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REVIEW ARTICLE **OPEN ACCESS**

The Effect of Natural Polymers On Transdermal Drug Delivery System

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ABSTRACT

Natural polymers can be used as the means of achieving predetermined rates of drug delivery. Natural polymers are basically polysaccharides so they are biocompatible and without any side effects. Natural materials like gums, mucilages, resins, and plant extracts are frequently used in both traditional and cutting-edge dosage forms. The major reasons why natural polymers are still in demand are that they are cheaply available, easily modified chemically, potentially biodegradable, and compatible due to their origin. The applicability of polymers of transdermal drug delivery system is to control the release of the drug from the transdermal drug delivery system and may be used to formulate various controlled and targeted drug delivery system. Natural polymers are an effective way to deliver drugs at specified rates, and their availability combined with favourable physico-chemical properties makes them an ideal choice for transdermal drug delivery systems. In order to administer the drug(s) embedded in the patch through the skin over a predetermined length of time, a transdermal drug delivery system is a patch constructed of one or more types of polymers. Another method for achieving controlled drug release is to embed the drug on a polymeric material, which will then release the medication into the bloodstream in a preplanned, regulated manner.

Keywords: *Natural polymers, Transdermal drug delivery, Controlled release*

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INTRODUCTION

A transdermal drug delivery system is a method of administering drugs topically through the use of patches that release the medication through the skin at a controlled and predetermined rate [1]. Transdermal drug delivery system is another term for the medicine that enters the systemic circulation through the skin in sufficient amounts to have a therapeutic effect [2]. The transdermal drug delivery system includes the diffusion of medications across the epidermal layer into sustained release after passing through the stratum corneum of the skin. Due to the comparatively straightforward and non-invasive administration of this technique, also known as topical medication delivery, research interest has expanded noticeably over the past few decades [3]. Problems with gastrointestinal absorption and the hepatic first pass effect are reduced with transdermal drug delivery system. The advantages of transdermal drug delivery system is, the reduction in strength and dosing frequency, predictable and extended duration of action, better patient compliance, and immediate termination of system from the skin surface by simple removal, and self-application is also possible[4].

The polymers are the important part of the transdermal drug delivery system, which regulate the drug release from the system. A polymer is a large macro molecule which made up of repeating monomer unit. These monomer units are connected with each other by covalent bond. The polymers are classified as natural polymers, semi synthetic and synthetic polymers. Plant derived or natural polymers are efficiently used in pharmaceutical formulations to prepare the solid monolithic matrix systems, implants, films, beads, micro particles, and nanoparticles, viscous liquid formulations, inhalable and injectable systems. Polymeric materials have served as binders, matrix former or drug release modifiers, film coating formers, thickeners or viscosity enhancers, stabilizers, disintegrates, emulsifiers, suspending agents, gelling agents, and bio adhesives within various dosage forms. A transdermal drug delivery system's main component is polymer.

New drug delivery system techniques and novel mechanisms of action are being sought after as frontier research areas. It offers a multidisciplinary scientific approach that will significantly increase therapeutic

index and bioavailability in certain drug delivery. A drug delivery system integrates engineered technology with one or more conventional drug delivery methods. The technologies make it possible to target a drug release in the body at a certain region of the body and/or at a specific rate.
In nature, natural polymers are biodegradable and bio-absorbable and it offer high biocompatibility. Different types of polymers are now used for the delivery of drugs [5].

Advantages of transdermal drug delivery over other routes[6]
The transdermal route has proven to be more favourable than other methods for the following reasons:

- It allows patients to administer themselves in pain-free, comfortable manners.
- Transdermal drug delivery system may be effective in those individual who are taking multiple medications.
- To avoid frequent dosage administration, TDDS is helpful for drug with short half-life.
- Reduce inter and intra – patient variability by simplified medication regimen.
- Patients with unconsciousness, dysphagia, or constipation benefit more from transdermal drug delivery system.
- Eliminating pre-systemic metabolism reduces the amount of medication provided, reducing side effects and making patients safer who have limited liver function.
- It is Beneficial in especially when long-term treatment is required, as in chronic pain treatment hormone replacement, smoking cessation therapy etc.
- By removing the patch, the drug input can be ceased at any time.
- Because patches are designed to deliver drugs for 1 to 7 days, transdermal drug delivery system is generally less expensive and more cost effective than other therapies.
- People who are not preferred to take medications orally can use topical patches as an alternative.

Advantages of natural polymers[7]

A. Natural polymers are produced by living organisms, so they have no adverse effects on the environment or humans.
B. These are non toxic in nature because they are all plant materials, which are carbohydrate in nature and made up of repeating monosaccharide units. Hence, they are non-toxic.
C. They are cheaper and their production cost is less than synthetic material.
D. They are derived from natural sources, making them safe and free of side effects.
E. In many countries, they are produced due to their wide application in many industries**.**

Mechanism of action
TDD is a painless approach for administering drugs to the body that includes applying a drug formulation to healthy, intact skin. Without accumulating in the dermal layer, the medication first penetrates through the stratum corneum and then travels into the epidermis and dermis. Once it reaches the dermal layer, the dermal microcirculation makes the medication available for systemic absorption [8].
The transepidermal and transappendegeal are the two conceivable routes for drug to cross skin. In the transepidermal route molecules must passes through the stratum corneum, an architecturally varied, multi-layered and multi-cellular barrier. Transepidermal penetration may be intraor intercellular.. Hydrophilic or polar solutes can be transported intracellularly through corneocytes or keratinocyes and Lipophillic and non polar solute can transport via inter-cellular spaces through the continuous lipid matrix. The transappendegeal route leads molecules passing via hair follicles and sweat glands [9].

NATURAL POLYMERS USED IN TRANSDERMAL DRUG DELIVERY SYSTEM
Gum Arabic
It is also known as Acacia gum, Indian gum, or Arabica gum. It is the dried gummy discharge of Acacia Senegal (Leguminosae) or Acacia Arabica (Combretaceae) stems and branches. Other names for gum include gum arabic, gummi arabicum, gum acacia, and gummi africanum. Gum arabic is a branching molecule with 1, 3-linked -D galactopyranosyl units as its primary structural component.It is made up of monosaccharide sugars like rhamnose, glucuronic acid, and arabinose[10].
Agar
Agar, also known as agar-agar, is a dried gelatinous substance derived from Gelidium amansii (Gelidaceae) and several other red algae species such as grailaria (Gracilariaceae) and Pterocladia (Gelidaceae). Agarose and Agaropectin are the two main polysaccharides found in agar. Agarose is used to determine the gel strength of agar (a neutral gelling fraction). Agaropectin is responsible for agar solution viscosity (a sulphated non-gelling fraction) [11].
It can create gels that are more resistant (stronger) than those created by any other gel-forming substance due to its excellent aqueous environment gelling capacity. Because of its great reversibility, its

gel can be repeatedly melted and gelled without changing any of its original characteristics. In the pharmaceutical industry, it serves as a laxative, tablet disintegrates, bacterial culture medium, suppository gelling agent, surgical lubricant, and suspending agent.

Alginates

Sodium alginate is a naturally occurring polysaccharide that can be found in seaweeds, marine brown algae, and bacteria including Pseudomonas aeruginosa and Azobacter vinelandi.Many pharmaceutical experts use alginate and its derivatives for tissue engineering and drug delivery applications. Alginates have been used as stabilizers in emulsions, suspending agents, tablet binders and tablet disintegrants[12].

Xanthum Gum

By fermenting the gram-negative bacterium *Xanthomonas campestris*, xanthan gum, a high molecular weight extracellular polymer, is formed. In the oral controlled release dosage form it is used as matrix former and potential excipients[13]. The reasonable fast initial release demonstrated by the xanthum patches, followed by controlled drug release over a 10 hour period.

It has pharmaceutical applications as a sustained release agent, pellets, and a controlled drug delivery system. It is also used in toothpaste and ointments as a suspending agent, emulsifier, and stabiliser. At concentrations less than 0.5%, xanthan gum is most commonly used as a stabiliser in suspensions and emulsions.

Tamarind Gum

Tamarind Gum, also known as Tamarind Kernel Powder (TKP). It is obtained from Tamarindus indica seed polysaccharide (Leguminoseae).It is insoluble in organic solvents but dispersible in hot water to form a highly viscous gel, such as a mucilaginous solution. Pharmaceutical applications include hydrogels, mucoadhesive drug delivery for ocular purposes, and nasal drug delivery[14].

It serves as a binding agent, an emulsifier, a suspending agent, and a sustaining agent. As a result, it is used as a stabiliser, thickener, gelling agent, and binder in the food and pharmaceutical industries. Other significant traits of tamarind seed polysaccharide (TSP), in addition to these, have recently been discovered[15]. They include mucoadhesivity, biocompatibility, high drug holding capacity, non-carcinogenicity, and high thermal stability.

Guar Gum

Guar gum is a seed gum made from the powdered endosperm of Cyamopsis tetragonolobus seeds (Leguminoseae). Because of this gelling property, it can be used as a versatile carrier for extended drug release formulations. Pharmaceutically, it is used as a carrier for oral extended release drug delivery. It has a high potential for use in colon targeted drug delivery as a carrier for oral controlled release matrix systems and as cross-linked microspheres[16].

It is used as a binder, disintegrant, thickening agent, emulsifier, bulk laxative, appetite suppressant, and sustained release agent. For the delivery of oral extended release formulations, guar gum has recently received attention for being both affordable and adaptable. Additionally, it serves as an emulsion stabiliser, tablet binder, and thickening agent for lotions and creams.

Tragacanth

The branches of the *Astragalus gummifer* are where this gum is sourced (Leguminosae). A water-soluble component termed tragacanthin can be found in tragacanth in amounts ranging from 20% to 30%. Tragacanth, either alone or in combination with other polymers, achieved excellent release prolongation when utilized as the carrier in the formulation of 1 and 3 layer matrices. Pharmaceutically, It is used in sustained-release formulations as an emulsifier, thickening agent, and suspending agent. It is used as a demulcent, emollient in cosmetics and stabiliser and diluent in tablet formulations. [17]

Chitosan

It is primarily obtained through the deacetylation of chitin derived from the exoskeletons of crustaceans such as shrimp, crab, lobster, and other shellfish. Hydrophylic macromolecules including peptide and protein drugs, heparins, and their derivatives can be delivered through the mucosa more effectively and safely by using chitosan and its derivatives as absorption enhancers. For regulated drug release, chitosan nano- and microparticles are also useful[18]. They are naturally hydrophilic, very stable, safe, biocompatible, biodegradable, non-toxic, and gel-forming. Chitosan is a promising candidate for the development of a various traditional and noval gastrointestinal dosage forms because of these qualities. Because of its gelling and adhesive properties, cationic polymer chitosan has been studied as an excipient in controlled delivery formulations and mucoadhesive dosage forms. Due to its biocompatibility, biodegradability, and potential to alter the charge density and molecular chain length of the chitosan in the membrane without affecting its status as a natural biopolymer, the use of chitosan in transdermal patches appears to be appealing [19].

Jackfruit Mucilage

The jackfruit, *Artocarpus heterophyllus*, is a member of the Moraceae family. It is referred to as Kathal in Hindi.The Western Ghats' evergreen forests, which are located at an altitude of 450–1200 m, are native to this enormous evergreen tree that grows to a height of 10–15 m. Straight, cylindrical stem which is covered in smooth or slightly rough black or green bark. Since jackfruit is primarily composed of carbohydrates, it serves as a good source of energy. After hydrolysis, the fruit pulp yields rhamnose, xylose, arabinose, and glucose[20].

In mucoadhesive formulations, jackfruit polysaccharide has reportedly been used as a pharmaceutical excipient. Due to its special characteristics including high wettability, water uptake, and swelling property, it may be used as a binder in tablets, sustaining agent in matrix tablets, and mucoadhesive substance in buccal tablets. In the future, jackfruit mucilage should be investigated as a suitable inert pharmaceutical excipient because it has the potential to be a promising polymer for the film formulation [21].

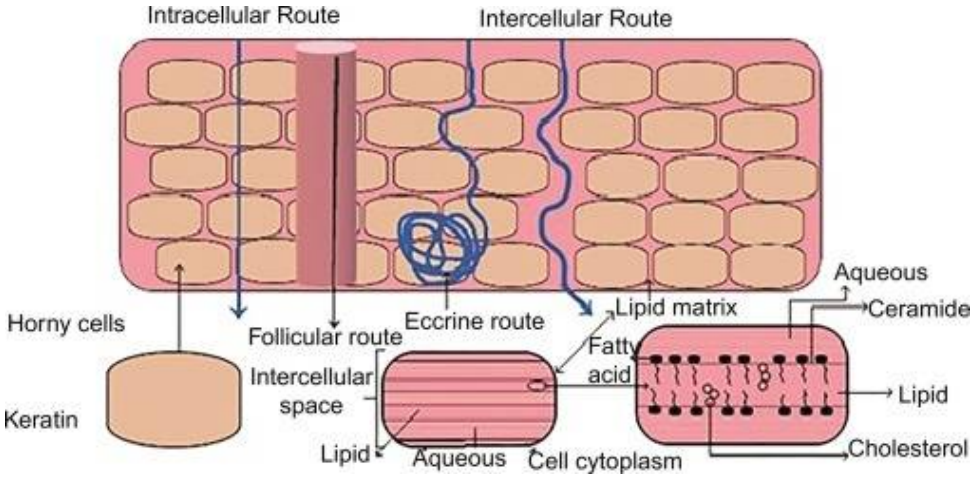

Fig 1:- Transcellular and Intercellular routes of drug delivery via the skin

Fig 2:- Types of Natural Polymer

CONCLUSION

Transdermal drug delivery continues to grow and develop, with rapid advances in fundamental knowledge fueling industrial development. With time, it is believed that the development of transdermal drug delivery would improve disease prevention, diagnosis, and control, improving the quality of life for people all around the world in terms of their health. Natural polymers play a key role in transdermal drug delivery. Therefore, choosing the right polymer plays a crucial role in drug formulations. However, when choosing the polymers, consider their toxicity, drug compatibility, and degradation pattern.

A wide range of biodegradable natural polymers have been studied and exploited for targeted drug delivery, prolonged or controlled drug release. According to this review, we can say that in transdermal drug delivery systems, natural polymers can be an effective replacement for synthetic polymers. The natural polymer can also help mitigate the side effects of synthetic polymers.

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