A Muco Adhesive Polymer From Tamarind Seeds

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Abstract- *Polymers are complex carbohydrates having good mechanical properties for application as fiber, films, adhesives, rheology modifiers, hydrogels, emulsifiers, and drug delivery agents. Tamarind seed polysaccharide (TSP) is a glucosaminoglycan derivative extracted from the kernel of seeds of Tamarindus indica Linn., Family Leguminosae. A polymer consists of cellulose-type spine that carries xylose and galactoxylose substituents. It can be used as a binder in tablets, as a mucoadhesive for buccal or sublingual delivery of drugs, in gastro-intestinal targeting as a bioadhesive tablet, and for ocular delivery of drugs for achieving zero-order controlled release. They also act as a carrier for delivery of certain drugs. TSP future perspective is wide application as a promising polymer in pharmaceutical industry as a novel carrier of drugs in various bioadhesive and other sustained release formulations.*

Keywords- Bioadhesive , Mucoadhesion ,Sustained delivery ,Tamarind seed polysaccharide

I. INTRODUCTION

In the last few years there has been an important development in controlled drug delivery systems,Xyloglucan polysaccharide is the major constituent of the seeds of Tamarindus indica. , mucoadhesion has become of interest for its potential to optimize localized drug delivery, by retaining a dosage form at the site of action . Various studies have been conducted on buccal delivery of drugs using mucoadhesive polymers including mainly polysaccharides It is a by-product of the tamarind pulp and are extensively used in food industries as food thickeners, stabilizers and gelling Crude preparations of tamarind seed polysaccharide (Tamarind Kernel Powder) are done by the crushed seeds and are used as an adhesive or binding agent in industries.agents

1.1Tamarind seeds.

Today, the whole world is increasingly interested in natural drugs and excipients. In recent years, plant derived polymers have evoked tremendous interest due to their diverse pharmaceutical applications such as diluent, binder, disintegrant in tablets, thickeners in oral liquids, protective colloids in suspensions, gelling agents in gels and bases in suppositories. They are also used in cosmetics, textiles, paints and paper making. These polymers such as natural gums and mucilage are biocompatible, cheap and easily available and are preferred to semi synthetic and synthetic excipients because of their lack of toxicity, low cost, availability, soothing action and non irritant nature. Further more, they can be modified to obtain tailor made materials for drug delivery systems allowing them to compete with the synthetic products that are commercially available. Many kinds of natural gums are used in pharmaceutical industry and are regarded as safe for human consumption.

Gums are considered to be pathological products formed following injury to the plant or owing to unfavourable conditions, such as drought, by a breakdown of cell walls (extra cellular formation; gummosis) while, mucilages are generally normal products of metabolism, formed within the cell (intracellular formation) and/or are produced without injury to the plant. Gums readily dissolve in water, whereas, mucilage form slimy masses. Gums are pathological products, whereas mucilages are physiological products.Acacia, tragacanth, and guar gum are examples of gums while mucilages are often found in different parts of plants. For example, in the epidermal cells of leaves (senna), in seed coats (linseed,psyllium), roots (marshmallow), barks (slippery elm) and middle lamella (aloe)(2). Gums and mucilages have certain similarities—both are plant hydrocolloids. They are also translucent amorphous substances and polymers of a monosaccharide or mixed monosaccharides and many of them are combined with uronic acids. Gums and mucilages have similar constituents and on hydrolysis yield a mixture of sugars and uronic acids. Gums and mucilages contain hydrophilic molecules, which can combine with water to form viscous solutions or gels. The nature of the compounds involved influences the properties of different gums. Linear polysaccharides occupy more space and are more viscous than highly branched compounds of the same molecular weight. The branched compounds form gels more easily and are more stable because extensive interaction along the chains is not possible[9].

1.2 Advantages of Natural Polymers

Natural plant–based materials have various advantages like biodegradable- Naturally available biodegradable polymers represent truly renewable source and they have no adverse impact on humans or environmental health biocompatible and non-toxic- Chemically, nearly all of these plant materials are carbohydrates composed of repeating sugar (monosaccharides) units. Hence, they are non-toxic.

Low cost—it is always cheaper to use natural sources.

Capable of chemical modifications- Modified polymers can meet the requirements of drug delivery systems and thus can compete with synthetic excipients.

Better patient tolerance as well as public acceptance and local availability are some other advantages of natural polymers.

Natural plant – based polymers can either be: -

1) shrubs/tree exudates—gum arabica, gum ghatti, gum karaya, gum tragacanth,
2) Seed gums—guar gum, locust bean gum, starch, amylose, cellulose
3) Extracts—pectin, larch gum
4) Tuber and roots—potato starch

Tamarind seed polysaccharide is a seed gum having wide application in pharmaceutical industry. Tamarind seed is a by – product of the commercial utilization of the fruit however it has several uses. Wasted decorticated kernels contain 46 to 48 % of a gel forming substance. Polysaccharides obtained from tamarind seed kernels form mucilaginous dispersions with water.[3]

1.3Disadvantages of Synthetic Polymers

The synthetic polymers have certain disadvantages such as high cost, toxicity, environmental pollution during synthesis, nonrenewable sources, side effects, and poor patient compliance. They need long development time for synthesis compared to natural polymer. Acute and chronic adverse effects like skin and eye irritation are observed with synthetic polymers like methyl methacrylate and poly- (methyl methacrylate) (PMMA). Another synthetic polymer, povidone have shown the formation of subcutaneous granulomas at the injection site . Carbomer dust is irritating to the eyes, mucous membranes and respiratory tract. Some disadvantages of biodegradable polymers used in tissue engineering applications are their poor biocompatibility, release of acidic degradation products, poor processing ability and rapid loss of mechanical properties during degradation. [3]

II. LITERATURE SURVEY

Gupta V et al (2009) Showed that, Polymers are complex carbohydrates having good mechanical properties for application as fiber, films, adhesives, rheology modifiers, hydrogels, emulsifiers, and drug delivery agents. Tamarind seed polysaccharide (TSP) is a glucosaminoglycan derivative extracted from the kernel of seeds of Tamarindus indica Linn., Family Leguminosae. A polymer consists of cellulose-type spine that carries xylose and galactoxylose substituents. It can be used as a binder in tablets, as a mucoadhesive for buccal or sublingual delivery of drugs, in gastro-intestinal targeting as a bioadhesive tablet, and for ocular delivery of drugs for achieving zero-order controlled release. They also act as a carrier for delivery of certain drugs. TSP future perspective is wide application as a promising polymer in pharmaceutical industry as a novel carrier of drugs in various bioadhesive and other sustained release formulations

Yerram Chandramouli et al (2012) Showed that, Controlled release drug delivery systems are gaining importance in the last few decades for their clinical benefits which are not obtained from conventional oral drug delivery. Hydrophilic matrices involving natural polysaccharides are an interesting option for developing sustained release formulation. One of such polysaccharides is Tamarind seed polysaccharide (TSP) isolated from seed kernel of Tamarindus indica. Although TSP is used as an ingredient in food materials, it has not been extensively evaluated till date for its utility in pharmaceuticals formulations. So, this review mainly focuses on the utility of TSP as an excipient in novel drug delivery systems.

M. Hindun Pulungan et al (2001) Showed that, Tamarind kernel is a kind of waste that is not yet used optimally. As natural hydrocolloid source, for it is containing starch and gum, the kernel can be changed in powder form to increase its utility. In powder processing, kernel shell must be separated. One manner to separate it is by roasting where problem of roasting Research is designated to achieve combination of the best behavior of roasting temperature and roasting duration in processing of tamarind kernel as well as the calculation of production cost. Hypothesis is made. It is estimated that the inter-relation between roasting temperature and roasting duration increases the characters of tamarind kernel powder. Experimental method is used. Group random engineering, arranged by factorial, that is, two factors and three replications is implemented. Factor I is roasting temperature such as 1400C, 1500C, 1600C, and Factor II is roasting duration such as 10 minutes, 15 minutes, and 20 minutes. Analysis result of product random on tamarind kernel powder indicates that interaction between roasting temperature and roasting duration

on water level, powder degree, viscosity, gel strength, rendemens and color pleasure is observed. However, interaction between roasting temperature and roasting duration in scent pleasureis not achieved. Analysis to obtain the best alternative results in best alternative of roasting temperature treatment at 1400C for 10 minutes by water level averages to 8,717% bk, starch level to 61,18% bk, viscosity 53,82 cP, gel strength 0,0097mm/g/seconds, color and scent pleasures and rendemens to 77,17% bk, production cost in first year is Rs. 525,00 for each 1 kg.

Pranjal Saikia et al (2014), showed that,The present study is aimed at development and optimization of mucoadhesive nanoparticles (NPs) from natural mucoadhesive polysaccharides extracted from Tamarind seeds (Tamarindus indica) for the sustained delivery of anticancer drug irinotecan. The drug loaded NPs were prepared by ion gelation method with the isolated polysaccharide by homogenization followed by lyophilization. The polysaccharides were cross‐linked with sodium alginate in different ratios. The formulations were optimized using two level factorial design (Design Expert ‐ 8.0.7.1) using the polysaccharide to alginate ratio, homogenization time and homogenization speed as independent variables and particle size (PS), drug entrapment efficiency and cumulative drug release as the dependent variables. The NPs were characterized in terms of PS, entrapment efficiency, drug loading (DL), in vitro drug release and cell viability studies in mice. Stable NPs were obtained with average PS of 405 ± 25.2 nm. The preparations were homogenous showing polydispersity index of 0.497 ± 0.02. The formulation showed up to 95.36 ± 3.1% (w/w) yield showing DL of 1.0 ± 0.2% (w/w). The entrapment efficiency was found to be 46.56 ± 1.5% (w/w). In vitro drug release showed initial burst release followed by controlled release pattern showing up to 60% release in 12 h. The average cell viability was found to be 80% in case of the control group, which was reduced to 36% for NPs treated groups respectively. The Fourier transform infrared studies showed no incompatibility in the formulated NPs. It may be concluded from the study that tamarind seed polysaccharides may be suitable for formulation of mucoadhesive NPs for better efficacy and sustained delivery of anticancer drug irinotecan with reduced toxicity.

Dr. Rashmirekha Sahoo et al (2015) showed that,Natural polysaccharide-based biomaterials are currently being explored as novel drug delivery devices. Important properties of the polysaccharides include controlled biological activity and biodegradability. The tamarind seed is a by-product of the tamarind industry. The decorticated flour, known as tamarind kernel powder has been tried for various biomedical applications such as drug delivery carriers. The xyloglucan component of it, a hemicellulose, was found to be a biocompatible, non-toxic and cheap agro-based material that could be used safely for controlled drug delivery systems. Studies with tamarind-seed polysaccharide nanocomposites have been conducted, where tamarind and polyvinyl alcohol were blended with Cloisite 30B solution in different ratios showing a sustained delivery of drugs. We certainly foresee the prospect of bioadhesive carriers, such as muco-adhesive polymers of tamarind-seed polysaccharides an effective solution of achieving bioavailability of various ocular drugs when used as topical preparations.

Rashmi Manchanda et al (2014), Showed that, In recent years there has been an important development in different dosage forms for existing and newly designed drugs and natural products, semi- synthetic as well as synthetic excipients often need to be used for a variety of purposes. Gums and mucilages are widely used natural materials for conventional and novel dosage forms. With the increasing interest in polymers of natural origin, the pharmaceutical world has compliance to use most of them in their formulation. In the present review we have discussed naturally derived polysaccharide as a potential candidate for novel drug delivery system. These natural materials have advantages over synthetic ones since they are chemically inert non-toxic, less expensive, biodegradable and widely available. They can be modified in different ways to obtain tailor made materials for drug delivery system and thus can compete with the available synthetic excipients. Controlled release drug delivery systems are gaining importance in last few decades for their clinical benefits which are not obtained from conventional oral drug delivery systems. Hydrophillic matrices involving natural polysaccharides are an interesting option for developing sustained release formulations. One such polysaccharide is tamarind seed polysaccharide (TSP) isolated from seed kernel of Tamarindus indica. The utility of TSP and modified TSP as an excipient in novel drug delivery systems is the main focus of this review.

Shailaja T et al (2012) Showed that,Tamarind seed polysaccharide (TS) is derived from the kernel powder of seeds of Tamarindus indica linn.. TS has various pharmaceutical applications, however its application is limited due to uncontrolled rate of hydration, drop in viscosity on storage and susceptibility to microbial contamination. Keeping this in view an attempt was made to overcome some of the disadvantages by suitably grafting the TS with methyl methacrylate (MMA). Chemical method of grafting by potassium per sulphate and ascorbic acid redox pair was selected for grafting. Taguchi L9 design was applied to optimize the grafting process. The grafted product was subjected to physical, chemical andspectral analysis. The

physical characterization reveals no drop of viscosity on storage, controlled rate of hydration of Grafted tamarind seed polysaccharide (GTS). The chemical and spectral characterization confirmed the grafting procedure. Metoprolol succinate a low bioavailable (40-50%) drug was selected for the present study and buccal patches were formulated using TS and GTS as polymers. Central composite design was applied to find out the relationship between percentage of TS/GTS and drug release characteristics and to optimize buccal patches with 12 hour drug release. The 2% of TS and 2.86% of GTS buccal patches were able to show a sustain drug release for 12 hours. Invitro, exvivo drug release studies, release kinetics, physical parameter studies for all optimized patch formulations reflect the ideal characteristics of buccal patch for delivery of metoprolol succinate.

Braja .B et al (2010) Showed that,The prime importance of granulation is to improve the flow properties of the powder properties and its compression properties. To form granules bond must be formed between the particles so that they will adhere with each other with sufficient strength. Granulating agent, which aid drug and excipient aggregation, are a function of the binder type, the physical properties of the drug and the processing methods. This work is to evaluate the physical properties of the granules, the tableting performance and the physical characteristics of the tablets by the use of gum tamarind and comparison with the established binders which prove the binding efficiency of the gum tamarind. The results suggest, due to the high binding capacity of the tamarind gum the characteristics of the granules and tablet are better than the other and for its lower cost and easy availability in the market the gum can be a binding agent of choice.

Rupali Singh et al (2011) Showed that,The objective of the present work was extraction of polysaccharide from tamarind seed and further characterization as pharmaceutical excipient. study includes phytochemical screening, micromeritic properties. Work also emphasize to study gelling properties of extracted polysaccharide. Methods: Water based extraction procedure was used to extract polysaccharide from tamarind seed. Pharmacopoeial procedures were used to study the micromeritic properties, solubility, organoleptic properties and pH. Different concentration based solution were prepared to evaluate gelling properties of seed polysaccharide. Key findings: results obtained from the study showed that used procedure was efficient to extract gum from tamarind seed. Obtained results easily predict the fact that extracted polymer can be used as pharmaceutical excipient in terms of micromeritic properties and flow behavior. It was also found that obtained gum showed gelling behavior at 8% w/v solution of water. Conclusions: It can be concluded from whole study that tamarind seed polysaccharide can be an important pharmaceutical excipient for solid. Obtained results also showed that extracted seed polysaccharide may be used as natural gelling agents in different pharmaceutical formulations.

Rashmi Manchanda et al (2014) Showed that, In recent years there has been an important development in different dosage forms for existing and newly designed drugs and natural products, semi- synthetic as well as synthetic excipients often need to be used for a variety of purposes. Gums and mucilages are widely used natural materials for conventional and novel dosage forms. With the increasing interest in polymers of natural origin, the pharmaceutical world has compliance to use most of them in their formulation. In the present review we have discussed naturally derived polysaccharide as a potential candidate for novel drug delivery system. These natural materials have advantages over synthetic ones since they are chemically inert non-toxic, less expensive, biodegradable and widely available. They can be modified in different ways to obtain tailor made materials for drug delivery system and thus can compete with the available synthetic excipients. Controlled release drug delivery systems are gaining importance in last few decades for their clinical benefits which are not obtained from conventional oral drug delivery systems. Hydrophillic matrices involving natural polysaccharides are an interesting option for developing sustained release formulations. One such polysaccharide is tamarind seed polysaccharide (TSP) isolated from seed kernel of Tamarindus indica. The utility of TSP and modified TSP as an excipient in novel drug delivery systems is the main focus of this review.

Bhavin Patel1 et al (2009) Showed that,The buccal mucoadhesive tablets of nifedipine were fabricated with objective of avoiding first pass metabolism and prolonging duration of action. The mucoadhesive polymers used in formulations were carbopol (cp934), hydroxyl propyl methyl cellulose (HPMC K4M), carboxy methyl cellulose (CMC), and tamarind seed polysaccharide (TSP). These formulations were characterized for physiochemical parameters, in vitro retention time, in vitro bioadhesive strength, percent hydration and drug release. The modified in vitro assembly was used to measure the bioadhesive strength of tablets with fresh goat buccal mucosa as a model tissue. The best mucoadhesive performance and in vitro drug release profile were exhibited by the tablet containing carbopol and TSP in the ratio of 1:1. This formulation was more comfortable to the user due to less erosion, faster hydration rate, and optimum pH of surrounding medium.

Kittiya Klahal et al (2012) showed that, The technical feasibility of using tamarind kernel powder from different

areas in Thailand (Uthaithani, Ang Thong, and Nakhon Sawan) as a thickening agent for printing polyester with disperse dye in comparison to the commercial tamarind kernel powder from India as presently used in textile printing was examined. All tamarind kernel powder samples presented high polysaccharide and protein contents. The obtained result indicated that the properties as colour values, colour strength (K/S), overall fastness properties, handling, and sharpness of printed polyester fabric were good to very good levels. Only slight differences were observed between two places of tamarind kernel powder (Thailand and India) utilized for thickening agent.

III. OBJECTIVES

The main focus of this project is thatTSP is for pharmaceutical use. It is used as a carrier for variety of drugs for controlled release applications. Many techniques have been used to manufacture the TSP-based delivery systems which makes it an exciting and promising excipient for the pharmaceutical industry for the present and future applications.

IV. EXPERIMENTATION

Materials used for the preparation of adhesive that tamarind seeds kernel, ethanol ,PVA for enhancing.

Methods of isolation and extraction

We employed two methods for isolation and here we are used extraction of tamarind seed on first method, 200 g of tamarind seeds are soaked in double distilled water and boiled for 5 h to remove the outer dark layer. When the outer dark layer is removed, to the inner white portion sufficient amount of double distilled water was added and boiled with constant stirring to prepare the slurry. Now cool the resultant solution in refrigerator so that most of the undissolved portion settles down. The supernatant liquid can be separated out by simple decantation or best by centrifugation at 500 rpm for 20 min. After this, the solution is concentrated on a water bath at 60°C to reduce the volume to onethird of the initial volume. Now cool the solution and pour into 3 volumes of acetone by continuous stirring. Precipitates obtained were washed with acetone and drying in vacuum at 50-60°C.

Slurry preparation:

20 g of fine kernel powder is to be added to 200 ml of cold distilled water to prepare slurry.The slurry obtained poured into 800 ml of boiling distilled water and boiled for 20 min on a water bath to obtain a clear solution which must be kept aside overnight. The thin clear solution was then centrifuged at 5000 rpm for 20 min to separate all the foreign matter.

Fig 1 Slurry preparation

Now cool the resultant solution in refrigerator so that most of the undissolved portion settles down. The supernatant liquid can be separated out by simple decantation or best by centrifugation at 500 rpm for 20 min. After this, the solution is concentrated on a water bath at 60°C to reduce the volume to onethird of the initial volume.

Fig 2 **slurry precipitated image**

Slurry is prepared and is kept for cooling under room temperature. Precipitates is obtained from the slurry prepared Solution obtained is centrifuged at 500 rpm. The slurry obtained is than poured into 800 ml of boiling distilled water and are boiled for 20 min on a water bath; a clear solution was obtained which was kept overnight. The thin clear solution was than centrifuged at 5000 rpm for 20 min to separate all the foreign matter. The supernatant liquid can be separated out by simple decantation or best by centrifugation at 500 rpm for 20 min. After this, the solution is concentrated on a water bath at 60°C to reduce the volume to onethird of the initial volume. Now cool the solution and pour into 3 volumes of acetone by continuous stirring. Precipitates

obtained were washed with acetone and drying in vacuum at 50-60°C.

Fig 3. Sample before treating with acetone
fig 4 Sample after treating with acetone

V. COMPARSION OF RESULT

The adhesive nature of tamarinds kernel can be determined by the using FTIR .the strength of adhesive nature is found by using DSC

5.1 FTIR

- FTIR scanning with the Perkin Elmer Frontier spectrometer makeIdentification of organic molecules.Identification of simple mixtures of organic and inorganic compounds both as solids or liquids.Identification of polymers and polymer blends. molecules absorb light in the infra-red region of the electromagnetic spectrum.frequency range are measured as wave numbers typically over the range 4000 – 600 cm-1.
- FTIR (Fourier Transform Infra-Red Spectroscopy) is used to quickly identify compound such as plastics ,rubber, paint, resin, adhesive.This makes it useful for scientist and engineers for product development, quality control, problem solving.

Fig 5 FTIR EQUIPMENT

5.2 FTIR RESULT

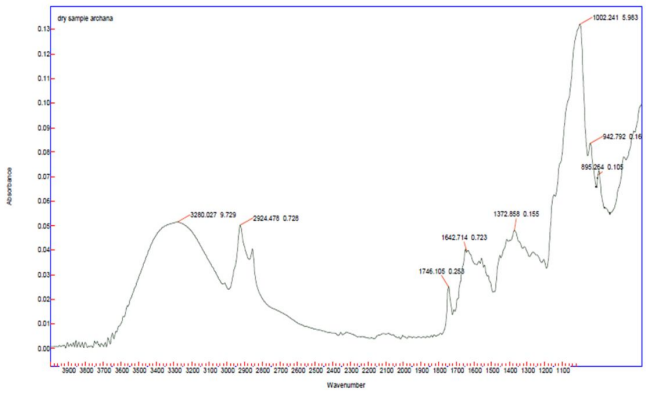


Fig 6 From FTIR , the Polysaccharides spectrum

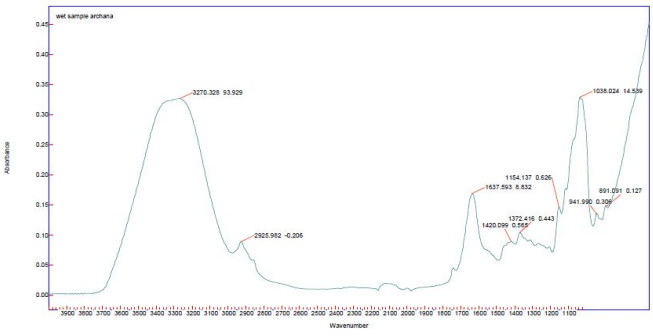


fig 7 From FTIR spectrum , there is a peak in 3000-3500 cm^{-1}
-OH peak treating with acetone

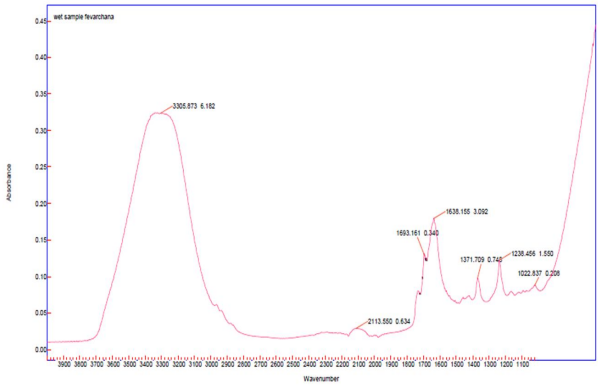


Fig 8 Adhesive sample from seed mixed with 2 % polyvinyl acetate

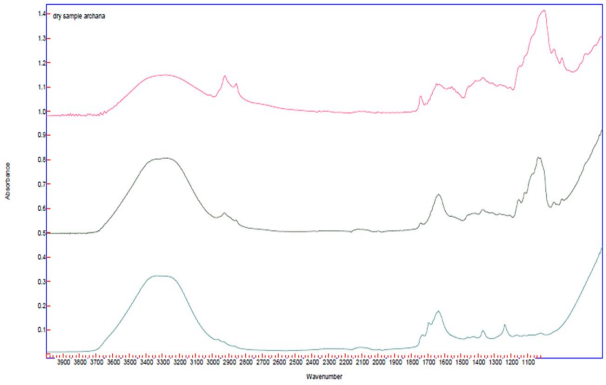


Fig 9 Comparision

VI. Differential Scanning Calorimeter

DSC Q 20 TA instruments make determines the heat flow associated with the system endothermic (heat absorption) and exothermic (heat evolution) processes , physical transitions that are caused by phase changes, melting, oxidation, and other heat-related changes

Fig 10 DSC EQUIPMENT

6.1 DSC RESULTS

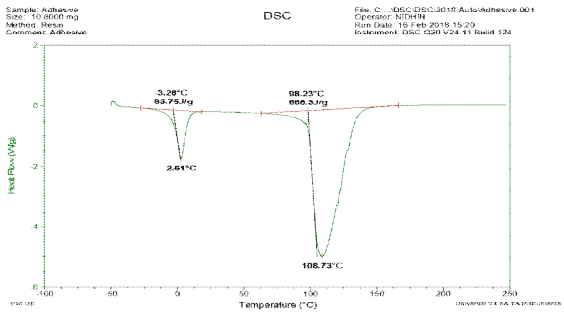


Fig 11 DSC OF ADHESIVE SAMPLE ADHESIVE+PVA

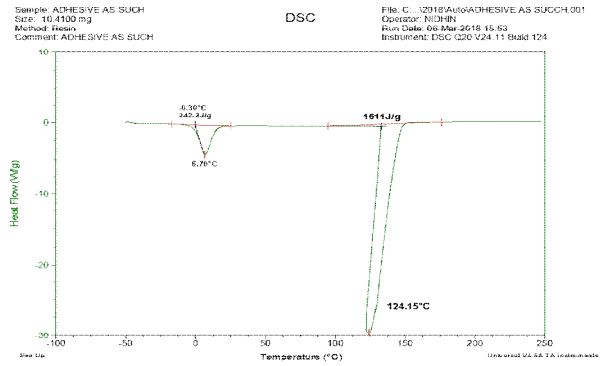


Fig 12 DSC OF ADHESIVE +PVA

6.3 DCS CALCULATION (1. Table)

	Melting 1			Melting II		
	Onset Temperature®	Peak Max(C)	Enthalpy (J/g)	Onset Temperature®	Peak Max(C)	Enthalphy (J/g)
Adhesive as such	-3.28	2.61	83.75	98.23	108.73	668.3
Adhesive + PVA	-3	6.7	242.2	100	124	1611

VII. PEEL TEST

7.1 PROCEDURE:

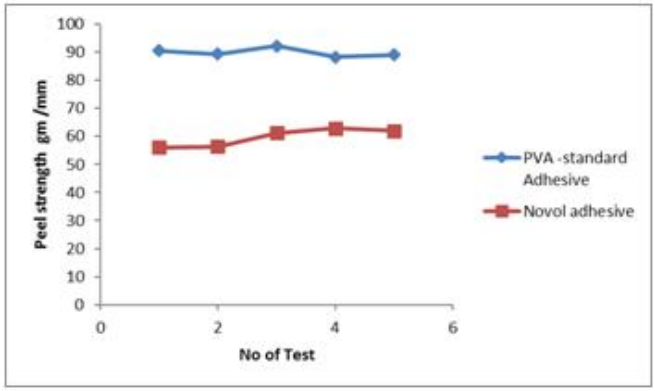
Peel testing of adhesive and pressure sensitive tapes is used for quality assurance, and provides a means of assessing uniformity of the adhesion of a given type of tape. The assessment may be within a roll of tape, between rolls, or between production lots. Adhesive properties for tapes are measured using a standard test surface, a specified angle and test speed

Sample Dimensions
Length: 220±5 mm
Width: 25±1mm

Testing Matrices
Rubber rolls -2 kg (including Handle weight)
SS 304 Plate – length 130±5 mm
Width 50 ±1 mm
Roughness (Ra) 50±220 nm

Testing Parameters
Load cell: 50 kg with 10 g accuracy
Jaw speed: 300± 5 mm/min
Gauge length: 100± 5 mm.

No of Tests	180 Peel strength(gm/25 mm) PVA -standard Adhesive	Novol adhesive
1	90.55	56.13
2	89.31	56.426
3	92.31	61.27
4	88.23	62.82
5	**89.12**	62.04
Avg	**89.904**	**59.7372**
std	**1.579233992**	**3.206710027**



Graph between peel strength and no of test

VIII. CONCLUSION

From above experimentsthe development of dosage form of drug delivery systems has resulted in a need for new invention to support the desired properties.Natural substance can be good substitute for synthetic polymers. Natural polymers (tamarind seeds are used as binding agents, gelling agents, disintegrating agents, sustaining agents in matrix tablets,as a coating for tablets has wide application in drugs system, film forming agents, suspending and emulsifying agents and as solubiliser. Various other modifications of TSP can be made to eliminate certain drawbacks of basic polymer and can be further explored as an excipient in novel drug delivery systems.

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