A Dissertation thesis entitled

"STUDIES ON SYNTHESIS OF CARBOXY METHYLATED TAMARIND STARCH & IT'S PROPERTIES"

Submitted in partial fulfilment of the requirements

For the award of the degree of

Master of Science

IN

INDUSTRIAL CHEMISTRY

Submitted By

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FACULTY OF SCIENCE (FoS)
ATMIYA UNIVERSITY
RAJKOT-360 005, GUJARAT, INDIA.
2022-2023

CERTIFICATE

This is to certify that the dissertation thesis entitled **"Studies on the Synthesis of Carboxy methylated Tamarind Starch and its properties"** submitted by **MR. PATEL JAYESHKUMAR JAGDISHBHAI (Enroll. No: 200722033),** a Post-Graduate student of the Semester-IV, Department of Industrial Chemistry, Faculty of Science, Atmiya University, Rajkot.

He has undertaken and conducted this dissertation work as a part of the curriculum to earn credits for obtaining the degree of Master of Science (M. Sc.) in Industrial Chemistry during academic year 2022-2023.

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Dedicated to

My Beloved Family

Without their love, support and constant encouragement,
this would not have been possible

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DECLARATION

We undersigned, hereby declare that the work assimilated in the dissertation thesis entitled **"STUDIES ON SYNTHESIS OF CARBOXY METHYLATED TAMARIND STARCH & ITS PROPERTIES"** has been carried out by us at Faculty of Science, Department of Industrial Chemistry, Atmiya University, Rajkot, Gujarat, India, under the supervision and Guidance of (**Dr.) Viral H. Kariya, Assistant Professor, Department of Industrial Chemistry, Faculty of Science, Atmiya University, Rajkot, Gujarat, India.**

To the best of our knowledge and belief, the work included in this thesis is quite original and has not submitted to any other Institution or University for the award of any degree either in this or any other form.

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We wish to express our sincere gratitude and honour to our Research supervisor **(Dr.) Viral H. Kariya, Assistant Professor, Department of Industrial Chemistry, Faculty of Science, Atmiya University, Rajkot,** for their inspiring, splendid and authentic guidance, moral support and constant encouragement throughout our research work. Their passion and dedication towards research has stimulated, provoked and facilitated us to complete this endeavour. We could not have imagined having a better Research Supervisor and mentor for our M. Sc study. Their role will always remain fundamental in shaping our future.

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INDEX

ABSTRACT

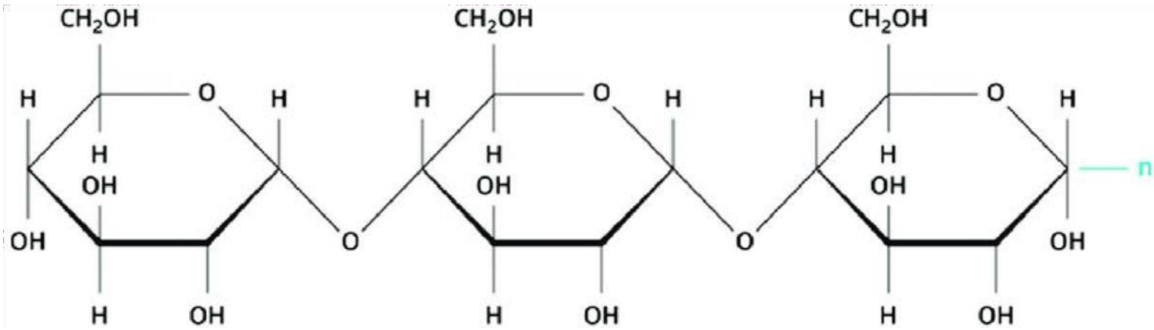
Tamarind Kernel Powder (TKP) is derived from the seeds of Tamarindus Indica. It is a rich source of xyloglucan gum. The gum can be utilized in number of industries. With a view to utilize the gum for broader applications, Carboxymethylation of tamarind kernel powder was carried out. The reaction conditions were optimized with respect to concentration of NaOH, Monochloro acetic acid, Alcohol, reaction time and temperature. Tamarind kernel powder is a polysaccharide product and carboxymethylation of TKP increases its solubility in cold water. It has wide range of application, in food industries it is used as preservatives, binding agent, solidifying agent. Also used in textile industries, leather industries, paper industries and medical field. TKP based gum is a valuable thickener and stabilizer, used in different industries.

The purpose of this study was to extract, alter, and characterise tamarind kernel powder, as well as to investigate its potential medicinal uses. Tamarind kernel powder was isolated from tamarind seeds and carboxymethyl tamarind kernel powder was created by treating it with sodium salt of monochloroacetic acid. The pH, solubility, and viscosity of carboxymethyl tamarind starch were determined using attenuated total reflectance – Fourier transform infrared (ATR-FTIR) spectroscopy, and carboxymethylation of tamarind starch was validated using ATR-FTIR. The study's findings suggested that carboxymethyl derivatives might be utilised to construct a variety of medication delivery methods. It may be concluded that carboxymethylated tamarind kernel powder (saccharine) has a lot of promise in the pharmaceutical sector as an excipient.

INTRODUCTION

What is Starch?

- The basic chemical formula of the starch molecule is ($C_6H_{10}O_5$) n. Starch is a polysaccharide comprising Glucose molecules



- Starch is a soft, white, tasteless fluffy powder that is insoluble in cold water.

[FIGURE-1 : STARCH POWDER]

- Starch is a natural polymer or polysaccharide, meaning that it is a long chain comprising one type of molecule. It consists of glucose molecule and occurs in two forms: amylose and amylopectin. Starch is one of the most abundant biopolymers.

- It is completely biodegradable, inexpensive, renewable and can be easily chemically modified. Starch is also known as amylum is an important food product and biomaterial used worldwide for different purpose.

Types of starch:

The main commercial refined starches are corn starch, potato starch, rice starch, cassava starch, wheat starch and now a days tamarind starch powder (Kernal powder - TKP) are also used.

Corn starch

Potato starch

Rice starch

Cassava starch

Wheat starch

Tamarind starch

[FIGURE-2 : TYPES OF STARCH]

Properties of starch:

- Physical features, such as solubility and gelatinization, occur without a change in the chemical characteristics of starch and do not entail the breaking and production of chemical bonds.
- Chemical properties change due to chemical reaction and usually involve the breakage and creation of new bonds. Examples of such chemical process: In starch include hydrolysis, oxidation and esterification.

Application of starch:

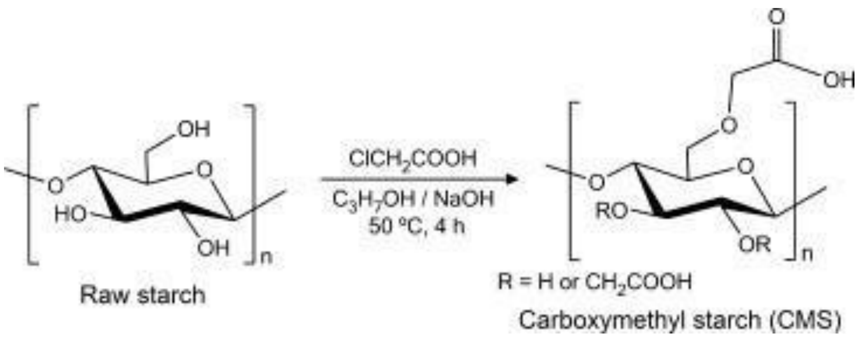
[FIGURE-3 : APPLICATION OF STARCH]

- Starch is used in many industrial applications as **viscosities, emulsifiers, defoaming agents, for encapsulation, and as sizing agents**. Starches are valued for their ability to impart textural characteristics and provide gelling or film formation.
- The most common carbohydrate in the human diet is starch, which can be found in a variety of foods. Potato, corn, cassava, wheat, rice, and tamarind, for example.
- Papermaking is the world's largest non-food use of starches.
- Bioplastics are made with starch, a natural polymer. Starch can be converted into "thermoplastic starch" using water and plasticizers like glycerol.
- Starch is employed in oil exploration to modify the viscosity of drilling fluid, which is utilised to lubricate the drill head and suspend the grinding residues.
- Instead of talcum powder, powdered corn starch is utilised as a body powder.
- Corrugated board adhesives are the second largest application for starches. Starch glues are mostly based on unmodified native starches.
- Clothing and laundry starch is a liquid prepared by mixing a vegetable starch in water, and is used in the laundering of clothes.
- Preservatives in jams.
- Thickening, binding agent in soups & sauces.
- Cooling effect in chewing-gum.
- Moistening in bakery products.

WHAT IS CMS (Chemically modified starch / Carboxy methyl starch)?

- Chemical modification is the process of changing the physiochemical properties of starch by adding new chemical or functional groups to the molecule without changing its form or size. Each of the three reactive hydroxyl groups in amylase and amylopectin's glucose units are the main locations for chemical alteration of starch.
- The most frequent techniques of chemical modification of starch include oxidation with various oxidising agents, etherification with the addition of hydroxyethyl, hydroxypropyl, or CARBOXYMETHYL moieties to the hydroxyl groups of starch, and phosphorylation with various phosphorylating agents.
- Cationization by introducing some cationic molecules, cross-linkage by adding various crosslinkers, and graft polymerization of starch with synthetic polymers. Esterification by condensation of some fatty acids, other carboxylic acids, and phosphates with active hydroxyl group of starch.

REACTION FOR CARBOXY METHYLATION OF STARCH:



- First step is an equilibrium reaction between NaOH and the hydroxyl group of starch.

$$St - OH + NaOH \rightleftarrows St - O - Na+ + H2O$$

- The second step is the actual formation of the carboxymethyl group by substitution of SMCA

$$St - O - Na+ + ClCH2COO - Na+ \rightarrow St - O - CH2COO - Na+ + NaCl$$

- Here, St-OH is the hydroxyl group of starch which is substituted by carboxymethyl group.
- SMCA can also react with NaOH to form the side product sodium glycolate.
- The goal of carboxy methylation of starch is to replace the starch's hydroxyl group with a carboxy methyl group. Because hydrophobic groups are added to the starch molecule.
- This modification procedure has the advantage of increasing starch stability in aqueous conditions, lowering recrystallization ability, and preventing damage from heat and microbes.
- Carboxy methyl starch is a chemically modified starch that is widely used. It is made by reacting starch with monochloro acetic acid or its sodium salt (SMCA) in the presence of sodium hydroxide (NaOH).

USES OF CMS:

It can be used in…

1) Textile sizing and printing
2) Paper sizing
3) Oil well drilling
4) Water based distemper
5) Oil based distemper
6) Electrode making
7) Ceramics
8) Pesticides
9) In soaps, a small addition of sodium CMS increases the suspending power and over all washing efficiency of the soaps.
10) It is used in noodles to improve consistency, reduce softening, in soups to reduce clouding.

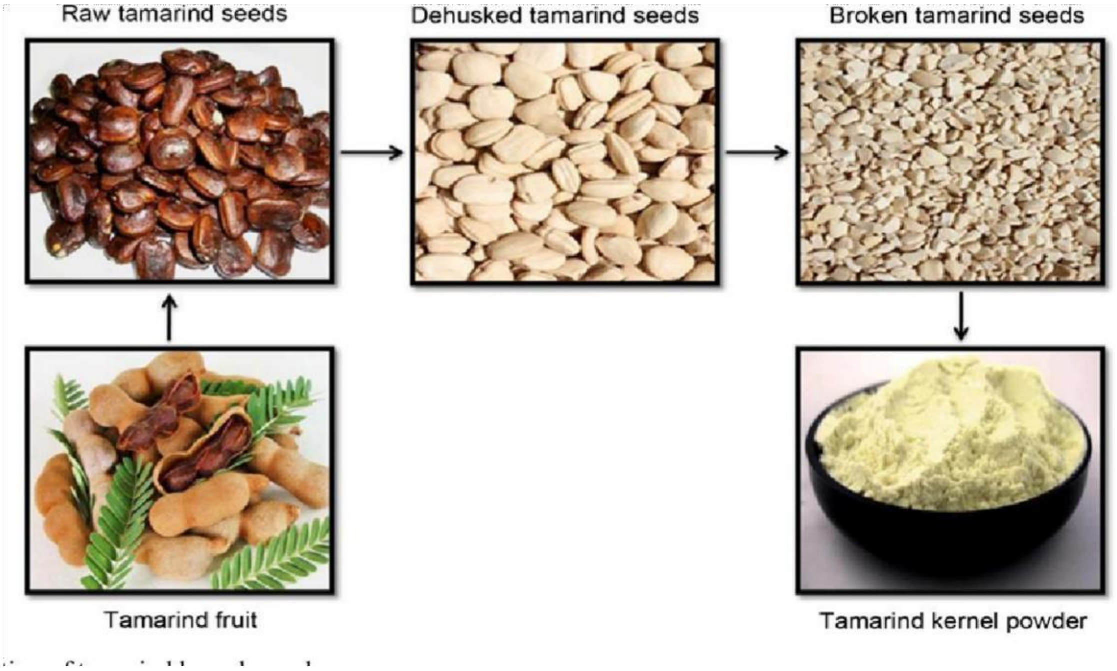
Discussion of starting material (TKP):

My dissertation work is based on carboxy methylation of tamarind kernel powder (polysaccharide), we must have to go through understanding of our beginning material, TAMARIND KERNEL POWDER, which was generously provided by SWASTIK GUM INDUSTRIES, AHMEDABAD.

So, I'm going to talk about chemical composition, characteristics, and how they're used in different commercial enterprises.

WHAT IS TAMARIND KERNEL POWDER?

Tamarind Kernel Powder, often known as TKP, is a natural polysaccharide derived from the endosperm of the tamarind seed of the Tamarindus indica Linn tamarind tree. This TKP-based gum is widely available and has an excellent economic return on investment. Tamarind xyloglucan is another name for TKP.



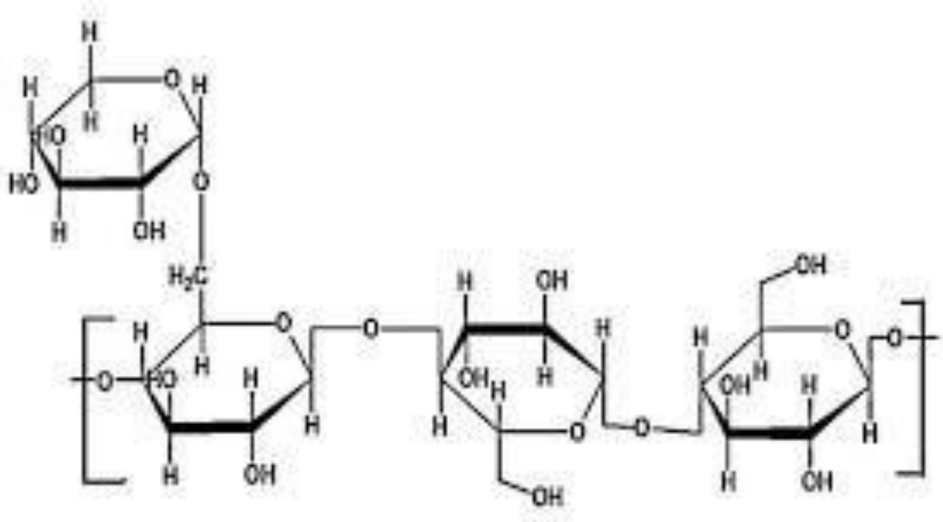
[FIGURE-4 : PROCESS OF TARMARIND KERNEL POWDER]

Tamarind kernel powder has a dry weight of 67-68 percent, with the primary ingredients being Glucose 38 percent, Xylose 35.5 percent, and Galactose 22.2 percent, with a little amount of Arabinose 4.3 percent.

CHEMICAL STRUCTURE OF TKP

Tamarind kernel powder is a natural hydrocolloid source derived from tamarind pulp industry by products. The viscous nature of TKP paste has led to its use in a variety of sectors.

Natural polymers such as Tamarind kernel powder, Guar gum, Karaya gum, and Fenugreek gum have advantages over synthetic and semi synthetic polymers such as low cost, natural origin, fewer side effects, local availability, and superior solubility over synthetic and semi synthetic polymers.



Tamarind seed polysaccharide

CHEMICAL COMPOSITION OF TKP

[TABLE-1 : CHEMICAL COMPOSITION OF TKP]

Starch	0.24 – 0.54 %
Fat	2.39 – 3.19 %
Ash	2.45 – 3.30 %
Moisture	3.42 – 3.74 %
Protein	16.43 – 17.07 %

Crude fibre	1.20 – 1.68 %
Carbohydrates	65.1 – 72.2 %

The major component of TKP is **STARCH**. The polysaccharide xyloglucan makes up more than 77 percent of the TKP component. Xyloglucan is made up of pentose sugars, which make up about 20% of the soluble carbohydrates. The two most common soluble sugars are mannose (17-35%) and glucose (11-80%). The TKP monosaccharide residues are linked together by glycosidic bonds. Binders, film formers, fibres, adhesives, rheology modifiers, hydro gels, emulsifiers, and drug delivery agents all benefit from their mechanical qualities.

Properties of TKP:

- Tamarind seed polysaccharide (TKP) is a neutral branching polymer with a high molecular weight made up of cellulose, Xylose, and galactoxylose derived from tamarind seeds.
- It is easily biodegradable because it is a natural polysaccharide.
- It is favoured because of its natural origins and inexpensive production costs, as well as the fact that it has less negative effects. It is readily available in the area and has a higher patient tolerance.
- It's insoluble in organic solvents but dispersible in warm water to create a viscous gel with a wide pH range and good adhesive properties.
- It has non-Newtonian rheological characteristics, as well as mucoadhesive and pseudoplastic qualities.
- It has haemostatic activity and is non-toxic and non-irritant.
- With higher concentration, TKP powder exhibits strong non-Newtonian behaviour, similar to consistency latex, by causing stress and imparting apparent viscosity.

- The purity, source, and microbial contamination of these natural polysaccharides are all disadvantages. This natural substance will be a better alternative to synthetic polymers if these factors can be found and managed.

- It's utilised as a binding agent, gelling agent, dissolving agent, matrix tablet sustaining agent, film forming agent, suspending agent, emulsifying agent, and solubilizing agent, among other things.

Applications of TKP:

There are many uses of Tamarind kernel powder…

1) Food industries
2) Pharmaceutical industries
3) Textiles industries

Food industries:

- This natural polysaccharide TKP is also known as 'Jellose' or 'polyose' in food preparations, and is utilised as a fruit preservation as well as in jelly preparations.
- TKP can form gel across a wide pH range and is employed as an emulsifier in the manufacturing of essential oils, heat resistant low acid emulsions, meals, and salad dressings.
- It is used in the preparation of puddings, desserts, confectionery, sour milk gel, low water release gel, yoghurt, jelly, jams, pie fillings, sauces, vegetable pan cake, protein free food, and acidic protein food preparations as a gelling and thickening agent and bulking agent.
- It has a viscosity that is higher than corn starch, but it is also less expensive and requires a smaller quantity than corn starch.
- TKP is utilised as a coating material in sausage casings, as well as in protective coatings, pineapple storage, and fried dishes.
- TKP is employed in the enzyme treatment of xyloglucan to make a health beverage. Cakes and chewing gums also contain it.
- A cellulose hydrolysate of tamarind polysaccharide is used to replace a percentage of metabolizable carbs in processed foods, resulting in a low-calorie, high-organopletic-quality product.
- TKP is also utilised as a preservative in soybean curd, bread, boiling noodles, and as a fruit, vegetable, and meat freshness maintainer.
- TKP-based gum is used in processed foods as an antibacterial agent and also increases the palatability of instant noodles.
- In ice cream, frozen food, freeze dried gel, yum, frozen food covered with jelly, as an odour improver, glazing agent, filler, film forming gum, crystallisation inhibitor
- TKP is employed as a deformation inhibitor, which is critical in cooked foods.

Pharmaceutical industries:

- TKP is used to treat boils and dysentery, as an antiviral agent, to lower blood sugar, to treat rheumatism, to treat eye illness, to cure ulcers, and to prevent the growth of pimples, chronic diarrhoea, and jaundice.
- It is utilised as a penicillin alternative, as well as in the formulation of lather-free creams and moisturising creams.
- It prolongs the shelf life of anti-oxidant ingredients. It's used as a stabiliser in the production of capsules, dentures, and contact lens storage solutions. Because it can help prevent dental cavities, it's also found in toothpaste.
- TKP is used to make and preserve powdered products as a dehydrating agent.
- TKP gum is utilised as an anti-proliferative agent for gram-negative bacteria. It also serves as a transporter and fixer for beta-galactosidase, as well as having a laxative effect on dietary fibre composition.
- TKP is used to make greaseless ointment, colloidal iodine jelly, mulching sheets, capsules, and pesticides for sensitive foliage. TKP is used as an oral cavity composition gel to clean the mouth.
- for the treatment of obesity as an anti-obesity agent.

Textile industries:

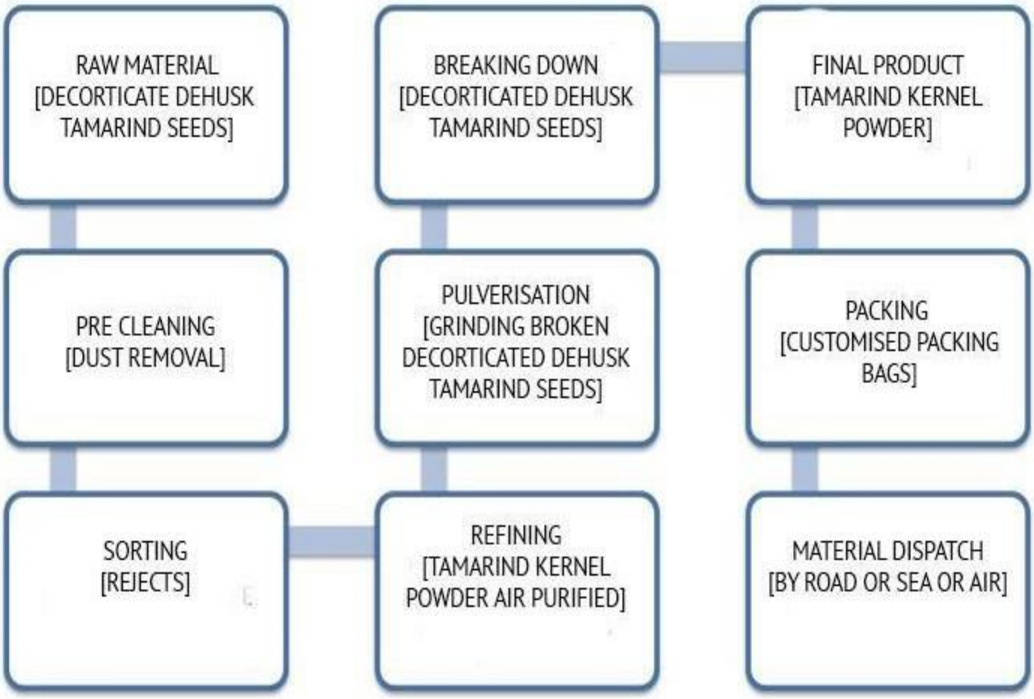
- In the jute and textile sectors, TKP is commonly utilised as a sizing material.
- In the textile processing industry, it is used as a thickener in the printing, dyeing, and finishing of textiles.
- TKP is useful for sizing spun viscose since it has the advantage of being easier to remove from the spun fabric than starch.

Other applications:

- In the leather industry, TKP is utilised as a tanning substance.
- TKP is commonly fed to cattle, pigs, and pets. It's a superb thickening agent that's utilised in the production of canned pet food for cats and dogs. TKP powder is nutrient-dense and contains fibres that aid digestion in pets.
- When TKP is cooked with water, it produces an excellent paper adhesive.
- It can also be used as a soil conditioner and stabiliser during the brick-making process, as well as a binder in the production of sawdust briquettes.

➢ As a result, we may conclude that TKP is a high-molecular-weight natural polysaccharide with good viscosity and sticky properties. It has a wide range of applications in a variety of industries, including food, pharmaceuticals, and textiles, as a stabiliser and emulsifier. In addition, TKP is commonly used in many types of flavouring for sauces, as well as for thickening and stabilising. It is inexpensive due of its widespread availability, safe to handle, and completely biodegradable.

Manufacturing process of TKP:



[FIGURE-5 : MFG. PROCESS OF TKP]

- Drying the seeds, roasting them, and finally decorticating them are all steps in the process of making this powder from tamarind seeds. To manufacture tamarind kernel powder, the seeds' kernels are sorted by colour sorters and then ground meticulously. The nutritious elements of tamarind are preserved in powdered form in this approach. The acid and sugar content of tamarind pulp is the primary reason for its use in syrups, curries, sauces, and beverages.

- Tamarind seed powder is a complex mixture of Galactoxyloglucal polysaccharides, lipids, proteins, and other substances. This powder makes a homogeneous solution when heated with water and agitated. In Ahmedabad, Adachi is a significant tamarind seed powder exporte

MATERIALS AND METHOD

PREPARATION OF CARBOXY METHYL TAMARIND KERNEL POLYSACHHARIDE FROM TAMARIND KERNAL POWDER.

REQUIREMENTS : Tamarind kernel powder

Distilled water

NaOH flax

Sodium monochloro acetate (SMCA)

Methanol

FLOWCHART OF PROCEDURE:

Tamarind kernel powder 18gms

↓

Distilled water185ml

↓

Add NaOH flax 1.5gms in 15ml water

↓

Stir for 30mins

↓

Add sodium monochloro acetate 3gms

Stir for 1 hr at 60°C

↓

Cool at room temperature

↓

Add 100ml methanol

↓

PPT obtained

↓

Filter it and wash it

↓

Dry it in hot air oven

EXPERIMENTAL WORK

STEP-1: Mixing of Tamarind kernel powder in Distilled water.

With an analytical weigh balance, weigh 18 grammes of tamarind kernel powder and place it in a 400 ml borosilicate beaker. Add exactly 180 ml water to the beaker and mix thoroughly for a few minutes on a mechanical mixer.

[FIGURE-6 : TAMARIND KERNEL POWDER IN DISTILLED WATER]

STEP 2: Sodium Hydroxide (NaOH) solution is added.

Weight exactly 1.5 gramme of NaOH and dissolve it in 10 to 15 ml distilled water. Add this NaOH solution to the previously made and mixer of tamarind kernel powder and stir for 30 minutes on a mechanical stirrer at 300-400 rpm.

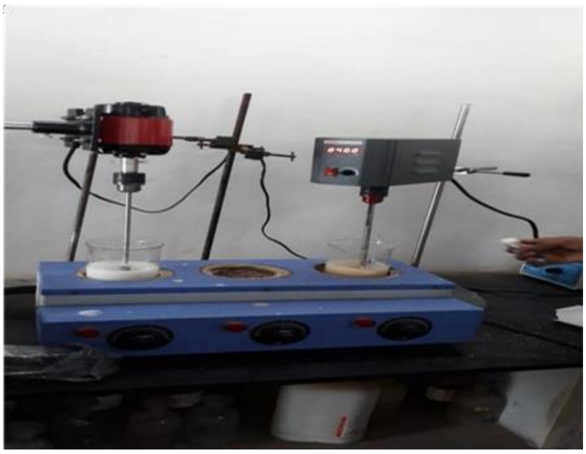
In tamarind kernel powder, this process is known as the equilibrium reaction of NaOH with the hydroxyl group of starch.

[FIGURE-7 : ADDITION OF NaOH SOLUTION]

STEP 3: Sodium monochloro acetate is added to the mixture.

Weigh exactly 3 grammes of sodium monochloro acetic acid (SMCA) (about 16 percent of our starting material) and slowly add it to the mixture while constantly stirring to avoid lumps.

Place it on a thermostat set to 70°C and keep it there for 60 minutes, stirring constantly with a mechanical stirrer.



[FIGURE-8 : GRADUAL ADDITION OF SODIUM MONOCHLORO ACETATE (SMCA)]

STEP-4: Addition of Methanol for ppt formation.

After stirring it for constant 60 minutes at 70 ◦C, place the mixture in water bath to cool it up to room temperature.

Then add 100 to 130ml of pure methyl alcohol till the ppt formation of carboxy methyl tamarind in beaker is completed, add access amount of methanol for the complete ppt formation in whole bulk.

[FIGURE-9 : PRECIPITATION OF CARBOXY METHYL TAMARIND]

STEP 5: Filtration of ppt using an 80 percent methanol/water wash.

Filter the ppt with Whatman filter paper no.1 when the Carboxy methyl tamarind has completely precipitated. After that, wash the ppt twice with 5 mL 80 percent methanol and dry it in the sun to remove the excess methanol.

[FIGURE-10 : FILTERATION AND WASH OF 80% METHANOL]

[FIGURE-11 : REMOVING ACCESS OF METHANOL INFRONT OF SUNLIGHT]

STEP-6: Drying of ppt in hot air oven

After eliminating all traces of methanol and water, place the ppt in a hot air oven set to 105°C for 24 to 48 hours to ensure that it is entirely dry and devoid of water and methanol.

[FIGURE-12: PRODUCT CMT IN HOT AIR OVEN FOR 24+ HOURS]

After removing the product from the hot air oven, I crush and grind it into the smallest granular form possible, as shown in the diagram below.

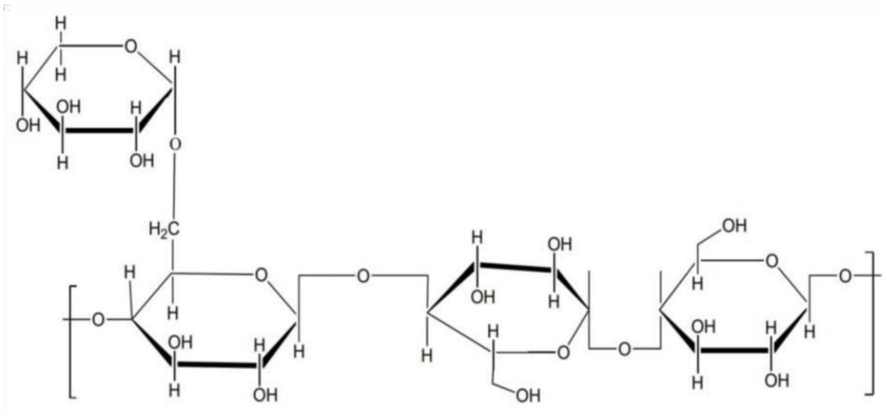
[FIGURE-13: CRUSHED CARBOXY METHYL TAMARIND POWDER]

[FIGURE-14: PACKED FOR THE FURTHER ANALYSIS AND CHARACTERIZATION]

REACTION & MECHANISM

Below is a reaction based on carboxy methylation of tamarind kernel powder (polysaccharide).

Reaction:



Tamarind kernel powder (polysaccharide) $(C_{32}H_{58}O_{20})_n$

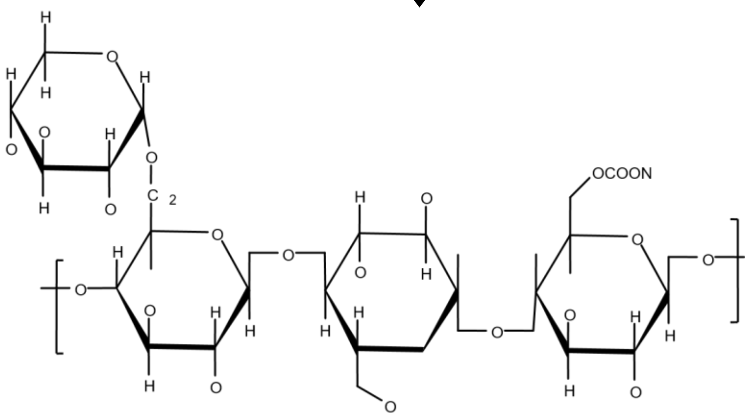
NaOH

+

Sodium Monochloro Acetate

+

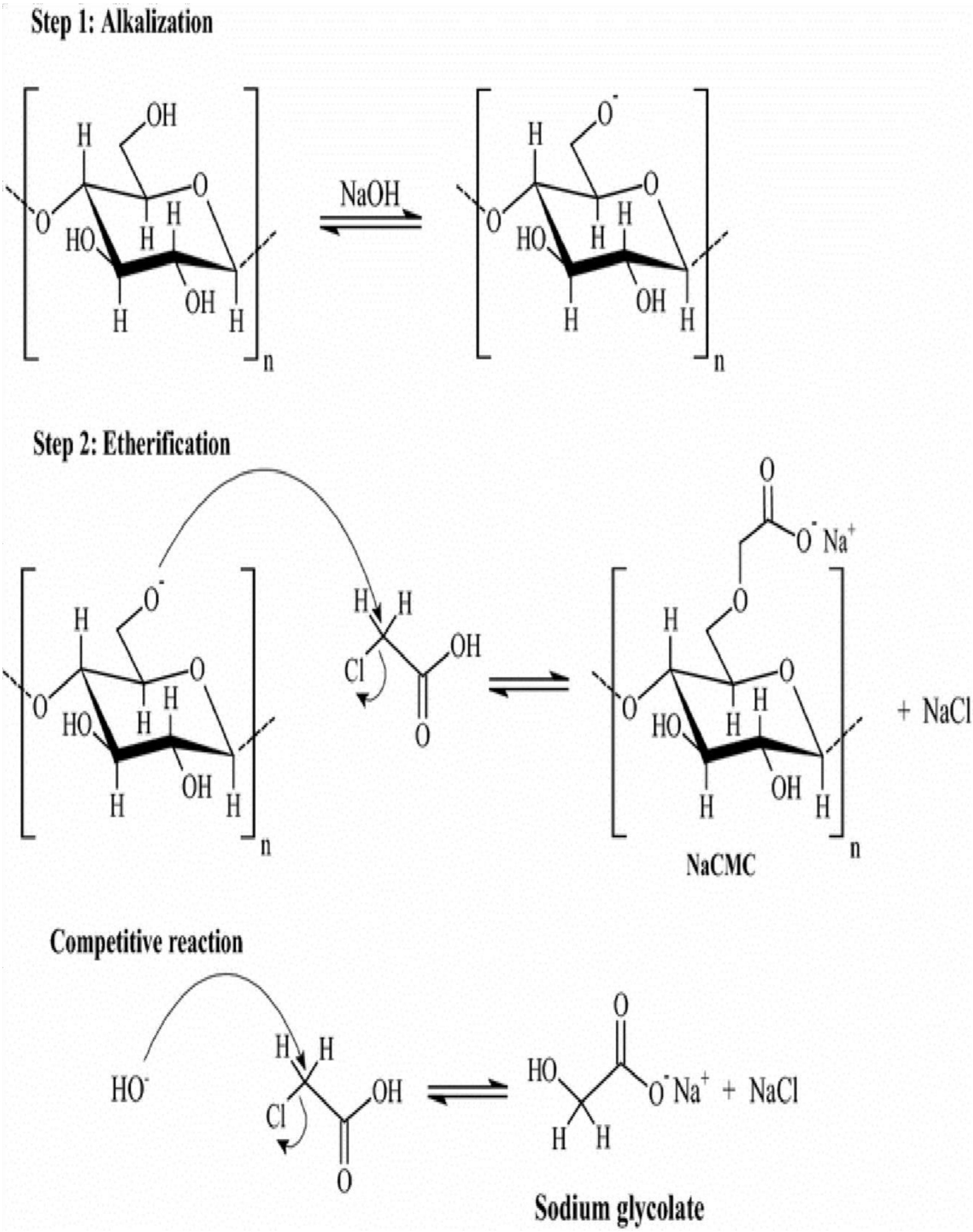
80% Methyl Alcohol



Molecular Weight 854.8

Carboxy methyl tamarind kernel powder (polysaccharide) $(C_{33}H_{57}NaO_{22})_n$

Mechanism:



Step 1: Alkalization
NaOH
Step 2: Etherification
NaCMC
+ NaCl
Competitive reaction
HO⁻
+ NaCl
Sodium glycolate

CALCULATION AND RESULT

THEORETICAL YIELD:

Theoretical yield is the quantity of a product obtained from the complete conversion of the limiting reactant in a chemical reaction. It is the amount of product resulting from a perfect (theoretical) chemical reaction, and thus not same as the amount you will actually get from a reaction in the lab.

Theoretical yield is commonly expressed in terms of grams or moles.

$$\textbf{Theoretical Yield} = \frac{\text{M.w of Product}}{\text{M.w of Starting Material}} \times \textbf{Wt. of Starting Material}$$

= 854.87778.80 ×18 gms

= 19.75 Gms

PRACTICAL YIELD:

Amount of product actually obtained from the completion of the reaction is called practical yield.

Practical yield = 14.10 Gms

PERCENTAGE YIELD:

The ideal amount of product is called the theoretical yield and it is obtained by working a stoichiometric problem. Measuring the amount of product formed gives us the actual yield. From the ratio of the actual (practical) yield to the theoretical yield, we can calculate the percentage yield.

$$\textbf{Percentage Yield} = \frac{\textbf{Practical Yield}}{\textbf{Theoretical Yield}} \times 100$$

$$= \frac{14.10}{20}$$

= 71%

RESULT CASE:

[TABLE-2 : RESULT OF REACTION]

TYPE OF YIELD	RESULT
Theoretical Yield	19.75 Gms
Practical Yield	14.10 Gms
Percentage Yield	71%

CHARACTERIZATION OF CMTKP

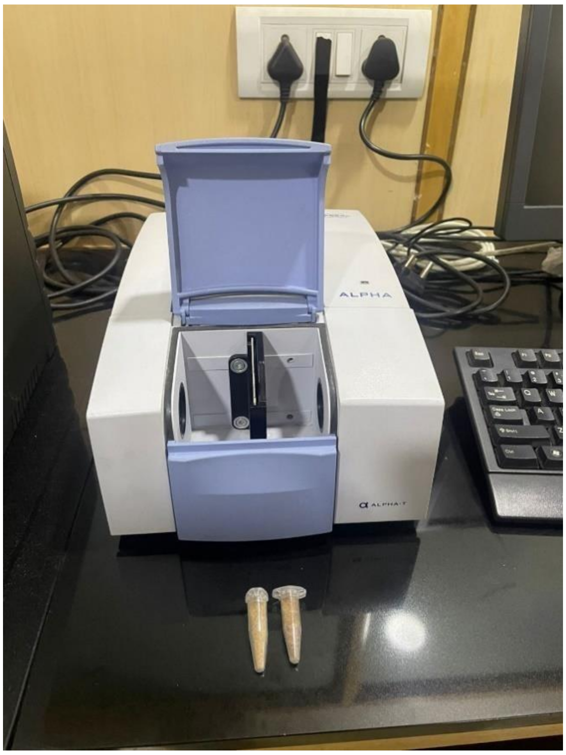
1. FTIR SPECTROSCOPY:

The method of infrared spectroscopy known as FTIR stands for Fourier transforms infrared. When infrared light travels through a sample, part of it is absorbed by the sample, while the rest is delivered to the detector.

The composition of solids, liquids, and gases may be determined using FTIR spectra. The most prevalent applications are for identifying unfamiliar materials and verifying manufacturing materials. In most situations, the information content is quite particular, allowing for fine differentiation amongst similar elements.

For characterization and comparison, we utilised our product created by wet process in our collage laboratory and a product made by dry method

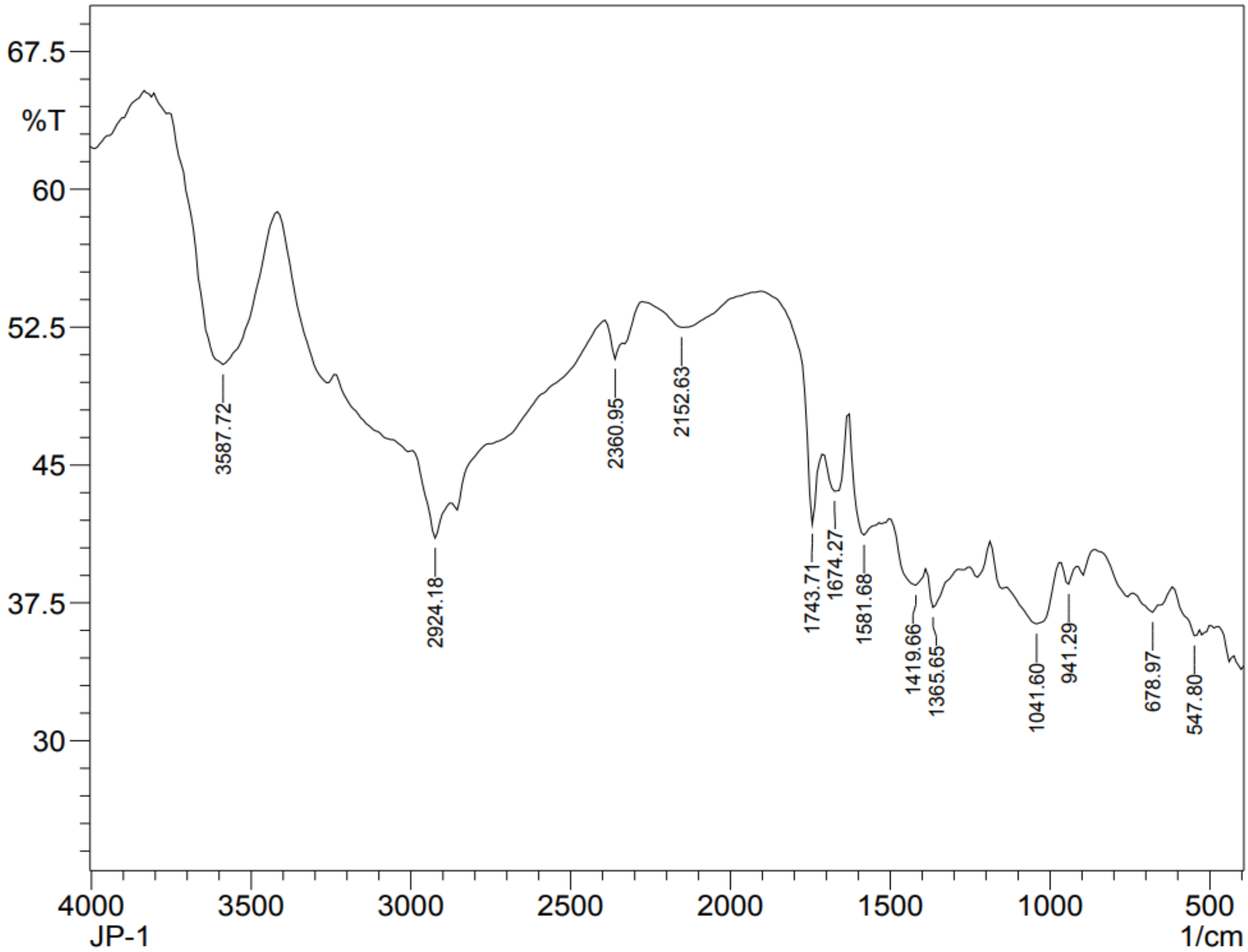
We submit our sample to SAURASHTRA UNIVERSITY Department of Forensic Science. They examine and scan our product and provide us with IR spectra data for both of our samples, as seen below.



[FIGURE-15 : IR SPECTROMETER]

SPECTRAL INTERPRETATION:

[Graph-1 : FTIR OF CMTKP]

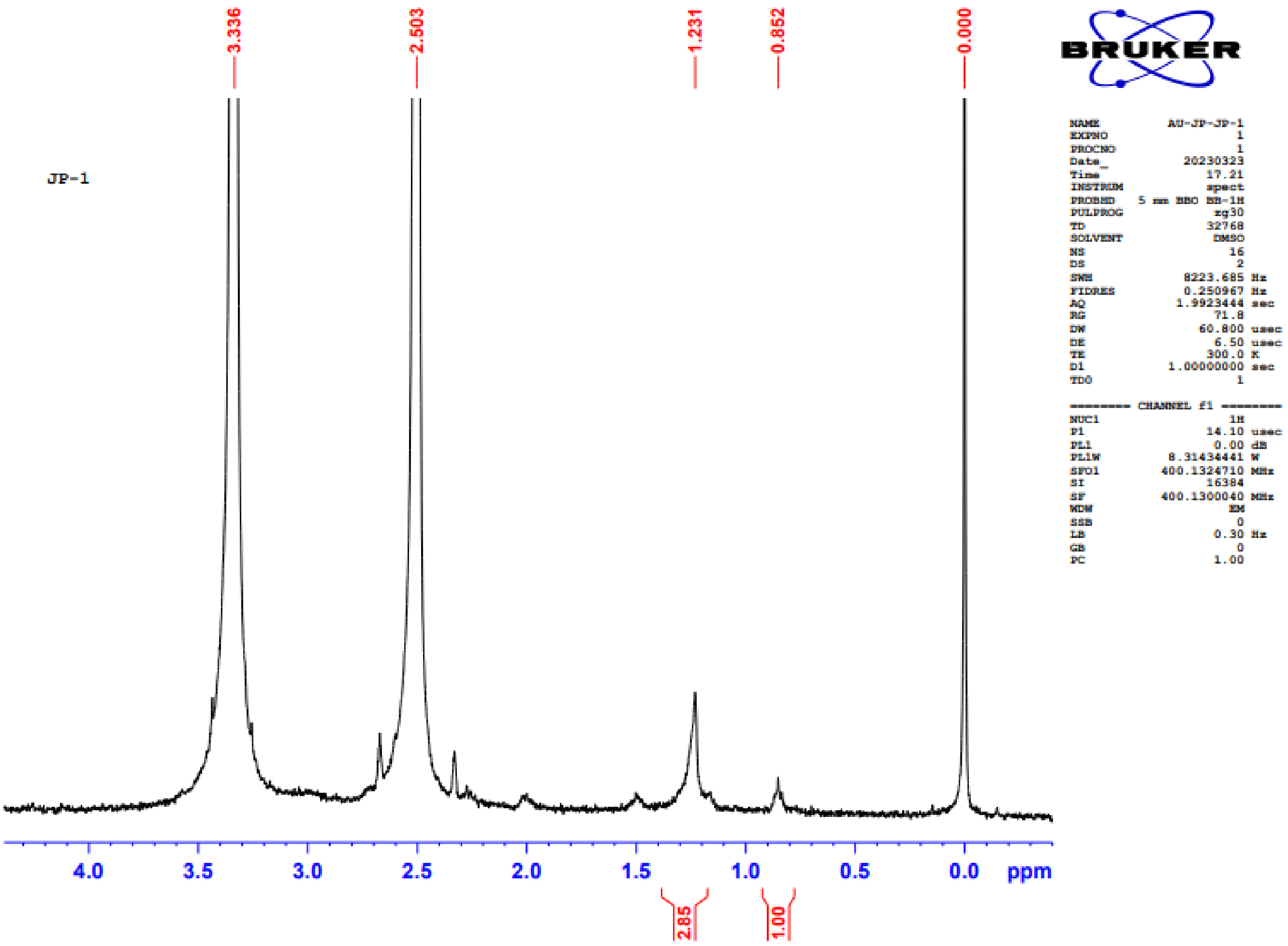


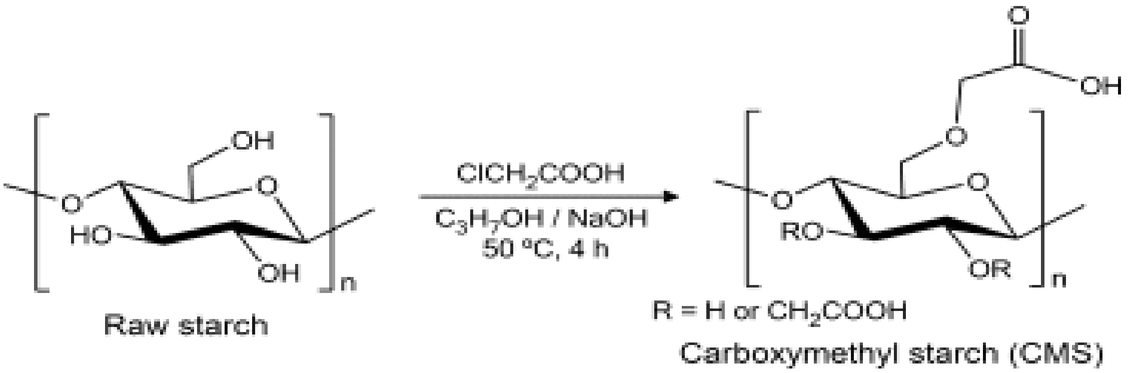
- Carboxy methylated tamarind polysaccharide shows the following sets of important vibrations which are taken into consideration for the structure determination and verification.

O-H stretching	3742 Cm^{-1}	Strong/sharp	Alcohol
C=C stretching	1650- 1680 Cm^{-1}	medium/broad	Alkenes
C-H bending	1750-2000 Cm^{-1}	weak/ broad	Alkyls
C-H stretching	3250-3350 Cm^{-1}	strong/sharp	Alkyls
O=C-O stretching	1011 Cm^{-1}	weak/broad	Aliphatic ether

2. NMR SPECTROSCOPY :

[GRAPH-2 : NMR OF CMTKP]





- Graph 2 shows the 1H NMR Carboxymethaylated starch (400 MHz, DMSO-d6) δ 0.52 (s, 1H), 1.23 (s, 2H)

3. VISCOSITY:

A fluid's viscosity is a measurement of its resistance to deformation at a certain rate. It relates to the informal idea of thickness for liquids.

In general, viscosity is determined by the condition of a fluid, which includes temperature, pressure, and rate of deformation. In certain circumstances, however, the reliance on some of these features is minor.

We produce an 8 percent solution of our product in water and utilise 4 number spindles measure the viscosity of our product.

RESULT for Viscosity at 25 ◦C is mentioned below:

- **27450 cps at 20 RPM and %54.9**

4. PH MEASUREMENT:

The purpose of measuring the pH of materials is to determine whether they are basic or acidic.

pH is a measure of hydrogen ion concentration, a measure of the acidity or alkalinity of a solution. The pH scale usually ranges from 0 to 14. Aqueous solutions at 25°C with a pH less than 7 are acidic, while those with a pH greater than 7 are basic or alkaline. A pH level of 7.0 at 25°C is defined as "neutral" because the concentration of H_3O^+ equals the concentration of OH^- in pure water. Very strong acids might have a negative pH, while very strong bases might have a pH greater than 14.

AT ATMIYA UNIVERSITY we tested the pH of our product and discovered that it is Basic, with a pH of roughly 10. It is satisfied in the usage of food industries and many other sectors under the leadership of **VIRAL KARIYA SIR.**

5. MOISTURE CONTENT:

Moisture content level of product is about 14 to 15% which slightly more than its standards.

6. ASH CONTENT:

Ash content is found less than 15 so it is within the criteria of standard product which is made by dry process in Industries.

APPLICATIONS OF CMTKP

1. Carboxy methyl tamarind kernel powder is commonly used as a thickening in textile printing.
2. It's also utilised as a sizing agent and thickening in jute yarn.
3. CMTKP is widely utilised as a viscosity booster in the paper and explosive industries.
4. CMTKP is utilised as a slurry explosive binder in place of guar gum.
5. CMTKP is also used in foundries and mosquito coils as a core binder.
6. In the paper industry, CMTKP is utilised as a sizing material.
7. It is now widely utilised as a soil stabiliser and lubricant in oil drilling businesses.
8. CMTKP has a variety of different uses, and its inexpensive cost sets it apart from other thickening agents.
9. It's also employed as a medication delivery method in the medical profession.

CONCLUSION

This research concludes that a synthetic technique for preparation may be built using fundamental concepts and knowledge application. The research also considers how changes in reaction conditions, such as solvents, might impact any reaction.

Tamarind seed, a byproduct of tamarind pulp industries, is a typical underutilized material. Though there are industrial uses for decorticated seeds as a low-cost sizing material in jute and textile industries, there have been hardly any other uses including using it as an additive in food formulations. The excellent gelling and adhesive characteristics of decorticated seed powder possess several applications in food and pharmaceutical industries which are evident by a number of research papers as well as patent applications. It is desirable that more research works are conducted on the processing aspects of this seed to make it more useful for the food processors.

The carboxy methylation of tamarind kernel powder is carried out here using a previously developed process. Based on the results of the experiment and analysis, carboxy methylation of tamarind kernel powder improves its solubility in cold water and aqueous media, reduces its recrystallizing ability, and provides protection against heat and microorganisms.

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