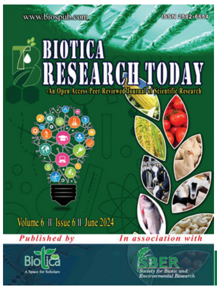

Bio. Res. Today 2024, 6(6):345-348

Biotica Research Today

e-ISSN: 2582-6654

June, 2024

Article ID: RT1677

Popular Article

Role of Food Engineering in Formulation of Texture-Modified Foods

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Open Access

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Conflict of interests: The author has declared that no conflict of interest exists.

How to cite this article?

Matondkar, P.M., Goswami, K., 2024. Role of Food Engineering in Formulation of Texture-Modified Foods. *Biotica Research Today* 6(6), 345-348.

Abstract

Texture-modified foods (TMFs) are specially designed for individuals with chewing or swallowing difficulties, such as the elderly and those with dysphagia. This article explores the engineering principles and techniques involved in the formulation of TMFs, focusing on rheology, mechanical testing and thermal processing. Advanced technologies like 3D food printing and high-pressure processing are highlighted for their role in creating safe, nutritious and palatable TMFs. The study underscores the importance of sensory evaluation, nutritional adequacy and consumer acceptance in the development of TMFs, aiming to improve the quality of life for affected populations.

Keywords: Consumer acceptance, Food engineering, Nutrition, Texture-modified foods

Introduction

Texture-modified foods (TMFs) are specially designed food products that have altered textures and are designed to assist individuals who have difficulties in chewing or swallowing particularly for addressing the dietary needs of specific populations such as the elderly and individuals with dysphagia (Aguilera and Park, 2016). The engineering aspects of these foods involve modifying their texture to ensure they are safe, nutritious and palatable. This requires a deep understanding of food rheology, material science and food processing techniques.

Importance of Texture in Food Engineering

The formulation of TMFs is a critical area of food engineering. Texture is a fundamental attribute of food that affects its consumer acceptance, preference, palatability and safety. It encompasses attributes, such as hardness, cohesiveness, adhesiveness, springiness, chewiness and viscosity. For individuals with swallowing disorders inappropriate textures can lead to serious health risks, including choking and aspiration pneumonia. Therefore, texture modification is essential to create safe and enjoyable eating experiences for these populations. Texture modification can prevent choking and ensure proper nutrition. The design of TMFs involves manipulating the physical properties of food through various engineering techniques to achieve the desired texture. Typical view of texture modified food is illustrated in figure 1 (Anonymous, 2023).

Figure 1: Illustration of texture modified food

Article History

RECEIVED on 16th June 2024 RECEIVED in revised form 22nd June 2024 ACCEPTED in final form 23rd June 2024

Classification of Texture-Modified Foods

Texture-modified foods are classified into several categories (Table 1) based on their consistency and ease of swallowing (Wang, 2020):

• *Pureed Foods*: Smooth and homogenous, requiring no chewing.

• *Minced and Moist Foods*: Small, soft pieces that require minimal chewing.

• *Soft and Bite-Sized Foods*: Soft foods that can be easily chewed and swallowed.

• *Liquidized Foods*: Foods that have been blended to a liquid consistency.

Table 1: Classification of texture modified foods

Class	Chopped/ coarsely minced	Finely minced/ soft and moist	Blended / Puree
Food characteristics	**Solid**		
	Cut into small pieces. Easily broken up with a fork or spoon.	Chopped into very small pieces. Lumps can be easily mashed with the tongue. Food should not fall through the fork when lifted.	Soft, moist, and smooth with no lumps; Requires no chewing; Non-sticky.
	Fluids		
	Mildly thick.	Moderately thick.	Extremely thick.
	Runs freely off the spoon.	Slowly drips in drops.	Adhered to spoon and does not flow off it.

Engineering Principles and Techniques

• *Rheological and Colloidal Aspects*: Rheology, the study of flow and deformation, is crucial in understanding how food behaves under different forces. For TMFs, modifying the viscoelastic properties is essential to ensure that the food is easy to swallow and does not pose a choking hazard. Colloidal science deals with the behavior of small particles suspended within a medium. In food engineering, this can involve the use of hydrocolloids, which are substances that form gels and modify the texture of foods. Hydrocolloids like xanthan gum and guar gum are commonly used to alter the texture of TMFs.

• *Mechanical Testing and Physical Measurements*: Mechanical properties such as compression, penetration and shear strength are measured to evaluate the texture of foods. These tests provide data on how food behaves under mechanical forces, which is vital for ensuring that TMFs have the appropriate softness and cohesiveness.

• *Thermal Processing*: Thermal processing techniques, including blanching, high-pressure processing and sous-vide, can significantly impact the texture of foods. These methods are used to achieve the desired textural properties by modifying the structural components of food, such as pectin, starch and proteins.

• *Use of Protein Hydrolysates*: Enzymatically hydrolyzed proteins are used to improve the functional properties of TMFs. These proteins enhance the texture by improving foaming, gelling and emulsifying properties, which are critical for creating palatable and safe TMFs.

Selection of Raw Materials

The choice of raw materials is crucial in texture-modified food production. Ingredients must be selected based on their ability to create the desired texture and maintain nutritional quality. Commonly used materials include:

• *Starches and Hydrocolloids*: These are used to modify viscosity and create smooth textures. Examples include corn starch, tapioca starch, xanthan gum and guar gum.

• *Proteins*: Proteins like gelatin and whey protein concentrate can improve texture and provide structural integrity.

• *Lipids*: Fats and oils can enhance mouth-feel and provide lubrication, making swallowing easier.

Modification Techniques

Several physical methods are employed to achieve the desired texture in food this can be physical or chemical or often combination of both.

Physical Modification Techniques

• *Grinding and Milling*: Grinding and milling are used to reduce particle size and create homogenous mixtures. This is particularly important for pureed and minced foods, where uniform texture is critical.

• *Emulsification*: Emulsification involves mixing two immiscible liquids (such as oil and water) to create a stable emulsion. Emulsifiers like lecithin and mono- and diglycerides are used to stabilize the mixture, contributing to a smooth and creamy texture.

• *Gelation*: Gelation is the process of forming a gel from proteins or polysaccharides. This technique is used to create soft, yet cohesive textures. Gelatin and pectin are commonly used gelling agents in texture-modified foods.

Chemical Modification Techniques

• *Enzymatic Modification*: Enzymes such as amylases, proteases and cellulases can break down starches, proteins and fibers, respectively, altering the texture of food. For example, proteases can be used to tenderize meat, making it easier to chew and swallow.

• *pH Adjustment*: Altering the pH of food can influence the texture by affecting the solubility and gelation properties of proteins and polysaccharides. Acidulants like citric acid and phosphoric acid are commonly used to adjust pH.

Technologies in Texture Modification

• *3D Food Printing*: 3D food printing is an innovative technology that offers precise control over the texture and shape of food products. By layering ingredients in specific patterns, it is possible to create customized textures and consistencies. This technology is particularly useful for creating visually appealing texture-modified foods that can improve the eating experience for individuals with swallowing difficulties.

• *High-Pressure Processing (HPP)*: High-pressure processing is a pasteurization technique that employs high pressure to deactivate microorganisms and enzymes in food without using heat. HPP can also modify the texture of food by altering the structure of proteins and polysaccharides. This technique helps in maintaining the nutritional and sensory qualities of the food while achieving the desired texture.

• *Ultrasound Processing*: Ultrasound processing involves the use of high-frequency sound waves to modify the texture of food. This technique can enhance the emulsification, gelation and homogenization processes, leading to smoother and more uniform textures. Ultrasound can also improve the efficiency of other texture modification methods, such as enzymatic hydrolysis.

Sensory and Rheological Evaluation

Sensory evaluation is a critical step in the development of texture-modified foods. It involves the assessment of food products by trained panels or consumers to evaluate attributes such as appearance, texture, flavor and overall acceptability. Sensory tests help ensure that the modified textures are not only safe but also appealing to the target population; while rheological evaluation deals with rheological properties such as viscosity, elasticity and firmness which are essential in defining the texture of foods. Rheometers and texture analyzers are used to measure these properties and provide quantitative data that can guide the formulation and processing of texture-modified foods. Understanding the rheological behavior of ingredients and final products is crucial for achieving consistent and desirable textures.

Nutritional Considerations

One of the challenges in developing texture-modified foods is ensuring that they meet the nutritional needs of the target population (Kampuse *et al.*, 2022). Texture modification processes should not compromise the nutritional quality of the food. Strategies to maintain or enhance nutritional content include:

• *Fortification*: Adding vitamins, minerals and other nutrients to compensate for potential losses during processing.

• *Use of High-Nutrient Ingredients*: Incorporating nutrient-dense ingredients such as legumes, dairy and fortified cereals.

• *Controlled Cooking Methods*: Using cooking methods that preserve nutrients, such as steaming or microwaving, instead of prolonged boiling.

Applications and Practical Considerations

• *Dysphagia Management*: For dysphagic patients, the texture of food must be modified to prevent aspiration and choking. This involves creating foods that are easy to chew and swallow while maintaining their nutritional value. Techniques such as 3D printing are being explored to create customized TMFs that meet the specific needs of individuals.

• *Elderly Nutrition*: The elderly population often requires TMFs due to reduced chewing and swallowing capabilities. These foods must be designed to be nutritionally complete and easy to consume. The use of hydrocolloids and other texture-modifying agents can enhance the quality of life for elderly individuals by making food consumption safer and more enjoyable.

• *Institutional Settings*: In healthcare and educational institutions, TMFs are used to ensure that individuals receive adequate nutrition. Standardizing the texture and ensuring consistency in food preparation is critical for these settings. Legislation and guidelines help in standardizing practices to ensure the safety and acceptability of TMFs.

Challenges and Future Directions

Developing texture-modified foods presents several technological challenges; to overcome these, future research and innovation are likely to focus on following (Figure 2).

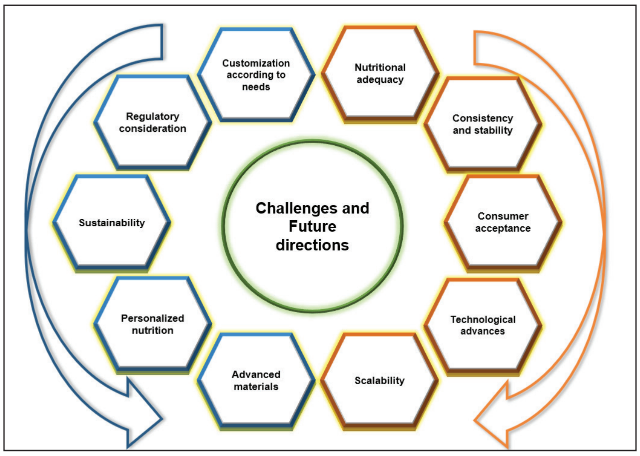

Figure 2: Challenges and future directions in formulation of texture modified foods

• *Nutritional Adequacy/ Tailoring Nutrition to Individual Needs*: Ensuring that TMFs meet the nutritional needs of individuals is a significant challenge. While modifying texture, it is essential to retain or enhance the nutritional profile of the food. This requires careful selection of ingredients and fortification with necessary vitamins and minerals. Dietitians and nutritionists play a critical role in evaluating these specialized food products to ensure they meet the dietary requirements of the target population.

• *Consistency and Stability*: Achieving consistent texture and stability over the shelf life of the product is challenging, especially with natural ingredients that can vary in composition.

• *Consumer Acceptance/ Sensory Quality*: The sensory attributes of TMFs, such as taste, aroma and appearance, are crucial for consumer acceptance. Research indicates that visually appealing and palatable TMFs are more likely to be accepted by individuals, which can improve their nutritional intake and overall well-being. Balancing texture modification with maintaining or improving the sensory quality of food is crucial for consumer acceptance.

• *Technological Advancements*: Advances in food processing technologies, such as 3D printing and high-pressure processing, offer new opportunities for the development of TMFs. These technologies can create complex textures and customize foods to meet individual dietary needs. However, challenges such as cost, speed and technical limitations need to be addressed.

• *Scalability*: Scaling up the production of texture-modified foods from lab to commercial scale requires careful optimization of processes and equipment.

• *Advanced Materials*: Exploring new food-grade materials and additives that can provide better control over texture and stability.

• *Personalized Nutrition*: Developing technologies for personalized texture modification based on individual dietary needs and preferences.

• *Sustainability*: Incorporating sustainable practices and ingredients to reduce the environmental impact of texture-modified food production.

• *Regulatory Considerations*: Manufacturers must comply with food safety regulations, labeling requirements and nutritional standards set by authorities such as the Food and drug administration (FDA) and other relevant bodies. Ongoing research and collaboration with regulatory agencies are essential to keep up with evolving standards and consumer expectations.

Conclusion

The engineering of texture-modified foods is a complex and multidisciplinary field that addresses the needs of individuals with difficulties in chewing and swallowing. Leveraging rheology, mechanical testing, thermal processing and the use of protein hydrolysates helps food engineers to create TMFs that are safe, nutritious and palatable. By combining knowledge from food science, materials science and mechanical engineering, it is possible to create safe, nutritious and enjoyable food products. Advances in technology, such as 3D food printing and high-pressure processing, offer new opportunities for innovation in this field. As the population ages and the prevalence of dysphagia increases, the demand for texture-modified foods will continue to grow, driving further research and development to meet these challenges. Through careful selection of raw materials, innovative processing techniques and rigorous sensory and rheological evaluation, the future of texture-modified foods looks promising, with the potential to significantly improve the quality of life for those who depend on these specialized products.

References

Aguilera, J.M., Park, D.J., 2016. Texture-modified foods for the elderly: Status, technology and opportunities. *Trends in Food Science & Technology* 57(Part A), 156-164. DOI: https://doi.org/10.1016/j.tifs.2016.10.001.

Anonymous, 2023. Texture modified food and meals that are wholesome, nutritious, and versatile. In: *Textured Concept Foods*. Available at https://texturedconceptfoods.com. Accessed on: 16th June, 2024.

Kampuse, S., Ozola, L., Kruma, Z., Klava, D., Galoburda, R., Straumite, E., Siksna, I., 2022. Nutritional composition of plant-based texture: Modified foods for dysphagia patients. *Proceedings of the Latvian Academy of Sciences. Section B. Natural, Exact and Applied Sciences* 76(1), 22-29. DOI: https://doi.org/10.2478/prolas-2022-0004.

Wang, I.C., 2020. International classification systems for texture-modified foods. *Journal of Nursing (Hu li Za hi)* 67(4), 24-32. DOI: https://doi.org/10.6224/JN.202008_67(4).04.