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Optimized Extraction Condition and Characterization of Pectin from Orange Peel

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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 Orange 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 yield extracted by using citric and nitric acid as reagents medium varied from 15.5% to 67.3% and 10.6% to 44.4% respectively. The best extraction condition by both the extraction reagents showed higher in yield by using citric acid at 80°C, 60min, 1.5pH. The isolated pectin using citric acid and nitric acid as reagents contained 294.11 and 515 equivalent weight, 5.89 and 5.58% methoxyl content, 93.28% and 65.82% anhydrouronic acid respectively. The degree of esterification of extracted pectin showed low methoxyl pectin. The ash and moisture content of isolated pectin were also determined. The sensory quality of the developed jelly was analysed.

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

1. Introduction

Orange (*Citrus sinensis*) are citrus fruits, most commonly grown tree fruit in the world. 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**). An orange,
specifically, the sweet orange (*Citrus sinensis*), Nagpur is well known in central Asia as largest orange producing region. It is also known as the California of India, producing excellent quality oranges in large number. Nagpur is major orange producing centre in the subcontinent and even recognized in the name of oranges as, Orange city. Though it has great production of oranges, the downstream processing and value added product manufacturing technology is not yet developed. 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 orange peel powder, which is the waste of citrus juice processing industry. The present work revealed that the sweet orange 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 orange and lemon peel. Researchers and Scientists have been working on the separation pectin from orange peel and reporting their findings in journals of repute.

Fruit wastes, which are highly perishable and seasonal, it 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 characterization and evaluation

2. Materials and Methods

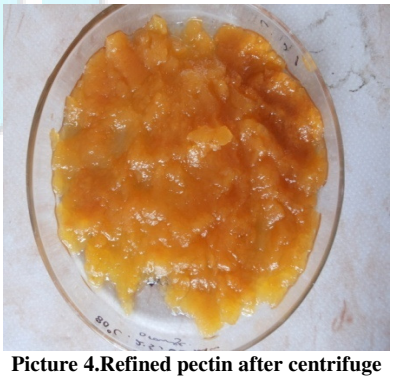
2.1 Sample collection: Orange was obtained from mahewa local market, Naini, Allahabad. Orange were peeled and washed in order to remove dirt, dust and the residues of the pesticide spray. They were cut into small pieces, then blanching with boiling water for 5 minutes to inactivate enzyme. Then filtered 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 orange 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 orange peel slices **Palate 2. Dried orange peel**

2.2 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.

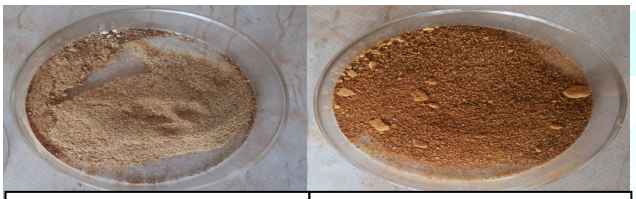
Palate 3.Coagulated pectin after ethanol addition and strained after refrigeration

2.3 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.



Picture 4.Refined pectin after centrifuge

Palate 5. Dried pectin extracted using nitric and citric acid



Pectin powder from OPP extracted using citric acid	Pectin powder from OPP extracted using nitric acid

Palate 6. Pectin powder from orange peel powder extracted using citric and nitric acid

2.4. 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).

2.5. Characterization of Pectin

2.5.1 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.

2.5.2 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

2.5.3 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.

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

2.5.4 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.

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

2.5.5 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

2.5.6 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

3. Results and Discussion

3.1 Effect of solution reagents on pectin extraction.
3.1.1 Effect of extraction reagent on pectin yield extracted from orange peel powder (OPP) using citric acid as reagent at different treatment combination.
The percentage yield of pectin extracted by using citric acid from orange peel powder (OPP) ranged from 15.5% to 67.3%. The percent yield was minimum for OPP using citric acid at treatment combination of 2.5 pH, 30min. and 60°C i.e 15.5% yield. The yield was maximum at treatment combination of 1.5 pH, 60min. and 80°C i.e 67.3% yield. The percentage yield ranges of pectin at 1.5pH was higher than 2.0pH and 2.5pH.
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.
3.1.2 Effect of extraction reagent on pectin yield extracted from orange peel powder (OPP) using nitric acid as reagent at different treatment combination.
Pentin yield obtained from OPP using nitric acid was less as compared to using citric acid, may be due higher in molecular weight of citric acid and less depolymerisation of pectin. The percentage yield of pectin extracted by using nitric acid from OPP ranged from 10.6% to 44.5%. The percentage yield ranged of pectin at 2.0 pH was little more higher than 1.5pH and 2.5pH for 30min extraction.
By using nitric acid as reagents the yield obtained at the same pH, time and of extraction is less as compared with the yield obtained by using citric acid. Similar results was found in literature of **Aravantinos-Zafiris and Oreopoulou (2006).**Less time of extraction found less in yield, this was not satisfactory, in this case also too much higher or lower in pH of extraction medium was found to be less in yield.

3.2 Effect of parameters on pectin yield
3.2.1 The effect of extraction time, pH of solution and temperature on pectin yield extracted from OPP using nitric acid.
Extraction of pectin by using nitric acid as reagent from orange peel powder was found to be less in percent pectin yield as compared to citric acid as reagents. The percent yield of pectin extracted from OPP using nitric acid at 1.5pH for 30min at temperature 60, 70 and 80°C are 24.8, 27.6 and 28.4% respectively.At 1.5 pH for 45min at temperature 60, 70 and 80°C are 29.6, 30.2 and 34.4% respectively. Likewise at 1.5pH for 60min at temperature 60, 70 and 80°C the % yield are 40.6, 42.8 and 44.5% respectively.
At this fixed pH, the effect of time and temperature on percent pectin yield was found to be more when extracted for 60 min. There was less increased on yield when extracted for 30 and 45 min. This is shown in fig.1, as the temperature and time increases then more in the pectin yield.

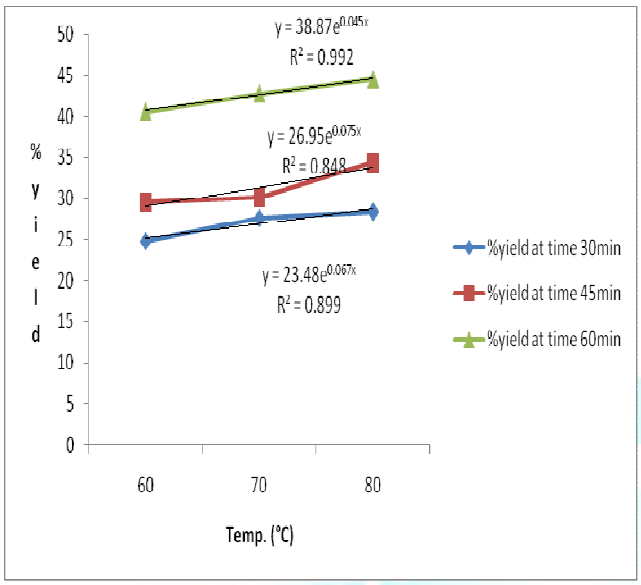


Fig.1 Effect of time and temp. on pectin yield at pH 1.5 using nitric acid.

The pecentage yield of pectin at 2 pH for 30min. at temperature 60, 70 and 80°C are 26.2, 28.0 and 29.8% respectively. At 2 pH for 45min. at temperature 60, 70 and 80°C the percent pectin yield are 29.3, 30.5 and 32.4% respectively. Likewise at 2 pH for 60min. at temperature 60, 70 and 80°C the % yield are 31.0, 31.7 and 33.1% respectively as shown in fig.2.

As the temperature increased, there was increased on pectin yield also. At this fixed pH, effect on pectin was more as the time period of extraction and temperature increases, this effect shown in fig.2 below. For 60min of extraction there is less difference on the pectin yield at 70 and 80°C temperature. Pectin yield increased initially but declined after 60min, the degradation is mainly caused by the depolymerisation mechanism of galacturonan chain of pectin.**Woo et al., (2010)**

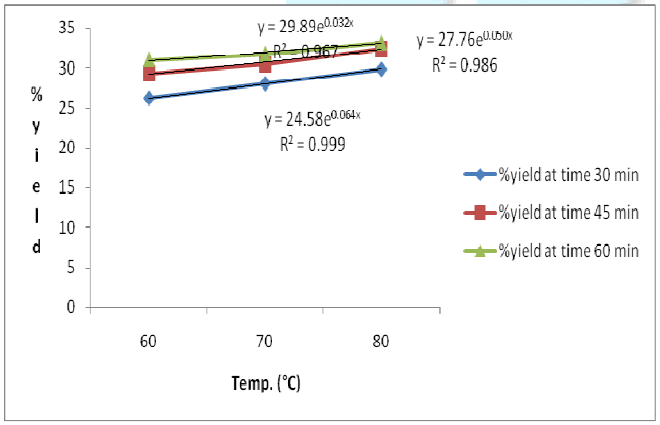


Fig.2 Effect of time and temp. on pectin yield at pH 2.0 using nitric acid.

The percentage yield of pectin extracted from OPP using nitric acid at 2.5 pH for 30min at temperature 60, 70 and 80°C are 10.6, 13.6 and 14.8% respectively. At 2.5 pH for 45min. at temperature 60, 70 and 80°C are 13.4, 16.2 and 17.8% respectively. Likewise at 2.5 pH for 60min. at temperature 60, 70 and 80°C the % yield are 14.6, 17.4 and 19.8% respectively, as shown in fig. 3.

At this fixed 2.5 pH, as the time of extraction increased, the yield was found to be more at higher temperature. But the effect of 30min time of extraction obtained low percent of pectin yield. Less time found less in pectin yield, low temperature and more time also initially increased on pectin yield but as the time increases up to a limit then yield also decreased, similar results by **Aravantinos and Oreopoulou(2006)**

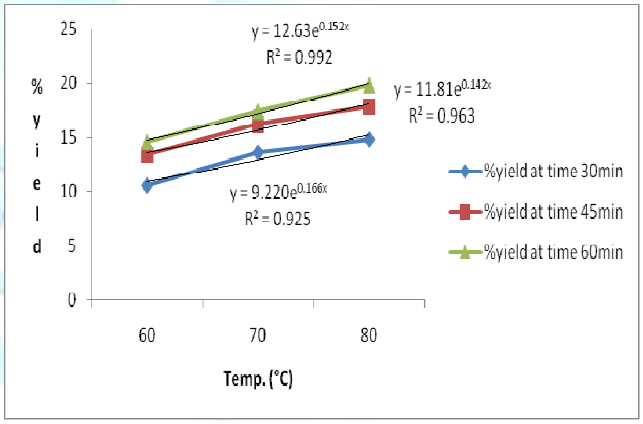


Fig.3 Effect of time and temp. on pectin yield at pH 2.5 using nitric acid.

3.2.2 The effect of extraction time, pH of solution and temperature on pectin yield extracted from Orange peel powder (OPP) using citric acid.

The percentage yield of pectin extracted from OPP using citric acid at 1.5pH for 30min. at temperature 60, 70 and 80°C are 30.4, 35.3 and 39.6% respectively. At 1.5 pH for 45min. at temperature 60, 70 and 80°C are 59.4, 63.3 and 65.0% respectively. Likewise at 1.5pH for 60min. at temperature 60, 70 and 80°C the % yield are 64.0, 66.2 and 67.3% respectively as shown in fig.4.

At this fixed pH 1.5, the effect of time and temperature on percent pectin yield was found to be more at 60 min of extracted. There was less increased on the pectin yield for 30 and 45 min of extracted. This is shown in fig.4, as the temperature and time increases then more in the pectin yield. Lower pH values negatively affected the galacturonic acid content of pectin, but increased the pectin yield. **Thomas et al., (2008)**

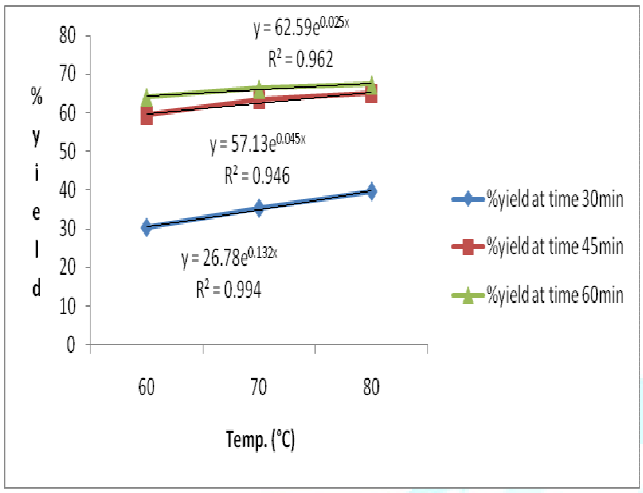


Fig.4 Effect of time and temp. on pectin yield at pH 1.5 using citric acid.

The percentage yield of pectin extracted from OPP using citric acid at 2 pH for 30min. at temperature 60, 70 and 80°C are 23.4, 27.7 and 30.4% respectively. At 2 pH for 45min. at temperature 60, 70 and 80°C are 33.4, 40.7 and 47.4% respectively. Likewise at 2 pH for 60min. at temperature 60, 70 and 80°C the % yield are 48.4, 53.8 and 58.5% respectively. The fig. 5 below showed, by increasing temperature and time at this fixed pH, there was increased on the pectin yield also. At this pH range the difference on the pectin are also more as compared with the rest two other pH ranged.

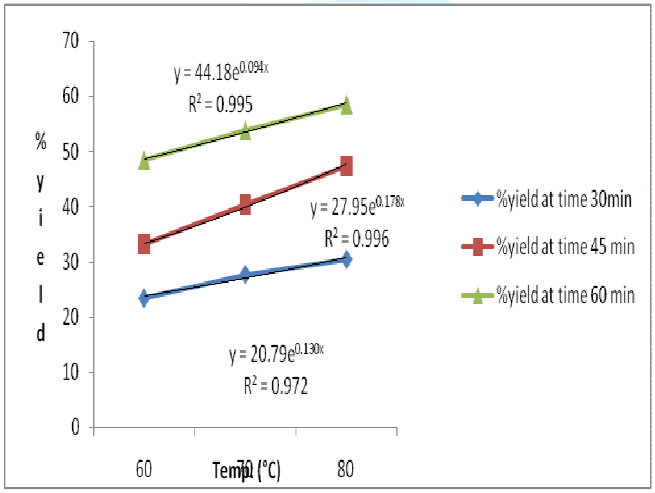


Fig.5. Effect of time and temp. on pectin yield at pH 2 using citric acid.

The percentage yield of pectin extracted from OPP using citric acid at 2.5 pH for 30min. at temperature 60, 70 and 80°C are 15.5, 19.4 and 21.5% respectively. At 2.5 pH for 45min. at temperature 60, 70 and 80°C are 22.7, 25.5 and 26.8% respectively. Likewise at 2.5 pH for 60min. at temperature 60, 70 and 80°C the % yield are 33.3, 38.2 and 40.4% respectively. At this fixed pH range the increased on the pectin yield was found to be more for 60min time period of extraction. The graph shows increased on yield by increasing temperature and extraction time increased.similar results found by **Tekeste et al., (2011)**

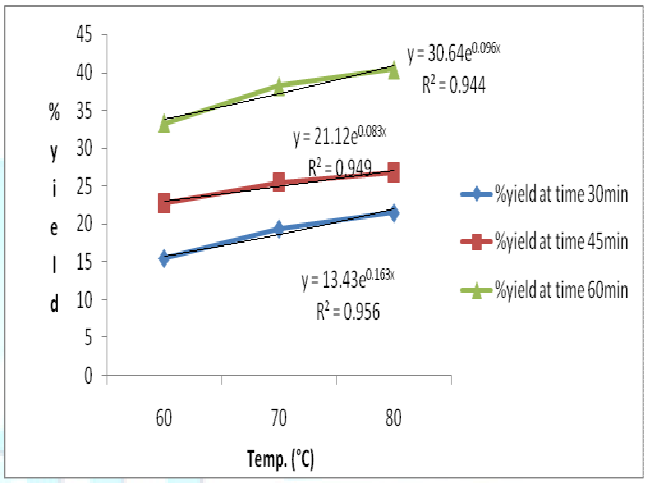


Fig.6. Effect of time and temp. on pectin yield at pH 2.5 using citric acid.

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. In order to improve the yield, this type of pectin constituent (protopectin) is suggested to be hydrolysed by acid. Alkaline conditions were found by Knee and Jarvis *et al.,* to break the bonds between the pectin molecule and the cell wall in a similar manner to acidic solvents. Knee and Jarvis *et al.*, found that substantial amounts of pectin were extracted under alkaline conditions as compared with neutral conditions. Nevertheless, alkaline conditions cause instability in the backbone of pectin molecule (galacturonic acid) and consequently, the pectin molecule tends to decompose. Due to the decomposition of pectin molecules, the extracted pectin cannot be precipitated with alcohol. Therefore, the recovery of the extracted pectin tends to be reduced under alkaline conditions. Thus low pH is essential for higher yield that is not achievable at higher pH condition. According to Adamson the capillary pressure of the plant tissues affects penetration of solvents significantly. The capillary pressure is influenced by factors such as the surface tension between the solvent and the gas phase, the solvent contact wetting angle and the capillary radius. Because of the presence of waxes and resins on the surfaces of plant tissues, the surfaces become resistant to the solvent giving a high wetting angle. Hence the amount of extractable pectin is reduced considerably. The ethanol, as a surfactant solvent, significantly reduces the wetting angle of the plant tissues by modifying the drainage properties of the plant tissues. Consequently, the capillary pressure of the plant tissues is increased, and this condition causes an improvement in the penetration rate of the solvent.

3.3 Moisture Content

The moisture content of pectin extracted from orange peel powder (OPP) using citric and nitric was found to be 6.4% and 10.1% 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 6 to 10.1%, 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)**

3.4 Ash Content: The ash content of pectin extracted from orange peel powder (OPP) using citric and nitric was found to be 3.1% and 6.66% 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), 7.1-8.1% Kinnow, Musambi, Malta and Feutral, orange peels contents 6.5-8.9% ash, 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, supported by **(Azad et al., 2014).**

3.5 Equivalent Weight: The equivalent weight of pectin extracted from orange peel powder (OPP) using citric and nitric was found to be 294.11 and 515 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).**

3.6 Methoxyl content

The methoxyl content of pectin extracted from orange peel powder (OPP) using citric and nitric was found to be 5.89% and 5.58% respectively,this results was supported by **Azad et al., (2014).**The methoxyl content for isolated pectin which is against 3% for commercial pectin. This

parameter varies depending on the nature and method used. Literature shows that the premature lemon pomace sample had higher methoxyl content (10.25%) followed by mature (4.24%) and over ripe (4.26%) ones. 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.

3.7 Anhydrouronic acid (AUA)

The AUA content of pectin extracted from orange peel powder (OPP) using citric and nitric was found to be 93.28% and 65.824% 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%).

In literature showed premature lemon pomace give higher AUA content than mature lemon pomace. Resembled values were found in apple pomace pectin, commercial apple pectin and dragon fruit pectin which was 59.52 to 70.50%, **(Kumar & Chauhan, 2010),** 61.72% and 45.25 to 52.45% **(Ismail et al., 2012)** respectively. 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).**

3.8 Degree of esterification

The degree of esterification of pectin extracted from from orange peel powder (OPP) using citric and nitric was found to be 35.85 % and 48.13% respectively this results was supported by **(Azad et al., 2014)**.

In this study, the pectin 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).**

4. Conclusion

This research emphasized on pectin extraction and characterizations from orange peel. In general, the research had been divided into three parts namely effect of reagents on pectin yield, effect on pectin yield by different parameters and characterization of pectin. 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 67.3%. Purification using APP was sufficient to yield pectin of high purity.From the results obtained,orange 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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References

[1] Crandall PG, Braddock RJ, Rouse AH. 1978. Effect of drying on pectin made from lime and lemon pomace.Journal Food Sci. 43 (5):1680.

[2] Crandall P.G, Braddock R.J, and Rouse R.H. (1978). Determining the yield and quality of pectin from fresh peel and pomace. Proc. Fla. State Hort. Soc. 91:109-111.

[3] Carvalho AB, De Assis SA, Leite KM, Bach E, Oliveira OM 2009. Pectin methylesterase activity and ascorbic acid content from guava fruit, cv. Predilecta, in different phases of development.Int. Jounal Food Sci Nutr.;60(3):255-65.

[4] Fishman, M.L., Chau, H.K., Hoagland, P., Ayyad, K. 2006. Characterisation of pectin, flash extracted from orange albedo by microwave heating under pressure. Carbohydrate Research, 323, 126-138.

[5] Ferreira & Renata D. M. 2009 Optimisation of pectin acid extraction from passion fruit peel(Passiflora edulis flavicarpa) using response surface methodology, International Journal of Food Science and Technology. 44, 476–483.

[6] Georgiev Y., Ognyanov M., Yanakieva ,Kussovski V., and Kratchanova M. 2012. Isolation, characterization and modification of citrus pectins. J. BioSci. Biotech. 2012, 1(3): 223-233.

[7] Hussain, T., Baig, M.Q., and Rashid, H. 1991. Extraction and evaluation of pectin from mango peel. *Pakistan journal of agriculture volume* 12(3), 213-216.

[8] Hamapitour, M.S., Majidi, S.M., Abdi, M., Farbodnia 2004. Potentials for industrial utilization of citrus byproducts.16th

International Congress of Chemical and Process Engineering, 22-26 APrague, Czech Republic, pp. 9263..
[9] Hashmi S.H, Ghatge P, Machewad G.M and Pawar S. 2012. Studies on extraction of essential oil and pectin from sweet orange.Dept. of Food Chem. And Nutrition.
[10] Jin-ming H.E, Yan-hue and Jun 2008. Study on extraction conditions of pectin substances from citrus peel.Chinese Journal.
[11] Krishnamurti (1949).Study on the preparation and purification of pectins and jelly development. Journal of Food Engineering,26,251-259.
[12] Shaha R.K, Nayagi Y., Punichelvana A.P, and Afandi A. 2013. Optimized extraction condition and characterization of pectin from kaffir lime. Research Journal of Agriculture and Forestry Sciences ISSN 2320-6063 Vol. 1(2), 1-11.

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