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Development and characterization of modified gums (some plant sources)

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(Pharmaceutical Chemistry)

Abstract

Natural gums, that means gum which is obtained from natural sources such as plants. Natural gums are polysaccharides (carbohydrates) consisting of multiple sugar units linked together to create large molecules. Gums can be grouped into three major categories namely natural gums, modified gums and synthetic gums. Natural gum is better alternative to synthetic polymer or viscosity modifier used in designing of different formulation but some physiochemical characteristics, stability and chance of microbial growth restricted the use of natural gum. Chemical modification improve the characteristics of natural gum and produce semisynthetic derivative which better alternative option with respect to synthetic agents. So natural gum are tamarind gum, fenugreek gum, linseed gum was extracted from tamarind seed, fenugreek seed, and linseed. These gums were modified by using crosslinking agent TPP after extraction, modification result to change in properties of it like viscosity, pH, sedimentation volume and degree of flocculation etc. On the basis of obtained result it was found that as a result of chemical modification viscosity of all modified gums (modified tamarind gum, modified linseed gum, modified fenugreek gum) hasincreased as compare to natural gums(tamarind gum, fenugreek gum, linseed gum), but the viscosity of tamarind gum significantly increased. In this study we have concluded that the tamarind to modified tamarind seed gum shown significant changes in their properties remembering were not shown significant change, so crosslinking agent was found suitable for tamarind to modified tamarind seed gum. From these results are concluded that TPP was found suitable crosslinking agent. But this is not suitable for modification of fenugreek seed gum and linseed gum. So there are further scope available to think about the other crosslinking agent for modification of fenugreek seed gum and linseed gum.

INTRODUCTION:

Natural gums, that means gum which is obtained from natural sources such as plants. Natural gums are polysaccharides (carbohydrates) consisting of multiple sugar units linked together to create large molecules. Gums can be grouped into three major categories namely natural gums, modified gums and synthetic gums. Natural gums are found in a natural state such as the tree exudates or seaweed hydrocolloids. Examples include gum arabic, guar gum and gum tragacanth.

Classification of Gums

Gums are present in high quantities in varieties of plants, animals, seaweeds, fungi and other microbial sources, where they perform a number of structural and metabolic functions; plant sources provide the largest amounts. The different available Gums can be classified as follows,

Table No. 1.1 Classification of gum

Sr.No.	Classification system	Categories	Examples
1	According to the charge	Non-ionic	Guar, locust bean, tamarind
		Anionic	Arabic, karaya, Tragacanth
2	According to the source	Marine	Agar, carrageenans, alginic acid
		Plant	Gum arabica, guar gum, locust bean
		Animal	Chitin, chitosan, chondrotoinsulfate,
		Microbial	hyaluronic acid, Xanthan, dextran,curdian
3	Semi-synthetic	Starch derivatives	Hetastarch, starch acetate, starchphosphates
		Cellulose derivatives	Carboxy methyl cellulose (CMC), hydroxypropyl methylcellulose (HPMC), methylcellulose (MC), microcrystalline cellulose (MCC)
4	According to shape	Linear	Algins, amylose, cellulose
		Branched	Xanthan, xylan, amylopectin
5	According to monomericunits	Homoglycans	Amylose, arabinanas, cellulose
		Di-heteroglycans	Algins, carragennans, galactomannans
		Tri-heteroglycans	Arabinoxylans, gellan, xanthan
		Tetra-heteroglycans	Gum arabic, psyllium seed gum
		Penta-heteroglycans	Ghatti gum, Tragacanth

Advantages of Natural Gums in Pharmaceutical Sciences

• **Biodegradable**—Naturally available biodegradable polymers are produced by all living organisms. They represent truly renewable source and they have no adverse impact on humans orenvironmental health (*e.g.*, skin and eye irritation).

• **Biocompatible and non-toxic**— chemically, nearly all of these plant materials are carbohydrates composed of repeating sugar (monosaccharide's) units. Hence, they are non-toxic.

• **Low cost**—it is always cheaper to use natural sources. The production cost is also much lower as compared with that for synthetic material.

• **Environmental**-Friendly processing— gums from different sources are easily collected in different seasons in large quantities due to the simple production processes involved.

Disadvantages of Natural Gums

- Reduced viscosity on storage
- Batch to batch variation
- Microbial contamination

Applications of Natural Gum

Gums are used in medicine for their demulcent properties for cough suppression. They are ingredients of dental and other adhesives and can be used as bulk laxatives. These hydrophilic polymers are useful as tablet binders, disintegrates, emulsifiers, suspending agents, gelling agents, stabilizing agents, thickening agents, film forming agents in transdermal and periodontal films, buccal tablets as well as sustaining agents in matrix tablets and coating agents in microcapsules including those used for protein delivery.

Gums are used in cosmetics (acacia, tragacanth and karaya gum), textiles (starch, dextrin,cellulose, pectins, and tamarind gum), adhesives (acacia gum, and tragacanth), lithography (gum arabic, tragacanth, and locust bean gum), paints (pectins, hemicellulose, and resins) and paper manufacture (tamarind, and cellulose).

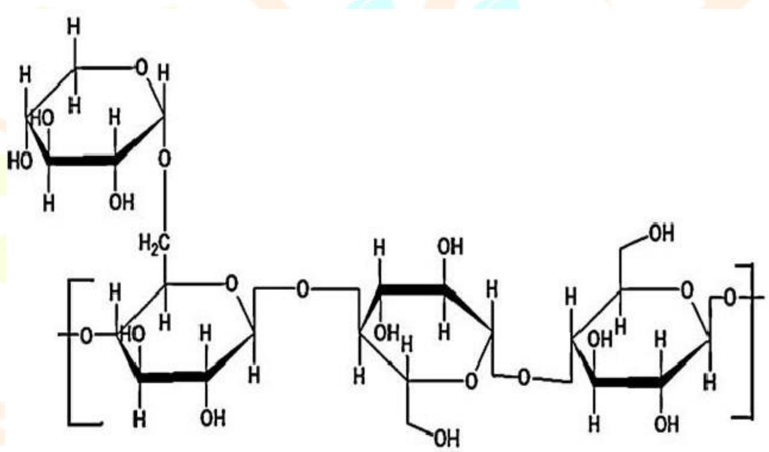
Investigative Gums

Tamarind Seed Gum

Tamarind (*Tamarindus indica Linn.)* is one of the most extensively planted and highly valuedtree in India. It belongs to the family Pabaceae (Leguminasae) and sub family Caesalpiniaceae. The name tamarind is derived from theArabic word “Tamr-ulhind”, which means, “Date of India”.

Utilization of Tamarind: The pulp is often eaten fresh, directly from the pod but it is also used in the preparation of many foods for e.g., chutney, curries, preservatives, confectioneries, ice cream, juice and syrups.

The tamarind pulp is rich in calcium, phosphorus, iron, thiamine and riboflavin. It is also good source of niacin. It is considered useful as a cooling agent during fever, carminative, mild laxative, digestive problems, bile disorders, and bronchial problems and even as a gargle for sore throats.



Tamarind seed polysaccharide

Fig 1.1 Chemical structure of tamarind seed

Fenugreek Seed

Fenugreek (*Trigonella foenum graecum*) is an annual plant belonging to the family Leguminosae. It is a famous spice in human food. The seeds and green leaves of fenugreek are used in food as well as in medicinal application.

Seeds of fenugreek spice have medicinal properties such as hypocholesterolemic, lactation aid,antibacterial, gastric stimulant, for anorexia, antidiabetic agent, galactagogue, hepatoprotective effect and anticancer.

These days it is used as a food stabilizer, adhesive and emulsifying agent due to its high fibre, protein and gum content. The protein of fenugreek is found to be more soluble at alkaline pH Fenugreek is havingbeneficial influence on digestion and also has the ability to modify the food.

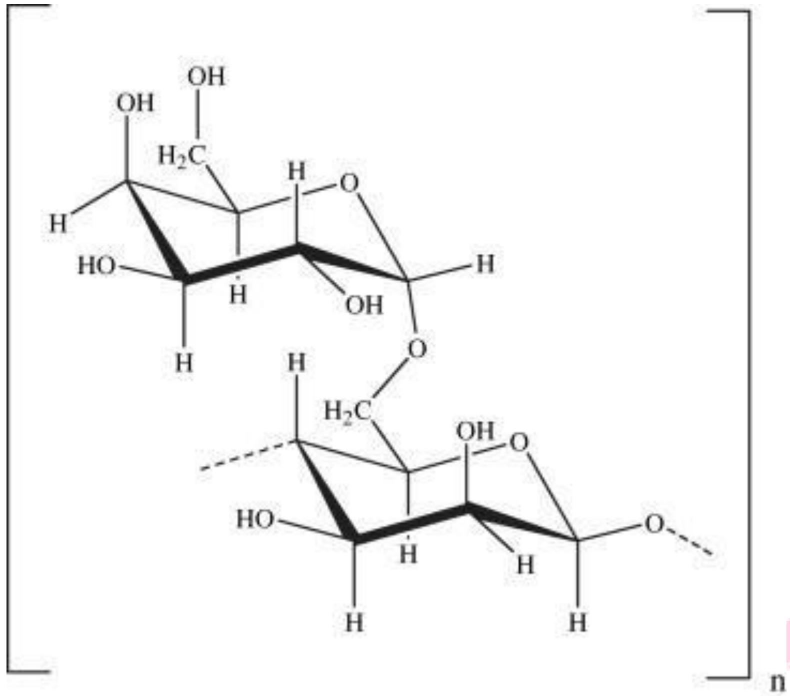
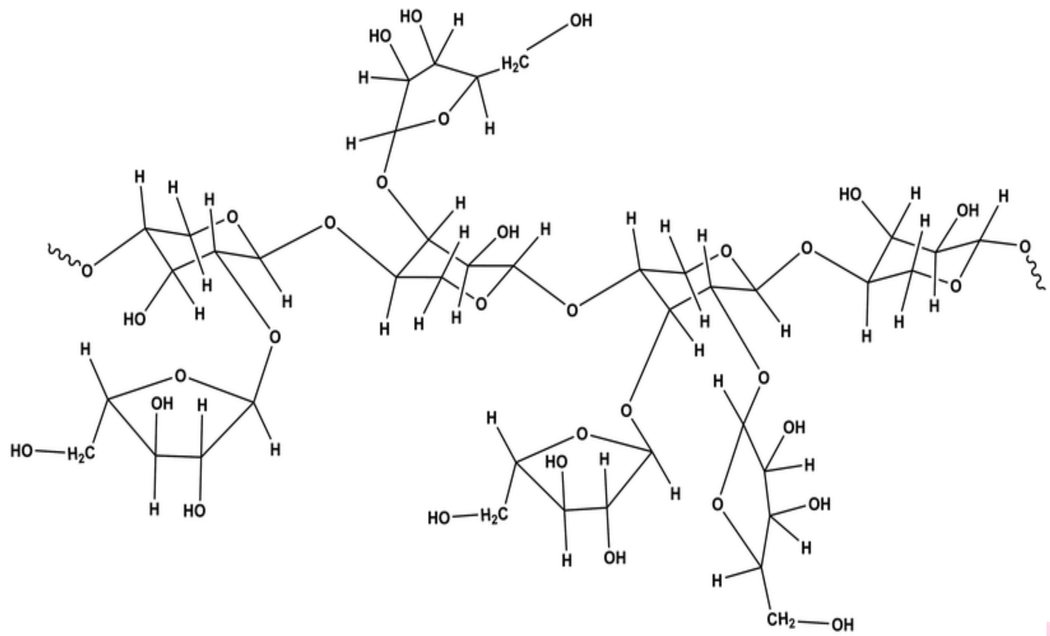


Fig 1.2 Chemical structure of fenugreek seed gum

1.4. 3 Linseed Gum

Linseed seed (*Linum usitatissimum*), known as common flax. It is a member of thegenus *Linum* in the family Linaceae. It is a food and fiber crop cultivated in cooler regions of the world. Flaxseeds occur in two basic varieties/colors: brown or yellow (golden linseeds). Most types of these basic varieties have similar nutritional characteristics and equal numbers of short- chain omega-3 fatty acids.

Linseed mucilage, consisting mainly of water-soluble polysaccharides, was isolated from the seeds and a partially defatted meal by different extraction regimes. The mucilage yield (3.6- 9.4%) and level of contaminating proteins varied substantially with the temperature of extraction and nature of the raw material; lower yields of relatively pure polysaccharide extracts were obtained from the seeds at 4°C. Although the relative monosaccharide composition varied with the extraction conditions, galacturonic acid, galactose, xylose, and rhamnose were the major monosaccharides; fucose, arabinose, and glucose were minor constituents.Isolation techniques. Extraction in chemistry may be a separation technique consisting within the separation of a substance from a matrix.



Arabinoxylans

Fig 1.3 Chemical Structure of Linseed Gum

Cross-Linking of Natural Gum

Cross-linking is the process of stabilizing collagen by creating new links between strands of collagen; this process inhibits degradation of the collagen by proteases and prolongs its presence in the wound. Newerprocesses of cross-linking produce more elastic and flexible cross-links between strands of collagen and are less prone to enzymatic breakdown. These more flexible bonds produced by newer processes are thought to allow cells to migrate and proliferate in an organized manner similar to normal tissue repair.

Cross-linking agent: Crosslinking is the formation of chemical links between molecular chains to form a three-dimensional network of connected molecules. Cross linker can be aldehydes, for example, formaldehyde, acetaldehyde, glyoxal and glutaraldehyde to form acetals, maleic acid or oxalic acid to form cross linked ester bridges or dimethylurea, poly(acrolein), diisocyanate and divinylsulfonate.

Significance of Cross linking

Adding cross-links between polymer chains affect the physical properties of the polymer depending upon the degree of cross linking and presence and absence of crystallinity. Cross linking results in:

Elasticity (they can stretch and return to their original form). Elastomers are elastic polymers created by limited cross-linking. As the number of cross-links increases, however, the polymer becomes more rigid and cannot stretch as much; the polymer will become less viscous and less elastic and might even become brittle. The vulcanization or sulfur curing of rubber, for example, results from the introduction of short chains of sulfur atoms that link the polymer chains in natural rubber. Bridges made by short chains of sulfur atoms tie one chain of polyisoprene to another, until all the chains are joined into one giant super molecule. The chemical process of vulcanization is a type of cross-linking which increases the strength of rubber. It makes rubber hard and durable material associated with car and bike tires.

i) Decrease in the viscosity (the resistance to flow) of polymers. In order for polymers to flow, the chains must move past each other and cross-linking prevents this. As a resultof restriction in flow there is improvement in the creep behavior.

ii) Insolubility of the polymer. Cross linking results in insolubility as the chains are tied together by strong covalent bonds. Cross linked materials can't dissolve in solvents, but can absorb solvents. Cross linked material after absorbing a lot of solvent is called a gel. For example cross linked polyacrylamide gel. Uncross linked polyacrylamide is soluble in water, and cross linked polyacrylamides can absorb water but is insoluble. Water-logged gels of cross-linked polyacrylamides are used to make soft contact lenses.

iii) Increased Tg and increased strength and toughness. Crosslinking changes the local molecular packing, resulting in a decrease in free volume, leading to increase in Tg. PVA cross-linked with boric acid showed increased glass transition temperature. Cross- links slow down the PVA molecular motion and must not be included in the crystalline domains.

iv) Lower melting point. For crystalline polymers with low degree of cross linking there isa decrease in the crystalline behavior, as cross linking introduces hindrance to the chain orientation resulting in a softer, elastic polymer having lower melting point.

v) Transformation of thermoplastics and thermosets. Heavy cross-linking changes thermoplastics to thermoset plastics. Once the cross-links form, the polymer’s shape cannot be changed again without destroying the plastic. Unlike thermoplastic polymers, the process cannot be undone by reheating; thermoset plastics will start to decompose rather than becoming moldable and pliable. The first thermoset was polyisoprene. More the sulfur crosslinks are put into the polyisoprene, the stiffer it gets. Lightly cross- linked, it's a flexible rubber. Heavily cross-linked, becomes a hard thermoset.

Methods of Crosslinking

Depending upon the nature of the polymer, different techniques may be used to cause cross linking. Cross-linking may occur through polymerization of monomers having functionalities more than two (by condensation) or by covalent bonding between polymeric chains through irradiation, sulphur vulcanization or chemical reactions by adding different chemicals in conjunction with heating and, sometimes, pressure. In all cases, the chemical structure of the polymer is altered through the cross linking process. Cross linking by irradiation is done by using high energy ionizing radiation, like electron beam (e-beam), gamma, or x-ray.

Tripolyphosphate

- Sodium triphosphate (STP), also sodium tripolyphosphate (STPP), or tripolyphosphate(TPP), is an inorganic compound with formula Na5P3O10.
- It is the sodium salt of the polyphosphate penta-anion, which is the conjugate base oftriphospheric acid.

- It is produced on a large scale as a component of many domestic and industrial products,especially detergents.

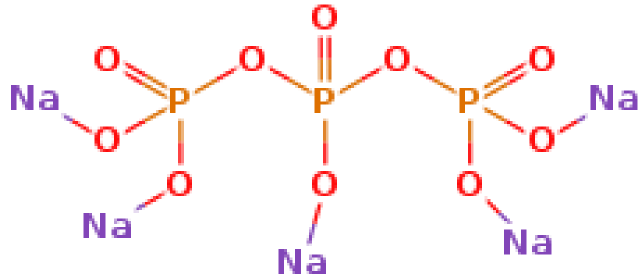


Fig 1.4 chemical structure of tpp

Application:-It is used as a ceramics, leather, tanning, anta caking, flame retardant, paper, anti- corrosion pigments, textiles, rubber, manufacture fermentation, antifreeze. TPP is used as a polyanions cross linker in polysaccharide based drug delivery.

METHOD

Extraction process

Extraction process for Tamarind seed gum

Gum was extracted from tamarind seed by following procedure, the schematic representation is illustrated in fig 6.1 for extraction of gum, 50 g of tamarind seed was converted to coarsely powdered form with pestle- mortar. The powdered seed was boiled with 1L distilled water for 30minutes. Gum extract was filtered with muslin cloth. Filtered extract treated with 100 ml of acetone for 10 min. the gum get precipitated from the solution, precipitated gum was dried inhot air oven at 60○°c for 48hrs.dried gum cake again powdered

Fig 1.1 Sequential process of gum extraction from tamarind seed

Extraction process for linseed gum

Gum was extracted from linseed by following procedure, the schematic representation is illustrated in fig 6.2 for extraction of gum, and 50 g of linseed was converted to coarsely powdered form with pestle- mortar. The powdered seed was boiled with 1L distilled water for 30minutes. Gum extract was filtered with muslin cloth. Filtered extract treated with 100 ml of acetone for 10 min. the gum get precipitated from the solution, precipitated gum was dried in hotair oven at 60○°c for 48hrs. Dried gum cake again powdered[42].

Fig 1.2 Extraction process for fenugreek seed gum

Gum was extracted from fenugreek seed by following procedure, the schematic representation is illustrated in fig 6.1 for extraction of gum, 50 g of fenugreek seed was converted to coarsely powdered form with pestle- mortar. The powdered seed was boiled with 1L distilled water for 30minutes. Gum extract was filtered with muslin cloth. Filtered extract treated with 100 ml of acetone for 10 min. the gum get precipitated from the solution, precipitated gum was dried in hotair oven at 60◌°c for 48hrs. dried gum cake again powdered.

Fig 1.3 Sequential process of gum extraction from fenugreek seed

Scheme of chemical modification with natural gum

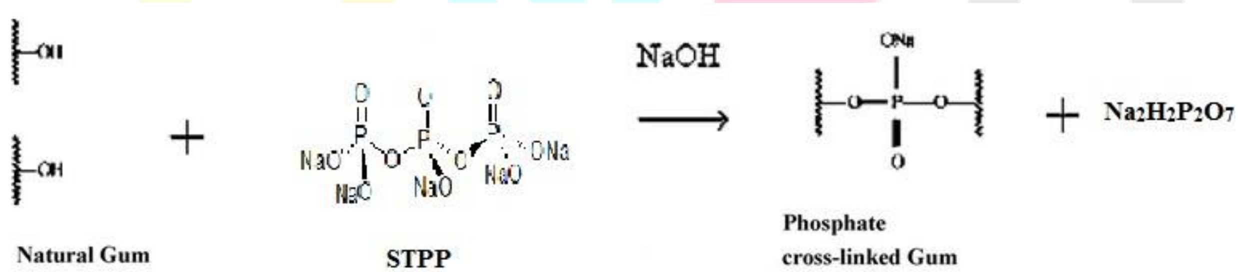


Fig. 1.4 Schematic representation of chemical modification of natural gum

Chemical Modification of Gums

Synthesis of cross-linked tamarind gum

0.5 g of sodium tripolyphosphate was weighed and added accurately into 10 ml of distilled waterto make 5% solution, prepared solution was added drop by drop into the 1gm tamarind gum that is previously wetted with some amount of water. Mixed properly efficient crosslinking Reaction. The resulted mixture was dried and powdered.

Synthesis of cross-linked linseed gum

0.5 g of sodium tripolyphosphate was weighed and added accurately into 10 ml of distilled waterto make 5% solution, prepared solution was added drop by drop into the 1gm linseed gum that is previously wetted with some amount of water. Mixed properly efficient crosslinking Reaction. The resulted mixture was dried and powdered

Synthesis of cross-linked fenugreek gum

0.5 g of sodium tripolyphosphate was weighed and added accurately into 10 ml of distilled water to make 5% solution, prepared solution was added drop by drop into the 1gm fenugreek gum thatis previously wetted with some amount of water. Mixed properly efficient crosslinking Reaction. The resulted mixture was dried and powdered.

Characterization

Differential scanning calorimetric studies

For DSC analysis, 2-3 mg of sample was weighted in aluminium pan. Its accurate weight was noted down. The pan was hermetically sealed with lid by sample pan crimper press. Thermal analysis was done by using pyris software followed by appropriate temperature range 30-300°c at scanning rate of 10°c per min under nitrogen atmosphere ,the melting endotherm were calculatedby the software.

I.R. spectroscopy

For IR spectroscopy of gum sample to dehydrate KBr, put into hot air oven at 60°c for 30 minutes. The gum sample with KBr was triturated in ratio of 1:3 triturated sample was spreaded uniformly in sample holder and scanned for 10 cycles. To obtain spectra.

Preparation of Suspension

0.5 g of tamarind seed gum and 0.37gm of talc were triturated together with 10 ml of water to form a smooth paste. To above solution 2.5 g of sucrose was gradually added. Adjusted volume up to 50 ml with distilled water and mixed properly by glass rod. The above procedure was repeated with fenugreek gum, linseed gum, modified tamarind gum, modified fenugreek gum, modified linseed gum and Tragacanth gum.

6.3.4 Evaluation of suspension

Sedimentation volume

Sedimentation volume of the suspensions were determined by keeping 50 ml portion of each suspensions in stoppered measuring cylinder and stored undisturbed at room temperature. The separation of clear liquid noted between regular intervals for 3 days. The sedimentation volume, F (%), was then calculated using the following equation.

$$F = \frac{Vu}{V0} \qquad \text{……………Eq 1}$$

Where Vu is the ultimate volume of the sediment and Vo is the original volume of thesuspension.

Determination of the pH of the suspensions

The pH of each of the prepared suspension was measured by pH meter.

Determination of viscosity

2% of gum solution or suspending agent was taken and viscosity was determined with Brookfield viscometer using spindle no. 61 at 20.3◌°c (ambient temperature). The viscosities with different rpm were taken in replicate. Result are shown in Table No 7.10 at page no

Degree of flocculation

For the determination of degree of flocculation 2% gum solution was treated with 2ml of 1M potassium dihydrogen phosphate solution and final volume sedimentation were noted at regular intervals for 24 hrs.

$$\beta = \frac{F}{F\alpha} \qquad \text{……………..Eq 2}$$

F is the ultimate flocculation height in the flocculated system and, Fα is the ultimatesedimentation height in deflocculated system.

CHARACTERIZATION OF GUMS

IR Spectroscopy of Gums

Tamarind seed gum

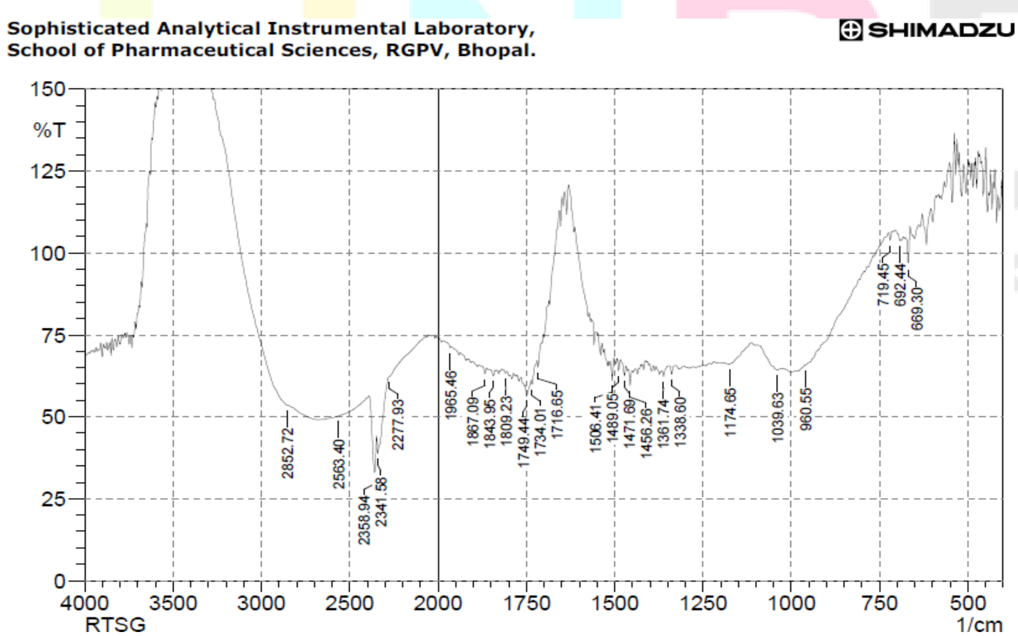


Fig 1.1: FTIR spectrum of tamarind seed gum

Table 1.2 FTIR spectral peak assignment for tamarind seed gum

S No.	Standard frequency(cm^{-1})	Sample frequency(cm^{-1})	Interpretation
1.	2840-3000	2852.72	C-H (stretch
2.	1450-1470	1470.05	C-H(bend)
3.	1400-1500	1489.05	C-C (stretch)
4.	1000-1320	1039,1174.65	C-O (stretch)

The FTIR spectra of tamarind seed gum observed characteristic IR wave no. from the spectrumof gum were shown in table no.1 and figure 6.1 a broad band at 3412.9 cm^{-1} attributed to the O-Hgroup stretching of gums 2852.1 cm-1 were assigned to C-H stretching modes of methylene group of sugar. In the same spectrum the band at 1039, 1174.65 cm-1 were due to the presenceof C-O group stretching in the gum.

7.1.1.2 Modified Tamarind seed gum

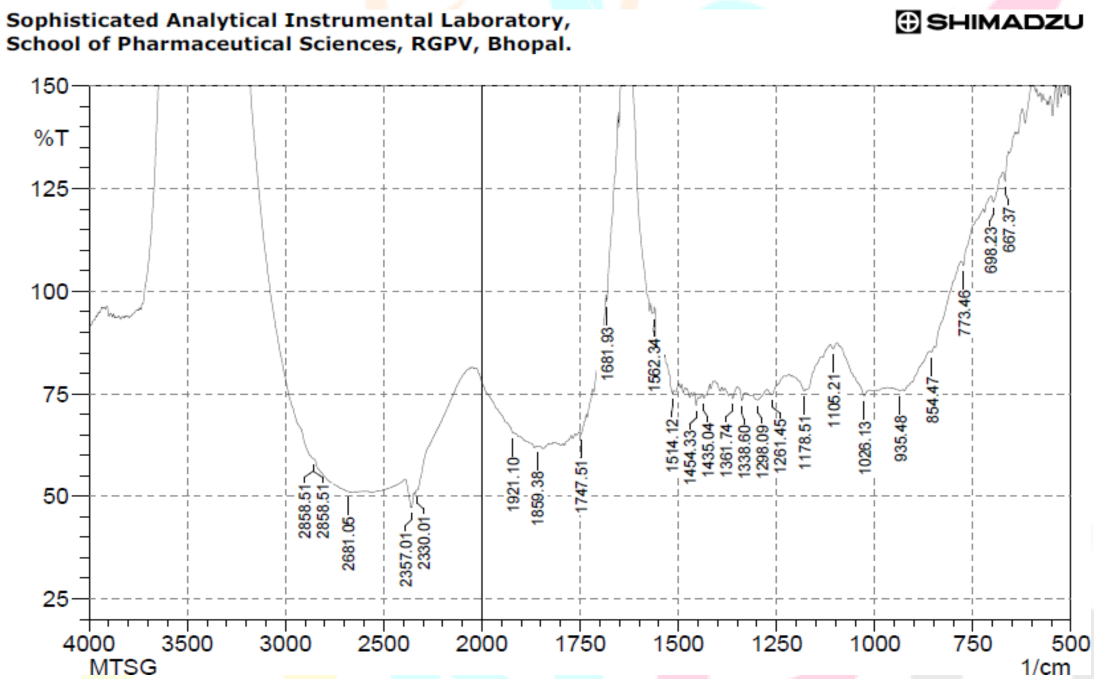


Fig. 1.2: FTIR spectrum of modified tamarind seed gum

Table 1.3 FTIR spectral peak assignment for modified tamarind seed gum

S No.	Standard waveNo.	Sample waveNo.	Interpretation
1.	665-920	854.47	O-H (bend)
2.	1020-1250	1178.51	C-O (stretch)
3.	1665-1760	1747.51	C=O(stretch)
4.	2850-3000	2858.51	C-H (stretch)
5.	2900-3300	2621.05	O-H (stretch)

Modification of gum indicate that esterification and reduction of the compound has been interpreted on the basis of the following peaks such as 2241.58, 2277.93, 1843.96, 1809.23 $cm^{-1}$and new peak appeared at 1298.09, 1261.45 cm^{-1}.

Fenugreek seed Gum

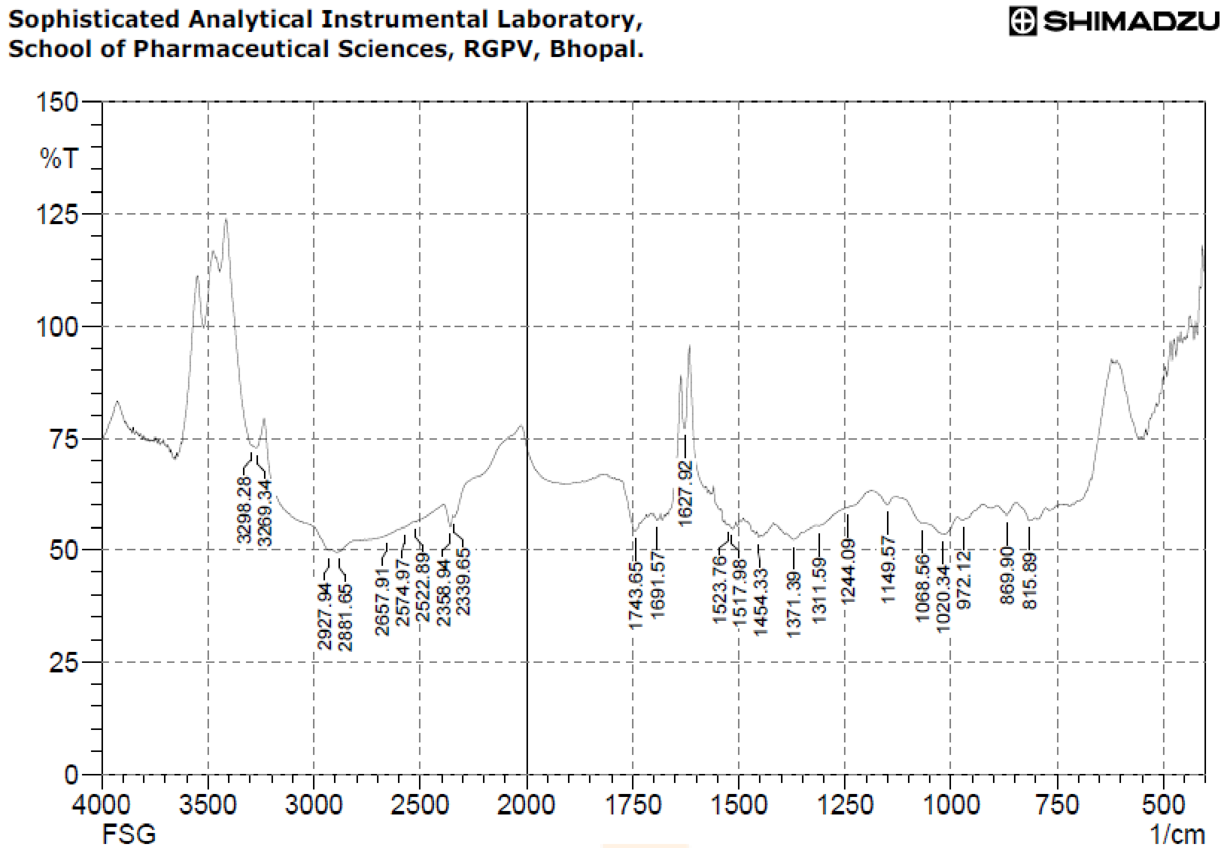


Fig. 1.3: FTIR spectrum of fenugreek seed gum

Table 1.4 FTIR spectral peak assignment for fenugreek seed gum

S. No.	Standard wave no.	Sample wave no.	Interpretation
1.	3200-3500	3269	O-H(stretch)
2.	1000-1320	1068	C-O (stretch)
3.	1400-1500	1454.33	C-C(stretch)
4.	1450-1470	1454.33	CH2(bend)
5.	1665-1760	1745.58	C=O (stretch)

The FTIR spectra of fenugreek seed gum observed characteristic IR wave no. from the spectrum of gum were shown in table no. 3 and figure 6.4 a broad band at 3269 cm^{-1} attributed to the O-H group stretching of gums 2881 cm-1 were assigned to C-H stretching modes of methylene group of sugar. In the same spectrum the band at 1627 cm-1 were due to the presence of C=O group stretching in the gum.

Modified Fenugreek seed Gum

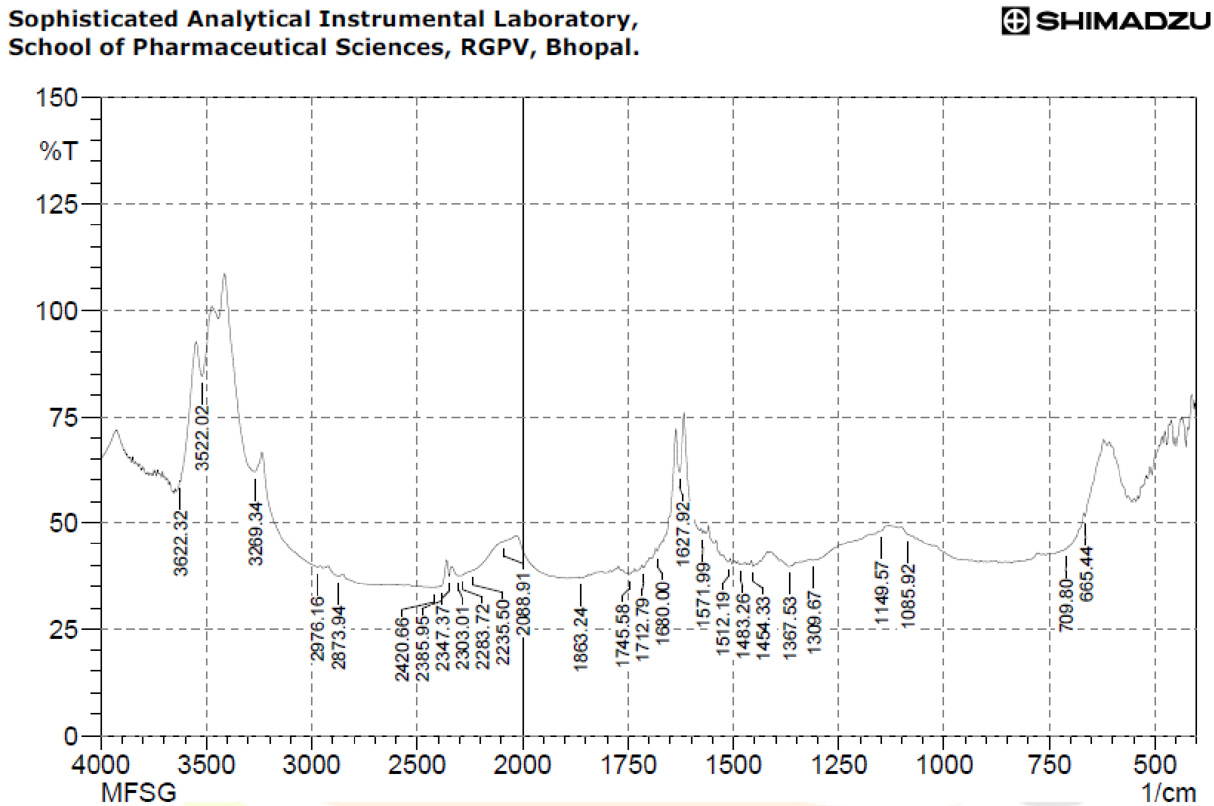


Fig 1.4: FTIR spectrum of modified fenugreek seed gum

Table 1.5 FTIR spectral peak assignment for modified fenugreek seed gum

S No.	Standard waveNo.	Sample waveNo.	Interpretation
1.	1020-1250	1085.92	C-N (stretch)
2.	1450-1470	1454.33	C-H (bend)
3.	1690-1760	1712.79	C=O (stretch)
4.	2850-3000	2873.99	C-H (stretch)
5.	3610-3640	3622.52	O-H (stretch)

Modification of gum indicate that esterification and reduction of the compound has been interpreted on the basis of new peak appeared 2283.72, 2235.50, 2068.91, 1863.24 cm^{-1} and disappearance of the following peak 2657.91, 2574.97, 2522.89 and 1244.09 cm^{-1}.

Linseed Gum

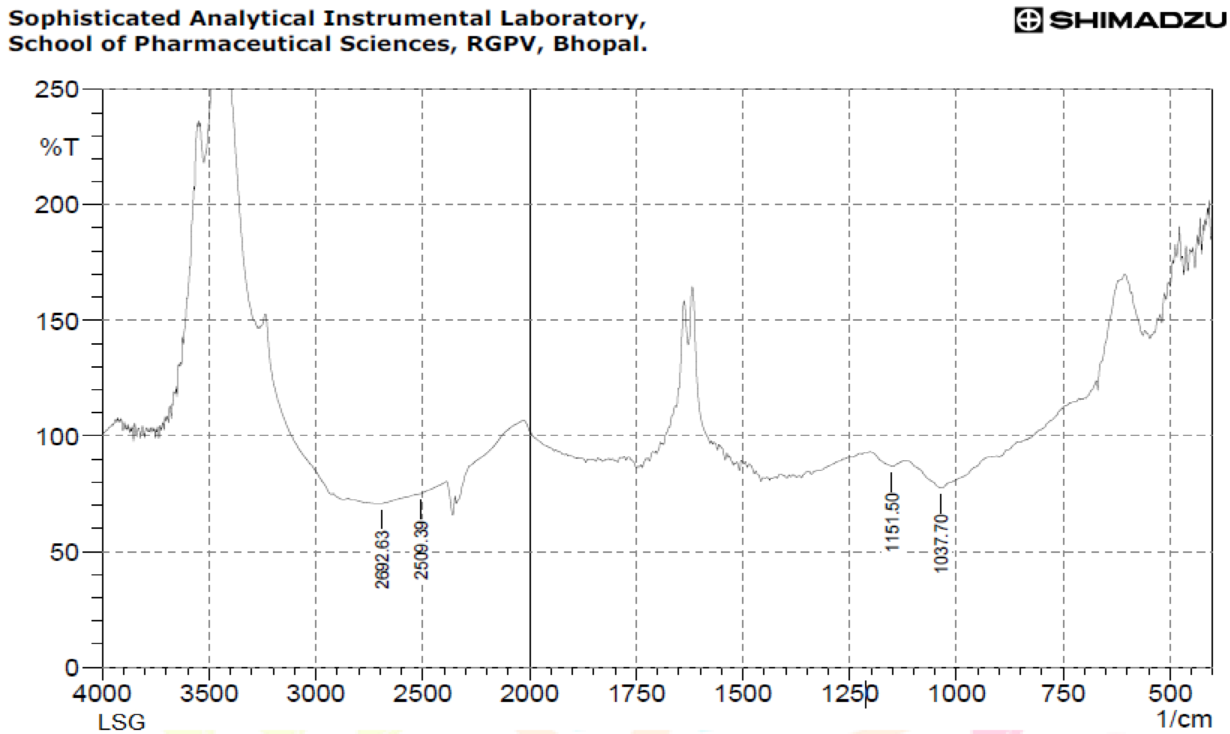


Fig 1.5: FTIR spectrum of linseed gum

Table 1.6 FTIR spectral peak assignment for linseed gum

S No.	Standard waveNo.	Sample waveNo.	Interpretation
1.	2500-3300	2692.63	O-H (stretch)
2.	2500-3000	2509.39	O-H (stretch)
3.	1000-1320	1151.50	C-O (stretch)
4.	1000-1320	1037.70	C-O (stretch)

The FTIR spectra of fenugreek seed gum observed characteristic IR wave no. from the spectrum of gum were shown in table no. 5 and figure 6.5 a broad band at 2692.63 cm^{-1} attributed to the O-H group stretching of gum. In the same spectrum the band at 1151.50, 1037.70 cm-1 were due to presence of C-O group stretching in the gums.

Modified Linseed Gum

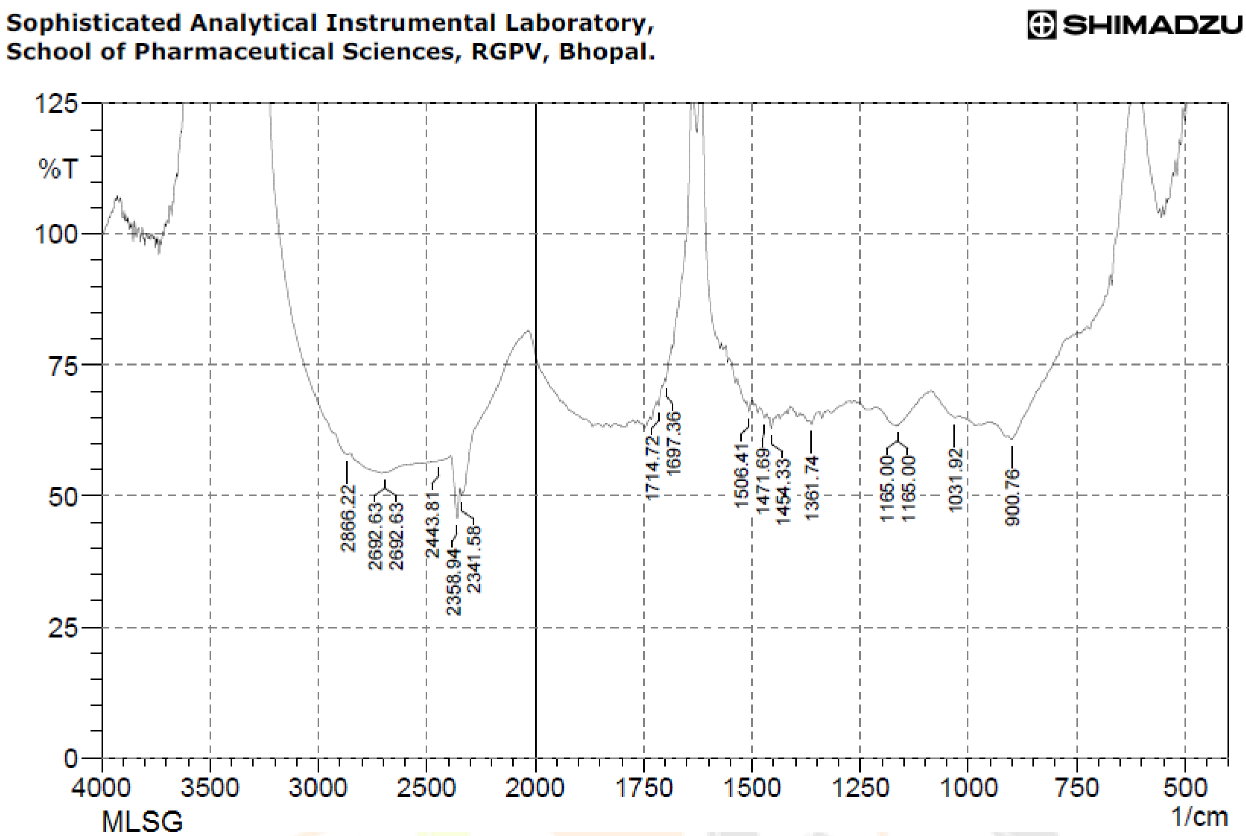


Fig 1.6: FTIR spectrum of modified linseed gum

Table 1.7 FTIR spectral peak assignment for modified linseed gum

No.	Standard waveNo.	Sample waveNo.	Interpretation
1.	675-900	900	C-H "oop"
2.	1020-1250	1165	C-O (stretch)
3.	1400-1500	1471.69	C-C (stretch)
4.	1690-1760	1714.72	C=O (stretch)
5.	2850-3000	2866.22	O-H (stretch)

Modification of gum indicate that esterification and reduction of the compound has beeninterpreted on the basis of new peak appear 1714.72, 1697.36, 1506.41, 1471.69 and 1361.7 cm^{-1}

XRD Pattern of Gums

XRD of Tamarind gum and modified Tamarind gum

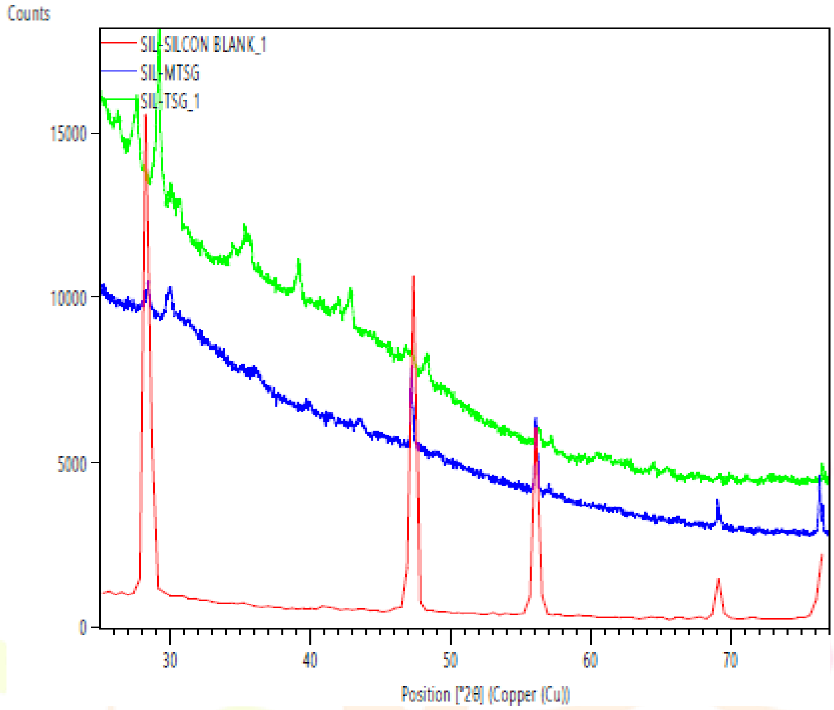


Fig. 1.7 Overlay of Tamarind gum and modified Tamarind gum

XRD of Fenugreek gum and Modified Fenugreek gum

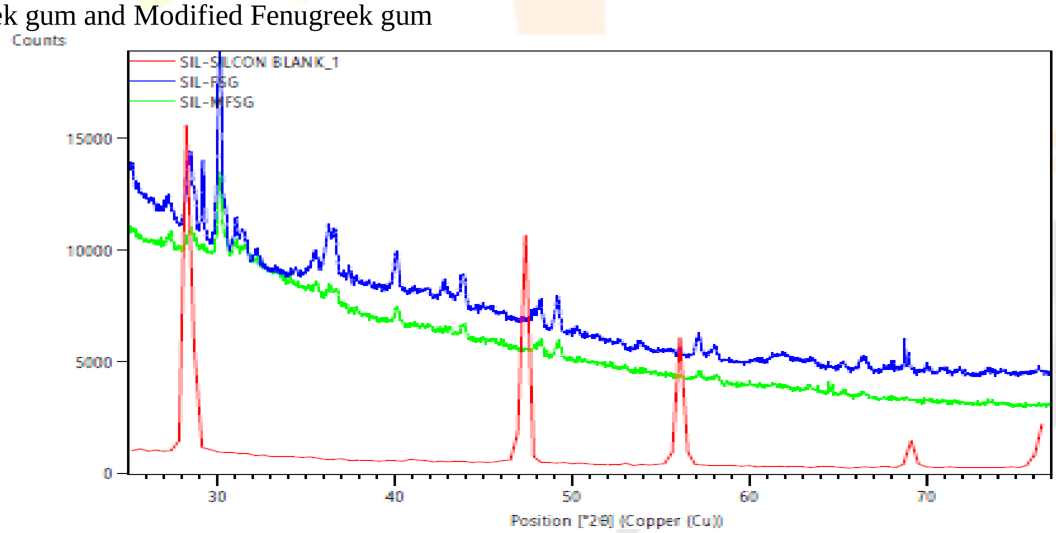


Fig. 1.8 Overlay of Fenugreek gum and modified Fenugreek gum

XRD of Linseed gum and Modified Linseed gum

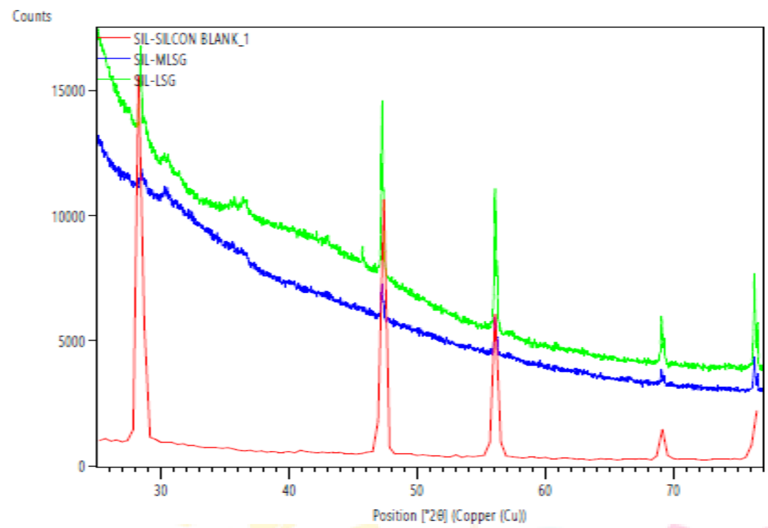


Fig. 1.9 Overlay of Linseed gum and modified Linseed gum

Sedimentation volume: To evaluate the suspending properties of different gum, talc suspension was prepared by using different suspending agents (gum) like tragacanth gum, tamarind gum, modified tamarind gum, fenugreek gum, modified fenugreek gum, linseed gum, and modified linseed. The suspension were evaluated for their sedimentation profile, rheology and pH.

It is quite known that the better is the suspending medium the lesser the rate of sedimentation. Suspension are routinely evaluated for their suspending property. The rate of sedimentation depends on the chemical nature of the suspending agent. Sedimentation volume shown in Table 7.7

Table 1.8: Determination of Sedimentation volume (%) using different suspending agent

S. No	Time	Tragacanth	Tamarind gum	Modified tamarind gum	Fenugreekgum	Modified fenugreek gum	Linseedgum	Modified linseed gum
1.	30 min	0	0	0	0	0	0	0
2.	1 day	0.96	0.8	0.88	0.30	0.32	0.76	0.78
3.	2 day	0.90	0.78	0.84	0.27	0.29	0.73	0.74
4.	3 day	0.88	0.75	0.80	0.25	0.27	0.69	0.70

Sedimentation volume of different gum with respect to Tragacanth(0.88) were found 0.80, 0.70, 0.69, 0.27, 0.25 for tamarind gum, modified tamarind gum, fenugreek gum, modified fenugreek gum, linseed gum and modified linseed gum respectively.

On the basis of obtained result it was found that modified tamarind gum higher rate of sedimentation as compare natural tamarind gum. Fenugreek seed gum and linseed gum were not significantly difference sedimentation volume after modification.

pH: The pH of the suspension were measured using a pH meter. Suspension prepared with different suspending agent (tamarind gum, modified gum tamarind gum fenugreek gum, modified fenugreek gum, linseed gum, modified linseed gum, Tragacanth) were recorded and stored at room temperature. The pH of all suspension was found to be between 3.6 -5.9. After modification of gum/suspending agent pH will be decreases.

Table 1.9: Determination of pH of formulation using suspending agent

S.No.	Tragacanth	Tamarind gum	Modified tamarind gum	Fenugreek gum	Modified fenugreek gum	Linseed gum	Modified linseed gum
Ph	5.9	4.8	3.7	5.2	3.6	5.6	5.1

pH of different gum with respect to Tragacanth were found 4.8, 3.7, 5.2, 3.6, 5.6 and 5.1 for tamarind seed gum, modified tamarind seed gum, fenugreek seed gum, modified fenugreek seed gum, linseed gum and modified linseed gum respectively.

pH rate of natural tamarind gum and modified tamarind gum was 4.8 and 3.7 respectively. On the basis of obtained result it was found that modified tamarind gum had lower pH rate as compare to natural tamarind gum, pH rate of natural fenugreek gum and modified fenugreekgum was 5.2 and 3.6 respectively. It was found that modified fenugreek gum had lower pH rateas compare to natural fenugreek gum. pH rate of natural linseed gum and modified linseed gum was 5.6 and 5.1 respectively. It was found that modified linseed gum had lower pH rate as compare to natural linseed gum.

Degree of flocculation: The flocculation behavior of the talc suspension formulation was studied for various suspending agent. The flocculation behavior of the formulations containing tamarind gum, modified tamarind gum, fenugreek gum, modified fenugreek gum, linseed gum modified linseed gum and tragacanth gum is shown in **Table 7.9** flocculated suspension produce bulky sediments which redisperse easily with mild agitation while deflocculated suspension settle to from very compact sediment which does not redisperse easily, a condition known as cacking.

Table 1.10: Degree of flocculation of prepared formulation

S. No.	Suspending agent	Degree of flocculation
1.	Tragacanth gum	0.22
2.	Tamarind gum	0.45
3.	Modified tamarind gum	0.32
4.	Fenugreek gum	0.90
5.	Modified fenugreek gum	0.93
6.	Linseed gum	0.51
7.	Modified linseed gum	0.56

Degree of flocculation of different gum with respect to Tragacanth degree of flocculation(0.22) was found that in case of tamarind gum, modified tamarind gum, fenugreek gum, modified fenugreek gum, linseed gum and modified linseed gum degree of flocculation (0.45, 0.32, 0.90, 0.93, 0.51, 0.56) increased as compared to tragacanth.

On the basis of obtained result it was found that modified tamarind gum had lower degree of flocculation as compare natural tamarind gum. Fenugreek seed gum and linseed gum were not significantly difference degree of flocculation after medication.

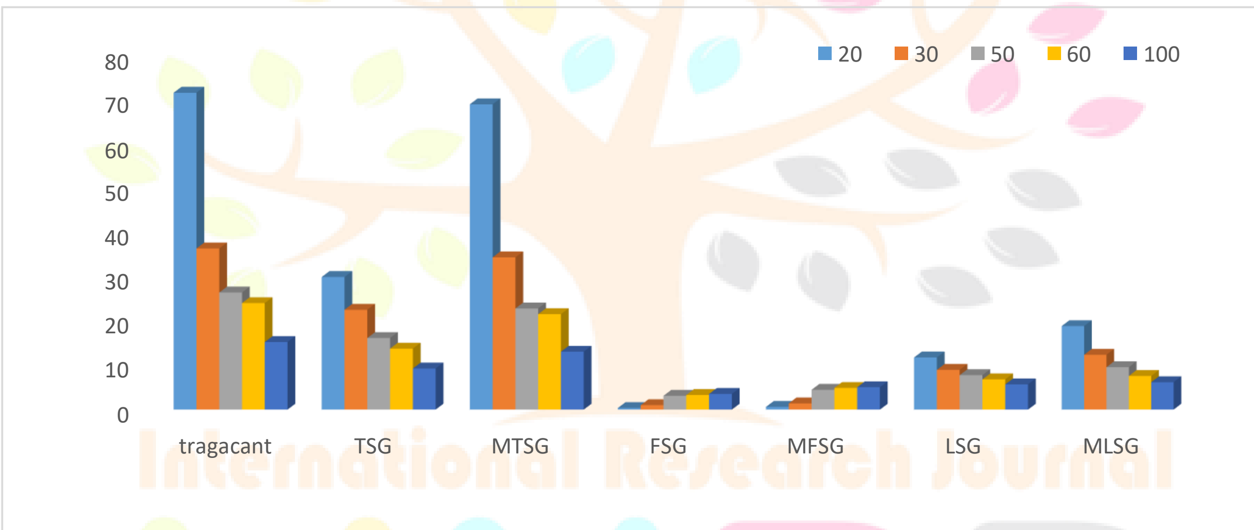
Table 1.11: Determination viscosity of suspension

S.No.	Suspending agent	Viscosity(cp)
1.	Tragacanth	71.4
2.	Tamarind gum	30.0
3.	Modified tamarind gum	68.8
4.	Fenugreek gum	5.06
5.	Modified fenugreek gum	5.7
6.	Linseed gum	11.8
7.	Modified linseed gum	18.9

Viscosity: viscosity of prepared suspension was determined by Brookfield viscometer using spindle no. 61 and temperature 20.0C viscosity of different gum with respect to tragacanth was found 30.0, 68.8, 5.06, 5.7, 11.8, and 18.9 for tamarind seed gum, modified tamarind gum, fenugreek gum, modified fenugreek gum, linseed gum and modified linseed gum respectively. Viscosity of natural tamarind gum and modified tamarind gum was 30.0 and 68.8 respectively. On the basis of obtained result it was found that modified tamarind gum had higher viscosity as compare natural tamarind gum. Viscosity of natural fenugreek gum and modified fenugreek gum was 5.06 and 5.7 respectively. It was found that modified fenugreek gum had higher viscosity as compare natural fenugreek gum. Viscosity of natural linseed gum and modified linseed gum was 11.8 and 18.9 respectively. It was found that modified linseed gum had higher viscosity as compare natural linseed gum. Fenugreek seed gum and linseed gum were not significantly differences in viscosity after modification. The rheological studies of suspension of different suspending agent like tamarind gum, modified tamarind gum, linseed gum, modified linseed gum and tragacanth shows that the suspension are pseudo plastic in their nature and their viscosity decrease with increase in rate of shear, and fenugreek gum , modified fenugreek gum suspension shows that the suspension are dilatant flow in their nature and their viscosity increase with increase in shear stress which is an essential property of suspension.

Table 1.12: Effect of stress on viscosity

Gum /rpm	20 rpm	30 rpm	50 rpm	60 rpm	100 rpm
Tragacanth	71.4	36.4	26.5	24.1	15.3
Tamarind gum	30.0	22.6	16.2	13.8	9.30
Modified tamarind gum	68.8	34.4	22.9	21.6	13.1
Fenugreek gum	0.35	1.00	3.12	3.30	3.54
Modified fenugreek gum	0.61	1.4	4.48	4.9	5.06
Linseed gum	11.8	9.0	7.8	6.84	5.7
Modified linseed gum	18.9	12.4	9.6	7.6	6.2



Effect of gum on viscosity

Summary and Conclusion:

The natural gums are biocompatible, economic and abundantly available. Many natural gums are included in GRAS (Generally Recognized as Safe) list under the federal food, drug and cosmetic act. In present study tamarind gum, fenugreek gum, linseed gum was extracted from tamarind seed, fenugreek seed, and linseed. These gums were modified after extraction, modification result to change in properties of it like viscosity, pH, sedimentation volume and degree of flocculation etc. we observed the changes happened after modification were:

On the basis of obtained result it was found that as a result of chemical modification viscosity of all modified gums (modified tamarind gum, modified linseed gum, modified fenugreek gum) has increased as compare to natural gums(tamarind gum, fenugreek gum, linseed gum), but the viscosity of tamarind gum significantly increased. In this study we have concluded that the tamarind to modified tamarind seed gum shown significant changes in their properties remembering were not shown significant change, so crosslinking agent was found suitable for tamarind to modified tamarind seed gum. From these results are concluded that TPP was found suitable crosslinking agent. But this is not suitable for modification of fenugreek seed gum and linseed gum. So there are further scope available to think about the other crosslinking agent for modification of fenugreek seed gum and linseed gum.

Modified tamarind seed gum greatly increment in viscosity, so it may provide more stability to suspension in low concentration. On the other hand there may be chances of hard cake formationand it may create problem in redistribution of suspension. So it require for their detailed study of comparison of natural tamarind seed gum and tamarind modified gum.

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