

The shea butter family - the complete emollient range for skin care formulations.

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Introduction

Shea butter and its derivatives have been known to the cosmetics industry for a long time but recent research has revealed a number of interesting new features, especially concerning the bio-activity of the shea butter minor lipids.

Shea butter is an excellent emollient for both skin and hair care applications. The functionality of native shea butter is further improved by fractionation, yielding liquid emollients enriched in the characteristic triterpene esters such as lupeol and amyirin cinnamates.

Possible beneficial effects in skin care applications from these components include anti-irritant and anti-inflammatory action as well as enhancement of the sun protection factor of organic sunscreens. This article gives examples of the characteristics and functionality of shea butter based emollients.

Origin, history and composition

The history of the Shea tree, *Butyrospermum parkii*, is well known and documented in the Western world since the days of Mungo Park, the British explorer who first described the tree from his journeys in West Africa in the 18th century. In the semi-arid sub-Saharan region the Shea tree is a valuable asset, yielding edible oil for domestic use and products for cosmetic and pharmaceutical uses.

The shea butter is extracted from the fruits and the resulting oil is refined in several steps in order to improve flavour, colour and oxidative stability. The main use of shea butter in the Western world is in chocolate where the similarity in composition and crystallisation properties between shea butter and cocoa butter is utilised. Native shea butter consists mainly of triglycerides and a large fraction of unsaponifiable materials (**Table 1**)

The fatty acid composition of the triglycerides is dominated by oleic, stearic and linoleic acids. The unsaponifiable fraction contains high amounts of cinnamic acid esters of triterpene alcohols but also a smaller fraction

Table 1: Composition of Shea butter and its fractions

Component	Standard shea butter	Liquid shea butter	Shea butter concentrate
Glycerides (%)	92	90	75
Unsaponifiables (%)	8	10	25
- Triterpene cinnamates (%)	4	9	24
Tocopherols (ppm)	100-150	150-200	250-300
Fatty acid composition of glyceride fraction (%)			
Palmitic acid	4	5	5
Stearic acid	42	27	9
Oleic acid	45	57	68
Linoleic acid	6	9	14
Triterpene alcohol composition of unsaponifiable fraction (%)			
Alpha-amyirin	(40-50)	40	37
Beta-amyirin	(5-10)	6	6
Lupeol	(10-20)	9	8
Butyrospermol	(15-25)	14	16

of sterols. The most characteristic triterpene alcohol of shea butter is butyrospermol but other important constituents are lupeol as well as alpha- and beta-amyirin. Shea butter also contains tocopherols (Vitamin E) functioning as antioxidants.

The native shea butter can be modified by both physical and chemical methods. It can be fractionated to yield a hard fraction (shea stearine) containing high melting triglycerides and a low-melting, liquid fraction (shea olein). It can also be hydrogenated to increase the melting point and oxidative stability. The high melting shea butters find their uses as bodying agents in sticks and skin care emulsions while the olein fractions can be used as emollients in a large number of different types of products. Furthermore, emulsifiers and dispersing agents based on shea butter can be made using reactions with polar constituents like polyglycols or glycerol.

The unsaponifiable fraction of shea butter can be

further concentrated, for example by different fractionation techniques, to give products with high amounts of the active triterpene alcohol esters⁽⁹⁾.

The different products coming from the shea butter constitute Karlshamns' Shea Butter Family which can be used in a variety of cosmetic applications. **Table 2** summarises the different product groups available and some typical properties and applications.

Physical and chemical properties

The native shea butter is a semi-solid, waxy material which melts at approximately 30-35°C. However, as always in the case of vegetable fats, the melting point is a poor descriptor of the behaviour and it is more useful to look at the melting profile of the product. The melting profile, also known as the solid fat content (SFC) profile, shows the proportion of solid fat remaining in the sample at different temperatures. The SFC profile for different ranges in the Shea Butter Family is shown in **Figure 1**.

The native shea butter as well as the hydrogenated shea butter find their uses in sticks and other solid formulations. Sometimes it can be difficult to formulate a good product with the native shea butter due to its crystallisation properties. The triglyceride composition of shea butter is such that in order to obtain a good crystallisation and stable crystals, a tempering process needs to be applied to the product. This tempering or pre-crystallisation process brings the triglycerides into a stable crystal form and facilitates the crystallisation when cooling the product. This cumbersome process can be eliminated by using the hydrogenated shea butter which has a simpler crystallisation behaviour. Poor crystallisation can lead to oil migration and bloom formation in the product. Another way to include shea butter in a stick formulation is to replace some of the liquid oil phase with liquid shea butter such as Lipex 205.

The liquid shea fractions do not crystallise at room temperature and are therefore ideally suited for

formulation into both dry and emulsified products. Their oxidation stability is good as illustrated in **Figure 2** showing the development of the peroxide value in samples stored in open bottles at 22°C.

Ethoxylated shea butter is water soluble or dispersible if the degree of ethoxylation is high enough, for example 75 moles of ethylene oxide per mole of glyceride. Such products are often used in hair care preparations where they confer some conditioning effects and lower the irritation potential of the preparation. Lower degree of

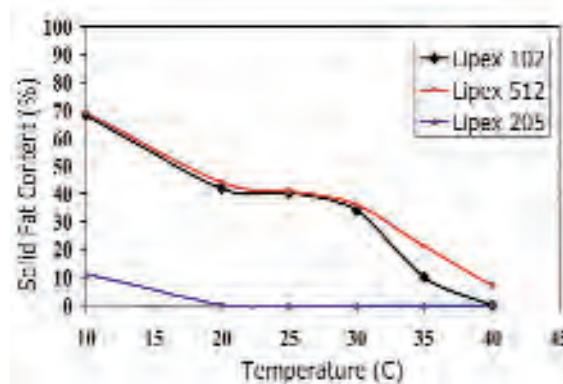


Figure 1: Solid Fat Content (%) measured by pulsed NMR for three Shea Butter based emollients

ethoxylation yields emulsifiers and refatting agents for use in skin care products.

Emollient effect

All shea butters are good emollients and moisturisers due to their unique combination of triglycerides and the unsaponifiable fraction. However, the liquid fractions are easier to use, give a lighter skinfeel and better skin penetration than the more high-melting varieties and are therefore more universally applicable in cosmetic formulations⁽⁹⁾. The emollient effect is well known and numerous skin care products exist with different shea butters added.

Table 2: Karlshamns' Shea Butter family, properties and applications

Category	Name	Melting Point (C)	Unsaponifiables (%)	Applications (%)
Standard	Lipex 102	31	7	Skin care emulsions
Liquid	Lipex 205	8 (cloud point)	8	All round, skin care emulsions, sunscreens, stick products
High melting	Lipex 512	34	8	Stick products
Concentrate	Lipex Shea-U	-5	Min 20%	Active skin care, emulsions, sunscreen sticks
Water dispersible	Lipex 102 E-75	45	N/A	Shampoos, comditioners, shower gels, hair care products

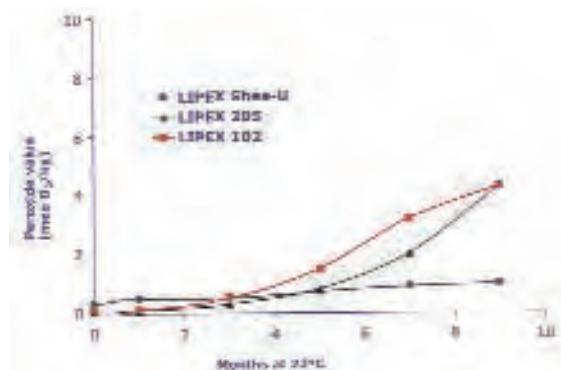


Figure 2: Oxidative stability for three Shea Butter based emollients at 22°C in open bottles stored in darkness

Anti-irritant effects

The ethoxylated shea butter has been shown to have a strong irritation reducing effect when used in a surfactant solution. Lipex 102 E-75 was added to a 25% solution of sodium lauryl sulphate at 1% and 5% and applied to the forearm of human volunteers. The TEWL was measured and an irritation score was determined after 24 hours by evaluating the redness of the treated area.

The TEWL for SLS treated areas was 35 g/m²*h which was reduced to 24 and 18 g/m²*h at 1% and 5% of the ethoxylated shea butter respectively. Eighteen out of twenty test subjects showed no redness when treated with water only as a control.

This number was reduced to 6/20 for the group treated with SLS solution but was improved to 11/20 at 1% and restored to 18/20 at 5% of Lipex 102 E-75. These results indicate that Lipex 102 E-75 acts as an anti-irritant additive in the surfactant solution, probably by complexing the low-molecular weight irritating surfactant in mixed micelles. This effect can be used in formulating mild shampoos and shower products.

UV-absorbing function

The unsaponifiables which are concentrated in the liquid shea butters are rich in cinnamic acid esters of triterpene alcohols. Like all phenolic substances the cinnamic acid has a strong absorbance of UV radiation in the 250-300 nm wavelength range.

When incorporated in a sunscreen formulation, the unsaponifiables give a synergistic interaction with the sunscreen agent by increasing the absorbance values in the UV-B range (Figure 3). This effect is also measured as a SPF value which is around 2 for Lipex 205 and 4 for Lipex Shea-U. This makes Lipex 205 and Lipex Shea-U good emollients for sunscreen formulations, both when used as emulsions but also when incorporated as part of stick formulations.

Anti-inflammatory effect

Triterpene alcohols such as lupeol and alpha/beta-amyrin have been shown to possess anti-inflammatory effects, especially in their esterified forms⁽⁶⁻¹⁰⁾. As these triterpene alcohols are present in significant amounts in native shea butter and at even higher concentration in the liquid varieties, the anti-inflammatory effects of Lipex Shea-U were investigated in an in vitro assay. Normal human epidermis keratinocytes in a growth medium were exposed to a non-sensitizing irritant (croton oil) in the presence of different concentrations of the oil. An increased intracellular synthesis and release of proinflammatory cytokines, measured by intracellular IL-1 α and extracellular IL-8, were taken as signs of an increased irritant stress induced by the croton oil.

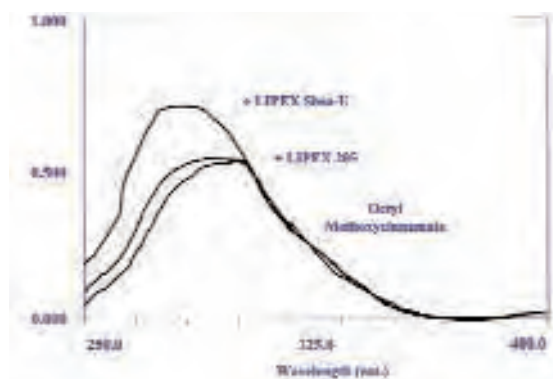


Figure 3: Effect of liquid shea butters on the UV absorption of octyl methoxycinnamate.

Shea butter/octyl methoxycinnamate ratio 6:1

A consistent reduction of the levels of IL-1 α and IL-8 were observed in the presence of hydrocortisone 21-hemisuccinate which was used as a positive control. The results (Figure 4) showed that the production of IL-1 α was reduced with approximately 25% at concentrations between 0.5 to 2.5 mg/ml while the production of IL-8 was unaffected. It was concluded that the fractionated shea butter gave a significant reduction of the inflammatory response of human keratinocytes to croton oil.

The effects of lupeol, alpha- and beta-amyrin on arthritis cited in the references above are related to their ability to suppress the breakdown of collagen in the arthritic joints. A similar effect on collagen regeneration in skin is also associated with sterols and triterpene alcohols⁽¹¹⁾.

Conclusions

The significance of these findings, together with the numerous reports on the bio-activity of triterpene alcohols from other sources, indicate that shea butter unsaponifiables are indeed a very promising active component for new functional cosmetic products. The good stability and the

inherently good formulating properties associated with shea butter in general open up a number of possibilities, extended by the variety of derived products that can be obtained from this well researched raw material.

References

1. Peers, K.E. (1977) The non-glyceride saponifiables of shea butter, *J. Sci. Food. Agric.* 28, 1000-1009.
2. Itoh, T., Uetsuki, T., Tamura, T., and Matsumoto, T. (1980) Characterization of triterpene alcohols of seed oils from some species of Theaceae, Phytolaccaceae and Sapotaceae, *Lipids* 15, 407-411.

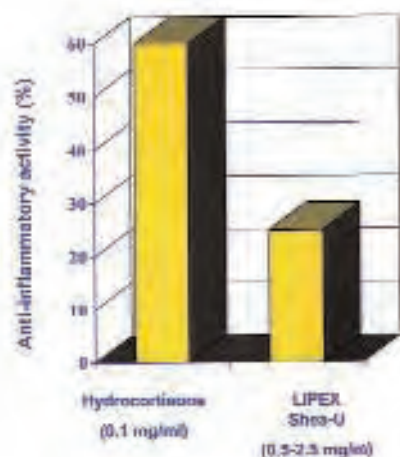


Figure 4: In-vitro comparison of anti-inflammatory effect of Lipex Shea-U with hydrocortisone, measured as release of cytokine IL-1alpha

3. Jeong, T. M., Itoh, T., Tamura, T., and Matsumoto, T. (1975) Analysis of methylsterol fractions from twenty vegetable oils, *Lipids* 10, 634-640.
4. Alander, J., Andersson, A.-C., Malmros, H., and Nilsson, J., (2000) Fractionation process. Karlshamns AB, Sweden, Patent, SE 9801955-7.
5. Zabotto, A., Griat, J. and Bracco, U., (1988), Composition cosmetique aqueuse ou anhydre contenant une phase grasse a base d'huile de karite. L'Oréal, France, Patent, EP0145607
6. Kweifio-Okai, G., De Munk, F., Macrides, T. A., Smith, P., and Rumble, B. A. (1995) Antiarthritic mechanisms of lupeol triterpenes, *Drug Dev. Res.* 36, 20-24.
7. Kweifio-Okai, G., De Munk, F., Rumble, B. A., Macrides, T. A., and Cropley, M. (1994) Antiarthritic mechanisms of amyirin triterpenes, *Res. Commun. Mol. Pathol. Pharmacol.* 85, 45-55.
8. Kweifio-Okai, G. and Macrides, T. A. (1992) Antilipoxygenase activity of amyirin triterpenes, *Res. Commun. Chem. Pathol. Pharmacol.* 78, 367-372.
9. Safayhi, H. and Sailer, E. R. (1997)

Anti-inflammatory actions of pentacyclic triterpenes, *Planta Med.* 63, 487-493.

10. Singh, S., Bani, S., and Singh, G. B. (1997) Anti-inflammatory activity of lupeol, *Fitoterapia* 68, 9-16.
11. Wepierre, J., Papin, A., and Cormier, M. (1988), Protective effects of avocado and soybean lipidic non-saponifiables on proliferation of fibroblasts cultured in altered conditions, *Int. J. Cosmetic. Science* 10, 15-21.

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