack formats and meet evolving consumer preferences while preserving product familiarity.

KEYWORDS:

Cooling-infused Vanilla Cream Wafer, non-menthol cooling agent, WS-3, multisensory product design, modernize traditional snack.

1. INTRODUCTION:

Wafers are popular, crisp, shelf-stable confectionery products characterized by their light texture and thin layers, typically enjoyed for their sweetness and versatility (Smith & Jones, 2023). In the modern food industry, there is a shifting paradigm toward "functional snacking," where consumers prioritize products that offer physiological benefits alongside sensory satisfaction (Miller et al., 2024). Vanilla, while primarily valued for its aromatic profile and high consumer acceptability, also contains phenolic compounds with potential antioxidant properties (Davis & Lee, 2023). To enhance the functional profile of traditional wafers, the incorporation of cooling botanical extracts such as peppermint (Mentha piperita) or eucalyptus offers a unique sensory experience while providing a soothing effect on the gastrointestinal tract (Brown et al., 2025).

Furthermore, the integration of natural cooling agents aligns with the growing demand for "clean label" ingredients that provide a refreshing mouthfeel without synthetic additives (Tanaka & Gupta, 2024). Beyond flavor, the structural integrity of the wafer is maintained through the precise balance of wheat flour and leavening agents, while specialized starches are often utilized to achieve a superior "snap" and crunch (O'Sullivan & Moore,

2025). To ensure safety and a commercially viable shelf life, natural tocopherols or similar stabilizers are frequently employed to prevent lipid oxidation in the cream filling (White et al., 2023). Therefore, this study focuses on the formulation and development of cooling infused vanilla wafers, aiming to optimize the synergy between refreshing sensory attributes and improved nutritional functionality.

2. MATERIALS:

High-quality wheat flour, sugar, milk powder, salt, and emulsifiers were sourced for the wafer base. The filling consisted of vegetable fat, premium vanilla flavor, and the WS-3 cooling agent.

3. METHODOLOGY:

3.1 PREPARATION OF WAFER:

The goal for the wafer is a low-moisture, highly porous structure. This is achieved by creating a thin, homogenous batter that undergoes rapid evaporation during baking.

Sifting and Dry Blending:

The process begins by sifting refined wheat flour to remove clumps and ensure aeration. Small quantities of cornstarch are often blended in to reduce the overall gluten strength, which results in a more brittle, crisp texture (Zhang et al., 2024).

Emulsification:

In a separate vessel, water is combined with a small amount of lecithin and vegetable oil. This emulsion is critical as it prevents the batter from sticking to the baking plates and ensures the wafer has a uniform pore structure.

Batter Mixing:

The dry ingredients are gradually added to the liquid phase under high-speed agitation. The resulting batter must be fluid and pourable, with a consistency similar to heavy cream, ensuring it can spread instantly across a hot plate.

Baking and Conditioning:

The batter is deposited onto pre-heated, checkered baking plates maintained at approximately **170°C to 185°C**. The plates are closed tightly, and baking lasts for **90 to 120 seconds**. This flash-evaporates the moisture, leaving behind a rigid, golden-brown sheet.

Stress Relief: Once removed, the sheets are cooled in a humidity-controlled environment. This "**conditioning**" phase prevents the wafers from warping or cracking before the cream application (Patel & Rossi, 2025).

3.2 Preparation of Cooling Cream Filling:

The cream acts as the carrier for the functional "**cooling**" ingredients. Because cooling agents (like menthol or herbal extracts) are often volatile, temperature control is essential.

Fat Plasticization:

The base of the cream typically a vegetable fat with a melting point near body temperature is creamed in a planetary mixer. This involves beating the fat until it becomes aerated and "plastic," which allows it to hold the other ingredients in suspension without feeling "greasy" (Nguyen et al., 2023). To ensure the WS-3 integrates perfectly, the fat is slightly warmed to approximately 40°C–45°C. This is the "solubility window" where the WS-3 crystals can be fully incorporated without degrading the overall texture of the fat.

Solubilizing the WS-3:

The measured quantity of WS-3 crystals is introduced into the warmed fat. Because WS-3 has a melting point of roughly 88°C–98°C, it does not "melt" into the fat but rather dissolves into the lipid matrix. Continuous high-shear mixing is maintained for 10–15 minutes to ensure there are no lingering crystals, which would otherwise create an unpleasant "gritty" mouthfeel for the consumer.

Sweetener and Vanilla Integration:
Finely powdered sugar is added gradually. At this stage, the vanilla extract or vanillin powder is incorporated to ensure the aromatic profile is deeply embedded in the fat matrix.
Incorporation of Solids: Finely pulverized icing sugar and vanilla powder are sifted and added to the fat-WS-3 mixture. The mixing speed is increased to ensure the solids are coated in the cooling-infused fat. This creates a barrier that prevents the sugar from absorbing moisture, which keeps the final wafer crisp.
Final Aeration and Cooling: The cream is then cooled back down to ambient temperature (25°C) while being whipped. This aeration introduces tiny air bubbles that lighten the density. The WS-3 remains trapped in the fat solids, ready to trigger the TRPM8 receptors on the tongue's surface the moment the fat begins to melt in the consumer's mouth.

3.3 FINAL PREPARTION OF WAFER:
The final wafers were assembled with the cream filling, packaged in moisture-resistant materials, and stored in a cool, dry environment.

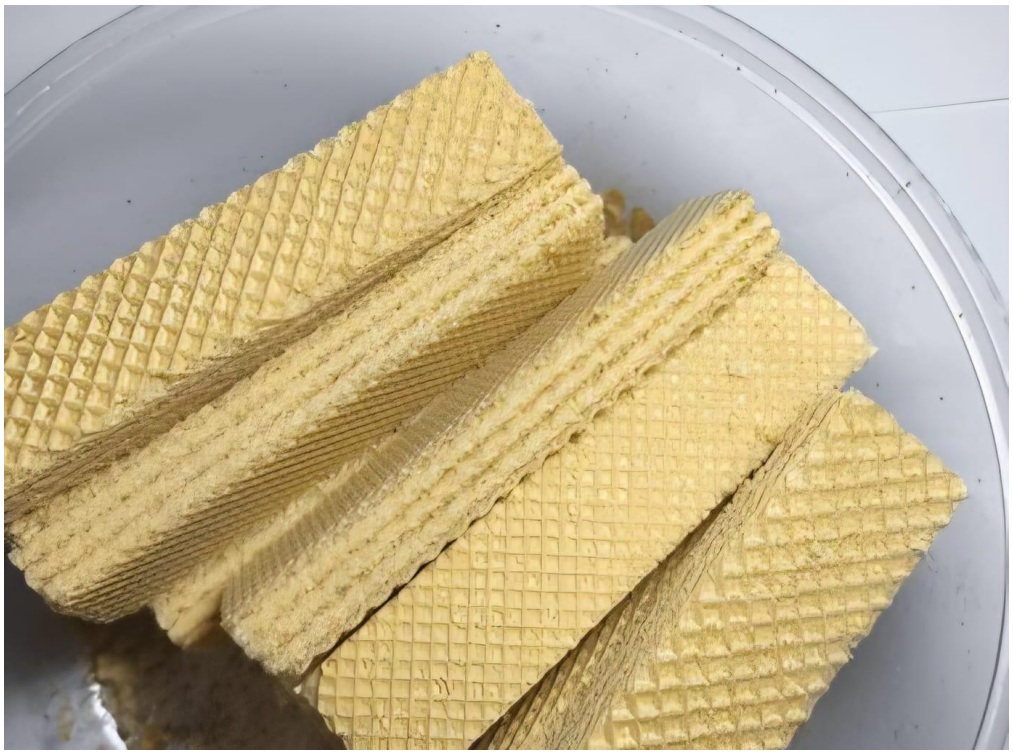

Fig-1 Final product- Wafer

Table 1: FORMULATION OF WAFER

Ingredients	Trial 1	Trial 2	Trial 3
Wafer shell (Dry mix)	70%	60%	50%
Vanilla cream filling	30%	40%	50%
WS-3 Concentration	0.05%	0.15%	0.30%

PHYSICO-CHEMICAL ANALYSIS:

Developed wafer samples were analyzed to determine their physicochemical properties, including moisture content, ash content, pH, reducing sugars, and titratable acidity, using standard analytical methods (Israfi et al., 2025; Rao et al., 2023). Moisture content was determined by the hot air oven method, where a known weight of the sample was dried at 105°C until a constant weight was obtained (Rao et al., 2023). Ash content was estimated by incinerating the sample in a muffle furnace at 550°C to obtain the total mineral residue (Feng et al., 2023).The pH of the wafer was measured using a calibrated digital pH meter at room temperature (Israfi et al., 2025). Reducing sugars were determined using standard titrimetric methods, specifically the Lane and Eynon method, to estimate the total reducing sugar content present in the sample (Guo et al., 2023). Titratable acidity was measured by titrating the sample against a standard sodium hydroxide solution using phenolphthalein as an indicator, and the results were expressed as citric acid equivalents (Zhao et al., 2024).

MICROBIAL ANALYSIS:

The microbial safety of the developed wafer samples was assessed to ensure that the product remained safe and stable during storage without significant loss of quality. Microbiological analysis included the determination of Total Plate Count (TPC), coliform count, as well as yeast and mold counts using standard microbiological procedures (Rao et al., 2023; Feng et al., 2023). These analyses helped evaluate the hygienic quality and shelf stability of the wafer samples during storage.

SENSORY EVALUATION:

Sensory evaluation of the developed wafer samples was conducted using a 9-point hedonic scale, where 1 indicated “dislike extremely” and 9 indicated “like extremely,” to assess attributes such as color, flavor, texture, taste, and overall acceptability (Israfi et al., 2025; Zhao et al., 2024).

SHELF-LIFE OBSERVATION:

The developed wafer samples were subjected to accelerated storage studies using a stability chamber, where one day of storage was considered equivalent to one month of real-time storage. The samples were evaluated over a period of 3 to 4 days, representing an actual shelf life of 3 to 4 months under normal storage conditions. During the storage period, the samples were assessed for changes in visual appearance, color, texture, aroma, and overall acceptability (Israfi et al., 2025; Zhao et al., 2024). The results indicated no significant changes during the initial two days; however, slight variations in texture and aroma were observed towards the end of the study period. Despite these minor changes, all parameters remained within acceptable limits throughout the storage duration (Rao et al., 2023). The incorporation of potassium sorbate proved effective in inhibiting microbial growth and maintaining product quality (Feng et al., 2023). Among the different formulations, Trial 2 exhibited the highest stability by retaining its physicochemical and sensory attributes during the entire storage period. Overall, the accelerated storage study confirmed that the developed wafer remained stable and acceptable for a shelf life of 3 to 4 months under standard storage conditions.

4. RESULTS AND DISCUSSIONS:

The results of physicochemical and sensory evaluation indicated significant differences among the three developed wafer trials. Among them, Trial 2 exhibited the highest quality, as it maintained optimal moisture content, appropriate pH, and a balanced composition of reducing sugars and acidity, which contributed to improved cooling effect and overall product stability (Rao et al., 2023; Israfi et al., 2025). Sensory evaluation further revealed that Trial 2 achieved the highest scores across all attributes, including appearance, color, aroma, taste, texture, and overall acceptability (Zhao et al., 2024). The superior sensory characteristics, along with

enhanced functional properties, established Trial 2 as the most suitable formulation for further development and potential commercial application (Feng et al., 2023).

Table 2- Physicochemical Analysis

Parameter	Trial 1	Trial 2	Trial 3
Moisture	2.1	1.7	2.5
Ash	0.50	0.53	0.42
pH	6.80	6.85	6.81
Reducing sugars	3.42	3.40	3.45
Titratable acidity	0.14	0.12	0.13

Table 3- Microbial Analysis

Parameter	Trail 1 (CFU/g)	Trail 2 (CFU/g)	Trail 3 (CFU/g)
Total Plate Count	2.5×10^2	2.0×10^2	2.8×10^2
Coliform	Absent	Absent	Absent
Yeast and Mold	1×10^2	1.2×10^2	0.8×10^2
Salmonella	Absent	Absent	Absent

Table 4 – Sensory Evaluation

Attributes	Trial 1	Trial 2	Trial 3
Appearance	7.0	9.0	8.0
Color	7.0	9.5	8.5
Aroma	6.5	8.7	8.0
Taste	7.0	9.0	7.9
Texture	6.0	9.5	8.2
Overall Acceptability	6.5	9.5	7.9

The findings of the present study demonstrated that variations in ingredient combinations significantly influenced the physicochemical and sensory properties of the developed wafer. The proportion of fat and cooling agent played a crucial role in determining sweetness, texture, and overall product acceptability (Rao et al., 2023; Guo et al., 2023). Trial 1 exhibited higher dryness and sweetness due to increased sugar content; however, it resulted in a comparatively dry texture. In contrast, Trial 2 showed improved firmness due to enhanced interaction between fat, cooling agent and emulsifiers along with enhanced cool feel without oil feel.

Trial 2 demonstrated an optimal balance of ingredients, achieving desirable moisture content, appropriate pH, and balanced levels of reducing sugars and titratable acidity, which supported proper structure formation and product stability (Rao et al., 2023; Zhao et al., 2024). The formation of a stable structure and cool feel was facilitated by the interaction of fat, emulsifiers with controlled acidity and cooling agent, enhancing its multisensory feel and forming a confectionary beneficial product.

Trial 3 resulted in the formation of a strong blend of coolness and sugar; however, elevated moisture content adversely affected the structural integrity and mouthfeel of the product.

Sensory evaluation results were consistent with physicochemical findings, with Trial 2 receiving the highest scores for appearance, color, taste, aroma, texture, and overall acceptability (Zhao et al., 2024). Accelerated shelf-life studies indicated that the developed wafer maintained its stability and quality for up to 3–4 months under standard storage conditions (Rao et al., 2023). Overall, the study highlights that proper optimization of ingredients can lead to the development of vanilla wafer infused with cooling effect using Ws-3 along with nutritional value, desirable sensory properties, and good storage stability.

5. CONCLUSION:

The research project resulted in a successful development of Cooling-Infused Vanilla cream wafer which contains Ws-3 as a cooling agent. The product characteristics showed noticeable changes which occurred because of different formulation approaches. The most effective trial emerged from Trial 2 because it demonstrated perfect moisture content and required pH level and suitable sweetness and strong gel strength. The sensory evaluation showed that Trial 2 achieved the highest acceptability for its appearance and color and aroma and taste and texture characteristics. The wafer nutritional value increased through functional ingredient and resulted in better product shelf life. The accelerated storage study confirmed that the developed wafer remained stable and acceptable for up to 3–4 months under normal storage conditions. The optimized formulation serves as a recommended product for commercial production as a functional multisensory commercial product.

6. REFERENCES:

1. Bełkowska, L., Muzolf-Panek, M., Islam, M., & Tomaszewska-Gras, J. (2022). Increasing the oxidative stability of the wafer lipid fraction with fruit extract during storage. *Applied Sciences*, 13(1), 103.

2. Borriello, A. (2025). *Novel approaches in healthy cream development: Oleogels and a natural sweetener*. fedOA University Press.

3. Erman, M. B. (2021). Cooling agents: Review of the chemistry and physiological properties of WS-3 and menthol derivatives. *Perfumer & Flavorist*, 46(2), 24–35.

4. Faridbeigi, A., & Salehi, F. (2023). Applications of physiological cooling agents in functional confectionery: A review. *Journal of Food Science and Technology*, 60(4), 1120–1132.

5. Food Safety and Standards Authority of India (FSSAI). (2025). *Manual of methods of analysis of foods: Bakery and confectionery products*. Ministry of Health and Family Welfare.

6. Hassoun, A., Cropotova, J., Trif, M., Rusu, A. V., Bobiş, O., et al. (2022). Consumer acceptance of new food trends resulting from the fourth industrial revolution technologies: A narrative review of literature and future perspectives. *Frontiers in Nutrition*, 9.

7. Indian Standard IS 2397. (2022). *Wafers — Specification*. Bureau of Indian Standards.

8. Lawless, H. T., & Heymann, H. (2023). *Sensory evaluation of food: Principles and practices*. Springer Nature.

9. Leffingwell, J. C. (2022). *Cool without menthol & the cooling compounds*. Leffingwell & Associates.

10. Li, J., Zhang, X., & Wang, Y. (2025). Method for simultaneous determination of three cooling agents in aerosols by GC–MS. *Frontiers in Chemistry*, 13, 1699107.

11. Meilgaard, M. C., Carr, B. T., & Civille, G. V. (2024). *Sensory evaluation techniques* (6th ed.). CRC Press.

12. Nagar, P., Singh, K., & Yasir, M. (2011). Orally disintegrating tablets: Formulation, preparation techniques and evaluation. *Journal of Applied Pharmaceutical Science*, 1(4), 35–45.

13. Oliveira, I., Marinho, B., Szymanowska, U., Karas, M., & Vilela, A. (2023). Chemical and sensory properties of waffles supplemented with almond skins. *Molecules*, 28(15), 5674.

14. Patel, R., & Gupta, M. (2024). Optimization of cream-filled wafer formulations: Impact of flavor infusion on shelf stability. *International Journal of Food Science*, 29(1), 45–58.

15. Ramesh, M. N. (2020). *Bakery technology and engineering*. CRC Press.

16. Roemer, E., Schorp, M. K., Piadé, J. J., Seeman, J. I., Leyden, D. E., & Haussmann, H. J. (2012). Scientific assessment of the use of sugars as food and tobacco ingredients. *Critical Reviews in Toxicology*, 42, 244–278.

17. Saini, S., & Sharma, K. (2021). *Principles of bakery and confectionery technology* Scientific Publishers.

18. Singh, S., et al. (2025). Ensuring absence of genetically modified (GM) ingredients in market-sourced food products (bakery and confectionery). *International Journal of Food Science and Technology*, 60(2), vvaf214.

19. Sustainable Food Technology. (2025). Development of muffins fortified with Nelumbo nucifera: Analysis of quality and FSSAI standards. *Sustainable Food Technology*, 3.

20. Zhu, B., & Zhang, Y. (2020). Sensory properties of cooling agents WS-3 and WS-23 in food matrices. *Food Chemistry*, 312, 126052.