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Note

Cosmetic applications for solid lipid nanoparticles (SLN)

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Abstract

Solid lipid nanoparticles (SLN) are novel delivery systems for pharmaceutical and cosmetic active ingredients. This paper highlights advantages of SLN for cosmetic applications. The dependence of the occlusive effect on the particle size of SLN due to film formation is presented by in vitro data. An in vivo study showed that addition of 4% SLN to a conventional o/w cream lead to an increase of skin hydration of 31% after 4 weeks. The application of SLN as physical sunscreens and as active carriers for molecular sunscreens has also been investigated. The amount of molecular sunscreen could be decreased by 50% while maintaining the protection level compared to a conventional emulsion.

Keywords: Solid lipid nanoparticles; SLN; Sunscreens; Skin hydration; Occlusion

Solid lipid nanoparticles (SLN) have been introduced as a novel drug delivery system for pharmaceutical drugs in various application routes (Müller et al., 2000). They also represent a promising carrier system for cosmetic active ingredients due to their numerous advantages over existing conventional formulations (Müller and Dingler, 1998).

SLN possess some features which make them promising carriers for cosmetic applications:

(1) The protection of labile compounds against chemical degradation has been shown, e.g. for retinol and tocopherol (Dingler, 1998; Jenning and Gohla, 2001).
(2) Depending on the produced SLN-type, controlled release of the active ingredients is possible. SLN with a drug-enriched shell show burst release characteristics whereas SLN with a drug-enriched core lead to sustained release (zur Mühlen and Mehnert, 1998; zur Mühlen et al., 1998).
(3) SLN act as occlusives, i.e. they can be used in order to increase the water content of the skin (Wissing et al., 2001).
(4) SLN show a UV-blocking potential, i.e. they act as physical sunscreens on their own and can be combined with molecular sunscreens in order to achieve improved photoprotection (Wissing and Müller, 2001a,b).

This paper deals with the effect of SLN on skin hydration and with their UV-blocking ability.

We have investigated the occlusive effect of SLN depending on the particle size using an in vitro occlusion test developed by de Vringer (de Vringer, 1992). Here, the evaporation of water through a membrane is measured and the occlusion factor F is calculated. In the test, 10.6 mg/cm^2 sample were applied evenly on a cellulose acetate membrane. The samples were stored

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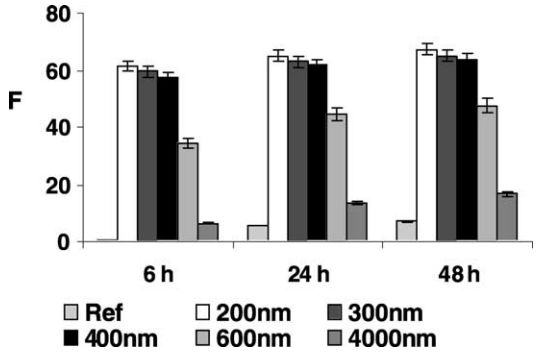

Fig. 1. Occlusion factor F in dependence on the time and as a function of the particle size of the SLN dispersions.

at 32 °C and 50–55% r.h. and weighed after 6, 24 and 48 h. Each experiment was carried out in triplicate.

Fig. 1 shows the dependence of F on the particle size of cetyl palmitate SLN dispersions. High occlusion factors of 50–60 can be obtained when the particle size is below 400 nm. Lipid microparticles are only slightly occlusive with F values below 15.

The effect of SLN on skin hydration has been further investigated in a blind, placebo-controlled in vivo study. Formulation A consisted of an o/w cream and formulation B was the o/w cream enriched with 4% SLN. 25 volunteers applied the creams twice daily for 4 weeks on their volar forearms. The skin hydration was measured with a Corneometer CM 825 (Courage & Khazaka, Germany).

Fig. 2 shows the results of the in vivo study. Within 14 days, the SLN containing cream lead to an increase

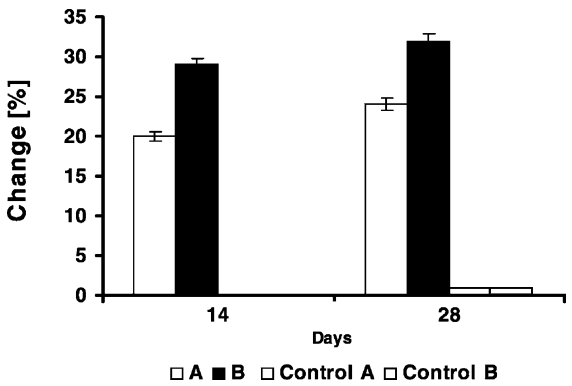

Fig. 2. In vivo study: changes in Corneometer values after application for 14 and 28 days (A: placebo o/w cream; B: o/w cream containing 4% SLN, controls: untreated areas).

in skin hydration of 29%, the placebo to an increase of 21%. After 28 days, these values came up to 32% for the SLN and 24% for the placebo. Both formulations were found to be excellent skin hydrating agents, however, the SLN-containing cream was significantly more efficient.

Today, the public awareness regarding the harmful effects of UV radiation combined with the problem of the ozone layer is rising (Gabard et al., 1999). Therefore, the use of sunscreens is common in daily life.

There are two different ways of action for sunscreens: physical sunscreens such as micronised titanium dioxide reflect and scatter incoming UV-radiation. Their efficacy depends strongly on their particle size, refractive index and film thickness on the skin (Wolf et al., 2001). Molecular sunscreens absorb UV-radiation. They contain conjugated π-and n-electrons which are excited by certain wavelengths. The absorbed radiation is then re-emitted as thermal energy or light (Patel et al., 1992; Wolf et al., 2001).

Due to their particulate character, SLN act as physical sunscreens on their own. Incorporation of molecular sunscreens is possible and leads to long-term stable formulations (Wissing and Müller, 2001a; Wissing, 2002). The composition and physicochemical characterisation of the investigated formulations is given in Table 1.

The Transpore test developed by Diffey served as an in vitro method to investigate the UV-blocking ability (Diffey and Robson, 1989). Here, the formulation is spread evenly on top of the Transpore tape at a concentration of 2 mg/cm^2. After a drying period of 15 min, the sample is scanned from 450 to 280 nm and the absorption is measured.

The wavelength scans of the placebo formulations are given in Fig. 3. Both SLN formulations are distinctly more effective than the corresponding

Table 1
Composition and PCS data (diameter, PI: polydispersity index) of the investigated SLN-formulations (X: 10%, 20%, 40%; Y: 5%, 10% with regard to the lipid matrix)

Code	Composition	PCS diameter (nm)	PI
10% SLN	X% cetyl palmitate	195	0.134
40% SLN	1.2%/2.4%/3.6%	223	0.081
20% SLN–5% O	Tego Care 450	188	0.120
20% SLN–10% O	Y% oxybenzone	186	0.070

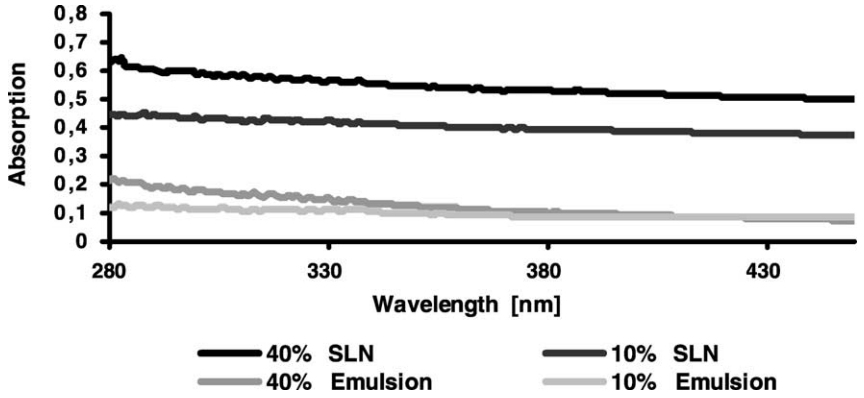

Fig. 3. Wavelength scans of placebo SLN formulations and reference emulsions containing 10 and 40% lipid (composition: c.f. Table 1).

emulsions. This is due to the particulate character of the SLN. The solid particles are stronger scatterers than the liquid emulsion droplets.

The wavelength scans of the formulations containing oxybenzone incorporated in the lipid matrix are shown in Fig. 4. Again, the SLN formulations are distinctly more effective than the corresponding emulsions. The concentration of the molecular sunscreen can be decreased by 50% while maintaining the absorption level. Due to the fact that the incorporation of molecular sunscreens in SLN leads to synergistic UV-blocking behaviour, SLN appear to be a promising carrier system for sunscreen formulations.

Concluding, it can be remarked that:

- SLN with a desired degree of occlusion can be produced when, e.g. the particle size is taken into account.
- It has been shown in vivo that SLN are excellent vehicles for skin hydration.

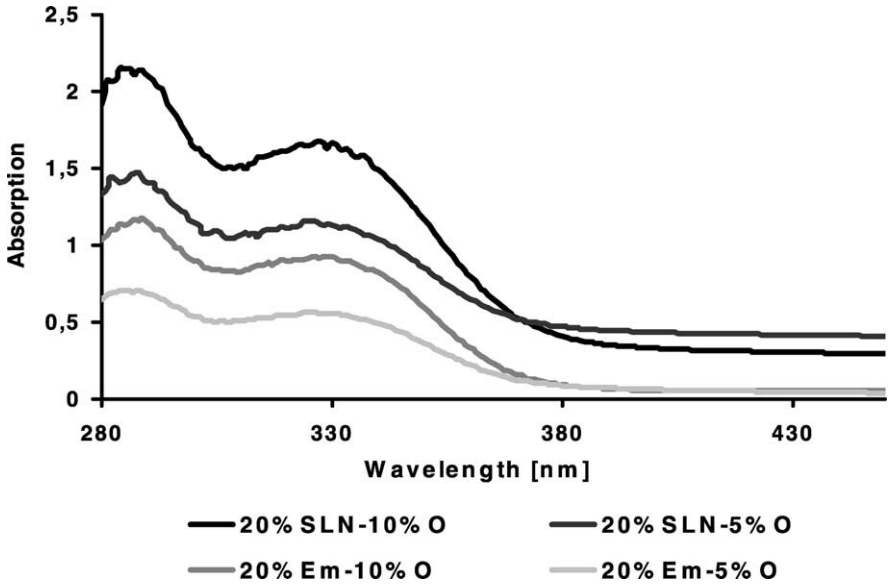

Fig. 4. Wavelength scans of SLN formulations and reference emulsions containing 5 and 10% oxybenzone with regard to the lipid matrix (composition: c.f. Table 1).

- SLN are physical sunscreens with increased UV-blocking ability compared to reference emulsions.
- Incorporation of molecular sunscreens in SLN leads to synergistic UV-blocking effects. Therefore, the concentration of molecular sunscreens of a formulation can be decreased while maintaining the protection level.

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