Extraction of Pectin from Citrus Fruit Peel and Its Utilization in Preparation of Jelly

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***Abstract*— The present study was focused on the potential of citrus peel as a source of pectin. Pectin was extracted from Sweet lemon (mosambi) peel powder using two different acids (citric and nitric) and at three different temperatures, time and pH viz (60, 70 & 80°C), (30,45 & 60 min),(1.5,2 & 2.5pH) respectively. Pectin yields varied from 21.4% to 76.0% and 17.4% to 46.4% extracted by using citric acid and nitric acid respectively. The best extraction condition was found to be higher in yield by using citric acid at 80°C, 60min, 1.5pH. The equivalent weight of pectin isolated from sweet lemon peel powder using citric acid and nitric acid as reagents contained 312.5 and 833.33 respectively. The percent methoxyl content of isolated pectin showed higher by using citric acid. The percent anhydrouronic acid of isolated pectin was found to be higher by using citric acid as compared to nitric acid as reagents. The pectin extracted using nitric acid in this study can be categorized as high methoxyl pectin because it has more than 50% of degree of esterification. The ash and moisture content of isolated pectin were studied. Sensory evaluation of developed jelly were observed.**

***Keywords*— AUA, Developed jelly, Equivalent weight., %DE, % Methoxyl content, Pectin yield, pH, Reagents, Time, Temperature, Waste utilization.**

I. INTODUCTION

Sweet lemon (*Citrus sinensis*) is citrus fruits, most commonly grown tree fruit in the world. 'Mosambi'(sweet lemon), is one of the most important commercial citrus fruits grown in central India with a total area of 41 018 ha and annual production nearly of 0.4 million tonnes (Shinde and Kulkarni 2000). Citrus fruits are at the top not only in total production, but also in economic value. Citrus fruits, which consist of two parts namely the peels (rind skin) and pulp. These two parts are easily separated from each other with the pulp serving as the edible parts of the fruit while the peels as a good source of pectin (McGready, 1996). A valuable by-product that can be obtained from fruit wastes is pectin.

The term pectin was first described and isolated by Henry Braconnot in 1825 (Braconnot, 1825). Pectin is a polysaccharide, naturally occurring substance present in all plant tissue. Pectin exists in varying amounts in fruit cell walls and has important nutritional and technological properties (Knox 2002). In the cell walls they serve as one of the main agents cementing the cellulose fibrils and may be linked covalently to other polymers. Intracellular pectins provide the channels for passage of nutrients and water (Tamaki et al., 2008).

The main use for pectin (vegetable agglutinate) is as a gelling agent, thickening agent and stabilizer in food. The classical application is giving the jelly-like consistency to jams, jellies or marmalades, which would otherwise be sweet juices (Sakai et al., 1993).

An extraction process is the most important operation to obtain pectin from vegetal tissue. Pectin extraction is a multiple-stage physical–chemical process in which hydrolysis and extraction of pectin macromolecules from plant tissue and their solubilisation take place under the influence of different factors, mainly temperature, pH and time (Kertesz 1951).Pectin extraction has been studied by several authors. (El-Nawawi & Shehata 1987) investigated the factors affecting the extraction of pectin from orange peel where the maximum yield was obtained using hydrochloric acid (90°C, pH 1.7 and 120 min). (Paga´n & Ibarz 1999) studied the extraction and the rheological properties of pectin from peach pomace, where the maximum yield was obtained using 70% nitric acid, 80°C, pH 1.2 and 60 min.

The present work is dedicated for the development of the part of the process technology needed for the extraction of value added products i.e. pectin from sweet lemon peel powder, which is the waste of citrus juice processing industry. The present work revealed that the lemon peels are good source of pectin and does have the potential to become important raw material for food processing industries. It is found from the experimentation that the peel as source, for extraction of pectin. The citrus processing industry can get a complete makeover if due importance is given

for separation of useful ingredient from lemon peel. Researchers and Scientists have been working on the separation pectin from lemon peel and reporting their findings in journals of repute.

The market potential can be analyzed on the basis of the growth prospects of its users industries. The food processing units have been mushrooming at a rapid pace. Apart from the indigenous consumption, there is a demand of pectin in export market. This industry may prove to be a good foreign exchange earner.
Fruit wastes,which are highly perishable and seasonal, is a problem to the processing industries and pollution monitoring agencies. Suitable methods have to be adopted to utilize them for the conversion into value-added products (Nand 1998).
Hence the present study is undertaken to establish a feasible and effective optimum extraction condition of pectin from the waste citrus peels as a waste utilization from nearby local fruit juice market and further evaluation.

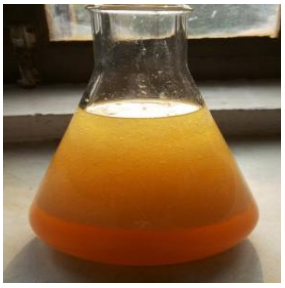
II. MATERIALS AND METHOD

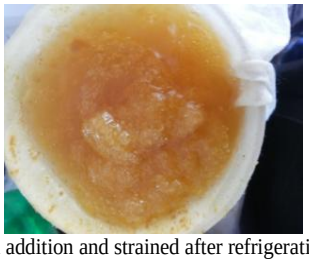
A.Sample collection: Mosambi was obtained from mahewa local market, naini, Allahabad.The mosambi were peeled and washed in order to remove dirt, dust and the residues of the pesticide spray.They were cut into small pieces,then blanching with boiling water for 5 minutes to inactivate enzyme. Then filtered by hands through two cheese cloths or muslin cloths, after which the insoluble materials (pieces) were treated in warm absolute ethanol for 30 minutes to remove oil from peel and then washed.Then pressed under hand pressure to remove excess water. The alcohol-insoluble solids (AIS) from mosambi peel pieces, thus obtained was dried at 60ºC in tray drier until the weight comes constant, then grinded and stored in tightly closed container i.e aluminium coated polyethylene bag at room temperature until use.

Palate 1.Washed mosambi peel slices

Palate 2. Driedmosambi peel

B. Extraction of pectin: The extraction procedure was based on method given by Kratchanova M. Et al, considering several variables. 5g of the peel powder was weighed and put into a 250ml conical flask, added 150 ml distilled water. Acid was added for maintaining different pH medium as reagents. For maintaining 1.5,2.0 and 2.5 pH medium, required 45g,14g and 10g citric acid(99.9% conc.) respectively. Likewise for maintaining the above three pH medium, added 0.8ml,0.4ml and 0.2ml nitric acid(70% conc.) respectively. Extraction was done by hot water bath procedure. Thereafter, the mixture was heated for each different pH medium of extraction while stirred at 60,70 and 80°C for each different time 30,45 and 60min. The hot acid extract was filtered through muslin cloth. For each acid, three different pH medium of extraction at three different range of time and temperature, extraction was carried out and collected the extract separately for further experiments. The filtrate was cooled to room temperature

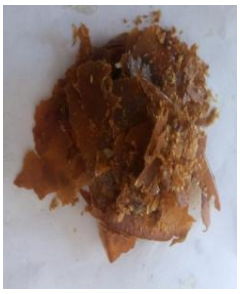




Palate 3. Coagulated pectin after ethanol addition and strained after refrigeration

C. Purification and Centrifugation Procedure: Pectin containing aqueous extract was coagulated by using an equal volume(1:1) of 99.1% ethanol at 4°C and was left for 3 hour. The precipitate(ethanol-insoluble fraction) formed was recovered through centrifugation and filtration, was washed with 55% and then with 75% ethanol.

Palate 4.Refined pectin after centrifuge



Palate 5. Dried pectin extracted using citric and nitric acid

Pectin powder extracted using citric acid	Pectin powder extracted using nitric acid

Palate 6. Pectin powder extracted using citric and nitric acid

D. Percentage yield of pectin

The pectin yield was calculated using equation 1.

$$Ypec(\%) = \left(\frac{P}{Bi}\right) \times 100 \ldots\ldots\ldots\ldots\ldots 1$$

Where, *y* pec (%) is the extracted pectin yield in percent(%),P is the amount of extracted pectin in g and Bi is the initial amount of orange or lime peel (5g).

E. Characterization of Pectin

a) Moisture contebt: 1g of sample was weighed in desiccators and was then dried in oven for 4 hour at 100°C.Then cooled over silica gel.Percent moisture observed is added (1%) to obtained agreement with the Fischer method.

b) Ash content: Ash content of pectin was determined by Ranganna's method (1995).

Weighed 1.2g of pectic substance (sample).The sample was ignited slowly, then heat for 3-4 hr at 600 ºC. Then cooled the crucible to room temperature in a desiccator and weighted properly. The process will be weighted till constant weight come and final weight will be noticed.

$$\%\ ash = \frac{(W2 - W1)}{W} \times 100 \ldots\ldots\ldots\ldots 2$$

Where, W2 - Final weight of dish and ash, W1- Weight of dish, W- Weight of pectin sample

c) Equivalent Weight: Equivalent weight is used for calculating the anhydrouronic acid content and degree of esterification. It is determined by titration with sodium hydroxide to pH 7.5 using either phenol red or Hinton's red indicator.Equivalent weight was determined by Ranganna's method (1995). 0.5 g sample was taken in a 250 ml conical flask and 5 ml ethanol was added. 1 g of sodium chloride to sharpen the end point and 100 ml of distilled water were added. Finally 6 drops of phenol red or Hinton's indicator was added and titrated against 0.1 N NaOH. Titration point was indicated by purple color. This neutralized solution was stored for determination of methoxyl content.

$$Equivalent\ weight = \frac{Weight\ of\ sample \times 1000}{ml\ of\ alkali \times Normality\ of\ alkali} \ldots\ldots\ldots\ldots 3$$

d) Methoxyl Content (MeO)

The methoxyl content or degree of esterification is an important factor in controlling the setting time of pectins, the sensitivity to polyvalent cations, and their usefulness in the preparation of low solid gels, fibres and film. It is determined by saponification of the pectin and titration of the liberated carboxyl groups.

Determination of MeO was done by using the Ranganna's method (1995). The neutral solution was collected from determination of equivalent weight, and 25 ml of sodium hydroxide (0.25 N) was added. The mixed solution was stirred thoroughly and kept at room temperature for 30 min. After 30 min 25 ml of 0.25 N hydrochloric acid was added and titrated against 0.1 N NaOH to the same end point as before like in equivalent weight titration.

$$Methoxyl\ content\% = \frac{ml\ of\ alkali \times Normality\ of\ alkali \times 3.1}{Weight\ of\ sample} \ldots\ldots\ldots 4$$

e) Total Anhydrouronic Acid Content (AUA)

Estimation of anhydrouronic acid content is essential to determined the purity and degree of esterification, and to evaluate the physical properties. Pectin, which is a partly esterified polygalacturonide, contains 10% or more of organic material composed of arabinose, galactose and perhaps sugars. Making used of the equivalent weight and methoxyl content value of titre used. Total AUA of pectin was obtained by the following formula (mohamed & Hasan, 1995).

$$\%\ of\ AUA = \frac{176 \times 0.1z \times 100}{w \times 1000} + \frac{176 \times 0.1y \times 100}{w \times 1000} \ldots\ldots\ldots 5$$

Where molecular unit of AUA (1 unit) = 176 g

Where,

z = ml (titre) of NaOH from equivalent weight determination.

y = ml (titre) of NaOH from methoxyl content determination.

w = weight of sample

f) Determination of Degree of Esterification (DE)

The DE of pectin was measured on the basis methoxyl and AUA content (Owens et al., 1952) and calculated by flowing formula

$$\%DE = \frac{176 \times \%MeO}{31 \times \%\ AUA} \times 100 \ldots\ldots\ldots\ldots 6$$

Where % MeO = Methoxyl content , % AUA=Anhydrouronic Acid Content

III. RESULTS AND DISCUSSION

Extraction of pectin were carried out by water bath heating method, weighed peel powder (5g), distilled water (150 ml) with addition of acids viz. Citric acid and Nitric acid. Different pH were adjusted, for maintaining 1.5,2 and 2.5 pH required 45g, 14g and 10g of citric acid (99.5% conc) respectively. Likewise for maintaining 1.5,2 and 2.5 pH required 0.8ml, 0.4ml and 0.2ml of nitric acid (70% conc. HNO_3), the pH of solution were adjusted in each extraction process according to different time, temperature and pH treatment combination. From mosambi peel powder extraction of pectin was done by using two different acids at different time (30, 45 and 60 min), temperatures (60,70 and 80 °C) and PH (1.5,2 and 2.5) total 54 times extraction i.e 2(acids) * 27 (treatment combination).

A. Effect of parameters on pectin yield

a) The effect of extraction time, pH of solution and temperature on pectin yield extracted from mosambi peel powder using nitric acid.

The percentage yield of pectin extracted from sweet lemon peel powder (SLPP) using nitric acid at 1.5pH for 30min. at temperature 60, 70 and 80°C are 21.4, 23.8 and 24.2%respectively.At 1.5 pH for 45min. at temperature 60, 70 and 80°C are 25.3, 26.8 and 29.0% respectively. Likewise at 1.5pH for 60min. at temperature 60, 70 and 80°C the % yield are 30.2, 37.6 and 46.4% respectively.

At low pH and higher extraction temperature it was found that there was sudden increased on percentage pectin yield. It was also found that the increased in the extraction time period also effect on the yield of pectin. The graph below fig.1 showed that at 1.5pH, the effect on percent pectin yield was higher by increasing extraction temperature and time.

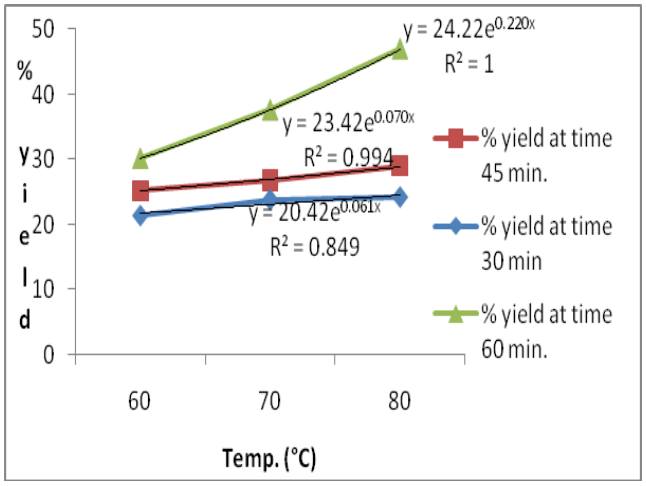


Fig.1 Effect of time and temp. on pectin yield at pH 1.5 using nitric acid.

The percentage yield of pectin extracted from SLPP using nitric acid at 2.0 pH for 30min. at temperature 60, 70 and 80°C are 25.4, 27.5 and 30.2% respectively. At 2.0 pH for 45min. at temperature 60, 70 and 80°C are 35.6, 38.4 and 41.4% respectively. Likewise at 2.0pH for 60min. at temperature 60, 70 and 80°C the % yield are 36.2, 39.6 and 42.8% respectively.

At 2.0 pH the effect on percent pectin yield showed that there was sudden increased on the yield as the time increased from 30 min. to 45 min at each temperature as shown in fig. 2. But there was less difference in the yield as the time increased from 45min. to 60min. at each extraction temperature. This results can be concluded that as the time range increased there was increased on the yield but up to a limit as the time of extraction increased to a extreme there was less effect on yield of pectin and also decreased from the maximum level due to the thermal degradation of the extracted pectin. Woo et al., (2010)

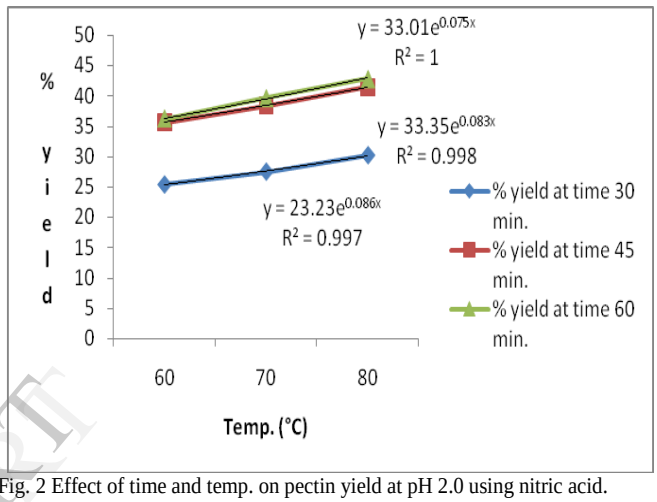


Fig. 2 Effect of time and temp. on pectin yield at pH 2.0 using nitric acid.

The percentage yield of pectin extracted at 2.5pH extracted from SLPP using nitric acid for 30min. at temperature 60, 70 and 80°C are 17.4, 18.6 and 20.6% respectively. At 2.5 pH for 45min. at temperature 60, 70 and 80°C are 24.8, 27.3 and 28.6% respectively. Likewise at 2.5pH for 60min. at the temperature 60, 70 and 80°C, the % yield are 25.6, 29.0 and 30.6% respectively.

The results in the fig.3 showed that at 2.5pH there was increased on yield by increasing temperature and time of extraction but time of 45 min to 60 min has less effect on pectin yield as compared to 30 to 45min of extraction at each temperature treatment. As the pH was fixed, the effect of time and temperature was clearly observed due to changes on pectin yield.

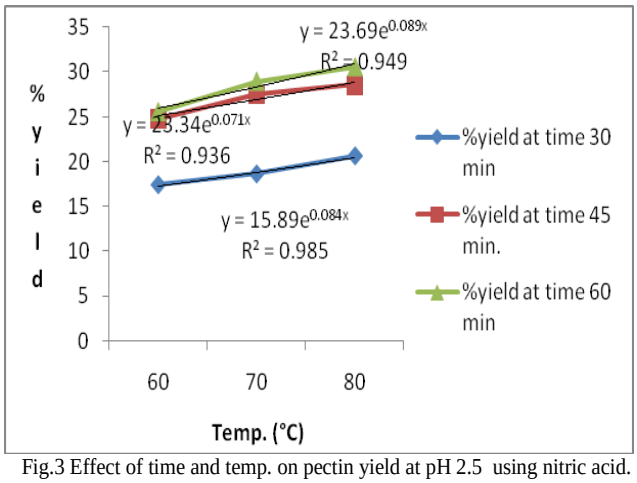


Fig.3 Effect of time and temp. on pectin yield at pH 2.5 using nitric acid.

b) The effect of extraction time, pH of solution and temperature on pectin yield extracted from sweet lemon peel powder(SLPP) using citric acid.

The percentage yield of pectin extracted from sweet lemon peel powder (SLPP) using citric acid at 1.5pH for 30min. at temperature 60, 70 and 80°C are 41.4, 45.6 and 47.8% respectively. At 1.5 pH for 45min. at temperature 60, 70 and 80°C are 59.4, 61.4 and 63.6% respectively. Likewise at 1.5pH for 60min. at temperature 60, 70 and 80°C the % yield are 65.4, 68.2 and 76.0% respectively.

At 1.5pH, the effect of time and temperature of extraction was more. As the temperature increased at this fixed pH, higher was the pectin yield. As the time increases from 30min to 45min there was more increased on pectin yield but less difference on the yield by the effect of time and temperature from 45min to 60 min of extraction.

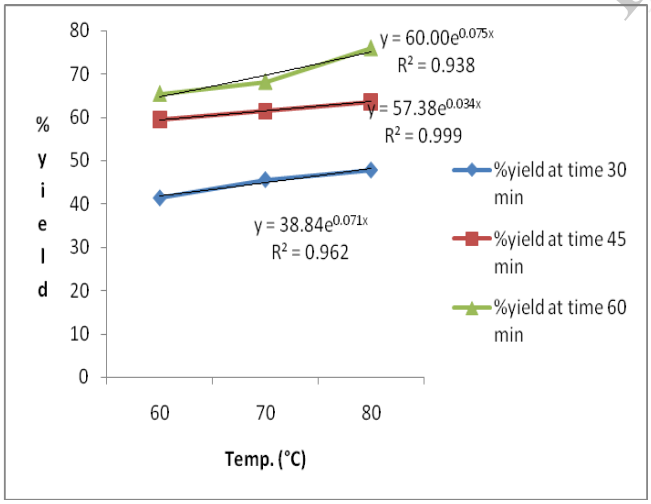


Fig.4 Effect of time and temp. on pectin yield at pH 1.5 using citric acid.

The percentage yield of pectin extracted from SLPP using citric acid at 2.0 pH for 30min. at temperature 60, 70 and 80°C are 44.2, 47.4 and 48.6% respectively. At 2.0 pH for 45min. at temperature 60, 70 and 80°C are 48.2, 52.2 and 55.2% respectively. Likewise at 2.0pH for 60min. at temperature 60, 70 and 80°C the % yield are 58.2, 60.3 and 70.4% respectively as shown in fig.4.

The fig.5 below showed that at the fixed pH 2.0, there was less effect on the yield, when the extraction time was 30 min but as the temperature increases the yield was also increased. For 60min extraction, as the temperature increased, the yield was also increased and maximum yield was obtained at this particular treatment combination. Schemin et al (2005)

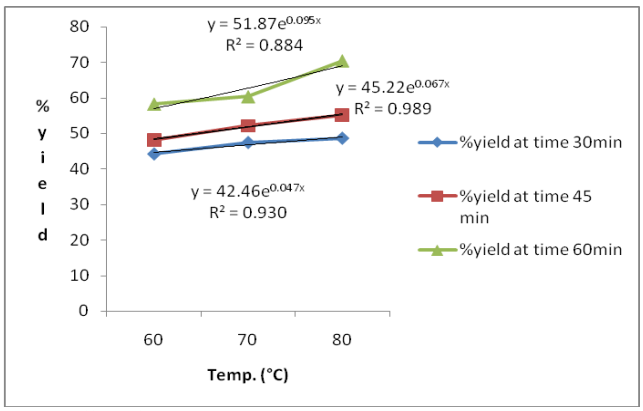


Fig.5 Effect of time and temp. on pectin yield at pH 2.0 using citric acid.

The percentage yield of pectin extracted at 2.5pH extracted from SLPP using citric acid for 30min. at temperature 60, 70 and 80°C are 21.4, 24.0 and 26.8% and at 2.5 pH for 45min. the percent yield are 28.2, 30.6 and 32.6% respectively. Likewise at 2.5pH for 60min. at the temperature 60, 70 and 80°C, the % yield are 44.6, 49.5 and 51.2% respectively as shown in fig.4.5.

At this fixed 2.5 pH, the effect time for 30 and 45min was found to be less on pectin yield as compared to effect of 60min extraction. At this pH, higher extraction time and temperature results more in pectin yield.

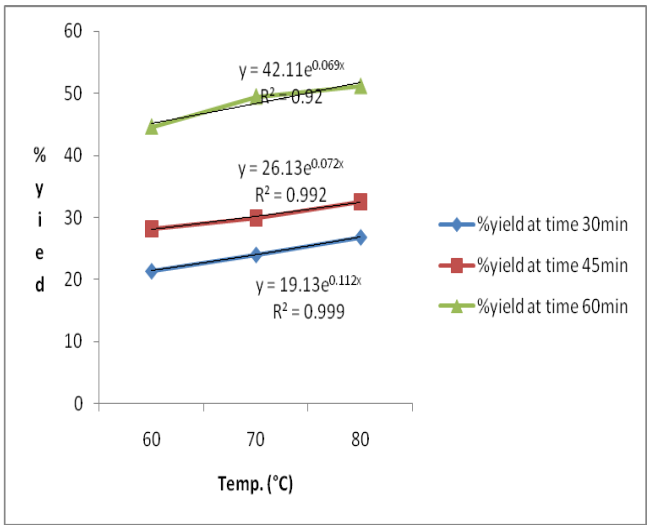


Fig.6 Effect of time and temp. on pectin yield at pH 2.5 using citric acid.

Highest yield (76%) is obtained from mosambi peel powder extracted using citric acid. Citric acid was the best for the extraction of pectin. This is an agreement with the results reported by Virk and Sogi and Schemin et al who had compared

the yields of pectin extracted from apple with different acids-hydrochloric acid, nitric acid and citric acid. Between the two strong acids, it was observed that there was a difference in pectin yield. Even though a low pH is necessary to improve the yield,the strong acid solution could lead to smaller pectin particles owing to partial hydrolysis. Consequently, pectin solubility would increase to the point that no precipitate was formed by the addition of alcohol. As reported by Kalapathy and Proctor this could be the reason why the use of a stronger acid resulted in a lower pectin yield.Yapo had reported that by using citric acid,nitric or sulphuric acid extractant,it has been shown that acid type strongly influences the macromolecular and gelling properties of isolated pectin,with citric acid being the least pectin degrading(depolymerising and deesterifying) extracting agent. Therefore, it leads to pectin isolates with the best gelling properties.

Extreme of high temperature and extraction time would lead to decomposition of pectin since pectin is composed of α-(1, 4) linked units of galacturonic acid or methyl ester. Yujaroen *et al.* had reported that the glycosidic bond is an ether bond that can go through hydrolysis reaction at the right conditions (80°C at pH 2, or at pH 8 for two hours). In this case, it is considered that by hydrolysis of high polymer of pectin molecules to low polymer leads to an increase of solubility in water, which makes it more difficult to separate pectin as a solid compound by the addition of ethanol. In the study carried out by Woo *et al*., pectin yield increased initially but declined after 60 minutes of extraction. The decrease in pectin yield by the increase in extraction period may be due to the thermal degradation of the extracted pectin. The degradation is mainly caused by the depolymerisation mechanism of galacturonan chain of pectin, which is known as beta-elimination. Thus, the pectin cannot be recovered by precipitation with alcohol. The pH during extraction was maintained at 1.5. Kertesz reported that high concentration of hydrogen ions present in the solvent (at low pH) stimulates the hydrolysis of protopectin. Protopectin is a compound formed by the combination of cellulose with pectin molecules. During acid hydrolysis, the combination is split up to produce soluble pectin and cellulose by eliminating water molecules. Besides, the removals of calcium and magnesium ions do occur. As a result, protopectin becomes soluble pectin. The research of Joye D. D. et al., demonstrated that extraction under strong acidic conditions (below pH 2.0) was sufficient to extract the non-calcium sensitive pectin (NSCP) and the remaining pectin present in citrus peel, which is primarily calcium sensitive- pectin (CSP). Extraction under intermediate acidic conditions (approximately pH 3.0) was reported to extract only non-calcium-sensitive pectin. At lower pH, the highly hydrated carboxylate groups are repressed in the larger hydrogen ion concentrations and therefore, converted into slightly hydrated carboxylic acid groups. The lost of charge is able to reduce the repulsion of the polysaccharide molecules which promote the gelation properties of pectin giving more precipitated pectin at lower pH. Thus, the decreased in pH is able to promote the liberation of pectin molecules from the peel during acid-washing stage because of the interaction of pectins to the hemicelluloses fractions are cleaved. Pectin yield is lesser in higher pH might be due to some pectin is still attached to the cell wall components, although pectin molecules can be partially solubilised from plant tissues without degradation by weakly acidic aqueous solvents. The ethanol, as a surfactant solvent, significantly reduces the wetting angle of the plant tissues by modifying the drainage properties of the plant tissues[41]. Consequently, the capillary pressure of the plant tissues is increased, and this condition causes an improvement in the penetration rate of the solvent.

B. Moisture Content:The moisture content of pectin extracted from sweet lemon peel powder (SLPP) using citric and nitric was found to 5.2% and 7.6% respectively, similar results was found by Azad et al., (2014). The moisture absorbed by isolated pectin in this work was found to be in the range of 5.2 to 7.6%, which is slightly lower than that of 9.4-11.3% for commercial pectin and those reported in the literature. The pectin is very hygroscopic,for this reason, it must be preserved in closed dry atmosphere. Literature data on the moisture content of pectin extracted from dragon fruit as well as different citrus peel like Kinnow, Musambi, Malta and Feutral lies in the range of 9.4-11.3. Thongsombat et al., (2007)

C. Ash Content: The ash content of pectin extracted from sweet lemon peel powder (SLPP) using citric and nitric was found to 7.5% and 3.5% respectively,which is against 15.2% for commercial pectin. In literature, showed some parameter regarding different ash content of fruits as 6.9-11.6% (dragon fruit), Musambi, Malta and Feutral, orange peels contents 6.5-8.9% ash. This parameter as reported in literature varies in a wide range depending on the method and the nature of the citrus fruits used for extraction. The upper limit of ash content for good-quality pectin is considered to be 10% from the view point gel-formation. Therefore, with respect to this parameter, the pectin isolated in this study may be considered to be of satisfactorily good quality. (Azad et al., 2014).

D. Equivalent Weight: Equivalent weight of pectin extracted from sweet lemon peel powder (SLPP) using citric and nitric was found to be 312.5 and 833.33 respectively. The present results has supported by Shaha et al.,(2013). The over ripens lemon pomace extracted pectin showed lower equivalent weight (368 }3) while the mature extracted sample showed the highest equivalent weight (1632 • }137), (Azad et al., 2014).This parameter as reported in literature varies in a wide range depending on the method and the nature of the citrus fruits used for extraction. High equivalent weight would have higher gel-forming effect.The lower equivalent weight could be higher partial degradation of pectin. The increased or decreased of the equivalent weight might be also dependent upon the amount of free acid (Ramli and Asmawati, 2011).

E. Methoxyl content: The methoxyl content of pectin extracted from sweet lemon peel powder (SLPP) using citric and nitric was found to be 6.2% and 5.27% respectively, this results was

supported by Azad et al., (2014).The methoxyl content for isolated pectin which is against 3% for commercial pectin. Methoxyl content is an important factor in determining the gel formation capacity. Methoxyl content is an important factor in controlling the setting time of pectins and the ability of the pectin to form gels (Constenla and Lozano, 2003).Spreading quality and sugar binding capacity of pectin are increased with increase methoxyl content (Madhav and Pushpalatha, 2002). Based on methoxyl content value in this study indicates that sweet lemon peel pectin was categorized as high and low methoxyl pectin depends on reagent used.

F. Anhydrouronic acid (AUA):

The AUA content of pectin extracted from sweet lemon peel powder (SLPP) using citric and nitric was found to be 91.52% and 51.04% respectively, this results supported by Azad et al.,(2014). The AUA indicates the purity of the extracted pectin and its value should not be less than < 65% (Food Chemical Codex, 1996). In this study the highest AUA content of pectin was found by using citric acid and the lowest using nitric acid (51.04%). Low value of AUA means that the extracted pectin might have a high amount of protein, starch and sugars in the precipitated pectins (Ismail et al., 2012).

G. Degree of esterification:

The degree of esterification of pectin extracted from sweet lemon peel powder (SLPP) using citric and nitric was found to be 38.46% and 58.62% respectively, this results was supported by (Azad et al., 2014). The sweet lemon peel powder (SLPP) pectin extracted using nitric acid produced in this study can be categorized as high methoxyl pectin (HMP) because it has a % DE that is higher than 50% and SLPP pectin using citric acid can be categorized as low methoxyl pectin (LMP) because it has a % DE that is lower than 50%.Degree of esterification decreased with the increase of maturity. The lower DE might be attributed to the conversion of pectins into protopectin which increases the sugars and makes the fruit softer during the maturation.DE actually depends on species, tissue and stages of maturity by (Sundar Raj et al. 2012).

H. Sensory analysis of jelly developed by using extracted pectin

The jelly was developed from 170ml fruit extract for each sample, added 0.52g of citric acid for each sample and from this amount of acid, little amount was added during fruit extract and the remaining citric acid was added after addition of 127.5g of sugar for each sample and alcohol test was done to checked the pectin content in fruit extract, it was found in the ranged of moderate pectin content as the clot showed less firm and fragmented. The amount of pectin was fixed to 0.5% for each sample, i.e 0.42g. After boiling testing was done by measuring temperature upto 105°C and checked °brix using refractometer till the TSS attend 65° brix.

Three jelly samples was developed from papaya fruit, using two pectin extracted from SLPP using citric and nitric acid. Controlled jelly sample was developed without addition of pectin and compared the rest two samples with the controlled sample in terms of colour, taste, aroma, flavour, texture, appearance and overall acceptability. Organoleptic score was taken from the 9 panelist using 9-Point Hedonic Scale sensory evaluation card.

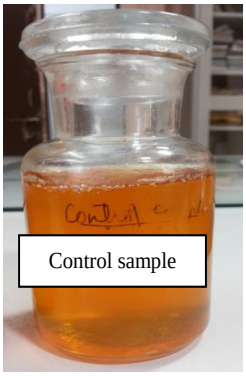


Fig.7 Control sample

Fig.8 Jelly developed by adding SLPP pectin extracted by using citric (3) and nitric acid (2)

The jelly developed with addition of 0.5% pectin extracted from SLPP using nitric acid has scored 8.5 for taste, color, aroma and and texture, 8.2 for flavor and appearance and 8.4 for overall acceptability. Appearance was not good as compared to control sample, it was found to be little foam suspended. Jelly gives smooth texture. The taste of jelly was good but it gave a little strong flavor, which was found to be not much desirable.

The jelly developed with addition of 0.5% pectin extracted from SLPP using citric acid has scored 8.5 for flavor and appearance, 8.2 for taste, texture, color and aroma, and 8.3 for overall acceptability. This jelly developed from papaya fruit extract with addition of 0.5% pectin extracted by using citric acid was found to be the less in score. Here for this particular sample the color, taste, aroma and texture is less as compared to the control sample. This jelly gave a little strong aroma somewhat citric acid flavor, this may be due to addition of pectin extracted from sweet lemon using citric acid, so the aroma of citric acid from

pectin might be influenced on the jelly. The texture of this jelly was good in terms of spreadability.

IV. CONCLUSION

This research emphasized on pectin extraction and characterizations from Sweet lemon (mosambi) peel. In general, the research had been divided into four parts namely effect of reagents on pectin yield, effect on pectin yield by different parameters, characterization of pectin and preparation and sensory evaluation of jelly. The results indicated that different:extractants, pH, extracting temperature and time effect on the extraction yield. The best condition were, extracting temperature at 80°C at 1.5pH for 60min and using citric acid as the extracting solvent. This gave a yield of 76%. Purification using APP was sufficient to yield pectin of high purity. From the results obtained, sweet lemon peel gives a significant amount of pectin whereby it can be considered in commercial production of pectin alongside with other citrus sources.

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