

# Emulsification of shea butter

Yuhe Yin

Dankook university, Yongin 16891, Republic of Korea

yinyuhe000718@126.com

**Abstract:** This paper reviews the widespread application of shea butter oil as a popular natural skincare ingredient in cosmetics and personal care products, and explores the importance and application of emulsification technology in the preparation of shea butter oil. Firstly, it introduces the origin, characteristics, and multiple effects of shea butter oil in cosmetics. Secondly, it elaborates on the basic concepts of emulsification, including the types and mechanisms of emulsifiers. Subsequently, it discusses the application of emulsification technology in shea butter oil and methods for optimizing the emulsification process. Finally, it emphasizes the importance of selecting appropriate emulsifiers, controlling emulsification process conditions, and experimentally optimizing to improve the quality and stability of shea butter oil products.

**Keywords:** Shea butter oil, cosmetics, skincare products, emulsification technology, emulsifiers, natural ingredients

## 1. Introduction

Shea butter is a vegetable fat extracted from the seed grains of the *Vitellaria paradoxa*, a fruit tree native to sub-Saharan Africa. Shea butter is becoming increasingly popular in the international market as an ingredient in cosmetics and personal care products[1-3]. Derived from the fruit of the shea tree, this oil is rich in nutrients such as vitamin E, carotenoids and fatty acids and is used in a wide range of skin care products, hair care products and makeup[4]. Its excellent moisturizing, nourishing and antioxidant properties have made shea butter a top choice for many consumers in their daily skincare routine.

In cosmetics and skin care products, shea butter has multiple benefits. It has excellent moisturizing ability to effectively moisturize dry skin and help restore the water and oil balance of the skin. Shea butter is rich in vitamin E and antioxidants that can help fight free radical damage and slow the aging process. Shea butter also has anti-inflammatory and soothing properties and is suitable for sensitive skin and people with skin problems.

To use shea butter in cosmetics, especially in water-based products such as lotions and creams, there is an important challenge to overcome: emulsification[5]. Emulsification is the process in which water and oil, which are not mutually soluble, are uniformly dispersed together by adding emulsifiers and appropriate technological processes. The application of emulsification technology is essential to ensure product quality, stability and user experience.

This paper will discuss the basic concepts of emulsification, including its role in the preparation of cosmetics and the types of emulsifiers; The characteristics of shea butter and the application of emulsification technology in shea butter; The selection of emulsifier and the optimization of emulsifying process, and the future development direction of emulsifying technology in shea butter. Through this review, we hope to better understand how to use emulsification technology to fully leverage the advantages of shea butter to provide consumers with better quality and more stable skin care and cosmetic products.

## 2. Basic concept of emulsification

Emulsification is the process of evenly dispersing oil and water, which are two insoluble liquids, through emulsifiers and appropriate technological processes. Emulsification is a crucial technology in the preparation of cosmetics because many cosmetics, such as lotions, creams, cleansers, etc., usually consist of an oil phase and a water phase. Through emulsification, it can ensure that the oil

and water components in cosmetics are evenly mixed to form a stable emulsion or gel-like product, thereby improving the quality, stability and use of the product.

Emulsifiers play a key role in the emulsification process. They have two main functions: one is to reduce the surface tension of the oil-water interface, so that the oil-water phase is easier to mix; The second is the formation of a stable emulsion to prevent the separation of oil and water. According to their chemical properties and mechanism of action, emulsifiers can be divided into two categories: hydrophobic emulsifiers and hydrophilic emulsifiers.

Hydrophobic emulsifiers are usually oily substances whose molecular structure is oleophilic and can interact with oil phase molecules and coat oil droplets to form emulsions. Common hydrophobic emulsifiers include waxes, oil esters and surfactants. They can stabilize the oil-water dispersion system and prevent the accumulation and precipitation of oil droplets. Lu Li et al. [6] published in 2023 in *Colloids and Surfaces A: The article on Physicochemical and Engineering Aspects*, as shown in Figure 1, evaluated the stability of nanoemulsions prepared with three emulsifiers (OSA modified starch, T/S80 and lecithin). There were significant differences in particle size, potential, turbidity and retention among the three emulsions, indicating that the stability of the three emulsifiers was different.

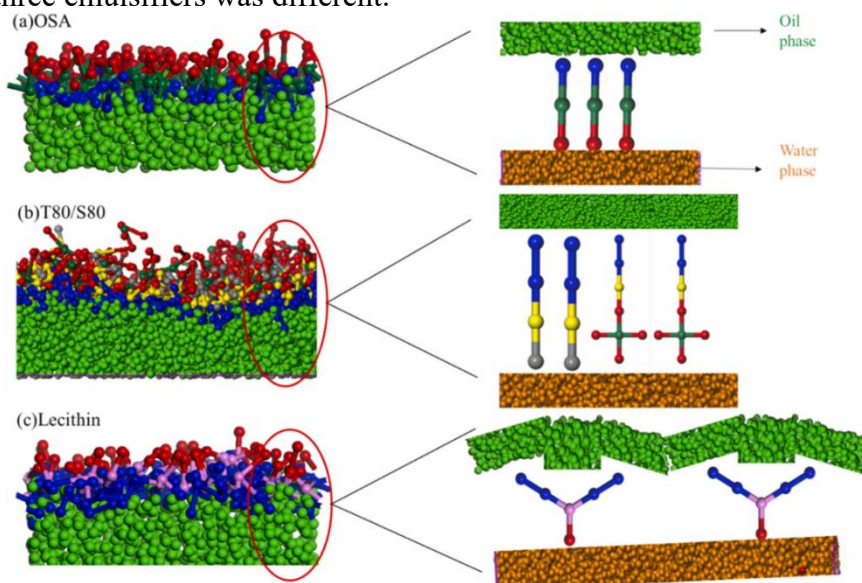


Fig. 1 Emulsification diagram of three emulsifiers[6]

Hydrophilic emulsifiers are water-based substances, their molecular structure has a hydrophilic, can interact with water phase molecules, and dispersed in the water phase to form micelle structure. These micelles are able to coat the oil droplets, preventing them from aggregating and settling, thus stabilizing the formation of the emulsion. Common hydrophilic emulsifiers include gelatin, hydroxyethyl cellulose, glycerin and so on. Dennis J Miller et al. [5] in *Colloids and Surfaces A: The article on Physicochemical and Engineering Aspects*, as shown in Figure 2, shows the structure diagram of the emulsifier constructed by PhysicoChemical and engineering Aspects, indicating that the W/O emulsion can be transformed into an O/W type system by adding hydrophilic emulsifier.



than synthetic ingredients, suitable for sensitive skin and children. Secondly, shea butter has excellent moisturizing and nourishing properties, which can effectively moisturize dry skin and improve dry skin, rough skin and desquamation problems. In addition, its antioxidant properties can help protect the skin from free radical damage, delay the skin aging process, and keep the skin young and healthy.

Shea butter is popular in skin care products for its rich nutrients and excellent skin care effects. It not only effectively moisturizes and nourishes the skin, but also protects the skin from environmental damage, making it an ideal natural skin care ingredient.

#### **4. Application of emulsification technology in shea butter**

The application of emulsification technology in shea butter is essential for cosmetic preparation, ensuring that the shea butter is evenly mixed with the water phase to form a stable emulsion or gel-like product. Different emulsification technologies, such as physical emulsification, chemical emulsification and mixed emulsification, have their own characteristics and applications.

Physical emulsification is a common emulsification technology, the main principle of which is the forced mixing of oil and water by mechanical force. In the application of shea butter, physical emulsification is usually achieved by means of stirring, high pressure homogenization or ultrasonic[9-10]. This method is simple and easy, does not require the addition of additional chemicals, and has less impact on the stability and nutritional content of shea butter. However, physical emulsification may take a longer time to reach a stable emulsion state and may generate a larger amount of heat, affecting the mildness of the emulsion.

Chemical emulsification is to achieve uniform mixing of oil and water by adding emulsifier. In the application of shea butter, common emulsifiers include surfactants, natural gums and polymers. These emulsifiers can reduce the surface tension of the oil-water interface, form a stable emulsion structure, and improve the stability and texture of the product. Chemical emulsification can quickly achieve the emulsification process, and can control the texture and touch of the emulsion, suitable for different types of cosmetic products. However, excessive use of chemical emulsifiers may cause a certain loss of nutrients in shea butter, and may also cause problems with allergies to chemical ingredients.

Mixed emulsification is a technology that combines physical emulsification and chemical emulsification. In the case of shea butter, mixed emulsification is often achieved by a combination of agitation and the addition of emulsifiers. This method combines the advantages of physical and chemical emulsification to achieve the emulsification process quickly while maintaining the nutritional composition and stability of shea butter. Mixed emulsification is a commonly used emulsification technology, which is good at maintaining the texture and nutritional content of the product.

Emulsifiers play a vital role in the application of shea butter, they can reduce the surface tension of the oil-water interface, promote the mixing of the oil-water two phases, and thus form a stable emulsion structure. When choosing emulsifiers suitable for shea butter, the common types include natural emulsifiers and synthetic emulsifiers.

Natural emulsifiers are natural substances derived from plants or animal sources, such as beeswax, gelatin, lecithin, etc. These emulsifiers usually have good biocompatibility and gentleness, are not easy to cause skin discomfort, and are suitable for sensitive skin and children. In addition, natural emulsifiers also have a good nutritional moisturizing effect, which can provide additional moisturizing and protection for the skin. However, natural emulsifiers may have a certain impact on the stability and texture of the product, and it is necessary to make reasonable selection and ratio according to the specific formula. Synthetic emulsifiers are chemical substances prepared by chemical synthesis or processing, such as anionic surfactants, cationic surfactants, non-ionic surfactants, etc. These emulsifiers usually have strong emulsification and stability properties, can quickly achieve the emulsification process, and can control the texture and touch of the product.

The amount and effect of synthetic emulsifiers are relatively easy to control, making them suitable for mass production and industrial applications. However, some synthetic emulsifiers may contain chemicals that may cause skin discomfort or allergic reactions, so caution needs to be considered when using them.

The choice of emulsifier has an important impact on the performance of the product, which is mainly reflected in the aspects of moisture, stability and permeability. The choice of emulsifier directly affects the moisturizing properties of the product. Emulsifiers with good moisturizing properties can help lock in water, enhance the moisturizing effect of the product, and thus keep the skin hydrated and soft. Secondly, the stability of the emulsifier is also crucial for the texture and service life of the product. The right emulsifier can maintain the stability of the product, prevent the separation of oil and water and the collapse of the emulsion structure, so that the product can be maintained in the ideal state for a long time. Finally, the permeability of the emulsifier affects the ability of the product to absorb and penetrate the skin. Choosing the right emulsifier can make the product better penetrate the skin, play the effect of the active ingredient, and improve the effectiveness and satisfaction of the product.

The selection of emulsifier of shea butter in the preparation of cosmetics is very important. Both natural emulsifier and synthetic emulsifier have their own characteristics and applications. When choosing an emulsifier, factors such as product formulation requirements, cost considerations and user groups need to be considered to ensure product quality and effectiveness. Through reasonable selection of emulsifiers, shea butter products can provide better quality and more stable skin care effects to meet the needs and expectations of consumers.

## **5. Optimization of emulsification process**

The emulsification process is a crucial step in the preparation of shea butter, but there may be some challenges in practice. These challenges include the influence of temperature, pH, mixing speed and other factors.

Temperature is one of the key factors to be considered in the emulsification process. The change of temperature will affect the performance of emulsifier and the stability of oil-water phase[11]. Generally, a higher temperature helps to reduce the surface tension of the emulsifier molecules and promote the mixing of the oil-water phase, thus improving the emulsification efficiency. However, too high a temperature may lead to the destruction of the emulsion structure and the failure of the emulsifier. Therefore, in the emulsification process, it is necessary to control the temperature to avoid too high or too low temperature on the quality of the product.

pH is another key factor. The change of pH value will affect the charge state of the emulsifier and the stability of the oil-water phase[12]. In general, emulsifiers work best in their most suitable pH range. Too high or too low a pH value may affect the solubility and stability of the emulsifier, which in turn affects the emulsification effect. Therefore, it is necessary to control the pH value during the emulsification process and select the appropriate emulsifier and formula to meet the requirements of the product.

The stirring speed is also one of the important factors affecting the emulsification process. Proper stirring speed can promote the mixing of oil-water phase and improve the emulsification efficiency. However, too high mixing speed may lead to the destruction of the emulsion structure and the generation of bubbles, affecting the texture and stability of the product. Therefore, it is necessary to select the appropriate mixing speed during the emulsification process and adjust it according to the requirements of the specific product.

In order to optimize the emulsification process to improve product quality and stability, the following measures can be taken. First of all, through the reasonable selection of emulsifiers and formulations, to ensure that it can play the best performance during the emulsification process. Secondly, control the temperature, pH value and stirring speed during the emulsification process to avoid adverse effects on the product caused by too high or too low conditions. In addition,

appropriate process flow and equipment are used to ensure the stability and repeatability of the emulsification process. Finally, sufficient experiments and tests are carried out to adjust and optimize the emulsification process in time to ensure that the product achieves the expected quality and effect.

## 6. Conclusion

Shea butter as a natural skin care ingredient is favored in the cosmetics and personal care products sector. Its rich nutritional content and excellent skin care efficacy make it the first choice for consumers' daily skin care. However, when shea butter is used in cosmetics, emulsification technology is an integral part to ensure that the shea butter is evenly mixed with the water phase to form a stable product. Physical emulsification, chemical emulsification and mixed emulsification are common emulsification technologies, and choosing the right emulsifier is crucial to the stability and use effect of the product. In addition, factors such as temperature, pH value and stirring speed need to be considered during the emulsification process to optimize the emulsification effect and product quality. The quality, stability and user experience of shea butter products can be improved by reasonable selection of emulsifier, control of emulsifying process conditions and experimental optimization to meet the needs and expectations of consumers.

## References

- [1] Abdel-Razek A.G., Abo-Elwafa G.A., et al. Effect of Refining and Fractionation Processes on Minor Components, Fatty Acids, Antioxidant and Antimicrobial Activities of Shea Butter [J]. *Foods*, 2023, 12(8).
- [2] Goubri B.W.F., Da Silva T.L.T., et al. African Shea Butter Properties Related to Common Extraction Technologies: A Review [J]. *Food and Bioprocess Technology*, 2022, 15(2): 231-48.
- [3] Nahm H.S., Juliani H.R., et al. Quality Characteristics of Shea Butter, *Vitellaria paradoxa* [M]//JULIANI H R, SIMON J E, HO C T. *African Natural Plant Products, Vol II: Discoveries and Challenges in Chemistry, Health, and Nutrition*. 2013: 167-84.
- [4] Kaseke T, Opara U L, Fawole O A. Fatty acid composition, bioactive phytochemicals, antioxidant properties and oxidative stability of edible fruit seed oil: Effect of preharvest and processing factors[J]. *Heliyon*, 2020, 6(9): e04962.
- [5] Vaishampayan P, Rane M M. Herbal nanocosmeceuticals: A review on cosmeceutical innovation[J]. *Journal of Cosmetic Dermatology*, 2022, 21(11): 5464-5483.
- [6] Xiong H., Xie X., et al. Stabilization mechanism of different emulsifiers using dissipative particle dynamic simulation [J]. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 2023, 673: 131797.
- [7] Miller D.J., Henning T., et al. Phase inversion of W/O emulsions by adding hydrophilic surfactant — a technique for making cosmetics products [J]. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 2001, 183-185: 681-8.
- [8] Ogunbiyi A, Enechukwu N A. African black soap: Physiochemical, phytochemical properties, and uses[J]. *Dermatologic therapy*, 2021, 34(3): e14870.
- [9] Kumar A, Dhiman A, Suhag R, et al. Comprehensive review on potential applications of microfluidization in food processing[J]. *Food Science and Biotechnology*, 2022, 31: 17-36.
- [10] Tarhan O, Spotti M J. Nutraceutical delivery through nano-emulsions: General aspects, recent applications and patented inventions[J]. *Colloids and Surfaces B: Biointerfaces*, 2021, 200: 111526.
- [11] Sousa A M, Pereira M J, Matos H A. Oil-in-water and water-in-oil emulsions formation and demulsification[J]. *Journal of Petroleum Science and Engineering*, 2022, 210: 110041.
- [12] Marhamati M, Ranjbar G, Rezaie M. Effects of emulsifiers on the physicochemical stability of Oil-in-water Nanoemulsions: A critical review[J]. *Journal of Molecular Liquids*, 2021, 340: 117218.