Available online on 17.12.2020 at http://jddtonline.info

Journal of Drug Delivery and Therapeutics

Open Access to Pharmaceutical and Medical Research

Open Access Review Article

Improving Bioavailability of Phytochemicals through Niosomes

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Abstract

The role of nanotechnology in different sectors is increasing and improving day by day. The nanovectors or nanovehicles play a very major role in transporting essential components into the body across barriers, such as skin, intestine, blood-brain barrier, etc., which is a very essential part of pharmacology. Niosomes are one such vehicle of nano size, which can effectively improve the delivering properties of therapeutically and cosmeceutically important compounds. This short review examines different research that has been carried out in the last two decades involving Niosomes to improve the bioavailability of pharmaceutically important phytochemical compounds.

Keywords: Niosomes, Phytochemicals, Bioavailability, Drug delivery

Article Info: Received 08 Oct 2020; Review Completed 26 Nov 2020; Accepted 09 Dec 2020; Available online 17 Dec 2020

Cite this article as:

Poorani V, Selvakumar K, Venkat Kumar G, Improving Bioavailability of Phytochemicals through Niosomes, Journal of Drug Delivery and Therapeutics. 2020; 10(6-s):119-121 http://dx.doi.org/10.22270/jddt.v10i6-s.4459

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INTRODUCTION

Nanotechnology is improving every science discipline in one or the other way through varied means. The role of nanotechnology in medicine, especially in pharmaceuticals is remarkable in recent decades. Nanotechnology provides nanoscale size-dependent tools for pharmacology to treat varied diseases effectively. Nanoparticles, nanorods, nanocones, nanofibers and nanovesicles are some of the greatest tools that nanotechnology has rendered to pharmaceutical technology in the recent past.

Among the same, nanovesicles form the base for different medicinal mechanisms, which involve the carrier-based drug delivery systems. Gene delivery and drug delivery are two of the major applications of the nanovesicles. Nanotechnology utilizes the evolutionarily important concept of supramolecular assembly for the synthesis of the nanovesicles. Liposomes are one of the prime nanovesicles reported several decades back, since then they have been modified greatly in varied forms to produce different nanovesicles that can actively function as carrier vehicles to transport different molecular passengers. This evolution of liposomes has led to several types of nanovesicles including but not limited to niosomes, discosomes, ethosomes, virosomes, transferosomes, etc. Among the list, the niosomes attract many researchers owing to their potential application scope in effectively carrying and delivering cosmeceuticals and pharmaceuticals[1].

Niosomes are a class of nanovesicles made up of surfactants, which are nonionic in nature. Niosomes have been researched much in the past two decades along with the growth of the nanomedicine sector. Plant compounds have been used since BC for the curing and ailment of humans and animals from varied diseases. However, there are several factors of the plant compounds that reduce them from becoming active drug-like molecules. Because of the same, the effective release of these plant drugs into the active site reduces and the question of bioavailability becomes a matter of discussion. Nanovesicles help these plant compounds greatly in different ways to improve their bioavailability. Niosomes have been found to contribute to their development greatly in both in vitro and in vivo conditions[2]. There is no remarkable review, which evaluates the role of niosomes in improving the bioavailability of phytochemicals. This short review article comprehensively covers the potency of niosomes in carrying plant-based pharmaceuticals and improving their bioavailability in the last two decades.

PHYTOCOMPOUNDS BIOAVAILABILITY IMPROVEMENT THROUGH NIOSOMES

Caffeine is one of the common ingredients found in widely used beverages, such as coffee, tea, etc. It acts as a mental stimulant and also possesses a range of pharmacological activities, which make its application wider. A research work attempting transdermal delivery of caffeine was carried out

by Payam Khazeli et al. in 2006. Niosomal formulation of caffeine was made and experimented with for release studies through Franz diffusion cell in vitro. The researchers tried altering the outer charge of the niosomes and studied the efficiency in the release of caffeine. Positively charged niosomes entrapped less caffeine than the neutral one; however, they were able to deliver more caffeine comparatively[3].

Oryza sativa (rice) is one of the most highly consumed staple foods across countries. Rice contains a hard outer layer called bran, which is usually removed during processing. The chemical constituents of the rice bran, such as oryzanol, ferulic acid, etc. possess therapeutic values and find usage in cosmetic products. Degradation over a short period is one of the key challenges in using the antioxidants in cosmetic applications and hence Aranya Manosrai et al. developed gel and cream containing niosomal formulations of rice bran extracts. The niosomal formulations were experimented in vitro, ex vivo and in vivo and were found to be more effective in producing good antioxidant activity and high skin hydration ability[4].

Gymnema sylvestre is a herb used widely in traditional medicine for its antidiabetic and antidiuretic properties. Gymnemic acid is one of the important components of the *Gymnema sylvestre* which is pharmacologically active. However, the drug-likeness property of this gymnemic acid is poor. The solubility and instability in gastric conditions and affinity towards cholesterol make it less preferable for therapeutical purposes. Niosomes can be a better option for improved delivery of these gymnemic acids. Bhagyashree Kamble et al. in 2013 developed niosomal constructs entrapping alcoholic extract of *Gymnema sylvestre* and tested their deliverability efficiency under in vitro and in vivo conditions. Gymnema-niosomal formulation exhibited a higher percentage of blood glucose level reduction comparatively[5].

Living fossil, *Ginkgo biloba* is a very old plant species that possess excellent medicinal properties including antioxidant and anticancer abilities. The phytochemical components of this plant were known to induce a neuroprotective effect. It is also a better candidate to treat diseases, such as Alzheimer's. However, the bioavailability of the phytocompounds is poor. To overcome the same, Ye Jin et al. in the year 2013 reported niosomal formulation development of *Ginkgo biloba* extract and its in vivo evaluation experiments in the rats. The niosomal formulations were found to cross the blood-brain barrier (BBB), which demonstrated niosomes as a potent vehicle for improving the bioavailability of therapeutical molecules across BBB[6].

Curcumin is one of the major components of the widely used *Curcuma longa*. It is well known for its medicinal properties across the world. But still, the solubility and stability issues of the compound make it less preferable for clinical applications. Xu et al. in the year 2016 developed a novel niosomal formulation of curcumin using chemical compositions, such as Span 80, Tween 80, and Poloxamer 188. The niosome construct was able to retain more than 92% of the loaded curcumin and proved to be a bioavailability enhancer (1.40 folds) in the antitumor cell line study performed in comparison to the crude extract[7].

Withania somnifera is a medicinal plant well known in ayurvedic medicines. It is commonly known as aswagandha. It is being used for its variety of medicinal properties, such as antibacterial, antidiabetic, antihypertensive, antiaging, anticancer, etc. Tawona N Chinembiri et al. developed niosomes entrapping crude extract of *Withania somnifera* and characterized the same. The complex was aimed for topical applications and the penetration of the phytoconstituents through the skin. In vitro and ex vivo studies have been performed for analyzing drug release efficiency of the niosomal construct. Niosomes have successfully taken the phytochemicals across the stratum corneum barrier[8].

Myrtus communis is a common flowering plant known for its traditional medicinal activities including wound and burn healing, curing ulcers, bleeding of nose, etc. It is a very good source of antibacterial compounds. Niosomal formulation of *Myrtus* extract was developed by Mahboobeh Raeiszadeh et al. and tested against different pathogenic microorganisms. The niosomal formulation tested has shown up to 93.4% entrapment efficiency and has shown consistent and steady release of the phytochemicals under in vitro conditions. The formulation was proposed by the researchers for oral drug delivery purposes[9].

Lawsone is of the phytochemical compounds present in the plants, such as henna and water hyacinth. It is a dye compound that renders orange stain to hair and skin through binding with the keratin. Apart from staining, medicinal values of lawsone have also been reported[10]. However, wide application of lawsone was limited as a result of its poor solubility, which in turn affects its stability, permeability and bioavailability. An attempt to improve the bioavailability of lawsone through niosomes was carried out by M. Barani et al. in 2018. The researchers have developed nano size (~250 nm) niosomes of henna extract using cholesterol and non-ionic surfactants as nanovesicles forming composition. The efficacy study of niosomal construct was carried out in MCF-7 cell line, which has shown increased anticancer activity thus proving the improved stability and bioavailability of the formulation[11].

Annona squamosa is one of the plant members known for its fruit called sugar apple and also for medicinal properties of its different plant parts. Different research analyzing its efficacy in evaluating antioxidants, antibacterial, anticancerous and antidiabetic potential has been performed so far. For improving the bioavailability, stability and prolonged release E.A. Mohammed et al. have developed niosomal formulations of the leaves extract of *Annona* squamosa. They have tested the usefulness of the niosomal form through in vitro experiments and also ex vivo experiments using the abdominal skin of the rat. The in vitro results have shown that, the niosomes help in the reduction of the rapid release of the extracts and increase the consistent release in a prolonged way. The skin-based penetration studies have shown the active penetration of the niosomal formulation across the skin barrier. The authors claim the usage of niosomal formulation for better transdermal delivery of the phyto extracts[12].

FUTURE PERSPECTIVES

Niosomes as a nano transporter can do a lot for improving delivery parameters of many compounds which usually lack drug-likeness due to different lagging in their physiochemical parameters. The potency of niosomes in increasing the bioavailability of phytochemicals is discussed in this review. Even though several works have been carried out in this genre, the real exploration about niosomes and their delivering capabilities are yet to be explored greatly. With special mention, the role of niosomes in developing effective phytocosmetics is still at a novice level. More research should be focused on in this way, which could essentially improve the quality of traditional medicine and skincare.

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