iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** IV **Month of publication:** April 2026

DOI: https://doi.org/10.22214/ijraset.2026.79621

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

Effect of High-Humidity Storage on Crumb Softness of Fresh Cream Cakes in Small Retail Bakeries

Dr. Jaisree Anand [1], C. Madhumitha[2]
[1]*Professor,* [2]*Student School of Hotel &Catering Management, Vels Institute of Science, Technology and Advanced Studies, Pallavaram, Chennai, India*

Abstract: ***Food products are taken into consideration as a highly perishable item, especially in the case of bakery products, where the shelf life of each product may differ depending on the ingredients used in addition to that, humidity may cause fungus growth and allow bacteria to act upon the food. Fresh cream cakes are taken into consideration as highly perishable bakery items whose quality will deteriorate rapidly during storage, especially in the case of small retail bakeries where advanced climate-controlled equipment is not available. The crumb softness is taken into consideration as one of the most important quality parameters that influence acceptance, which will also deteriorate depending on storage. The objective of this study is to identify the impact of high humidity storage conditions on the crumb softness of fresh cream cakes. Secondly, it emphasizes the principles of food science, moisture migration, and starch to explain how humidity can be controlled for extending the short shelf life***

Keywords: Fresh cream cakes, crumb softness, high-humidity storage, small retail bakery

I. INTRODUCTION

The fresh cream cakes are a high-end segment in the baking industry, appreciated for their soft crumb texture, complex sensory experience, and aesthetic appeal. These types of baked goods are commonly consumed during special occasions and are an essential source of revenue for retail bakeries, especially small and medium-scale bakeries. However, fresh cream cakes are among the most difficult bakery products to store and display, considering their high moisture content, soft texture, and tendency to deteriorate in quality. In small retail bakeries, fresh cream cakes are usually produced on a daily basis or in small batches and are displayed for a shorter period of time. Unlike large-scale industrial bakeries, small bakeries do not have sophisticated environmental control systems capable of controlling temperature and relative humidity. As a consequence, cakes are generally subjected to fluctuating storage conditions during refrigeration, display, and short-term storage. These factors can greatly affect moisture migration, texture retention, and overall freshness of the cakes. Crumb softness is an essential freshness indicator of cakes. A soft and tender crumb is linked to freshness, while hardness or dryness is instantly recognized as staleness, even if the product still looks fresh. A loss of crumb softness not only contributes to lower consumer acceptance but also results in higher product returns and wastage, which pose economic challenges to small retail bakeries operating on tight profit margins. Among the many environmental factors influencing cake quality, relative humidity is of particular significance. Humidity determines the migration of moisture from the cake, cream components, packaging materials, and surrounding air. In low-humidity environments, the rapid loss of moisture from the cake crumb can be accelerated, resulting in faster firming and textural deterioration. In contrast, high-humidity storage conditions can slow down the evaporation of moisture, thus contributing to maintaining crumb softness and delaying staling effects. Fresh cream cakes are a special case because they are made up of several components cake sponge, cream layers, and decorative parts, which have different moisture contents and water activity values. The behaviour of these components during storage is highly dependent on the surrounding humidity. Despite the extensive research and importance given to temperature control in bakery storage practices, the aspect of humidity, especially in small retail bakeries, has been explored relatively less. In most small bakeries, conventional refrigeration units are used, which are mainly designed for temperature control and not relative humidity control. The importance of understanding the impact of high-humidity storage on the softness of the crumb texture of fresh cream cakes, especially in the context of small retail bakeries, can be realized as it can provide significant inputs for improving freshness retention through cost-effective approaches. The objective of this article is to determine the impact of high-humidity storage on the crumb softness of fresh cream cakes.

©IJRASET: All Rights are Reserved

II. LITERATURE REVIEW

The fungal contamination in bakery products is a major concern in the food sector, as it affects the quality and safety of these food items. Fungi, such as molds and yeasts, can contaminate bakery products mainly during the storage. This contamination not only reduces the quality of the products but also causes severe health hazards to the consumer. Mycotoxins, toxic substances produced by some types of fungi, can cause adverse health reactions, such as allergies, breathing problems, and, in extreme cases, cancer. Bakery products, being rich in carbohydrates and moisture content, create an ideal environment for the growth of fungi. Some common types of fungi that can contaminate bakery products belong to the genera Aspergillus, Penicillium, and Fusarium. These fungi can grow during the cooling process of baked products, as well as during storage, especially when the products are stored in warm and humid environments. It has been observed that a large number of bakery products, especially bread and pastry, are susceptible to fungal contamination [1]. Indoor Temperature and Absolute Humidity were found to be well correlated with the data from the closest Weather Bureau Weather Stations, thus establishing a basis for determining target extremes (design conditions). Moisture absorption, as measured by package headspace relative humidity, was highly dependent on the type of packaging used and the integrity of that packaging. The Combos and Lorna Doones were received from the bakery packaged in either an intermediate quantity package or a vending machine package, both of which used metallized PET structures that are excellent barriers. These products were not influenced by the Assembler storage conditions. The Vegetable Crackers, although bulk, were adequately packaged to provide 3 to 6 months of interim storage life. The Baked cakes were not well protected, and as such, were unable to withstand the interim storage and still be within the maximum allowable moisture content. Sensory panel testing confirmed that texture and overall similarity decreased significantly from the time the product was received at the Assembler site [2]. Sustainable biomaterials are increasingly acknowledged for their ability to revolutionize the packaging of bakery items by making them more environmentally friendly. Bio-based materials like biodegradable polymers (PLA, PHA, PBAT, starch, and others) are gaining popularity as a substitute for conventional petroleum-based plastics, providing improved barrier properties that increase the shelf life of bakery items by protecting them from moisture, oxygen, and other environmental factors. The addition of nanotechnology to these materials further improves their barrier properties and provides antimicrobial properties, which aid in preserving the freshness of the bakery items. In addition, the application of fermented biomaterials with polyunsaturated fatty acids (PUFA) not only increases the nutritional value of bakery products but also has a positive effect on their rheological properties. With the increasing demand for eco-friendly packaging, regulatory bodies are now promoting the application of these biomaterials, ensuring that they meet the requirements of consumers while maintaining product integrity [3].

III. IMPORTANCE OF CRUMB SOFTNESS

Crumb softness is considered one of the most critical quality characteristics of fresh cream cakes and is a major freshness and eating quality indicator. It describes the soft, moist, and elastic texture of the internal structure of the cake, which has a significant influence on mouthfeel and overall acceptance. It is generally believed that consumers associate a soft crumb with freshly made products, and any enhancement in firmness or dryness is immediately detected as staleness, even if the product's favour and appearance are still acceptable. From a physicochemical point of view, crumb softness is primarily influenced by moisture content and distribution, starch gelatinization and retrogradation, protein-starch interactions, and the presence of fats and emulsifiers in the cake matrix. Moisture loss and starch retrogradation during storage cause crumb firming, thus reducing consumer acceptability and marketability. In small retail bakeries, crumb softness is a particularly important factor, as it has a direct influence on customer satisfaction and economic viability by reducing product rejection and waste. Bio preservation appears as a promising approach to improve the microbial stability of bakery food products while meeting the growing demand for clean-label food options. By lessening the dependence on synthetic preservatives like calcium propionate and sorbates, bio preservatives not only help in the development of healthier alternatives but also aid in sustainable food practices. When combined with good manufacturing practices (GMP), proper storage conditions, and modified atmosphere packaging (MAP), bio preservation provides a holistic approach to ensure the quality and safety of bakery food products, ultimately meeting the consumer demand for natural and healthier food options. This holistic approach not only deals with the issue of spoilage but also encourages a transition towards more eco-friendly and health-oriented food practices [4].

IV. HUMIDITY IN CAKE STORAGE

The relative humidity is a major environmental constraint that affects the physical, chemical, and sensory shelf stability of cakes. It determines the rate and manner of moisture movement between the cake crumb, cream components, packaging materials, and the surrounding environment.

©IJRASET: All Rights are Reserved | SJ Impact Factor 7.538 | ISRA Journal Impact Factor 7.894 |

Low humidity causes a large concentration gradient between the cake and the surrounding air, leading to a high rate of evaporation of water from the cake surface and crumb. This causes dehydration, hardening, and staling of the cake crumb, even if the temperature is well controlled. High humidity, on the other hand, causes a low concentration gradient between the cake and the surrounding air, thus slowing down the rate of dehydration and crumb hardening. In fresh cream cakes, humidity is a major factor to be controlled because of the complex composition of the cake. The sponge cake, cream fillings, and topping materials have different moisture contents, and an imbalance in humidity can cause an equilibrium problem in the cake components [5]. Low humidity can cause drying and cracking of cream, thus contributing to the migration of moisture from the cake crumb, while high humidity can cause condensation, texture problems, and increased susceptibility to microbial growth. It is, therefore, important to ensure that the optimal high humidity conditions are maintained to ensure the retention of moisture without affecting the safety of the product. In retail bakeries, where the storage and display environment is less standardized, variations in relative humidity can greatly affect the quality of cakes stored for a shorter period of time. Refrigeration equipment, which is mainly used for temperature regulation, may cause low humidity conditions that can accelerate crumb hardening [6]. It is important to note that the knowledge of humidity effects can enable the baker to use simple techniques such as better packaging, reduced air movement, and basic humidity control practices to extend the shelf life performance of fresh cream cakes.

V. IMPLICATIONS FOR SMALL RETAIL BAKERIES

The results regarding the importance of high-humidity storage in keeping the crumb soft have important implications for small retail bakeries. Unlike large industrial bakeries, which use advanced climate-controlled storage systems, small bakeries rely on simple refrigeration or open display cabinets that can potentially create low-humidity environments, accelerating the dehydration of the crumb [7]. However, by realizing the importance of humidity as a controllable variable, small bakery operators can easily resort to simple and inexpensive methods to improve product quality. Simple methods such as using display cabinets with simple humidity control, placing water trays inside refrigerated units, minimizing excessive air circulation, or using moisture-barrier packaging materials can greatly help in slowing down the dehydration of the crumb. Furthermore, synchronizing production schedules with the anticipated level of sales can help reduce storage time and quality degradation. Additionally, effective humidity control can also ensure that the moisture balance between the cake crumb and cream components is maintained [8]. When these measures are taken in conjunction with temperature control and proper sanitation, they can help improve the short-term shelf life, reduce waste, increase customer satisfaction, and improve the economic viability of small retail bakeries.

VI. LIMITATIONS AND SAFETY CONSIDERATIONS

The high humidity storage conditions in retaining the softness of the crumb, there are certain drawbacks and safety issues that need to be considered, especially in the case of fresh cream cakes. The high humidity has to be carefully managed, which can provide ideal conditions for the proliferation of microorganisms, mild, and pathogenic bacteria because of the high water activity of cream-containing products [9]. This problem can be further compounded by the absence of temperature regulation or poor sanitation standards during the production, storage, and handling of the product. Condensation on cake surfaces, packaging, or interior surfaces of display cabinets can also occur if the humidity is too high, resulting in aesthetic and texture-related problems, as well as increased microbial loads. Certain variations in product composition, including differences in fat, sugar, and emulsifier content, can also affect the susceptibility of cakes to humid storage conditions, thereby restricting the generalization of humidity storage strategies to all types of products. From a practical standpoint, the small retail bakery may encounter difficulties in accurately controlling relative humidity. This can lead to an inconsistent distribution of moisture within the cake, causing localized softening, sogginess, or degradation on the surface. Moreover, the extension of storage life solely based on high humidity conditions may have a negative impact on the expectations of safety and quality. Thus, high humidity storage should be considered a complementary approach rather than a substitute for sound manufacturing practices, proper refrigeration, and strict sanitation practices [10]. A harmonious approach combining controlled humidity, appropriate temperature, limited storage life, and regular quality assessments is necessary to ensure that advances in crumb softness are not achieved at the expense of food safety and consumer confidence.

VII. CONCLUSION

The preservation of the soft crumb texture is a basic quality requirement for fresh cream cakes and an important factor in consumer acceptance, freshness, and economic performance of retail bakeries. This paper points out the important role of storage humidity in maintaining the textural properties of fresh cream cakes, particularly in high-humidity conditions that can slow down dehydration and starch retrogradation and, consequently, preserve the soft crumb texture characteristic of high-quality products.

©IJRASET: All Rights are Reserved | SJ Impact Factor 7.538 | ISRA Journal Impact Factor 7.894 |

Unlike low-humidity storage, which promotes dehydration and crumb hardening, high-humidity storage is an effective approach to extend short-term freshness without changing the product composition or manufacturing technology. For small retail bakeries, where technological and economic limitations may impede the adoption of modern storage technology, humidity control is an especially useful and viable approach. By embracing the use of simple and low-cost approaches like enhanced packaging, basic humidity control in display or refrigeration units, and optimized production and display schedulesbakeries can improve crumb softness, preserve visual and sensory qualities, and minimize product wastage. Such enhancements not only help improve customer satisfaction and loyalty but also help ensure the sustainability and profitability of small bakery businesses. However, the advantages of high-humidity storage need to be properly balanced with food safety concerns, especially in view of the high water activity and perishable nature of fresh cream cakes. Proper temperature control, good hygiene practices, short storage life, and regular quality checks are critical to avoid microbial deterioration and ensure consumer safety. High-humidity storage should therefore be considered a supplementary method for preserving quality rather than a standalone approach. The controlled high-humidity storage is a scientifically valid and practical approach to preserving crumb softness in fresh cream cakes, especially in the context of small retail bakeries.

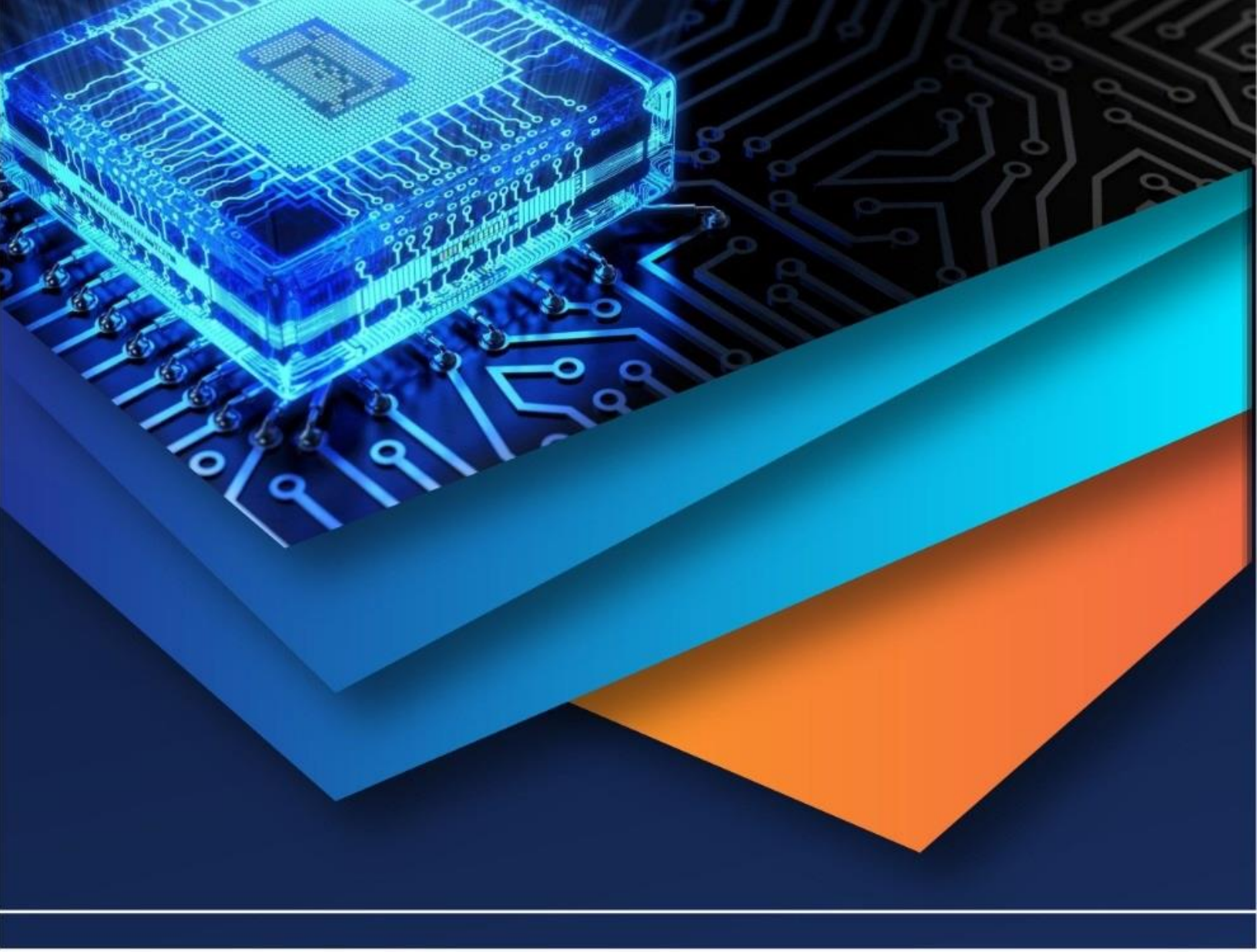
VIII. FUTURE RESEARCH

Future studies could be focused on optimal levels of humidity, interactions with different cake types, and joint effects of temperature and packaging may help to further improve storage recommendations. By bridging scientific knowledge and its application.

REFERENCES

[1] CHINECHEREM, DIM FRANKLIN. "BAKERY PRODUCT: EFFECT OF FUNGAL INFESTATION." (2024).
[2] Sowmya, K. L., and B. Ramalingappa. "Enhancing Bakery Product Quality: Addressing Spoilage and Promoting Healthier Practices."
[3] Kaur, Samandeep, Vikrant Singh, and Parmjit S. Panesar. "Sustainable Biomaterials for Bakery Products." Sustainable Biomaterials for Food Packaging. CRC Press 306-332.
[4] Poojara, Rashmi H., et al. "Composite flours for sustainable food systems: Integrating nutritional, environmental, and climate resilience strategies." Journal of Environmental Science and Sustainable Development 8.2 (2025): 490-522.
[5] Yang, Gaoji, et al. "Development of potential processing technologies for germinated edible seeds and their applications in food: a comprehensive review." Critical Reviews in Food Science and Nutrition (2025): 1-32.
[6] Alsaeed, Fatimah. Effects of Storage Conditions on the Composition, Physical Properties, and Functionalities of Peas and Lentils. MS thesis. South Dakota State University, 2025.
[7] Tarazona, Eduardo Zorrilla, et al. "Chemical and food processes applied to goat's milk: Non-Conventional Derivatives." 2025,
[8] Fortey, Richard. Close encounters of the fungal kind: in pursuit of remarkable mushrooms. Simon and Schuster, 2025.
[9] Payne, Jessie, et al. "Impact of Relative Humidity on Bacillus Probiotic Viability During Storage in Baked Products." Applied Food Research (2025): 101045.
[10] Payne, Jessie, et al. "Impact of Relative Humidity on Bacillus Probiotic Viability During Storage in Baked Products." Applied Food Research (2025): 101045.

©IJRASET: All Rights are Reserved | SJ Impact Factor 7.538 | ISRA Journal Impact Factor 7.894 |



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)