Extraction and assessment of pectin from pumpkin peels

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Abstract. Hamed AAR, Mustafa SE. 2018. Extraction and assessment of pectin from pumpkin peels. Biofarmasi J Nat Prod Biochem 16: 1-7. Pectin is characterized as intricate blends of polysaccharides that compose around 33% of the cell-wall dry substance of most kind of plants. This study was done to extract pectin from completely ripe pumpkin (Cucurbita spp.) using two distinct techniques; soxhlet acid extraction technique and acid extraction technique, and to find out the impact of utilizing distinctive acids on the yield of pectin; nitric and citric acids were utilized. In addition, to analyze the impact of time in pectin yield, the extraction procedure was carried out using 3 different times, namely, 30, 60 and 90 min. The chemical substances of pumpkin peel (dampness, ash, protein, fat, fiber, total sugar and calcium) and the chemical properties of pectin (methoxyl content, acetyl content, identical weight and level of esterification) extracted with both nitric and citric acids were also identified. The outcomes produced by the soxhlet acid extraction technique and acid extraction technique were 7.72% nitric acid and 6.80% citric acid, and 6.24% nitric acid and 5.36% citric acid respectively which demonstrated that the utilization of soxhlet acid extraction technique with nitric acid got the highest yield of pectin. Additionally it was also discovered that the time for pectin extraction was 60 min at very most. The outcome for the chemical substances of pumpkin peel (dampness, fiery remains, protein, fiber, fats, add up to sugar and calcium) were 20.1, 7.1, 3.2, 10.15, 2.3, 57.15 and 0.308% respectively. The examination discovered that the chemical properties of pectin extracted with both nitric and citric acid were for equivalent weight (1250 and1250 g/mol), methoxyl content (6.20 and 6.29%), acetyl contain (0.43 and 0.43%) and the level of esterification (66.53 and 66.57%) respectively. The outcome got from this examination showed that pectin extracted from pumpkin peel is with high quantity and quality and is promising for commercial production.

Keywords: Cucurbita, pectin, pumpkin peels

INTRODUCTION

Pumpkins belong to gourd family Cucurbitaceae which also contain water melons, cucumbers, gourds, marrow and squash (Elshafie, 1981). Cucurbitis consist of 110 genera and 640 species predominant in the tropics mostly as herbs of very rapid growth and climbing habit with abundant sap (Trease and Evans 1989). Pumpkin is rich in polysaccharides, carotene, mineral salts, vitamins, and other substances beneficial to health, resulting in various processed food products being developed (Ptichkina et al. 1998).

Ordinarily, fruits are productized into juice, beverage, squash and syrups. During productizing, peel presents almost 5-20% of the total fruit. Therefore, the vast sum of by-products (55-60% peel and 5-10% seed) has contributed to the pollution of the environment. Nevertheless, by-products can be utilized as functional food components such as photochemical, pharmaceuticals, food products, essential oils, seed oil, pectin and dietary fibers. Therefore by-products are considered to be rich sources of edible and heath promoting agents (Ali, 2014).

Pumpkin is also a low cost source of pectin (Murkovic et al. 2002). Pectin is a multifunctional abundant component from cell walls of all plants (Willats et al. 2006; Ngouémazong et al. 2012). Pectin is polysaccharides consist mostly of polymers rich in galacturonic acid, containing significant amounts of rhamnose, arabinose and galactose as well as 13 other different monosaccharides (Vincken et al. 2003). Waldron et al. (2003) reported that, the composition, structure, and physiological properties of pectin can be influenced by extrication conditions as well as source, location, and many other environmental factors. Therefore the network of pectin must be broken to be extracted.

Pectins are regularly extracted from citrus fruits and apple pomace and they are customarily utilized as a gelling agents for jams and marmalades. In combination with water and some other substances, it can act as a thickener, gelling agent, stabilizer, emulsifier, cation-binding agent, etc. (Bottger 1990). Once substance having so many properties of technological interest, this makes pectin a biopolymer especially valuable for medicine, food production as well as for applications in drug encapsulation (Ptichkina et al. 2008; Souza et al. 2009; Benjamin et al. 2012).

The objectives of this study were: (i) To determine chemical composition of pumpkin peels (moisture, protein, ash, fat, fiber, total sugar and calcium), (ii) To investigate the effect different extraction methods (soxhlet acid extraction method and acid extraction method) with different acids (nitric and citric acids) in yield of pectin, (iii) To examine the effect of time on pectin yield, (iv) To evaluate the properties of the extracted pectin.
MATERIALS AND METHODS

Materials

Pumpkin peels
Pumpkin was achieved directly from local central market for fruits and vegetables in North Khartoum, Sudan then was stripped manually using knife, baked at 70-49°C for 24h in oven and ground and kept for further analysis.

Chemicals:
In this study, all chemicals and reagent were of analytical grade. Nitric acid, hydrochloric acid, sulphuric acid, and boric acid are from SDFCL Sd Fine Chem Ltd. (Mumbai, India). Sodium hydroxide, citric acid, methyl red, phenol red, tablet of catalyst are from Lobach Emie Pvt. Ltd. (Mumbai, India). Petroleum ether is from Alpha Chemical (India), Magnesium sulphate is from Landcech Chemical (India), while Sodium chloride is from Scharlaau (Spain), and ethanol is from Drummer and Sons, Co. Ltd. (Sham Industrial City, Syria).

Instruments
Soxhlet, protein unit, ovens, pH meter, and centrifuge are from J.P Selecta (Spain), water bath from Daiham Scientific, Co., Ltd., (South Korea), thermometer (Omsons, India).

Methods

Analysis chemical composition of pumpkin peels

Moisture content. The AOAC method (1999) was used to consider the moisture content. Samples (5 g) were accurately weighed and dried to constant weight in vacuum oven at 70°C and 450mm Hg for three hours. The analysis was carried out in triplicate.

\[
\text{Moisture\%} = \frac{(W_1-W_2)}{S}
\]

Whereas:
- W₁ : weight before drying
- W₂ : weight after drying
- S : weight of sample.

Ash content. The method of AOAC (1999) was used to consider the ash content. Samples (5 g) were accurately weighed and put into relatively broad crucibles that have been ignited, then they were cooled in desiccators and weighed. The crucible and its content were ignited in a muffle furnace at 550 ºC until light grey ash of samples with constant weight was obtained. The analysis was carried out in triplicate samples.

\[
\text{Ash\%} = \frac{W_1-W_2}{W_1-W_0}
\]

Whereas:
- W₀ : weight of empty crucible
- W₁ : weight before ash processing
- W₂ : weight after ash processing

Protein content
The determination of Nitrogen content was done with the semi micro Kjeldahl distillation according to the method of AOAC (1999). Exact 0.2 g of the sample were assimilated in a small digestion flask using half tablet of catalyst (each tablet contains 1 g anhydrous sodium sulphate and 0.1 g copper sulphate). 3.5 mL of concentrated sulphuric acid were added in it and then the digest was diluted and transferred to the ammonia distillation apparatus using the minimum volume of distilled water and made alkaline with 20 mL of 40% sodium hydroxide. The ammonia was distilled into 2% boric acid solution (10 mL), plus methyl red indicator (3-4 drops) for 5-10 minutes. After lowering the receiving flask clear of the condenser, the apparatus was steam distilled for further 5 minutes. The distillate was then titrated with 0.02N hydrochloric acid.

\[
\text{N%} = \frac{(m_{1\text{HCL}}-m_{1\text{blank}}) \times \text{normality of HCL} \times 14 \times 100}{\text{sample (mg)}}
\]

Crude protein = % N×6.25 6.25= refer to formula of protin

Fats content. The estimation of fat content was done using the method of AOAC (1999). Triplicate samples (2 g) were weighed and put into a thimble plugged with a piece of cotton wool. The thimble was then put into a soxhlet extractor. A dry and accurately weighed soxhlet flask was fitted to the extractor. Boiling petroleum with temperature range of 60-80 ºC was poured to two third of the flask. The instrument was then set up and fitted to the condenser. Water was allowed to flow through the condenser and an electric heater was put on for reflux. The extraction was done for eight hours. Then the instrument was carefully disassembled and the liquid in the flask was evaporated to dryness in an oven at 100 ºC to a constant weight.

\[
\text{Fat\%} = \frac{\text{the weight of ether extract} \times 100}{\text{Weight of sample}}
\]

Fiber content. The method of AOAC (1999) was used to estimate the fiber content. The sample from the ether extract were air dried and transferred to a dry conical flask. Then 200 mL of 1.25% sulpharic acid boiled within one minute were added and the mixture then was boiled gently for 30 minutes, constant volume was maintained and the flask was shaken every few minutes. The residue was then filtered through apices of cotton fitted to Buchner funnel. The filtration of the solution was completed within 10 minutes. The insoluble matter was washed with hot water until it was free from acid, then washed back in to original flask by mean of a washing bottle containing 1.25% sodium hydroxide (200 mL) measured at room temperature and brought to boiling. It was allowed to boil for 30 minutes and then filtered immediately through an ash-less filter paper then washed with 1% HCL followed by boiling water until it was free from acid. The residue was transferred to a dried weight crucible and dried at100ºC to reach constant weight. The residue was finally ashed at
600°C in a muffle furnace. Weight of the ash was subtracted from the weight of the dish plus insoluble residue before ashing and the difference expressed as crude fiber percentage.

**Carbohydrate content.** It was estimated according to the method of AOAC (1999).

Carbohydrate% = 100-(moisture + ash + protein + fat and fiber%).

**Calcium content.** The method described by Elmer (1993) was used to determine the content of Calcium. One gram of the material was put in porcelain crucible, placed in a cool muffle furnace and ashed at 500 °C overnight. The crucible content were dissolved into 5 mL of 25% HCL. The solution was warmed to dissolve the residue, and filtered through an acid washed filter paper in to 50 mL volumetric flask. The filter paper was washed; the solution was diluted with distilled water to volume and mixed well. Using one milliliter of this solution, the amount of calcium was spectrophotometrically determined at wave length of 422.7 nm using Atomic Absorption spectrophotometer (AA-6800, Japan).

**Pectin extraction method**

The extraction method referred to the method by Malviya (2010). It can be carried out in two steps.

**Pectin extraction.** Pectin was extracted under reflux in condensation system using water which was acidified for 1 hr with acid to pH 2. Temperature of extraction media was maintained at 80°C, and extraction time was adjusted to about 6 h. Whatman cellulose thimble with 33 mm of internal diameter and 80 mm of external length was used as extractor thimble. Dried powdered pumpkin peel was taken in soxhlet and reflux was continued for 6 h.

**Pectin precipitation.** Hot acid extract was pressed in cheese cloth bag and the cake was cooled to 4 °C. Pectin was precipitated by alcohol treatment 2:1 (v/v), followed by continuous stirring for 15 min and allowed to stand for 2 h for better precipitation. This allowed to filter pectic substances because pectin remained floating on surface of alcohol. Floating pectin coagulate was filtered through cheese cloth, washed with alcohol 70% and pressed. Pressed pectin was further dried to constant weight at 35-45 °C in hot oven. Hard pectin cake was ground and sieved through 20 mesh size sieve, and at last was stored in desiccator for further use.

**Acid extraction method.** The method for acid extraction is according to Crandall et al. (1978) with some modifications. Four hundred mL of distilled water (DW) was poured into a 2000 mL Erlenmeyer flask and kept at the desired temperature, i.e. 80 °C, using the stirring hot plate or the shaking water bath and 100 g peel was added to the water. Measured amounts of acid using different acids (Nitric and Citric Acids) were added to the peel-water mixture until the desired pH 2. The mixture was stirred at a constant temperature until the desired extraction time had elapsed. The pH and temperature were recorded and the mixture was allowed to cool in an ice water until it reached 55 °C. The mixture was then centrifuged at 5050 rpm for 10 min. The filtrate was vacuum filtered using filter paper and the solids were resuspended in 400 mL of 60 °C DW water for 5 min. Acid extracted pectin was kept after overnight precipitation. The pectin was separated from the alcohol solution using a double layer of cheese cloth and the samples were washed three times with 70% diluted alcohol to remove any impurities. The resulting pectin was dried under vacuum at 50 °C in aluminum sample dishes until all moisture was removed. Pectin was cooled, weighed and ground using a mortar and pestle. Ground pectin was stored in small plastic sample bags. Both of the two extraction procedures were done twice using nitric and citric acids. The amount of pectin was calculated according to the following equation:

\[
\text{Pectin yield} = \frac{\text{Weight of extracted pectin} \times 100}{\text{Weight of dried peel}}
\]

**Effect of time in pectin extraction**

The effect of time on pectin yield was examined to determine whether the increase of extraction time will increase pectin yield. The extraction time was set at 30, 60 and 90 min; the extraction time followed the method by Crandall et al. (1978), with little modification. Effect of time on acid extracted pectin yield was done at extraction conditions of 80°C, pH 2 using 1 N nitric acid, and solid to liquid ratio of 1:4 g/mL using water bath.

**Chemical analysis of extracted pectin**

**Moisture content.** The method of AOAC (1995) was used to determine the moisture content of pectin. Triplicate samples (1 g) were weighed in dried and weight aluminum dishes. Samples were then dried for 4 hours at 105 °C (20 mmHg). They were then cooled in desiccators and their constant weights was determined. The moisture content was calculated as follows:

\[
\text{Moisture}\% = \frac{W_1 - W_2}{S} 
\]

Whereas:
- \( W_1 \) : weight before drying.
- \( W_2 \) : weight after drying.
- \( S \) : weight of sample.

**Ash content.** The AOAC (1995) method was used to determine the ash content of pectin. Triplicate samples (1 g) were previously weighed then heated, cooled and its crucible weight was weighed. Sample then was heated at 600 °C for 3 hours, cooled and constant weight was determined. The ash content was calculated as follows:

\[
\text{Ash}\% = \frac{W_1 - W_2}{W_1 - W_0}
\]

Whereas:
- \( W_0 \) : weight of empty crucible.
- \( W_1 \) : weight before ashing
- \( W_2 \) : weight after ash

**Ash alkalinity.** The method by Owens et al. (1952) was used to determine ash alkalinity of pectin. The ash was
dissolved in 25 mL of 0.1 N HCL, heated gently and then titrated with 0.1 N sodium hydroxide using phenolphthalein indicator. The alkaline number of an ash was calculated as the number of milliters of acid required to neutralize 1 g of ash.

**Equivalent Weight.** Ranganna’s method (1995) was used to determine Equivalent weight. Triplicate samples (0.5gm) were weighed into 250 mL conical flask and moistened with 5 mL ethanol. The product was mixed with 1 gm sodium chloride and 100 mL of distilled water. The mixture was stirred vigorously and free acidity was determined by direct titration against 0.1 N sodium hydroxide using phenol red as an indicator. Also blank containing the same quantities of reagents was tested. This titre is known as initial titre (IT) or free acid titre. The equivalent weight was calculated as follows:

\[
\text{Equivalent weight} = \frac{\text{weight of sample (mg)}}{\text{Meq of sodium hydroxide}}
\]

\[
\text{Meq (Miliqsquivalent of sodium hydroxide)} = \text{Normality} \times \text{Titre volume of Noah}
\]

**Methoxyl content.** The Ranganna’s method (1995) was used to determine MeO content. The neutral solution was collected from determination of equivalent weight, then 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 hydrochloric acid (0.25 N) was added and titrated against 0.1 N NaOH.

Methoxyl content was calculated by following formula:

\[
\text{Methoxyl content} \% = \frac{\text{Meq of NaOH} \times 3.1 \times 100}{\text{Weight of sample}}
\]

Whereas:

\[
\text{Meq of NaOH} = \text{normality of NaOH titre figure 3.1 refer to formula weight of methoxyl group.}
\]

**Degree of esterification (DE).** On the basis of methoxyl content (Owens et al. 1952), the DE of pectin was measured.

From IT and ST obtain the degree of esterification and Anhydrousac acid (AUA) content was calculated as follows:

\[
\text{Degree of esterification (DE)} = \frac{\text{ST} \times 100}{\text{ST}+ \text{Corrected IT}}
\]

The IT corrected for the ash alkalinity

**Acetyl content.** The method from Owens et al. (1952) was used to determine Acetyl content. Triplicate samples (0.5 gm) of each pectic substance was weighed in to flask and 250 mL of 0.1N NaOH were added. The flask was covered, shaken and left for one night. The solution was then diluted to 50 mL from which 20 mL were taken and placed in distillation apparatus.Twenty milliliter magnesium sulphate sulphuric acid solution (100 g magnesium sulphate and 1.5 gm sulphuric acid diluted to180 mL) were added. The solution was then steam distilled and 10 mL of distillate were collected. The acetic acid of the distillate was then titrated with sodium hydroxide (0.05 N) to phenol red point. The titre was corrected for the reagents blank. The acetyl content (formula weight 43) of sample was calculated according to the following equation:

\[
\text{Acetyl content} (\% w/w) = \frac{\text{ml NaOH} \times (\text{normality of NaOH}) \times 43}{\text{Weight of sample (gm) in the liquor}}
\]

Whereas:

\[
\text{MI NaOH} : \text{volume of required to titre distillate-volume of NaOH required to titre distillate blank run.}
\]

**Statistical analysis**

Microsoft Excel software on statistical page of social science was used to analyze the data of this study. Data was expressed as mean ± standard deviation (STD). The statistical significance was considered at \( P < 0.05 \). All experiments were organized using a completely randomized design with three replicates, repeated for reproducibility. The data obtained from the measurements were subjected to T-test which was used to compare difference between properties of pectin extracted by different acid. All measurements were carried out in triplicate for each sample. The experimental data were reported as the means ± SD of independent trials (Wagner, 1985).

**RESULTS AND DISCUSSION**

**Chemical compositions of pumpkin peel**

Chemical compositions which were expressed on dry basis were presented in Table 1. The moisture content was 20.1%. The Ash content of pumpkin peel was 7.1 %. The protein content of pumpkin peel was 3.2%. The fiber content was 10.15 %. The fat content was 2.3. The carbohydrates of pumpkin peel was 57.15 % and calcium was 0.308 %. This result was different from Ibrahim’s study (2008) who found that the chemical compositions of pumpkin peel on weight basis was as follows: the moisture content was 84.7-90.26%; the Ash content of pumpkin peel was 0.81-1.35%; the protein content of pumpkin peel was 1.3-1.64%; the fiber content was 3.21-4.82%; the content of fat, carbohydrates and calcium were 0.04, 5.17 and 0.062 % respectively.

**Table 1. Chemical compositions of pumpkin peels on dry basis**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>20.1</td>
</tr>
<tr>
<td>Ash</td>
<td>7.1</td>
</tr>
<tr>
<td>Protein</td>
<td>3.2</td>
</tr>
<tr>
<td>Crud fiber</td>
<td>10.15</td>
</tr>
<tr>
<td>Fats</td>
<td>2.3</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>57.15</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.308</td>
</tr>
</tbody>
</table>

Note: Values are means of 3 replicates for each parameter.
Effect of different method on pectin yield

Optimal extraction conditions of this study used nitric and citric acid to adjust pH of pumpkin peel to 2 which was then extracted for 60 min at 80°C. In Soxhlet extraction, it was done for six hours with alcohol precipitation two hours but in acid extraction without soxhlet, alcohol perception was ten hours. The results were 7.72% nitric acid and 6.80% citric acid using soxhlet acid extraction method and 6.24% nitric acid and 5.36% citric acid using no soxhlet acid extraction method. As shown in Figure 1, the result indicated that the use of soxhlet acid extraction method gave higher yield than that the use of acid extraction method without soxhlet to extract pectin from pumpkin peel. The result in this study was different from the result of the study by Yeoh et al. (2008) who showed that, for microwave extraction, the greatest total amount of pectin yield was found to be 5.27% on a dry basis for 15 minutes of extraction, although the greatest amount of material per unit time (%/min) was obtained after 5 minutes. This amount was the same with that result extracted by Soxhlet extraction method for three hours from orange peel.

Effect of different acids on pectin yield

The extracted pectin from pumpkin peels in this study was 6.24% by using nitric acid and 5.36% by using citric acid. The study showed that the use of nitric acid yielded higher result than the use of citric acid respectively as shown in Figure 1. Significant difference p<0.05 was found between two acids. The result was higher compared with the range of 0.253-0.233% for pectin extraction from alcohol insoluble pumpkin peel solids with the use of hydrochloric acid to adjust pH to 2 and which was extracted for 60 min at 80°C (Ibrahim, 2008). It was different from Sayah et al. (2014), who extracted pectin from a steam distillated and non conditioned orange peels using different acids.

Citric acid gave the best average yield (25.71% ± 0.007) while sulfuric, hydrochloric and acetic acids gave a very low average yield of pectin, namely 6.49% ±0.005, 7.96% ± 0.005, and 10.19% ± 0.006, respectively.

Effect of extraction time in pectin yield

The effect of extraction time on pectin yield was observed to determine the effect of the extraction time on the increase of pectin yield. The results were shown in Figure 2. There was an increase in pectin yield on 30 min and 60 min of extraction time. Since there was no noticeable trend of pectin yield increase with extraction time from 60 min to 90 min, so, the suitable extraction time was 60 min. The result of this study disagreed with (Campbell 2006). There was increasing in pectin yield between 0-45 min. No noticeable on time trend occurred with increasing extraction time from 45 min to 90 following min.

Chemical composition in pectin pumpkin peels

Moisture content

Moisture content of pectin pumpkin peels extracted by nitric and citric acids was 5.54±0.01% and 5.42±0.0% respectively as shown in Figure 3. Significant difference p0.05 was found between two samples. The result is lower than the value of grapefruit peels pectin with the range of 7.88-8.96% as claimed by Mohamed (1999). The values were also higher than mango pulp pectin with the range of 5.03-5.04% as reported by Abderahman (2002).

Ash content

Ash content of pumpkin peels pectin extracted with nitric and citric acids was 3.17±0.006 and 2.96 ±0.006% respectively as shown in Figure 4. There was a significant difference p0.05 between the two samples. The result is higher than lemon with the range of 1.56-1.65%, than orange with the range of 0.81-4.83% in orange and than apple with the range of 0.49-8.05% as stated by Abderahman (2002). Mohamed (1999) reported a range of 1.8% to 2.0% for grapefruits pectin.
The equivalent weight
The equivalent weights of extracted pectin from pumpkin peels, using nitric and citric acid, were 1250 ± 0.0 and 1250 ± 0.0 g/mol respectively as shown in Figure 5. The results showed that there were no significant difference p0.05 between two samples but they were higher than cocoa husk pectin (510.68-645.19 g/mol) that was reported by Ramli and Asmawati (2011) and the ones reported by Mohamed (1999) for grapefruit peels pectin for citrus pectin (620-749 g/mol). The equivalent weights obtained in this study was lower than, with range of 1389-2003 g/mol (Abderahman 2002) and than apple pomace pectin (833.33-1666.30 g/mol) (Kumar and Chauhan 2010) and ambarella peels (263,000-303,000 g/mol) (Koubla 2008).

Methoxyl content
The methoxyl contents of pumpkin peels pectin extracted by nitric and citric acids were 6.20±0.10% and 7.23±0.89% respectively as shown in Figure 5. No significant difference p 0.05 was observed between two samples. In this study, the methoxyl was lower than the one found by Ali, (2014) for lemon pomace (10.25±022%) and the one reported by Madhav and Pushpalatha, (2002) for pomelo peel (8.57%), Lime (9.92%), passion (8.81-9.61%); it was similar to peel of mango (7.33%), banana (7.03%) (Madhav and Pushpalatha, 2002) but it was higher than dragon fruit pectin (2.98% to 4.34%) (Ismail et al. 2012). Methoxyl content was an important factor in controlling the setting time of pectin and the ability of the pectin to form gels (Constenla and Lozano 2003).

Acetyl content
The acetyl contents of pumpkin peels pectin extracted with nitric and citric acids were 0.43±0.01 and 0.43±0.03% respectively (Figure 6). There was no difference p0.05 between two samples. The result was in accordance with the finding of Mohamed (1999) which showed that 0.46-1.63% for grapefruit peels pectin and it was also higher than the result reported by Abderahman (2002) for acetyl content in mango pulp pectin (0.117% to 0.314%). The acetyl group in pectin materials has important role on their effect on the jelly formatting ability (Abderahman 2002). Also the finding was lower than the one reported by Koubla et al. (2008) on amarelle peels i.e. 4-6%.

Degree of esterification
The results in Figure 7 showed the degree of esterification of pumpkin peels pectin extracted by nitric and citric acids were 66.53±0.058 and 66.57±0.058% respectively.
There was no difference p≤0.05 between two samples. The result was in agreement with the result reported by Eltinay et al. (1982) for mango peel pectin (66.9%) but higher than that obtained by Mohamed (1999) for grapefruit peels pectin, which was 51.01-51.24% and by Koubla et al. (2008) for ambarella pears which was 50-58%.

The values of degree in esterification of this study were lower than those reported by Eltinay et al. (1982) Abderahman (2002) and Ali (2014) for pumpkin pectin (73.9-86.8%), for mango pulp pectin(87.0%) and for lemon pomace pectin (79.51±0.36 and 70.39±4.20%) respectively.

Pumpkin peel has high level and good properties of pectin, and using soxhlet and nitric acid at 60 min for extraction process give the highest yield of pectin.

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