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Review Article

NATURAL POLYMERS: CARRIERS FOR TRANSDERMAL DRUG DELIVERY SYSTEM

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ABSTRACT

Controlled drug delivery designed to release a drug at a predetermined rate in order to maintained a constant drug concentration for specific period of time with minimum side effect. This leads to the concept of the controlled drug delivery. The primary objective of controlled drug delivery is to ensure safety and efficacy of the drug as well as patient compliance. TDDS lies under the category of controlled drug delivery, in which the aim is to deliver the drug through skin in a predetermined and controlled rate. Polymers are the backbone of a transdermal drug delivery system. The release mechanism of the drug from these polymers is by Degradation, Diffusion and Swelling.which control the release of the drug from the device. 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. Gums, mucilages, resins and plant extracts are widely used natural materials for conventional and novel dosage forms. The present article highlights the available information on natural polymers and their versatile use.

Keywords: Natural polymer, Gum, Mucilage, TDDS.

INTRODUCTION

Transdermal drug delivery system is defined as the topically administered medications in the form of patches which when applied to the skin deliver the drug, through the skin at a predetermined and controlled rate. Transdermal patches are delivered the drug through the skin in controlled and predetermined manner in order to increase the therapeutic efficacy of drug and reduced side effect of drug. Controlled drug release can be achieved by transdermal drug delivery systems (TDDS) which can deliver the drug via the skin portal to systemic circulation at a predetermined rate over a prolonged period of time. For effective Transdermal drug delivery system, the drug are easily able to peneterate the skin and easily reach the target site. Transdermal therapeutic systems are also defined as a self contained, discrete dosage forms which, when applied to the intact skin, deliver the drug, through the skin at control rate to the systemic circulation. The transdermal drug delivery system has attracted considerable attention because of its many potential such as better patient compliance, avoidance of gastrointestinal disturbances, hepatic first-pass metabolism and sustained delivery of drugs to provide steady plasma profiles, particularly for drugs with short half-lives, reduction in systemic side effects and enhanced therapeutic efficacy.

The basic component of transdermal device in that include Polymer matrix / Drug reservoir , Drug Permeation enhancers Pressure sensitive adhesive (PSA) , Backing laminates , Release liner Other excipients like plasticizers and solvents. In transdermal drug delivery system

polymers are the heart of TDDS, which control the release of the drug from the device. A polymer is a large molecule (macromolecules) composed of repeating structural units. These subunits are typically connected by covalent chemical bonds. Polymer are used to reduce the frequency of dosing and to increase the effectiveness of the drug by localisation at the site of action, to provide uniform drug delivery. These polymers are classified as natural polymers, semi synthetic and synthetic polymers. The specific application of plant-derived polymers in pharmaceutical formulations include their use in the manufacture of solid monolithic matrix systems, implants, films, beads, microparticles, nanoparticles, inhalable and injectable systems as well as viscous liquid formulations. Within these dosage forms, polymeric materials have fulfilled different roles such as binders, matrix formers or drug release modifiers, film coating formers, thickeners or viscosity enhancers, stabilizers, disintegrants, solubilisers, emulsifiers, suspending agents, gelling agents and bioadhesives. polymer are the backbone of a transdermal drug delivery system. Polymers used in TDDS should have good stability and compatibility with the drug and other components of the system and they should provide effective released of a drug throughout the device with safe status.

ADVANTAGES OF NATURAL POLYMERS

1. Naturally occurring polymers produced by living organisms hence they are biodegradable and biocompatible.
2. They show no adverse effects on the environment or human being.
3. Carbohydrates in nature and composed of repeating monosaccharide units. Hence they are non-toxic.
4. Economic and Easy availability
5. Safe and devoid of side effects – They are from a natural source and hence, safe and without side effects.

DISADVANTAGES NATURAL POLYMERS

1. Microbial contamination – During production, they are exposed to external environment and hence, there are chances of microbial contamination.
2. Batch to batch variation – Synthetic manufacturing is controlled procedure with fixed quantities of ingredients while production of natural polymers is dependent on environment and various physical factors.
3. The uncontrolled rate of hydration—Due to differences in the collection of natural materials at different times, as well as differences in region, species, and climate conditions the percentage of chemical constituents present in a given material may vary.
4. Heavy metal contamination – There are chances of Heavy metal contamination often associated with herbal excipients.

VARIOUS NATURAL POLYMERS USED IN TRANSDERMAL DRUG DELIVERY SYSTEM

Gum Arabic/ Gum Acacia

Acacia gum, Indian gum or gum Arabica is the dried gummy exudates from the stems and branches of Acacia Senegal (Leguminosae) or Acacia Arabica (Combretaceae). Synonyms are gum acacia; gummi africanum; gum arabic; gummi arabicum; gummi mimosae;and talha gum. Acacia gum consist of a glycosidal acid of high molecular weight, which has been termed arabic acid, combined with potassium, magnesium and calcium. Structurally, gum arabic is a branched molecule with the main chain consisting of 1, 3-linked β-D galactopyranosyl units .It consists of monosaccharide sugars such as arabinose, glucuronic acid and rhamnose.

Acacia is mainly used in oral and topical pharmaceutical formulations as a suspending and emulsifying agent, often in combination with tragacanth. It is also used in the preparation of pastilles and lozenges, and as a tablet binder, although if used incautiously it can produce tablets with a prolonged disintegration time. Acacia has also been evaluated as a bioadhesive; and has been used in novel tablet formulations, and modified release tablets. It is used as a general stabilizer in emulsions and used as an osmotic suspending and expanding agent to prepare a monolithic osmotic tablet system, binding agent for tablets and emollient in cosmetics. Its demulcent properties are employed in various cough, diarrhoea and throat preparations. It has widespread use in the food, drinks and other industries. B.Samyuktha Rani, *et al* (2013)formulated and develop a suitable matrix type transdermal patch of chlorpheniramine maleate with different ratio of drug/ acacia gum (1:1.5) by solvent evaporation techniques by using glycerine as plasticizer for improvement of bioavailability of drug. It

concluded that acacia containing formulation was brittle easily and more amount of moisture to be loss on storage.

Agar

Agar or agar-agar is the dried gelatinous substance obtained from *Gelidium amansii* (Gelidaceae) and several other species of red algae like, *grailaria* (Gracilariaceae) and *Pterocladia* (Gelidaceae).

Agar can be separated into two major polysaccharides named as Agarose and Agaropectin. Agarose (a neutral gelling fraction)is responsible for gel strength of agar and is composed of (+) – galactose and 3, 6-anhydro-(–)-galactose moieties. It contains about 3.5% cellulose and 6% of nitrogen containing substance. Agaropectin is (a sulphated non-gelling fraction) responsible for the viscosity of agar solutions, and comprises of sulphonated polysaccharide in which both uronic acid and galactose moieties are partially esterified with sulphuric acid. In short, it is believed to be a complex range of polysaccharide chains having alternating α–(1_3) and β–(1_4) linkages and varying total charge content.

Its great gelling power in an aqueous environment allows it to form gels which are more resistant (stronger) than those of any other gelforming agent, assuming the use of equal concentrations. Agar gives gels without flavour and does not need the additions of cations with strong flavours (potassium or calcium) it can be used without problems to gel food products with soft flavours. Its gel has an excellent reversibility allowing it to be repeatedly gelled and melted without losing any of the original properties. Pharmaceutically it is used as Suspending agent, emulsifying agent, gelling agent in suppositories, surgical lubricant, tablet disintegrates, medium for bacterial culture, laxative. It also used in preparation of jellies. B.Samyuktha Rani, *et al* (2013) formulated and develop a suitable matrix type transdermal patch of chlorpheniramine maleate with different ratio of drug/ agar (1:1.5) by solvent evaporation techniques by using glycerine as plasticizer for improvement of bioavailability of drug.

Alginates

Sodium alginate is a natural polysaccharide obtained from marine brown algae, seaweeds as well as produced by some bacteria such as *Pseudomonas aeruginosa* or *Azobacter vinelandi*. It is a hydrophilic salt of alginic acid consisting of two uronic acids, β-D-mannuronic acid (M) and α- L-glucouronic acid (G). It is composed of homopolymeric blocks MM or GG. Alginate and their derivates are widely used by many pharmaceutical scientists for drug delivery and tissue engineering applications. Various applications in drug de-livery are in matrix type alginate gel beads, in liposomes, in modulating gastrointestinal transit time, for local applications and to deliver the bio molecules in tissue engineering applications. Alginates have been used and investigated as stabilizers in emulsions, suspending agents, tablet binders and tablet disintegrants. The gelling properties of alginate's guluronic residues with polyvalent ions such as calcium or aluminium allow cross-linking with subsequent formation of gels that can be employed to prepare matrices, films, beads, pellets, microparticles and nanoparticles. Alginate-based systems have been successfully used as a matrix for the encapsulation of stem cells and for controlled release of proteins, genes, and drugs. In addition, alginate-based systems have been used as depots for bioactive agentloaded liposomes, for slow drug release. Alginates have proven to be effective for the symptoms of malignant wounds. Alginates are ideal for bleeding wounds as they have haemostatic properties. Anahita Rajoul Dezfuli *et al* (2012) prepared and evaluated transdermal films of metoprolol trartrate(MT) using sodium alginated and xanthan gum as biopolymer to minimize adverse effects associated with oral administration. It was investigated from the study XG/SA (40.5/ 51%) was found to be satisfactory providing drug relase for period 8hr. 51% to 85 % concentration of sodium alginate modulated drug release significantly. But it concluded that lower concentrations of sodium alginate sustain the drug release for an extended period.

Xanthan Gum

Xanthan gum is a high molecular weight extracellular polysaccharide produced by the fermentation of the gram-negative bacterium *Xanthomonas campestris*. The primary structure of this naturally produced cellulose derivative contains a cellulosic backbone (β-D-glucose residues) and a trisaccharide side chain of β-D-mannose-β-D-glucuronicacid-α-D-mannose attached with alternate glucose residues of the main chain. Xanthan gum is used as matrix former and potential excipient for oral controlled release tablet dosage forms. Xanthan gum is a high molecular weight extracellular

polysaccharide produced by pure .This gum is a cream coloured powder that is soluble in hot or cold water with high viscosity even at low concentrations.

Pharmaceutically, it is applicable as sustained release agent, pellets, controlled drug delivery system. It is also used as suspending agent, emulsifier, stabilizer in toothpaste and ointments..

Xanthan gum is used most frequently as a stabilizer in suspensions and emulsions at concentrations below 0.5%, higher concentrations in aqueous media yield viscid solutions that are jelly like in nature. Concentrated xanthan gum solutions resist flow due to excessive hydrogen bonding in the helix structure, but they display shear-thinning rheology under the influence of shear flow. This feature of xanthan gum solutions is critical in food, pharmaceutical, and cosmetic manufacturing processes. Anahita Rajoul Dezfuli *et al* (2012) prepared and evaluated transdermal films of metoprolol trartrate(MT) using sodium alginated and xanthan gum as biopolymer to minimize adverse effects associated with oral administration. It was investigated from the study XG/SA (40.5/ 51%) was found to be satisfactory providing drug release for period 8hr. 2% to 40.5 % concentration of modulated xanthan gum drug release significantly. It can concluded that drug diffusion from the films was controlled due to increased of amounts of xanthan gum showed higher swellability of the film. Rana Abu-Huwaij *et al* (2010) Bilayer nicotine mucoadhesive patches were prepared and evaluated to determine the feasibility of the formulation as a nicotine replacement product to aid in smoking cessation. Nicotine patches were prepared using xanthan gum or carbopol 934 as a mucoadhesive polymers and ethyl cellulose as a backing layer. Xanthan patches showed reasonable fast initial release profile followed by controlled drug release over a 10-h period.

Tamarind Gum

Tamarind Gum, also known as Tamarind Kernel Powder (TKP).Tamarind gum obtained from seed polysaccharide Tamarindus indica (Leguminoseae). Is composed of (1 4)-β-D-glucan backbone substituted with side chains of at the O-6 position of its glucopyranosyl residues with α-D-xylopyranose. Some of the xylose residues are β-D-galactosylated at O-2. Xyloglucan is a major structural polysaccharide in the primary cell walls of higher plants. Gum is a polysaccharide composed of glucosyl : xylosyl : galactosyl in the ratio of 3:2:1. It is insoluble in organic solvents and dispersible in hot water to form a highly viscous gel such as a mucilaginous solution with a broad pH tolerance and adhesivety. Pharmaceutically, It is applicable for Hydrogels, mucoadhesive drug delivery for ocular purposes, spheroids, nasal drug delivery. It is used as binding agent, emulsifier, suspending agent, sustaining agent.

This has led to its application as stabilizer, thickener, gelling agent and binder in food and pharmaceutical industries. In addition to these, other important properties of tamarind seed polysaccharide (TSP) have been identified recently. They include non carcinogenicity, mucoadhesivity, biocompatibility, high drug holding capacity and high thermal stability. This has led to its application as excipient in hydrophilic drug delivery system. It was found that the drug release was sustained in formulations containing TC gum as compared to the pure drug. This was attributed due to the excellent swelling properties of TC gum in water. Sahoo *et al.* formulated tablets using 10%, 20%, 30%, and 40% Tamarind Seed Polysaccharide (TSP) as a natural binding agent and observed that highest binder concentration showed maximum hardness and minimum friability. Thus, tablets with 20% TSP showed maximum drug release while tablets with 40% TSP showed minimum drug release after 24 hrs. It was concluded that increasing the amount of TSP decreases the release rate. G. V. Radha et al (2013) formulated and Designed of transdermal films of alfuzocin HCl by a natural polymer tamarind seed polysaccharide extract using 500,600,700 and 800 mg. Among all formulations was found to be having good release with low concentration of TSP 500mg and all other properties comparing to other formulations**.**

Moringa Oleifera Gum

A natural gum obtained from plant Moringa oleifera gum was extracted by using water as solvent and precipitated using acetone as non-solvent. It is a polyuronide constituting of arabinose, galactose and glucoronic acid in the preparation of 10:7:2, rhamnose present in traces. In a study potentials of moringa olifera gum was used as gelling agent, binder, release retardant in tablet formulations, and the effect of calcium sulpha dehydrate, lactose diluents on release of propronolol hydrochloride. Another study moringa gum used as a disintegrant.

In cosmetics, *Moringa oleifera* tree that purify hair and skin and offer protection against the effects of pollution. Moringa seed oil, known as Behen oil is widely used as a carrier oil in cosmetic preparations. Moringa oil is light and spreads easily on the skin. It is good oil for use in massage and aromatherapy applications. It can be used in body and hair care as a moisturizer and skin conditioner. Other uses include soap making and for use in cosmetic preparations such as lip balm and creams. *Moringa oleifera* butter, a semisolid fraction of Moringa oil, is used in baby products to contribute a free radical resistant emollient with exceptionally long lasting skin soften. D S Panda *et al* (2008) film were prepared using 5 parts of 10% w/w of mucilage of gum of *Moringa oleifera* with different proporations of plascitizer PGE400(0.1, 0.13.0.2 &0.3), Glycerine (0.15), PG (0.2) by evaporation method. It can be concluded that gum has enormous pontential for use in the preparation of polymeric films as drug delivery system.

Guar Gum

Guar gum is a seed gum produced from the powdered endosperm of the seeds of Cyamopsis tetragonolobus (Leguminoseae). Water soluble part of guar gum consist mainly galactomannan which is composed ofabout 34.5% of galactose anhydride and about 63.4% of mannose anhydride. It is known as guaran which constitute a major part of the gum. This gelling property retards the drug release and makes it a flexible carrier for extended release dosage forms. Pharmaceutically, it is used as carrier for oral extended release drug delivery. In colon targeted drug delivery it has high potential to serve as a carrier for oral controlled release matrix systems and as cross-linked microspheres. It is used as a binder, disintegrant, thickening agent, emulsifier, bulk laxative, appetite suppressant, and sustained release agent. Triacetatederivative of galactomannan from guar gum can be used to cast into strong, transparent, flexible films. Guar gum has recently been highlighted as an inexpensive and flexible carrier for oral extended release drug delivery. It is also used as thickener for lotions and creams, as a tablet binder and as an emulsion stabilizer. Deshmukh *et al.* [38, 39] observed that the increased concentration of guar gum decreases the drug release. Increased gum concentration raises the swelling index value, thereby resulting in slow erosion of gelled layer which favoured slow release of zidovudine from this viscous layer. Hence, there occurs diffusion through gel matrix coupled with erosion of matrix backbone mechanism for the drug release from Guar gum based formulations. Bhavya B B(2012)*et al* Drug release behavior of Polyvinylpyrrolidone Guar gum (GG) /PVP %, 70/30,60/40,50/50,40/60 polymer blend patches with Potassium Diclofenac as model drug was investigated. It concluded that the release profile follows non-Fickian model and drug release become sustained as concentration of (70/30%) guar gum increases in the polymer matrix. Megha N. Karemore *et al*(2012) Designed and evaluated of carvedilol transdermal patch using natural polymers**.** The polymers selected for the study are pectin and guar gum. It was observed that the system with pectin : guar gum in the ratio 4:1 along with usedplasticizers was a promising controlled release transdermal drug delivery system for carvedilol.

Tragacanth

This gum is obtained from the branches of *Astragalus gummifer* (Leguminosae). Tragacanth contains from 20% to 30% of a water-soluble fraction called tragacanthin (composed of tragacanthic acid and arabinogalactan). It also contains from 60% to 70% of a water-insoluble fraction called bassorin. Tragacanthic acid is composed of D-galacturonic acid, D-xylose, L-fructose, D-galactose, and other sugars. Tragacanthin is composed of uronic acid and arabinose and dissolves in water to form a viscous colloidal solution (sol), while bassorin swells to form a thick gel.

Tragacanth when used as the carrier in the formulation of 1- and 3-layer matrices produced satisfactory release prolongation either alone or in combination with other polymers.

As with other water-soluble gums, there is some preliminary evidence that concomitant ingestion of tragacanth with a high sugar load can moderate the blood sugar levels in patients with diabetes, although this effect has not been demonstrated consistently and requires much more detailed investigation. Although gum tragacanth swells to increase stool weight and decrease the GI transit time, it appears to have no effect on serum cholesterol, triglyceride or phospholipid levels after a 21-day supplementation period as do other soluble fibers. Tragacanth has been used since ancient times as an emulsifier, thickening agent, and suspending agent.

It contains about 15% of methoxy group which swell in water; this constituent of gum is responsible for its high viscosity. It has been classified as generally recognized as safe at the 0.2–1.3% level in food stuffs in the USA since 1961. Pharmaceutically, It is applicable as sustained release agent. It is used as emulsifying and Suspending agent, demulcent, emollient in cosmetics and stabilizer, it has been used as a diluents in tablet formulations. Tragacanth when used as the carrier in the formulation of 1- and 3-layer matrices produced satisfactory release prolongation. Dwarakanadha Reddy P (2015**)** this research work was to formulation and evaluation of transdermal drug delivery system of clopidogrel bisulfate using various polymers such as sodium carboxymethylcellulose (SCMC), guar gum and tragacanth with different proportions (3:1,3:1.5,3:2)by solvent evaporation technique. Based on the drug release and physicochemical values obtained the formulation (3:2) is considered as an optimized formulation, which shows higher percentage of drug release for 24 hr.

Chitosan

Chitosan is a natural polycationic copolymer consisting of glucosamine and N-acetyl glucosamine units. It is mostly obtained by deacetylation of chitin derived from the exoskeleton of crustaceans like shrimp, crab, lobster and other shellfish.Chitosan and their derivatives (*N*-trimethyl chitosan, mono-*N*-carboxymethyl chitosan) are effective and safe absorption enhancers to improve mucosal (nasal, peroral) delivery of hydrophylic macromolecules such as peptide and protein drugs and heparins. This absorption enhancing effect of chitosan is caused by the opening of the intercellular tight junctions, thereby favouring the paracellular transport of macromolecular drugs. Chitosan nano- and microparticles are also suitable for controlled drug release. They are highly stable, safe, biocompatible, biodegradable, non-toxic, and hydrophilic and gel forming in nature. These properties make chitosan a good candidate for the development of various conventional and novel gastrointestinal dosage forms. The most important property of chitosan with regards to drug delivery is its positive charge under acidic conditions. This positive charge comes from protonation of its free amino groups. Lack of a positive charge means chitosan is insoluble in neutral and basic environments. Chitosan is a novel drug carrier material and it improves the dissolution rate of controlled release matrix tablets. Chitosan is a cationic polymer and has been investigated as an excipient in controlled delivery formulations and mucoadhesive dosage forms because of its gelling and adhesive properties. The bitter taste of natural extracts such as caffeine has been masked using chitosan. Chitosan can potentially be used as a drug carrier, a tablet excipient, delivery platform for parenteral formulations, disintegrant, and tablet coating. Gels based on chitosan and ovalbumin protein have been suggested for pharmaceutical and cosmetic use. Chitosan can also be mixed with nonionic surfactants such as sorbitan esters to make emulsion like solutions or creams. It is also used in preparation of microspheres, as carrier for protein as nanoparticles and colon specific drug delivery. Neha Pachisia *et al* (2012) formulated and evaluated a novel matrix controlled transdermal systems of anti-diabetic drug glimepiride were prepared using natural polymer chitosan(accurately weighed dissolved in 4%v/v lactic acid) for the extended and controlled delivery of the drug. Lincy john (2013) designed and evaluated amlodipine transdermal patches using polymer such as hydroxypropylmethylceullose and chitosan in different proportions (1%, 1.5%, 2% and 2.5%). It concluded that use of chitosan in a transdermal patches seems to be attractive due to its biocompatibility and biodegradability as well as opportunities to modify the charge density and molecular chain length of the chitosan in the membrane without changing its status as a natural biopolymer. Thus the knowledge on the use of chitosan to control drug release in transdermal delivery systems might be applicable to other transdermal drug delivery system as well.

Locust Bean Gum

Locust Bean Gum (LBG), also known as Carob Gum is obtained from the refined endosperm of seeds from the carob tree *Ceretonia siliqua* Linn. (Leguminosae). It is a non-starch polysaccharide consisting of galactose and mannose in the ratio 1:4 and hence they are known as galactomanan. Locust bean gum consists mainly of a neutral galactomannan polymer made up of 1, 4-linked D-mannopyranosyl units and every fourth or fifth chain unit is substituted on C6 with a D-galactopyranosyl unit. The brown pods or beans of the locust bean tree are processed by milling the endosperms to form locust bean gum and it

is therefore not an extract of the native plant but flour Locust bean gum is a neutral polymer and its viscosity and solubility are therefore little affected by pH changes within the range of 3-11. In pharmaceutical formulations, Locust bean gum is used as a binder, flocculating agent, thickening and stabilizing agent. In pharmaceutical formulations, Locust bean gum is used as a binder, flocculating agent, thickening and stabilizing agent. Kulkarni P.K(2011) formulated biopolymer based transdermal film loaded with piroxicam using polymer sodium locust been(SLB) and sodium alginate(SA) by varying blend ratio by using casting method. It can be concluded that the developed optimized formlution (12:80.5%) has good potential to achieve transdermal drug delivery of PX for effective therapy. D.V.Gowda(2010) formulated transdermal film loaded with Aceclofenac (ACF) by solution casting method using chemically modified locust bean gum (MLBG) and sodium alginate (SA) in various proportions. It can be concluded that formulation (68:25.5%) has potential vehicle to achieve controlled transdermal delivery of ACF for effective therapy and showed good skin tolerability.

Jackfruit Mucilage

Artocarpus heterophyllus (Jackfruit) belongs to the family Moraceae. In Hindi, it is known as Kathal.6 It is a large evergreen tree of 10-15 m height and indigenous to evergreen forests of Western Ghats at an altitude of 450-1200 m. Stem is straight and cylindrical, covered with smooth or slightly rough black or green bark. Leaves are broad, 5-25 cm × 3.5-12 cm, obovate-elliptic to elliptic, decurrent, glabrous and entire. Fruits are markedly fleshy and firm with thickened stalk. Jackfruit is one of the most popular fruit in South India. Jackfruit is essentially a carbohydrate food and therefore, a useful source of energy. The fruit pulp on hydrolysis gives rhamnose, xylose, arabinose, glucose, galactose, galacturonic acid and pectic acid. It also contains proteins, fats, calcium, phosphorus and iron. The seeds are mostly starchy and contain fair amount of proteins, calcium and thiamine; and have good pectin content. The polysaccharide from jackfruit has been reported as a pharmaceutical excipient in mucoadhesive formulations. It may be used as binder in tablets, sustaining agent in matrix tablets, mucoadhesive material in buccal tablets, due to its unique properties such as good wettability, water uptake and swelling property. Vidyadevi Bhoyar(2015) formulated and characterization of transdermal patch of Acyclovir using *Artocarpus heterophyllus lam* mucilage as a natural polymer. It can be concluded that the Jackfruit mucilage can be a promising polymer for the film formation and thus should be explored in future as an inert suitable pharmaceutical excipient.

CONCLUSION

Polymers play a vital role in the drug delivery. So, the selection of polymer plays an important role in drug manufacturing. But, while selecting polymers care has to be taken regarding its toxicity, drug compatibility and degradation pattern. A wide variety of natural biodegradable polymers have been investigated and used for drug targeting or prolonged or controlled drug release. By this review, in transdermal drug delivery system we can say that natural polymers can be good substitute for the synthetic polymers and many of the side effects of the synthetic polymers can be overcome by using natural polymers.

REFERENCES

1. Harunusman Patel, Dr. Upendra Patel *et.al:* Transdermal Drug Delivery System As Prominent Dosage Forms For The Highly Lipophilic Drugs, International Journal Of Pharmaceutical Research and Bioscience. 2012,vol1(3),42-65
2. Dipen Patel, Kavitha k: Formulation and evaluation aspects of transdermal drug delivery system, International Journal of Pharmaceutical Sciences Review and Research. 2011, vol 6, 83-90
3. Ritesh Bathe and Reni Kapoor, Transdermal drug delivery system: formulation, development and evaluation-An overview, International Journal of Biomedical and Advance Research. 2015; 6(01),1-15
4. Ajay Sharma, Seema Saini and AC. Rana, Transdermal Drug Delivery System: A Review, International Journal of Research in Pharmaceutical and Biomedical Sciences. 2013, Vol. 4 (1),286-293
5. Rajeswari Kola, Bada Pragathi Kumar, A Detailed Description of Synthetic and Natural Polymers Which are Used In The Formulation of Sustained Release Drug Delivery System: A Review,

Journal of Chemical and Pharmaceutical Sciences. 2013,Vol 6(3), 161-169
6. Kulkarni Vishakha S, Butte Kishor D and Rathod Sudha S**:**Natural Polymers- A Comprehensive Review, International Journal Of Pharmaceutical Research and Bioscience. 2012 Vol. 3 (4),1597-1613
7. .Darekar Avinash Bhaskaret.al: Plant Exudates and Mucilage as Pharmaceutical Excipients:Journal of Advanced Pharmacy Education & Research. 2013,Vol 3(4),387-402.
8. S.Shanmugam, R manavalan,D Venkappayya: Natural Polymer and Their Application, Natural Product Radiance. 2005 Vol 4(6),478-481
9. S. Shalini, Advantages and Applications of Nature Excipients – A Review, Asian Journal of Pharmaceutical Research. 2012, Vol 2 (1),30-39.
10. Krushnakumar J Gandhi, Subhash V Deshmane, Kailash R Biyani, Polymers in Pharmaceutical Drug Delivery System: A Review, International Journal of Pharmaceutical Sciences Review and Research. 2012,4(2),57-66
11. Anupama Singh et. al, Release Behavior of Drugs from Various Natural Gums and Polymers. 2011:73-80
12. Abitha M H, Flowerlet Mathew, Natural Polymers in Pharmaceutical Formulation, International Journal of Institutional Pharmacy and Life Sciences. 2015, vol 5(1), 206-231.
13. JanaS ,Gandhi A , Sen KK , Basu Sk, Natural Polymers and their Application in Drug Delivery and Biomedical Field: Journal of PharmaSciTech. 2011,Vol 1(1),16-27
14. Ghanshyam Yadav, Nitin Sharma, Mayank Bansal and Nishi Thakur**,** Application of natural polysaccharide for delivery of biopharmaceuticals, International Journal of Pharmacy & Life Sciences. 2013, vol 4(6),2756-2765
15. Anonymous. The wealth of India - Raw materials, New Delhi: Council for Scientific and Industrial Research. 2005; 447-453.
16. Satheesh Madhav NV, Tangri P, Formulation and evaluation of zidovudine biomicro dwarfs using a novel bio-muco resident from Artocarpus heterophyllus: Int J Pharm Tech Res. 2011;Vol 3(1),169-174.
17. Sabale V, Patel V, Paranjape A. isolation and characterization of jackfruit mucilage and its comparative evaluation as a mucoadhesive and controlled release component in buccal tablets,Int J Pharm Investig. 2012,vol 2(2),61-69.
18. Pravin Kumar, Giriraj T Kulkarni, Characterization of Mucilage from *Artocarpus heterophyllus* as Pharmaceutical Excipient, Journal of Chronotherapy and Drug Delivery. 2016,31-46
19. Samyuktha R.B , Laxman Rao *et al*, Designing and Characterization of Chlorpheneramine Maleate Transdermal Patchs, An International Journal of Advances in Pharmaceutical Sciences. 2013,Vol4(2),254-258.
20. *A*nahita Rajoul Dezfuli, Aravindram A.S *et al*, Development and Evaluation of Transdermal Films Loaded with Antihypertensive Drug, internation Journal of Pharma and Bio Sciences. 2012,Vol3(3),559-569
21. Rana Abu-Huwaij, Rana M. Obaidat, *et al*, Formulation and In Vitro Evaluation of Xanthan Gum or Carbopol 934-BasedMucoadhesive Patches, Loaded with Nicotine, American Association of Pharmaceutical Scientists. 2011 Vol.12(1),21-27
22. G. V. Radha and M. Santosh Naidu, Design of transdermal films of alfuzocin HCl by using a natural polymer tamarind seed polysaccharide extract, Scholars Research Library. 2013 Vol, 5 (3),457-464
23. Sahoo R., Sahoo S., Nayak P. L.: Release behavior of anticancer drug Paclitaxel from tamarind seed polysaccharide galactoxyloglucan, Eur. J. Sci. Res. (2010), 47 (2), 197–206.
24. D.S panda,N S K Choudhury evaluation of film forming pontential of a natural gum ,Asian Journal of Pharmaceutics. 2008,50-52
25. Bhavya B B, Shivakumar H R , Vishwanath Bhat, IN- Vitro Drug Release Behavior of PVP/GUAR gum Polymer Blend Transdermal Film With Diclofenac Potassium, Asian Journal of Pharmaceutical and Clinical Research. 2012 Vol 5(2),149-152
26. Megha N. Karemore, Mayuri S. Dandare, A.V. Belgamwar, D. R. Mundhada,Dr. Shyamala Bhaskaran,

Design and evaluation of carvedilol transdermal patch using natural polymers. 2012,5(10),4947-4949
27. Deshmukh V. N., Singh S. P., Sakarkar D. M.: Formulation and evaluation of sustained release Metoprolol Succinate tablet using hydrophilic gums as release modifiers. Int. J. Pharm. Tech. Res. (2009), 1 (2), 159–163
28. Yadav A. S., Kumar P. A., Vinod R., Rao B. S.,Kulkarni S. V, Design and evaluation of guar gum based controlled release matrix tablets of Zidovudine. J. Pharmaceut. Sci. Technol. (2010),2 (3), 156–162.
29. Dwarakanadha Reddy P*, Swarnalatha D, Sidda Ramanjulu B, Karthik Sai Kumar ,P, Sardar Ussain M, Design, DevelopmenT and Characterization of Clopidogrel Bisulfate Transdermal Drug Delivery System, Asian J Pharm Clin Res. Vol 8, Issue 2, 2015, 277-280
30. Lincy John and Arun Kumar, Comparison of Amlodipine Transdermal Patches Using Hydroxypropylmethylcellulose and Chitosan, Asian J Pharm Clin Res. Vol 7, Issue 1, 2014, 86-90
31. Neha Panchisia, and Shyam Sunder Agrawal, Formulation ,development,evaluation of transdermal drug delivery system of glimepiride, Internation Journal of Pharmaceutical Sciences Reasearch. 2012,2(1)1-8
32. Kulkarni P.K, Dixit mudit, Development of evaluation of piroxicam loaded biopolymer based transdermal film, Internation research journal of pharmacy. 2011,2(11),119-123
33. D.V.Gowda, Rajesh.N, Somashekhara C.N and Siddaramaiah, Development and Evaluation of Aceclofenac Loaded Transdermal Film, Int.J. PharmTech Res. 2010,2(4),2224-2233
34. Vidyadevi Bhoyar, Gouri Dixit and Kanchan Upadhye, Fabrication and *IN-Vitro* Characterisation of TransdermaL Patch Using Jackfruit Mucilage as Natural Polymer, An International Research Journal, Pharmacophore. 2015, Vol. 6 (6), 267-280.