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Extraction, Identification, Evaluation and Comparative Study of Pectin Obtained from Various Natural Sources

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Abstract: ***Pectin is a family of complex polysaccharides that contain α-1-4 linked galacturonic acid that has widely gained importance due to its high economic value in the pharmaceutical, food, dairy and biotechnology industries. The primary sources to obtained pectin are limited but its commercial need is high, hence the present study is designed to carry extraction, evaluation and comparative study. Pectin is usually present in cell walls of plants and a major component of middle lamella where it contributes to the cell structures and can be extracted by acid hydrolysis followed by alcohol precipitation. In present investigation pectin was extracted from various natural sources namely orange, mango and sunflower moreover, comparative evaluation was done. The result reveled that all three are good sources of pectin and pectin obtained from all the sources are almost similar in its properties specially gelling strength. The highest yield was found in orange peel followed by mango and least in sunflower. The finding also suggested that all the three can be served as raw material for pectin and systematic use of all from agriculture sector can be beneficial for both farmers and manufacturers. Nevertheless, an agro-based industry can be set for extraction of pectin.***

Keywords: Pectin, extraction, evaluation, comparative study, yield, Pharmaceutical.

I. INTRODUCTION OF PECTIN

Producing and consuming fruit, vegetables, and their products at a growing rate lead to an increase in landfill usage. Although this trash is biodegradable, producing more than is necessary raises serious issues since it pollutes the environment. These wastes contain valuable and useful components as well it has industrial applications. As a result, research is focused more on how to extract and use these essential components [1].Fruits and vegetables waste is one of the components of agro-industrial waste that contains the most pectin. Pectin is obtained by aqueous extraction from the plant materials primarily from apple pomace and citrus fruit peel, then precipitating the result with salt or alcohol [1].

Plants' primary cell walls contain a structural hetero-polysaccharide called pectin that is derived from the Greek words as "congealed and curdled." In tropical and subtropical regions, orange trees are frequently farmed for the peel, which is peeled or chopped (to avoid the bitter rind) and consumed whole or processed to obtain orange juice. Pectin is a group of complex polysaccharides that are present in plant cell walls and serve as a hydrating agent and cementing for the cellulosic network. The use of pectin as a matrix for the entrapment distribution of various medications, proteins and cells has been made possible by a number of additional special properties that it possesses [2].

Orange is citrus fruit with two distinct parts: the peels (rind) and the pulp, which is the portion of the orange fruit that is edible, may be easily separated from the peels; however, it is a good source of pectin. Furthermore, it is a natural biopolymer with expanding uses in the pharmaceutical and biotechnology sectors is pectin.

The manufacturing procedure is more cost-effective since the raw materials have a big amount of high-quality pectin and are readily available [3]. Apples and citrus fruits are the most popular sources of pectin for commercial use. In keeping with the idea of the circular bio-economy, studies have concentrated on the extraction of pectin from a variety of industrial by-products, which offers itself as a green, sustainable solution for the valorization of agro-industrial leftovers [4, 5]. A minimum of 65% galacturonic acid must be present in pectin for it to comply with FAO regulations. This is mainly found in the cell walls and middle lamella of the plants. The primary raw materials used to make commercial pectin are sugar beet, sunflower heads, lemon and orange peel, apple pomace, and citrus peel. At a higher temperature and lower pH, pectin is extracted. Pectin forms gels with acid and sugar. Because pectin can alter during plant isolation, storage, and processing, it is particularly challenging to ascertain the structure of pectin [6].

In addition to being used in the culinary business to make jam, jellies, marmalades, ketchups, sauces, juices, syrups, and yoghurt, pectin is also utilized in the pharmaceutical industry to stabilize suspensions in medications. It plays a significant part in the cosmetic industry. Researchers studying food have been interested in it for a while due to its enormous possibilities. Pectin content has been investigated in orange peel and pomace, guavas, jack fruit, papaya, Assam lemon, mango peel and apple pomace.

Pectin has been used successfully as a thickening agent, a gelling agent, and a colloidal stabilizer in the food and beverage sector for many years. Additionally; it possesses a number of special qualities that have made it possible to use it as a matrix for the delivery or entrapment of numerous drugs, proteins and cells. It is widely utilized in the food sector as a natural food additive and its demand on the global market exceeds 30,000 tons annually with an annual growth rate of roughly 4-5% [7].About one-third of the cell walls in higher plants' dry matter are made of pectin. It is found in the intermediate lamellae and cell walls of plants [7]. The middle lamella of the cell wall has the largest amounts of pectin, which gradually diminish as one moves through the primary wall and towards the plasma membrane [8].Despite the fact that most plant tissues contain pectin on a regular basis; there are very few sources that can be exploited to make pectin's for sale. Due to differences in these factors, pectin from different sources does not have the same gelling ability. The size and level of etherification (DE) of pectin molecules affect their ability to form gel. Therefore; a fruit does not automatically qualify as a source of commercial pectin just because a significant amount of pectin is found in it [9].

The world's most plentiful crop is citrus. The Food and Agricultural Organization estimates that in 2007, Bangladesh produced 1.16x108 Tones of citrus fruits, of which lemons contributed 0.13x108 Tone [10]. Citrus fruits yield residue that makes up 50% of the original mass of the whole fruit [11]. According to estimates, a juice maker squeezes up to 9.0x104 Tones of fresh citrus fruits annually and as a result, about 4.5 x 104 Tones of citrus peels are produced annually as a waste byproduct [12, 13]. As a result, a sizable volume of citrus peels are produced as a byproduct. If the peels are handled as waste, they could lead to environmental issues, most notably water pollution.

If valuable byproducts like pectin could be collected from the peels, this issue may be turned into strength.

In most southern regions, mangoes (Mangifera indica L.) are farmed on around 75,000 hectares of land, yielding 0.5 million tones of mangoes annually, of which 70% are processed [14]. Large amounts of byproducts from mango processing, amounting to 35% to 60% of the weight of the fruit, are released. Peels, stones and occasionally pieces of perishable pulp are a part of this portion [15]. According to Dorta et al. [16], the annual production of mangoes results in about 75,000 tons of waste. Given that mango peels make about 15–20% of the fruit's weight, Vietnam produces between 50,000 and 70,000 tones of mango garbage annually. It is vital to make efficient use of this waste resource because at the moment these wastes have either been used as animal feed or disposed as trash. Mango byproducts have been the subject of numerous studies aimed at minimizing the harmful consequences of waste disposal. It's interesting to learn that mango peels are a good source of dietary fiber, as well as pectin, polyphenols, carotenoids and other bioactive substances that are good for human health [17, 18].

With an output of 23851 thousand tones of seeds in 2002, or roughly 18,934 hectares of cultivated land, sunflower (Helianthus annus L.), and the fourth source of oil-seeds globally is currently grown for its seeds. In 2002, Egypt produced 44 thousand tones of sunflower seeds annually (FAO, 2002) [19].

A. History of Pectin

Fruit jellies were made for a very long time before pectin was discovered. Vauquelin provided the first information on substances soluble in water that have a potent gelatinizing effect in 1790. He demonstrated how the expressed juice of fruits like tamarinds and other fruits becomes a

Clear jelly when let to stand and can be cleansed by draining the liquid and washing.

Henri Braconnot isolated and first described pectin in the year 1825. Pectin, according to his definition, is the gelatinous component of fruit that allows for the formation of jellies when it is heated with sugar. When preparing his jellies, Braconnot claimed that he had to add a small quantity of acid "to break up the pectates" because he knew that sugar and the proper pH were essential for the reaction. The word "pectin," which is derived from the Greek word Pektikos" to congeal or solidify," was coined by Braconnot.

During the Industrial Revolution, producers of apple juice were contacted by manufacturers of fruit preserves to get dried apple pomace, which was then boiled to extract the pectin. In countries that produced apple juice in both the USA and Europe, factories were built in the 1920s and 1930s that commercially extracted pectin from dried apple pomace and later from citrus peel [20].

Apple pomace, the waste product left over after crushing apples to make juice or cider, was where pectin was first extracted. The majority of pectin today is made from citrus rinds. Pectin, a long polymer, creates a gel by binding liquids with dissolved and suspended particles. A greater variety of fruits may be turned into jellies, jams, and preserves thanks to pectin [20].

B. Chemistry of Pectin

Pectin is essentially a linear polysaccharide in terms of structure. It is polydispersed and polymolecular, like the majority of other plant polysaccharides, and its composition varies depending on the source and the isolation circumstances. The molecular weight or the makeup of certain subunits can vary in each pectin sample, even from molecule to molecule. Despite being discovered more than 200 years ago, the structure and makeup of pectin are still not fully understood [21]. It has been noted via numerous research that it is challenging to ascertain the structure of pectin since the composition of pectin components might alter throughout plant isolation, storage, and processing [22]. Currently, it is considered that pectin consist of D-galacturonic Acid (GalA) units6, [23]. Linked together by α - (1-4) glycosidic linkage. These uronic acids contain carboxyl groups that are either naturally present as methyl esters or are artificially produced commercially by treating them with ammonia to form carboxamide groups [24, 25]. A chain-like arrangement of units with numbers ranging from a few hundred to a few thousand saccharine corresponds to typical molecular weights between fifty thousand and one million fifty thousand Dalton [26]. According to the literature, galacturonic acid is commonly substituted by (1-2)-linked L-rhamnose in the pectin backbone, which is made up of glycosides. It has been found that side chains of different neutral sugars can branch off from the rhamnose residues. Rhamnogalacturonan-I is the name of this particular type of pectin. In this case, rhamnose replaced by twenty fifth of the main chain's galacturonic acid. The majority of the neutral sugars in a pectin molecule are D-galactose, L-arabinose and D-xylose, whose types and proportions depend on where the pectin originated from [27].

According to X-ray fiber diffraction research, the sodium pectate molecule's galacturonan segments form helixes with three subunits per turn. According to literature references and NMR spectroscopy results, the structure of galacturonic acid units is 4C1 [27]. According to calculations, the helix is most likely right-handed. The same helix structure is visible in the X-ray fiber diffraction patterns of sodium, calcium pectates, pectic acids and pectinic acids; however, the arrangements of these helixes within the crystals vary to varying degrees. In contrast to the pectates, which pack as corrugated sheets of antiparallel helixes, it has been proposed that helical pectinic acid molecules pack in a parallel pattern [28].

Rhamnogalacturonan-II, which is a highly branched polysaccharide and a relatively less frequent complex, is another structural type of pectin. The origin, conditions of the extraction and age of the plant impact the molecular weight of this type of isolated pectin, which ranges from 60 to 130,000 g/mol [29, 30]. In the nature, methanol is used to esterify about 80% of the carboxyl groups in galacturonic acid. Nevertheless, it has been suggested that this fraction decreases slightly following pectin extraction. The behavior of pectin in food applications is governed by the ratio of esterified to non-esterified galacturonic acid. As a result, pectin's are divided into two categories: high-ester and low-ester pectin's or more succinctly, HM (high-methoxy) versus LM (low-methoxy) pectins, depending on more or less than half of the galacturonic acid is esterified [29].

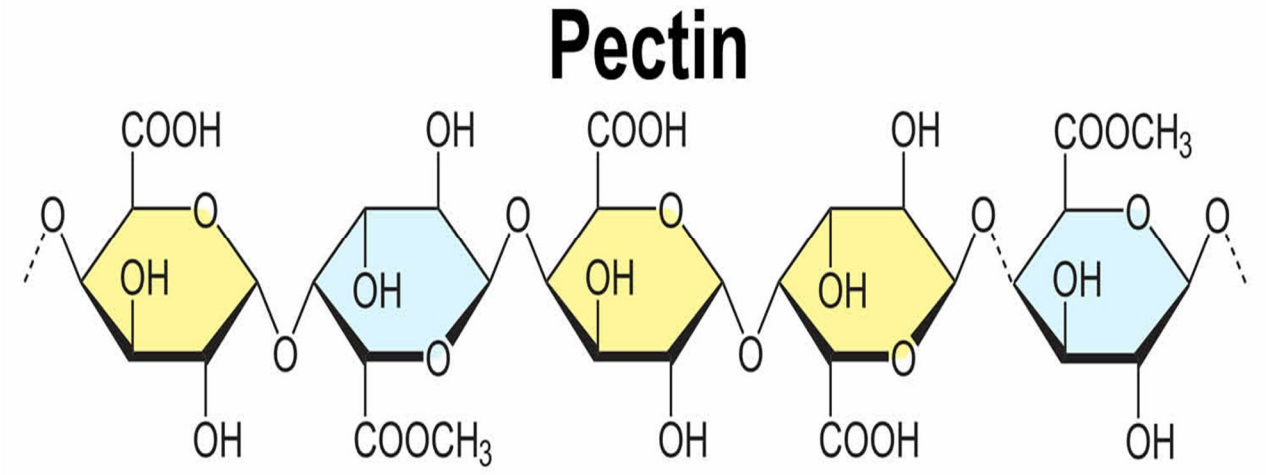


Fig.1 Structure of pectin.

C. Sources of Pectin

Apple pomace and citrus fruit peels are both widespread and commercial sources of pectin. They are byproducts from several industries, like the apple pomace from the cider manufacturer. Due to its high pectin concentration and desirable coloring qualities,

orange peel has typically been the material of choice for pectin production. Citrus pectin is mostly obtained from the peel of orange, lemon and lime. Peel needs to be unlimed; enzyme treatment is not an option.

When the peel is treated with lime, all of the pectin is hydrolyzed into pectic acid and when the peel is treated with an enzyme to promote peel removal, the pectin's molecular weight is decreased. Pectin from different sources, like sugar beet and sunflower, is finding its way to make market. Pectin content in these many sources varies greatly. For example, in the levels found in apple pomace (10–15%, citrus peel (25–35%), sugar beet (10–20%) and sunflower (15–25%) [20].

Some of the common fruits and their pectin content are demonstrated in the Table 1:-

Sr.No.	Fruits/vegetables	Tissue	Pectin content (%)
1.	Mango	Dry matter	11-15
2.	Sunflower head	Dry matter	15-24
3.	Citrus peel	Dry matter	20-30
4.	Apple pomace	Fresh	10-15
5.	Banana	Fresh	0.7-1.2
6.	Peaches	Fresh	0.1-0.9
7.	Strawberries	Fresh	0.6-0.7
8.	Cherries	Fresh	0.2-0.5
9.	Peas	Fresh	0.9-1.4
10.	Carrots	Dry matter	6.9-18.6
11.	Potatoes	Dry matter	1.8-3.3
12.	Tomatoes	Dry matter	2.4-4.6
13.	Sugar beet pulp	Dry matter	10-20

D. General Properties of Pectin

Pectin is soluble in pure water. Pectinic and pectic acid monovalent cation (alkali metal) salts are mainly soluble in water; di and trivalent cation salts are either weakly soluble or insoluble. When dry powdered pectin is mixed with water, it tends to hydrate very quickly and form clump. These clumps are made up of semi-dry pectin packets enclosed in a hydrated outer coating [24]. Such clump solubilization is very slow. Dry combining pectin powder with a water soluble carrier material will help prevent clumps, or by using pectin that has undergone particular processing during production to make it more dispenseable [33]. Although moderate concentrations of pectin solutions exhibit non-Newtonian, pseudo plastic behavior, diluted pectin solutions are Newtonian. Similar to solubility, a pectin solution's viscosity depends on factors such its molecular weight, degree of esterification, concentration, pH, and the presence of instance, factors that increases gel strength will elevate the tendency to form gel and reduce counter ions in the solution, gelation, solubility and viscosity are all generally connected. For solubility, increase viscosity and vice versa [34]. Several characteristics of pectins result from their structural makeup. The arrangement of ionic charges throughout the pectin molecule tends to keep it in extended form due to columbic repulsion; making monovalent cation salts of pectin strongly ionized in solution [35].The polymer chain aggregation is prevented by the same columbic repulsion between the carboxylate anions. The DE regulates the quantity of negative charges. Each polysaccharide chain will also be extremely hydrated, mainly each carboxylate group [36]. Because each polymer chain is hydrated, stretched, and independent, solutions of monovalent salts of pectin’s demonstrate stable viscosity. As the pH is decreased, the carboxylate groups' ability to ionize is suppressed, which leads to less hydration of the carboxylic acid groups. The polysaccharide molecules can combine and form a gel because of the reduced ionization, which makes them less likely to resist one another throughout their full length. A correlation exists between apparent pK-values (pH at 50% dissociation) and DE of the pectin [36]. The apparent pK of a 65% DE pectin is 3.55, while that of a 0% DE pectic acid is 4.10. However, as the amount of methylation increases, pectin will gel at a little higher pH because they contain less carboxylate anions at any given pH. Both depolymerization and

De-esterification of dissolved pectin’s occurring spontaneously, and the rate of this decomposition is depending on temperature, pH and water activity. In general, pH 4 is where stability is greatest. A certain amount of protection is provided by the presence of sugar in the pectin solution, whereas the rate of degradation is accelerated by high temperatures [24]. At low pH levels and high temperatures, deterioration caused by glycosidic linkage hydrolysis is seen. Low pH is also beneficial for deesterification. A HM-pectin that has undergone deesterification slows down or progressively adopts LM-pectin properties. Only room temperature keeps

HM-pectin stable and at a pH close to neutral (5–6). Chain cleavage and a very quick loss of viscosity and gelling qualities occur as a result of the so-called elimination process, which begins when the temperature (or pH) rises. The stability of LM-pectin's is a little bit better under these circumstances. Even at room temperature, pectin rapidly de-esterifies and degrades at alkaline pH values [37, 38].

While LM-pectin's are more stable and loss should not be considerable after one year of storage at room temperature, powdered HM-pectin's steadily lose their capacity to produce gels if stored under humid or warm conditions [37].

E. Applications of Pectin

Mucoadhesive polymer:-

Intestinal (GI) mucoadhesion was used to characterize various pectin types [23]. Three steps have been identified in the mucoadhesive process that results in the formation of bioadhesive bonds:

- Intimate contact with biological tissue is made possible through wetting and swelling of the polymer.
- Interpenetration of the bioadhesive polymer chain and tangling of the polymer and mucin chains.
- The development of weak chemical interactions between the entangled chains. In order to create mucoadhesive patches, pectin is used in conjunction with other mucoadhesive polymers such as carbopol and chitosan [39, 40].

1) Gelling Agent, Thickner and Water Binder

Pectin can thicken, bind to water, and stabilize in addition to being employed as gelling agents. In the presence of adequate (for example, 65% by weight) sugars like sucrose and at a low pH (3.5), high-methoxyl pectin quickly forms thermally irreversible gels; the lower the methoxyl content, the slower the set. In the presence of calcium ions and at low pH (3-4.5), low methoxyl pectins (50 percent esterified) create thermoreversible gels [41]. Commercial pectin methylesterase can be used to partially reduce the degree of esterification, which results in a higher viscosity and harder gelling when Ca2+ ions are present. Despite having a more hydrophobic character and a reported low capacity to gel, highly (2-O- and/or 3-O-galacturonic acid backbone) acetylated pectin from sugar beet is thought to have significant emulsification potential. Nevertheless, this could be because of related protein impurities. However, sugar beet pectin differs chemically from citrus pectin, so it may find new applications, particularly in industrial products [34].

Pectin, like other viscous polyanions like carrageenan, may protect milk casein colloids while increasing the properties of whey proteins (foam stability, solubility, gelation and emulsification) by using them as a calcium source. Pectin's primary function in food is a gelling, thickening and stabilizing agent [21]. The main use is to give jams or marmalades, which would otherwise be sweet liquids, a jelly-like consistency. Pectin is a component in jelling sugar, which is sometimes marketed as "sugar with pectin," and is diluted to the proper concentration with sugar and some citric acid to balance the pH.

For producing jam at home, pectin is also marketed in some nations as a solution, extract or mixed powder [42]. High-ester pectin's are utilized for traditional jams and marmalades that include more than 60% sugar and soluble fruit solids. Dietary goods can be produced using low-ester pectin and amidated pectin's since they require less sugar. Besides stabilizing acidic protein drinks like yoghurt, pectin may also be employed as a replacement to fat in baked products. Pectin levels used as food additives typically range from 0.5 to 1%, which is about the same quantity found in fresh fruit.

a) Diarrheal disorders and constipation are treated with pectin derivatives [20].
b) By raising faecal cholesterol, faecal fat, sterols and bile acid, pectin decreases blood cholesterol levels [20].
c) Pectin is used in medicine to treat constipation by increasing stools more viscous [20].
d) Pectin serves as a stabilizer in cosmetic preparations [20].
e) To give confectionery jellies a solid gel structure and a crisp bite, pectin is utilized [20].
f) Pectin also boosts the gel strength of low-calorie jams and decreases syneresis in jams and marmalades [20].
g) Pectin slows down digestion by immobilizing food particles in the gut [20].
h) It is a component of body lotions, shampoos and hair tonics [20].
i) Deodorants and dental pastes both contain it [20].
j) Specialty medical adhesives, such as those used in colostomy devices and preparations for wound healing both contain pectin, appropriate for the pastries' fillings.
k) On the other hand, citrus pectin is thinner and more suited as a texturizing ingredient for jams and candy jellies.

l) LM pectin can be used as a fat replacer in spreads, ice cream, fruit preparations for yoghurt, heat-reversible bakery glazing, emulsified meat, or low-calorie products like diet carbonated beverages, while HM pectin can be used as a gelling agent, stabilizer, emulsifier and thickener in the food industry for the production of jams and jellies.

m) Pectin can be added to milk-based products to change their texture and stability. Pectin's thickening and gelling abilities help to stabilize acidified beverages.

n) through interactions between HM pectin and casein, acidified dairy beverages can selectively stabilize acid casein particles

II. MATERIALS AND METHODS

A. Raw Materials

In our study we had used dried citrus peels, dried mango peels and dried sunflower head as a raw material.

B. Sample Collection

Dried orange peels were collected prior to experiment and were cut into fine pieces with a knife. Following this, pieces were grinded by a blender then they were dried under sun and then weighed and were employed in further study.

Dried Sunflower head was collected from farm and then, the seeds were removed from sunflower head. Further, they were cut into small pieces and blended. Simultaneously, weighed and used for further study.

Fresh mango peels were obtained from juice centre and they were dried under sunlight. Further, they were cut into small pieces and blended. Simultaneously, weighed and used for further study.

C. Reagents/Chemicals

In our study the chemicals used were: Hydrochloric Acid, 95% Ethanol, Potassium hydroxide, Iodine solution.

D. Equipments

Water bath, Beaker, Thermometer, Petri plate, weighing balance, Grinder, Specific gravity bottle, Knife, Ostwald viscometer, pH paper, Whatmann filter paper, Muslin cloth.

E. Extraction of Pectin. [31]

Extraction method for orange peels:-

First and foremost, after obtaining the citrus peels from the market or juice center, peels were cut into small fine pieces then, this pieces were transferred into distilled water which was heated at 80-90^{o}C in order to make it soft, by using thermometer. Furthermore, the acidic pH was maintained by adding hydrochloric acid (HCL). The sample was heated for 1.5 hours while maintaining the pH 2, using pH paper. After the completion of 1.5 hours the sample was filtered by using muslin cloth and whatmann filter paper. Then ethanol was added in the obtained filter solution in order to form gel. The process was repeated until the proper proportion of gel is obtained. In addition to this, the gel obtained was dried under the sunlight. Then, the obtained pectin was grinded to obtain fine powder of pectin.

F. Extraction Method for Mango Peels

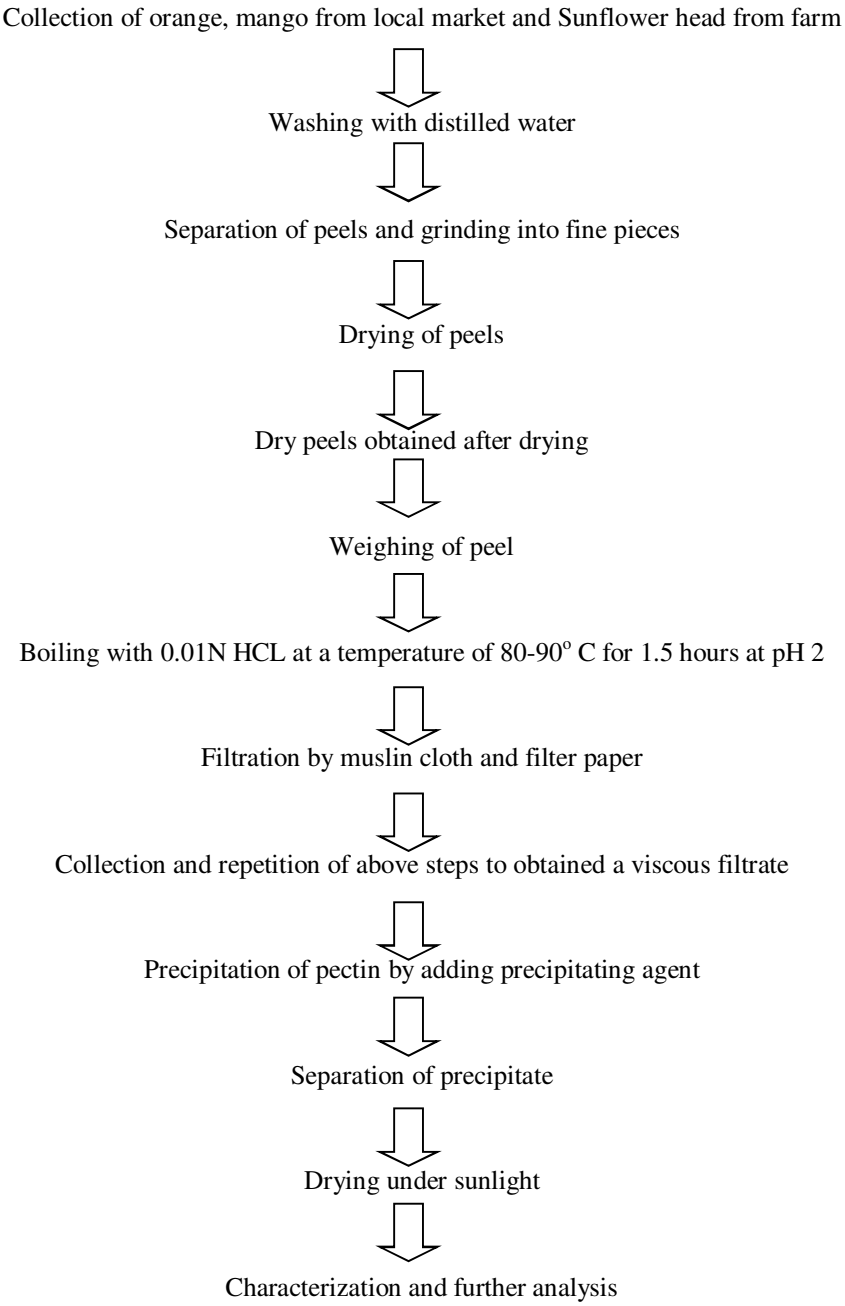
First and foremost, after obtaining the mango peels from the market or juice center, peels were cut into small fine pieces then, this pieces were transferred into distilled water which was heated at 80-90^{o}C in order to make it soft, by using thermometer. Furthermore, the acidic pH was maintained by adding hydrochloric acid (HCL). The sample was heated for 1.5 hours while maintaining the pH 2, using pH paper. After the completion of 1.5 hours the sample was filtered by using muslin cloth and whatmann filter paper. Then ethanol was added in the obtained filter solution in order to form gel. The process was repeated until the proper proportion of gel is obtained. In addition to this, the gel obtained was dried under the sunlight. Then, the obtained pectin was grinded to obtain fine powder of pectin.

G. Extraction Method for Sunflower Head

First and foremost, after obtaining the sunflower head from the farm, it was cleaned then the portion was cut into small fine pieces then, this pieces were transferred into distilled water which was heated at 80-90^{o}C in order to make it soft, by using thermometer. Furthermore, the acidic pH was maintained by adding hydrochloric acid (HCL). The sample was heated for 1.5 hours while maintaining the pH 2, using pH paper.

After the completion of 1.5 hours the sample was filtered by using muslin cloth and whatmann filter paper. Then ethanol was added in the obtained filter solution in order to form gel. The process was repeated until the proper proportion of gel is obtained. In addition to this, the gel obtained was dried under the sunlight. Then, the obtained pectin was grinded to obtain fine powder of pectin. The sequence of the operations performed for the extraction of pectin from orange peels, mango peels and sunflower head is presented in the flow chart:

This Method Is Followed On All Three Raw Materials



Digestion of the dried orange peels took place in 0.01N HCl for 1.5 hours at a temperature of 80–90°C. Initially, 100 ml of 0.01N HCl and 20g of peels were added. The mixture was then heated by following the above instructions. The heated solution was cooled after 1.5 hours, filtered through muslin cloth and then pressed to obtain the extract. The extract was further filtered using a funnel and Whattman No. 3 filter paper. To examine the effects of the precipitating agent, 95% pure absolute ethanol was added to the pectin to precipitate it. The precipitated pectin was separated and filtered after two hours. Furthermore pectin extract was dried under sunlight.

Note that, the pectin was stored in airtight container with Aluminum foil covering and kept in sunlight for further analysis.

Fig.1 Pectin obtained from natural sources.

III. EVALUATION PARAMATER OF PECTIN

A. Yield Calculation of Pectin

The yield of pectin was calculated on dry basis using following formula:

Yield (%) = $m_o/m*100$

Where, mo= weight of dried pectin (gm)

m = weight of dried powder obtained from raw material (gm)

The yield obtained after the extraction of pectin is depicted in the table number 2 in result and discussion.

B. Identification Test for Pectin [32]

Following identification test was performed on pectin obtained from all the sources, the test employed for identification are as follows;

1) A stiff gel is produced by heating 1 g with 9 ml of water on a water bath until a solution forms, replacing the water lost through evaporation.
2) A translucent, gelatinous precipitate forms (different from most gums) when an equal volume of ethanol (95%) was added to a 1% w/v solution.
3) In contrast to tragacanth, a translucent gel or semi-gel forms when 1 ml of a 2% w/v potassium hydroxide solution was added to 5 ml of a 1% w/v solution and placed under maintained temperature for 15 minutes. By adding diluted hydrochloric acid the gel and vigorously shaking it, gelatin precipitates in large quantities was colorless and turn white when heated.
4) Acidity : An aqueous solution is acidic to blue litmus
5) Starch: 2% w/v solution was boiled, cooled and 0.15ml of iodine solution was added to it resulting in no blue colour was produced.

C. Determination of pH

The pH was determine by the pH paper, by adding the obtained pectin in distill water and it is represented in the table number 3.

D. Determination of Viscosity of Pectin by using Ostwald Viscometer

What is viscometer?

A fluid's thickness can be determined with the assist of an instrument called as a viscometer.

A viscometer depicts readings mainly for a single flow pattern. A fluid's viscosity is determined by how much drag it creates as a surface moves in relation to it.

1) Ostwald Viscometer

The viscosity of a liquid density is measured with the assist of a viscometer. In honored of the philosopher "Wilhelm Ostwald" the instrument is known.

2) Procedure for Viscosity Measurement

- Fill the reservoir's tube with liquid sample of until the mark point is reached (mark C)
- Use a suction bulb to draw the liquid up to mark A by sucking it from the capillary tube.
- Using a stopwatch, record the duration of the liquid's descent from mark A (the starting time) to mark B (the finishing time).
- Finally Calculate the mean value obtained from the calculated reading.

The readings obtained after determination of viscosity using Ostwald viscometer is illustrated in table number 4.

E. Determination of Gelling Strength

1gm of sample was weighed, which was dissolved in 5ml of water. Following this, it was boiled on water bath until stiff gel was formed. Furthermore, it was cooled.

Therefore, we can conclude that 20% of pectin can be utilized to prepare the various formulations. The result obtained of gelling strength of pectin obtained from three natural sources was almost same as compared to standard pectin. Gelling strength of demonstrated in the table number 5.

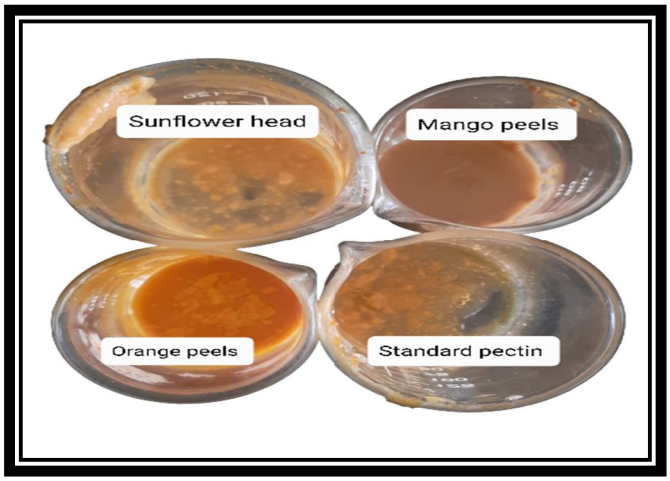


Fig.2 Formation of stiff gel.

F. Comparative Study

In this research we had compared three distinct natural sources; those were orange peels, mango peels and sunflower head. In this we had emphased on comparative study of pH, viscosity, yield and stiff gel formation ability.

IV. RESULT AND DISCUSSION

A. Yield of Pectin

The yield of pectin obtained from dried orange peels, mango peels and sunflower head differs from each other. Although same precipitating agent was added to them i.e., ethanol. Yield of pectin dried natural sources was obtained by maintaining and extraction period of 1.5, temperature of 80-90^{o} and pH of 2.

Precipitating agent	Type of raw material (gm)	Yield of Pectin (%) from 20gm
Ethanol	Sunflower head dry (3.2)	16
Ethanol	Mango peel dry (5.1)	25
Ethanol	Orange peel dry (10.6)	53

Table No. 2 Depicts the result of yield of pectin.

In our findings we had achieved highest pectin content from dry orange peels. Whereas, the lowest was in sunflower head following this pectin content in mango peels was satisfactory.

B. Characterization of Extracted Pectin

The dried pectin obtained from the orange peels, mango peels and sunflower head was subjected for the following characterization parameters.

1) Colour

a) Orange = Yellowish; almost odorless.

b) Mango = Brownish; almost odorless.

c) Sunflower = White Brown; almost odorless.

2) Solubility of dry pectin in ethanol and water

For determination of solubility of pectin. Pectin was transferred into beaker containing and another beaker containing ethanol. The result obtained was that it was fully soluble in water. Whereas, it was insoluble in ethanol.

C. pH

Sr.No.	Name of the sample	P^H
1.	Sunflower head	4
2.	Mango peel	3
3.	Orange peel	4
4.	Standard pectin	4

Table No.3 Depicts the result of pH on pectin

D. Viscosity: (Determination of viscosity of pectin by using Ostwald viscometer)

Part 1 – Determination of density of liquid:-

Where,

Weight of empty specific gravity bottle (W_1) = 11.3g

Weight of specific gravity bottle + Distilled water (W_2) = 43.2g

Weight of specific gravity bottle + Sample (W_3) = Sunflower 43.7

Mango 43.3

Orange 44.5

Standard 47.1

Density of liquid (P_2) = Mass of liquid / Mass of volume of water

$P_2 = W_3\text{-}W_1/W_2\text{-}W_1$

For Sunflower head:-

P_2= 43.7-11.3/43.2-11.3

= 32.4/31.9

=1.0156 g/ml

For Mango peels:-

P_2= 43.3-11.3/43.2-11.3

=32/31.9

=1.0039 g/ml

For Orange Peels:-

P_2= 44.5-11.3/43.2-11.3

= 33.2/31.9

=1.040 g/ml

For Standard pectin:-
P_2=47.1-11.3/43.2-11.3
=35.8/31.9
=**1.1222 g/ml**

Part 02- Determination of viscosity of liquid by Ostwald Viscometer:-
Viscosity of Liquid (n_1) = $P_2t_2/P_1t_1*n_1$
Where,
P_1= Density of water (g/ml)
P_2= Density of test sample (g/ml)
n_1= Viscosity of water (cp)
n_2= Viscosity of test sample (cp)
t_1= Mean time of flow of water from A to B
t_2= Mean time of flow of test sample from A to B

Viscosity of water at room temperature = 0.8937 cp
Density of water at room temperature (P_1) = 0.997g/ml (This is the standard value)
Viscosity of Liquid (n_1) = $P_2t_2/P_1t_1*n_1$
For sunflower head:-
= 1.0156*24.66/0.997*7.52*0.8937
= 0.3846/7.4974*0.8937
= 0.0513*0.8937
= **0.04585cp**

For Mango peel:-
= 1.0039*18.28/0.997*7.52*0.8937
= 18.35/7.4974*0.8937
= 2.44*0.8937
= **2.18cp**

For Orange peel:-
= 1.040*18.09/0.997*7.52*0.8937
= 18.81/7.4974*0.8937
= 2.50*0.8937
= **2.24**
For standard pectin:-
= 1.1222*14.17/0.997*7.52*0.8937
= 15.90/7.4974*0.8937
= 2.12*0.8937
= **1.89cp**

Sr. No.	Liquid sample	Time of flow (sec)			Mean time(t) (sec)	Density(p) (gm/ml)	Viscosity(n) (centipoise)
1	Distilled water	7.91	7.31	7.34	t_1=7.52	0.997g/ml	0.8937 cp
2	Sunflower	24.03	24.92	25.03	t_2=24.66	1.0156 g/ml	0.04585 cp
3	Mango	18.71	18.43	17.70	t_2=18.28	1.0039 g/ml	2.18 cp
4	Orange	20.72	18.94	17.04	t_2=18.09	1.040 g/ml	2.24 cp
5	Standard	14.25	14.01	14.25	t_2=14.17	1.1222 g/ml	1.89 cp

Table No. 4 Determination of viscosity

E. Gelling Strength

Sr.No.	Name of the sample	Quantity	Gelling effect
1.	Sunflower head	1gm	Stiff gel formed
2.	Mango peel	1gm	Stiff gel formed
3.	Orange peel	1gm	Stiff gel formed
4.	Standard pectin	1gm	Stiff gel formed

Table No.5 Determination of gelling property

V. CONCLUSION

Our research emphasis on extraction, identification, evaluation and comparative study of pectin using acid hydrolysis method from various natural sources. The properties of the extracted pectin are similar to that of commercially available pectin. In this study we had compared three sources namely, dried sunflower, dried orange peel and dried mango peel. The results of the research reveals that the gelling effect of all three raw material was almost same, which was demonstrated by formation of stiff gel concluding that pectin yielded from selected raw material can significantly employed as gelling agent in any industrial product. The yield of pectin from different sources is satisfactory and also suggests that suitable changes in collection process of raw material may yield more pectin. Currently highest yield was with orange peel (53%) and lowest with sunflower head (16%) and in mango (25%) respectively. The other properties of pectin such as pH, viscosity, gelling strength was tested and found similar hence, we can conclude that pectin obtained from all sources are of similar nature and can be used for commercial purposes.

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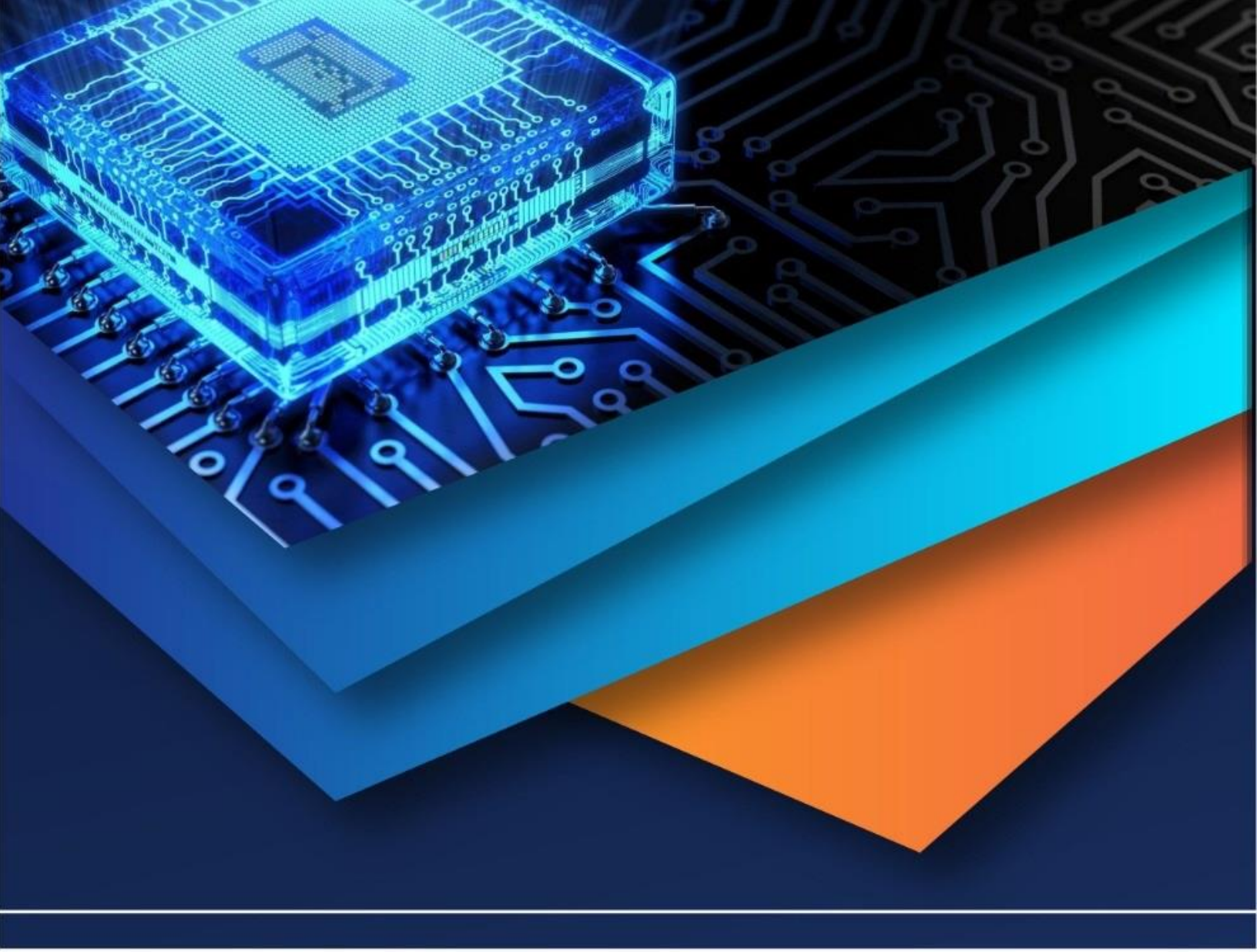

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