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Popular Article

Tribology: Advancing the Understanding of Food Mouthfeel and Sensory Perception

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Abstract

Tribology has emerged as an important tool in food science for understanding mouthfeel and sensory perception by evaluating friction and lubrication between interacting surfaces. The Stribeck curve explains lubrication regimes—boundary, mixed, and hydrodynamic—helping relate instrumental data to sensory attributes like smoothness and astringency. Instruments such as tribometers simulate oral conditions and assess thin film behavior beyond conventional rheology. Tribology finds applications in dairy, emulsions, and plant-based foods for texture optimization. Its key advantages include better correlation with sensory evaluation, improved product development, and enhanced consumer acceptability, making it a promising approach in modern food processing

Introduction

Tribology is a new oral processing method that serves as a crucial technology for assessing the oral sensations of various food products, such as smoothness and creaminess (Paul *et al.*, 2022). In this process, the lubricating properties of food are examined using the same principles as those employed in mechanical engineering to analyze the frictional properties of lubricants.

As food is consumed, it serves as a lubricant, and two surfaces in the mouth, the tongue, and the palate, interact. The characteristics of saliva, along with factors like roughness, speed, direction, and movement, have a direct impact on the lubrication of food in the oral cavity. In addition to rheology, the study of "oral" tribology has gained importance due to the



critical role that friction plays in how we perceive the oral texture of food (Pradal and Stokes, 2016).

Basic principle of tribology

Tribology is the study of friction occurring between two surfaces in contact, focusing on aspects like wear, tear, and lubrication (Sethupathy et al., 2020). When the two surfaces move relative to each other at a constant speed of V , the frictional force F_R can be represented by the following expression:

$$F_R = \mu \times F_L$$

where μ is the friction coefficient and is dimensionless and F_L is the normal force

Stribeck curve

In the field of food tribology, the lubrication properties of food samples can be analyzed using a familiar Stribeck curve (Figure 1), which illustrates the relationship between the coefficient of friction and a combined variable that includes viscosity, speed, and load; this is also known as the friction-speed curve. There are three main regimes included, such as boundary regime, mixed regime, and hydrodynamic regime (Upadhyay and Chen, 2019). This curve calculates the friction coefficient based on the ratio of friction force to the applied load in order to assess the lubrication characteristics of food.

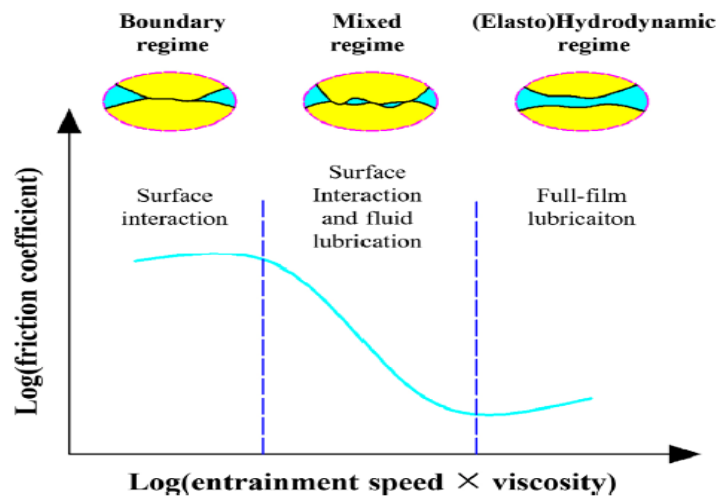


Fig. 1: Stribeck curve (Xu et al., 2022)

Instruments

To assess the lubrication characteristics of food, a tribometer is commonly employed. Various tribometers are utilized to evaluate the creaminess, smoothness, slipperiness, fattiness, astringency, and mouthfeel of food items. These consist of a friction tester, a mounted tribological device, a tribology cell, an optical tribological setup, and a mini-traction machine (Prakash et al., 2013).



S. No	Type of Tribometer	Principle	Food products studied	Texture parameter studied
1.	Friction tester	Spherical ball rotating against rubber band	Liquids with different combination of cereal hydrolysate, vegetable gum and carboxymethyl cellulose, honey, butterscotch syrup, pancake syrup, vanilla syrup and chocolate syrup	Smoothness and slipperiness
2.	Optical tribological configuration	Detachable surface applying force against oscillating glass surface	Emulsions prepared from whey protein isolate and sunflower oil	Roughness, fatty mouthfeel
3.	Mounted tribological configuration	Ball rotating on three motile plates	Heavy cream, milk with different fat percentage	Creaminess
4.	Tribological cell	Two cylindrical contact points rotating against annular disk	Different concentrations of corn syrup	Consistency
5.	Mini-traction machine	Spinning disk against rotating ball	Guar gum solutions, sunflower oil, tea catechins, skimmed milk fortified with inulin, milk with 0.06-8% fat	Slipperiness and fattiness, Astringency, Creaminess

A Tribological Perspective on Astringency

A study by Rudge *et al.* (2021) investigated astringency perception using a tribological approach under simulated oral conditions. The results showed that the structure of polyphenols plays a key role in astringency, with larger compounds causing protein precipitation and increased friction. Electrostatic interactions, particularly between mucins and charged compounds like alum, further contribute to this effect. Importantly, the study suggests that lubrication loss—a key factor in astringency—can be minimized by incorporating ingredients such as ethanol and glycerol in food systems

Applications:

- To develop a delicate low-fat food item that is acceptable to consumers.
- To classify dairy products based on their fat levels.
- In the beverage sector, to assess the astringency of the product.
- To examine the swelling properties of starch.
- To identify contaminants in food, such as melamine added to infant milk formulas to enhance protein content.



Advantages

Tribology in food systems encompasses both the rheological properties of fluids and the surface interactions between contacting substrates, providing a more comprehensive understanding of food behavior. It is particularly useful in explaining the behavior of thin films where conventional rheology falls short. This approach plays a crucial role in defining overall sensory perception or mouthfeel of food products. It also enables the evaluation of lubrication-related attributes such as smoothness, creaminess, slipperiness, and astringency. Additionally, tribological methods are considered safe, as they do not involve any significant hazards.

Tribological approaches in food systems also have certain limitations. They are not well suited for solid or particulate food materials, restricting their application mainly to fluid or semi-solid systems. Additionally, further processing such as heating or microwaving can alter the tribological behavior of texture-related molecules, thereby affecting sensory properties. Moreover, the instruments required for tribological measurements are often expensive, limiting their widespread use.

Conclusion

Tribology has emerged as a valuable tool for understanding and quantifying various aspects of mouthfeel in food systems. Its ability to study thin film behavior has attracted growing interest from both researchers and the food industry. However, as a semi-empirical approach, tribological measurements require careful interpretation, and comparisons of friction values across different studies should be made with caution.

Declarations

The authors declare that the article is original and not plagiarized. The article is solely submitted to this journal.

References

- Paul, V., Tripathi, A. D., Agarwal, A., Kumar, P., & Rai, D. C. (2022). Tribology–Novel oral processing tool for sensory evaluation of food. *LWT, Food Science and Technology*, 160, 113270.
- Pradal, C., & Stokes, J. R. (2016). Oral tribology: Bridging the gap between physical measurements and sensory experience. *Current Opinion in Food Science*, 9, 34-41.
- Prakash, S., Tan, D. D. Y., & Chen, J. (2013). Applications of tribology in studying food oral processing and texture perception. *Food Research International*, 54(2), 1627-1635.
- Upadhyay, R., & Chen, J. (2020). Rheology and tribology assessment of foods: A food oral processing perspective. *In Biopolymer-based formulations*, 697-715.
- Rudge, R. E. D., Fuhrmann, P. L., Scheermeijer, R., van der Zanden, E. M., Dijkman, J. A., & Scholten, E. (2021). A tribological approach to astringency perception and astringency prevention. *Food Hydrocolloids*, 121, 106951.



Sethupathy, P., Moses, J. A., & Anandharamakrishnan, C. (2020). Food oral processing and tribology: Instrumental approaches and emerging applications. *Food Reviews International*, 37(5), 538–571.

Xu, W., Yu, S., & Zhong, M. (2022). A review on food oral tribology. *Friction*, 1-40.

