Development and Evaluation of Resveratrol and Vitamin E Acetate-loaded Lipid Nanoparticles for Skin Care Applications

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ABSTRACT SUMMARY
Resveratrol and vitamin E acetate loaded Solid lipid nanoparticles (SLN) and Nanostructured lipid carriers (NLC) were formulated. The nanoparticles were evaluated for their ability to carry, protect, and control the release of the actives. It was found that the nanoparticles were developed with high size uniformity and high stability, and was able to provide desired sustained release of the active.

INTRODUCTION
Solid lipid nanoparticles and Nanostructured lipid carriers have been studied as potential carriers for both dermal and transdermal drug delivery. SLN contains lipid droplets that are fully crystallized and have a highly-ordered crystalline structure. NLC is a modified SLN in which the lipid phase contains both solid and liquid lipids at room temperature.1-3 SLN and NLC are thought to combine the advantages of polymeric particle, liposomes and emulsions. Therefore they provide high encapsulation percentages, better protection for incorporated actives and allow for control of desired release profile.

In this work, resveratrol and vitamin E acetate, both potent antioxidants known to provide protection to the skin, were formulated into lipid nanoparticles. Several different formulations were developed for each active with varying amounts of water, solid lipid, liquid lipid, and surfactant. Such nanoparticles were characterized and evaluated for their stability and active release profiles.

EXPERIMENTAL METHODS
The resveratrol and Vitamin E-acetate loaded lipid nanoparticles were prepared via a hot high pressure homogenization technique using a Micro-fluidizer.2,4 The prepared formulations were physicochemically characterized by photon correlation spectroscopy (PCS) and zeta potential (ZP) measurements. PCS gives information about the average particle size and the polydispersity index (PI). For PCS measurements, the samples were diluted with deionized water 400 times to a suitable concentration and measured with a Malvern Zetasizer nanoZS. After two months of storage, the particle size and zeta-potential was rechecked to ensure that the lipid nanoparticles were still stable.

Active entrapment efficiency (EE) in the nanoparticles was assessed by analyzing the active residue concentration in aqueous solution. The sample was placed into an Amicon ultra centrifuge filter unit and centrifuged at room temperature for 1 hr. The clear filtrate was collected for HPLC analysis. The nanoparticle sample was dissolved in ethanol for HPLC analysis of total active concentration in the formulation. The EE percentage was calculated by the equation, EE = (W_{total} – W_{free})/W_{total}.

Negative staining Electron transmission microscopy (TEM) was utilized to obtain imaging of the nanoparticles to help us understand the particle morphology and confirm the size of particles measured by zeta-sizer. 5 µL 1% aqueous phosphotungstic acid (PTA) (pH 6.5) was applied for negative staining before viewing on a JEOL JEM-1400 transmission electron microscope.

A simple and efficient release method was developed and utilized to monitor the release of the active from the lipid nanoparticles using a dissolution system. 1 mL of the nanoparticle formulation was placed in a Dialysis bag to help simulate release and contain other components that could interfere with the UV-Vis analysis and the dissolution system. The Dialysis bags were then placed in the dissolution vessels.
which contain 200 mL DI water. The release data was acquired every 15 min during the 24 hr assessment period.

RESULTS AND DISCUSSION

Produced resveratrol loaded lipid nanoparticles had an average size from 274–324 nm with relatively narrow PI and possessed zeta-potential -30– -34 mV. After two month of storage at 4 °C, the nanoparticles retained very similar size range and zeta-potential, 273–324 nm and -27– -34 mV. Vitamin E acetate loaded lipid nanoparticles had a smaller average size from 122–196 nm. The zeta-potential was from -25– -34 mV. After 1 year of storage at 4 °C, the data showed that the average size of the nanoparticles was 145-211 nm and the zeta-potential was -27– -45 mV.

Entrapment efficiency of actives in the nanoparticles was calculated as 98.8% for resveratrol, and 94% for Vitamin E acetate.

Negative staining TEM of Resveratrol loaded nanoparticles clearly showed the spherical morphology and suggested particle size around 300nm, which is in line with the Zeta-sizer data.

The release study showed sustained release for the resveratrol loaded lipid nanoparticles, where 50% of the loaded active released after 7.5 hours and 70% released after 24 hours.

CONCLUSION

Resveratrol and Vitamin E acetate loaded Solid Lipid Nanoparticles and Nanostructured Lipid Carriers were successfully prepared and demonstrated high uniformity and stability. The release study exhibited a sustained release of Resveratrol over 70% after 24hrs. Our findings suggest that lipid nanoparticles are promising viable carriers for the delivery of resveratrol and vitamin E acetate to provide long-lasting antioxidant benefits to the skin.

REFERENCES


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