International Journal of Farming and Allied Sciences
Available online at www.ijfas.com
©2020 IJFAS Journal-2020-9-1/1-4/ 01 Jul, 2020
ISSN 2322-4134 ©2020 IJFAS

The influence of particle size and acid type on pectin extraction

Zarifeh Raji, Faramarz Khodaiyan*, Karamatollah Rezaei, Hossein Kiani, Madelein Schultz, Sahar Zanganeh

Bioprocessing and Biodetection Laboratory, Department of Food Science, Technology and Engineering, University of Tehran, Postal Code 31587-77871, Karaj, Iran

Corresponding author: Faramarz Khodaiyan

ABSTRACT: The main objective of this study was determining the effect of acid type and powder particle size of melon peel as by product on the pectin extraction yield used for medicine and addressing environmental issues. Pectin extraction was performed by conventional method at 90 ˚C for 90 min (solid/solvent ratio of 1:30), using acidified water at pH**=**1.5 at the present of different acids including tartaric, citric, hydrochloric, acetic, lactic, nitric, phosphoric and sulfuric acids. Pectin yield results showed that citric acid gave highest yield which was 25.3% w/w for pectin extraction. In addition, pectin yield reached the peak (16.8 %) for smallest powder particles because of a higher surface to volume ratio providing a better situation for hydrolysis. The emulsifying activity of pectin extracted under mentioned condition was 35%. The emulsions were 89.6% stable at 4 ◦C and 79.5 % at 23 ◦C after 30 days of storage.

Keywords**:** *citric acid; conventional method; emulsion activity; mesh size*

INTRODUCTION

Melon peel can be a potential source of some carbohydrates specially pectin. It belongs to the family *Cucumis melo*, Iran is one of the main producers of melons after China and Turkey (FAOSTAT, 2005) (Barzegar, et al., 2013). Some portion of the fruit peel waste is consumed as animal feed, but the majorities of the processing wastes are disposed and consequently can cause environmental pollution. However, there have been some interests to use this by-product for the development of valuable ingredients. Accordingly, melon processing industries have been searching for alternative applications and processing options for this by-product which have been revealed to be a source of many important natural compounds including pectin, flavonoids, carotenoids, limonene and polymethoxy flavones (Li, et al., 2006). Pectin is a family of complex variable polysaccharides extracted from the primary cell wall of plants. Chemically, pectin consists of linear polymers of D-α-(1→4) anhydro-galacturonic acid (Vidal, et al.,2001)(Pilnik and Voragen, 1970). Pectin has different applications in food science and nutrition, cosmetics and pharmacy. It is widely used as thickening, gelling and emulsifying agents in jams, soft drink, fish, meat and milk products (May, et al., 1990). The objective of this work was to extract pectin from melon peel and to characterize it in order to observe the influence of some parameters on the yield of pectin for reaching the optimum condition.

2. Materials and methods

2.1. Samples preparation

Samples from melon peel were used as row material in this work. The fruit was dried at the oven 80 ˚C for 8h to a constant weight. This dry peel was then crushed and mixed.

2.2. Pectin extraction

Pectin was extracted under reflux in a condensation system at 90 ˚C for 90 min (solid/solvent ratio of 1:30), using acidified water at pH**=**1.5 using melon peel as row material. Next the samples were classified with four sieves (20-40-60-80) in a shaker for investigating the influence of particle size on pectin yield.
In the next step for choosing acid type Pectin extraction was performed in the same condition to investigate the effect of each kind at pH**=**1.5. The selected acids utilized for extraction were phosphoric, hydrochloric, nitric, sulfuric, citric, tartaric, acetic, lactic acids.

2.3. Determination of emulsifying activity (EA) and emulsion stability (ES)

EA and ES were determined using methods described by Dalev and Simeonova (Dalev, et al., 1995) with minor modifications. Determination of emulsifying activity is based on the ratio of the emulsified layer volume and the whole volume of the solution. Emulsions were prepared by adding 4 ml of vegetable oil to 4ml of pectin solution (0.5% w/w), containing 0.02% sodium azide as a bacteriocide. The mixture was homogenized at 12000 rpm for 3 min at room temperature in an Ultra-Turrax T-25 homogeniser (IkA T25 Digital Ultra-Turrax, Staufen, Germany).
Samples were centrifuged at 527 g for 5 min at 23 ˚C. After centrifugation, the whole volume of the solution (Wv) and the emulsified layer volume (ELV) were determined. Emulsifying activity (EA) was calculated as:

$$EA(\%) = \frac{ELV}{Wv} * 100 \qquad (1)$$

Similar emulsion samples were prepared to study the emulsion stability (ES) after 1 and 30 days of storage at 4 and 23 ˚C. The samples were centrifuged at 527g for 5 min at 4˚C and 23 ˚C. The initial emulsified layer volumes (VEi) were measured. After each storage period, the samples were centrifuged and the remaining emulsified layer volumes were measured (VEr). Emulsion stability was calculated using the following relation:

$$ES(\%) = \frac{VEr}{VEi} * 100 \qquad (2)$$

All experiments were performed in triplicate

3. Result and discussion

3.1 Effect of the acid type on the yield of extraction

Acid type is one of the outstanding important factors in pectin extraction process that affects not only the extracted pectin yield, but also the chemical and functional characteristics of pectin (Methacanon, et al., 2014). In this study, impact of some acid types on the yield of pectin extraction from melon peel were investigated that shown in **Error! Reference source not found.**, When the other factors such as pH, extraction temperature, extraction time and the So/Sa ratio were respectively fixed at 1.5, 90 °C, 90 min and ۳0. According to Table 1, organic acids were found to be more effective for pectin extraction and citric acid was identified as the most effective acid for pectin extraction from melon peel that produced 25.3% w/w pectin followed by tartaric aid accounted for 23.3%w/w (Pinheiro, et al., 2008). Citric acid is a natural and safe food ingredient and therefore, it is more attractive than generally used mineral acids. Thus, it could be considered as the preffered acid for the extraction in comparision with other acids in terms of economic and environmental aspects (Kurita, et al., 2008) (Yapo, 2009). In the present study, effect of different extraction agents on pectin yield were confirmed, moreover, it was found that the yields of pectin took an upward trend with increasing carboxyl groups in organic acid while this results is not in agreement with reports of other authors (Ma, S., et al.,2013)

Table 1. The effect of acid type on the yield of pectin extraction.

Acid type	Yield (% w/w)
Tartaric acid	23.3± 0.61
Citric acid	25.3± 0.28
Hydrochloric acid	19.5± 0.35
Acetic acid	17± 0.86
Lactic acid	14.7± 1.32
Nitric acid	14.4± 0.23
phosphoric	13.4±0.74
Sulfuric acid	1.4±1.21

3.2 effect of the size of the particles on yield of pectin extraction

According to the results in Table 2, the pectin yield was significantly higher with use of flour as row material for the 80 mesh size (16.8 %), when the extraction was made from the powder with lower mesh size the yield was lower. There are several explanations for this fact, but protopectin is more available in small particles than in large ones and fresh solvent can improved destruction of cell that can lead to better extraction.

Table 2. The effect of particles size

Mesh no.	Aperture (mm)	Yield of extraction
20	0.850	12.8%
40	0.425	14.2%
60	0.250	15.6%
80	0.180	16.8 %

3.3. Emulsifying properties

To measure the Emulsion activity and Emulsion stability, the pectin sample obtained under the mentioned extraction condition. Three different phases were seen after the emulsions were prepared: the oil phase was at top, the pectin solution phase was on the bottom, and the emulsified phase was in the middle. It was observed that the EA rate that is based on the definition is the emulsified layer volume over total volume was 35%. This value was nearly similar to the data of the pectin extracted from other by products (30-45%) under acid conditions (Yapo, et al., 2007). ES rates was represented in Table 4 when temperatures were fixed at 4 ◦C and 23 ◦C. The rate of ES, after one day was reported 90.1 and 80.2%, respectively and after 30 days they were 89.6% and 79.5%, in order. Over 30 days, the ES at 4 ◦C and 23 ◦C was reduced by 0.5% and 0.7%, respectively (S.S. Hosseini,et al., 2016). Based on the results, it can be said that the ES was suitable at both tested temperatures, but was a little higher at 4 ◦C than at 23 ◦C. This result indicates that emulsions are more stable at low temperatures (S. Ma, et al., 2013) which is studied the emulsifying properties of pectin extracted from sugar beet pulp, reported similar results. These researchers stated that the ES at a temperature of 4 ◦C is relatively more than at 23◦C (Z. Raji, et al., 2017).

Table 3. Emulsifying activity and emulsion stability (%v/v) of pectin solutions (0.5% w/w)

	Emulsion activity (%)	Emulsion stability (%)			
Storage time		Day 1		Days 30	
temperature	23 ˚C	4 ˚C	23 ˚C	4 ˚C	23 ˚C
The pectin extracted*	35 %	90.1%	80.2%	89.6%	79.5%

*The pectin extracted from melon peel in optimum condition

Conclusion

In the present study citric acid showed the highest yield among the organic acid and mineral acid tested and the optimum extraction conditions were used for recovery of the pectin from melon peel, when the effect of particle size was studied it was found that the maximum yield of extraction was approximately 16.8 % which was obtained when the particles were smaller. These results indicated that it was necessary to produce melon peel flour with smaller mesh size as an intermediary step in the acid extraction. The emulsifying activities of pectin extracted at the optimal condition were 35% and the emulsion stability were 90.1% and 89.6 % at 4 ◦C and 80.2% and 79.5% at 23 ◦C after 1 and 30 days, respectively.

REFERENCES

Barzegar, T., et al., C-labelling of leaf photoassimilates to study the source–sink relationship in two Iranian melon cultivars. Scientia Horticulturae, 2013. 151: p. 157-164.

Li, Z., et al., Transgenic approach to improve quality traits of melon fruit. Scientia horticulturae, 2006. 108(3): p. 268-277.

Vidal, S., et al., Polysaccharides from grape berry cell walls. Part I: tissue distribution and structural characterization of the pectic polysaccharides. Carbohydrate Polymers, 2001. 45(4): p. 315-323.

Pilnik, W. and A. Voragen, Pectic substances and other uronides. Biochemistry of fruits and their products, v. 1, 1970, 1970.

May, C.D., Industrial pectins: sources, production and applications. Carbohydrate Polymers, 1990. 12(1): p. 79-99.

Methacanon, P., J. Krongsin, and C. Gamonpilas, Pomelo pectin: Effects of extraction parameters and its properties. Food Hydrocolloids, 2014. 35: p. 383-391.

Kurita, O., T. Fujiwara, and E. Yamazaki, Characterization of the pectin extracted from citrus peel in the presence of citric acid. Carbohydrate polymers, 2008. 74(3): p. 725-730.

Pinheiro, E., et al., Optimization of extraction of high-ester pectin from passion fruit peel with citric acid by using response surface methodology. Bioresource technology, 2008. 99(13): p. 5561-5566.

Yapo, B.M., Lemon juice improves the extractability and quality characteristics of pectin from yellow passion fruit by-product as compared with commercial citric acid extractant. Bioresource technology, 2009. 100(12): p. 3147-3151.

Ma, S., et al., Extraction, characterization and spontaneous emulsifying properties of pectin from sugar beet pulp. Carbohydrate polymers, 2013. 98(1): p. 750-753.

B.M. Yapo, C. Robert, I. Etienne, B. Wathelet, M. Paquot, Effect of extraction conditions on the yield, purity and surface properties of sugar beet pulp pectin extracts, Food Chem. 100 (2007) 1356–1364.

S. Ma, S. Yu, X. Zheng, X. Wang, Q.-D. Bao, X. Guo, Extraction, characterization and spontaneous emulsifying properties of pectin from sugar beet pulp, Carbohydr. Polym. 98 (2013) 750–753.

P.G. Dalev, L.S. Simeonova, Emulsifying properties of protein–pectin complexes and their use in oil-containing foodstuffs, J. Sci. Food Agric. 68 (1995) 203–206.

Z. Raji, et al., Extraction optimization and physicochemical properties of pectin from melon peel,international journal of biological macromolecules , (2017) 709-716

S.S. Hosseini, F. Khodaiyan, M.S. Yarmand, Aqueous extraction of pectin from sour orange peel and its preliminary physicochemical properties, Int. J. Biol. Macromol. 82 (2016) 920–926.