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# STUDIES ON PECTIN:
# 2- PHYSIO-CHEMICAL AND TECHNOLOGICAL STUDIES ON PECTIN EXTRACTED FROM VARIOUS BLENDS OF CITRUS PEEL AND APPLE POMACE AND ITS APPLICATION

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## ABSTRACT

This study was carried out as an attempt to extract pectins from different blends of dried citrus peel namely (lemon, orange, grapefruit and shaddock) and dried apple pomace and study the optimal conditions for pectin extraction from blends which gave the highest yield and best quality properties. Also, the extracted pectins under the optimal conditions were used in making of fig jam. The obtained results can be summarized as follows:

1- Pectin yield extracted from the different blends at the optimum conditions for the predominant component in the blend was increased than pectins extracted under the same conditions, and ranged from 12.03-14.91% to 12.67–20.16%, respectively.
2- Methoxyl contents increased for all blends pectin (9.77-10.36% than before 8.66-9.15%.
3- Galacturonic acid content ranged from 79.79 to 81.55%, and no significant differences were recorded between all blends.
4- Viscosity and shear stress values were the highest values (especially after using the optimum conditions of extraction) for all blends except blend 4 which the lemon peel was predominant had the lowest values (69.77 c.P.s. and 41.86 $P_a$, respectively.
5- Molecular weights of pectins obtained from all blends were raised except blend 4. Molecular weight was decreased to 80.54 x $10^3$ Dalton.
6- Using HPLC, total neutral sugars content were higher than those of the same blends extracted under the same conditions. Rhamnose, galactose and arabinose were the predominant monosaccharides detected in all blends and manose was very high in blend 5. Also, xylose was found in the highest concentration in blends 3 and 4.
7- Sensory evaluation, the highest overall score for pectin from blend 1 was obtained at concentration of 0.05%, while the highest overall scores for pectin from blends 2, 3, 4 and 5 were obtained at level 0.20% of pectin in making on fig jam.

In conclusions, blends of citrus peel and apple pomace can be used to produce pectin with high quality properties. This had good benefits on increasing the national income and improving the environmental ecology of our industry.

**Keywords:** Pectin, Citrus, Apple, Peel, Pomace, Lemon, Orange, Grapefruit, Shaddock, Jam.

## INTRODUCTION

A large amounts of solid waste mainly citrus peel and apple pomace are left following the industrial extraction of citrus and apple juices. The peel which constitutes about 45-50% of the original weight of the citrus fruits and approximately 50% of apple pomace are considered an ecological problem for Egyptian food and canning industries where they are considered a main source of microbial contamination and pollution (Turki *et al.*, 1988 and Ma *et al.*, 1993). Fresh citrus peel and apple pomace are considered the more important source for pectin production. The albedo of citrus fruits particularly grapefruit and lemon is an especially rich source of pectin which can represents up to 50% of the dry cell wall material, while orange peel had more than 30% by weight of pectin (El-Nawawi and Shehata, 1987 and Ros *et al.*, 1996). Egypt produces annually about 2,291,483 tons of citrus fruits which are used as fresh fruits or in the field of food industries and the annual production of Egyptian apple fruits is about 455,000 tons (FAO, 1996). Pectins form gels under certain conditions and this property had made them very important food additives. In food industries, pectins are widely used as gelling, stabilizing, thickening or film forming agents. About 80-90% of the yearly production of commercial pectins from apple and citrus fruits are used to make jelly and similar products requiring high methoxyl pectin (May, 1990 and Ayyad, 1997).

Considerable evidence suggests that, pectins have several applications in pharmaceutical products and dietary supplementation with pectin may reduce levels of serum total cholesterol, decrease low density lipoprotein cholesterol and moderate the glucose response (Baker, 1994).

Therefore, this study was performed to investigate the possibility of utilizing the excess quantities of citrus peel and apple pomace in extraction of pectins from different blends and studying the optimal conditions for pectin extraction from each blend. Produced pectin was evaluated through studying the physical and chemical properties of pectin extracted from each blend. The suitability of pectins in manufacture of fig jam was also investigated.

## MATERIALS AND METHODS

### Materials:

The main raw materials used for producing pectin were the peel of citrus fruits namely lemon (*Citrus limon*), orange (*Citrus sinensis* var. Baladi), grapefruit (*Citrus paradisi*) and shaddock (*Citrus grandis* var. Reinking). Citrus and fig fruits (Sultani var.) were obtained from local market at Mansoura City, Egypt. Apple pomace which obtained from "BEST" Egyptian Canning Co. Minyet Samnnud, Aga, Dakahlia Governorate, Egypt.

### Methods:

**Preparation of citrus peel and apple pomace for extraction of pectin:**

Dried citrus peel and apple pomace were used to make various blends of peel for pectin extraction according to the percentage described in Table (1).

**Table (1): Various blends of citrus peel and apple pomace used in pectin extraction.**

| Sample | Components | | | | |
|---|---|---|---|---|---|
| | Apple pomace (%) | Grapefruit peel (%) | Shaddock peel (%) | Lemon peel (%) | Orange peel (%) |
| Blend (1) | 40 | 15 | 15 | 15 | 15 |
| Blend (2) | 15 | 40 | 15 | 15 | 15 |
| Blend (3) | 15 | 15 | 40 | 15 | 15 |
| Blend (4) | 15 | 15 | 15 | 40 | 15 |
| Blend (5) | 15 | 15 | 15 | 15 | 40 |

**Pectin extraction from various peel blends:**

Pectin was extracted from citrus peel and apple pomace blends, as follows: each dried blend was suspended in distilled water (1:30 w/v) and the pH of the media was adjusted at 1.6 with concentrated nitric acid. The mixture was heated in water bath at 80-90°C for 60 min. After that, there were five different conditions for pectin extraction from the five blends mentioned in Table (1). The applied extraction conditions were the ideal conditions for extracting pectin from the fruit peel, which represent the principle component of the blend.

These extraction conditions were done as follow:

- Treatment for the blend 1, containing 40% apple pomace was extracted at pH 2.0 with HCl, at 80°C for 120 min.
- Treatment for the blend 2, containing 40% grapefruit peel, was extracted at pH 1.6 with HCl, at 80°C for 60 min.
- Treatment for the blend 3, containing 40% shaddock, was extracted at pH 1.6 using nitric acid, at 80°C for 60 min.
- Treatment for the blend 4, containing 40% lemon peel, was extracted at pH 1.6 using nitric acid, at 90-95°C for 30 min.
- Treatment for the blend 5, containing 40% orange peel, was extracted at pH 1.6 using nitric acid, at 84°C for 60 min.

Then the extraction method was completed as mentioned by El-Bastawesy (1999).

**Isolation, precipitation and purification of the extracted pectin:**

The pectins present in the resulted liquor from the various sources of citrus peel and apple pomace were precipitated and purified according to the methods described by Allam (1988) and special modification reported by El-Bastawesy (1993).

**Analysis of pectin:**

**Physical properties of pectin:**

- Molecular weight of pectin was calculated according to Christensen (1954).

-Viscosity and shear stress were determined according to Phatak *et al.* (1988).

**Chemical properties of pectin:**

- Moisture content of pectin samples was determined according to Johnson (1945) by drying at 70°C for 10 hrs.
- Ash content, alkalinity of the ash and pH value were determined as described by A.O.A.C. (1990) by heating in muffle oven (MLW-Electro-Mod. LK 312-11) at 600°C for 3-4 hrs, and using pH meter (Mod. CG 710) West Germany.
- Methoxyl content, equivalent weight, and acetyl value were determined according to the method described by El-Bastawesy (1999).
- Degree of estrification (DE) and anhydrogalacturonic acid (AUA) and of pectin were determined titrimetrically after acid washing of the pectin according to Allam (1988).
- The neutral sugars composition was determined after acid hydrolysis using High Performance Liquid Chromatography (HPLC) at the Central Laboratory of Horticultural Research Institute, Agricultural Research Center, Giza, Egypt according to the method described by Weniger *et al.*

(1978) and Binder (1980) and the fractionated sugars were determined colorimetricaly using the phenolsulphuric acid method as described by Smith *et al.* (1956).

**Pectin application:**

Fig jam was manufactured and sensory evaluation was conducted by the methods described by El-Bastawesy (1999).

**Statistical analysis:**

The results were subjected to statistical analysis for correlation Coefficients according to Gomes and Gomes (1984).

## RESULTS AND DISCUSSION

### 1. Some physico-chemical properties of pectin extracted from various blends of citrus peel and apple pomace:

An attempt was carried out to produce pectin by using five blends from each by-product of lemon peel (LP), orange peel (OP), grape fruit peel (GP) and shaddock peel (ShP) in addition to apple pomace (AP) to improve the physio-chemical properties of extracted pectin with high viscosity and good gel power. The extraction method was carried out by using nitric acid (pH 1.6) at 80-90°C for 60 min. Pectin yields (PY) were 12.03, 13.67, 14.91, 14.42 and 13.0% for blends 1, 2, 3, 4 and 5, respectively (Table 2). The difference in PY may be due to the different blends percentage of every citrus peel and apple pomace. Moisture and ash content of different pectin blends were ranged from 6.79, 0.14 to 8.81%, 0.31%, respectively.

**Table (2): Physio-chemical properties of pectin extracted from various blends of citrus peel and apple pomace.**

| Properties | Blends* | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Yield of pectin (%) | 12.03 | 13.67 | 14.91 | 14.42 | 13.0 |
| Moisture content (%) | 7.66 | 7.72 | 7.74 | 8.81 | 6.79 |
| Ash (%) | 0.195 | 0.19 | 0.31 | 0.285 | 0.140 |
| Alkalinity of ash (%) | 50.00 | 45.00 | 30.00 | 66.00 | 30.00 |
| pH of 1% solution | 3.4 | 3.4 | 3.35 | 3.4 | 3.4 |
| Methoxyl content (%) | 9.15 | 8.93 | 8.71 | 8.66 | 8.71 |
| Equivalent weight | 588 | 5.38 | 532 | 510 | 485 |
| Acetyl value (%) | 0.14 | 0.14 | 0.25 | 0.11 | 0.14 |
| DE (%) | 59.93 | 58.70 | 57.35 | 53.76 | 56.85 |
| AUA (%) | 78.32 | 80.96 | 81.84 | 74.22 | 81.55 |
| Mol. Weight (dalton) | $94.55 \times 10^3$ | $91.57 \times 10^3$ | $91.32 \times 10^3$ | $92.71 \times 10^3$ | $73.25 \times 10^3$ |
| Viscosity (c.P.s.) | 101.98 | 101.98 | 104.66 | 80.51 | 52.62 |
| Shear stress (Pa) | 61.18 | 61.18 | 62.79 | 48.30 | 32.20 |
| Total sugars (%) | 0.88 | 2.59 | 1.41 | 1.01 | 1.87 |

*** Blends:**
**1. 40% AP + 15% GP + 15% ShP + 15% LP and 15% OP.**
**2. 15% AP + 40% GP + 15% ShP + 15% LP and 15% OP.**
**3. 15% AP + 15% GP + 40% ShP + 15% LP and 15% OP.**
**4. 15% AP + 15% GP + 15% ShP + 40% LP and 15% OP.**
**5. 15% AP + 15% GP + 15% ShP + 15% LP and 40% OP.**

Table (2) indicates that there are no difference between methoxyl contents for all blends except blend (1) which had a slightly higher methoxyl content (9.15%). Acetyl values were constant in blends 1, 2 and 5 (0.14%), while it was more higher in blend 3 (0.25%), generally, acetyl value was very lower than that of the standard citrus pectin (0.38%) as reported by Anon (1959). The maximum AUA% contents were in blend 3 (81.84%) and blend 5 (81.55%), which contained 40% (ShP) and 40% (OP), respectively, but blend 4 had the lowest value of AUA % (74.22%).

From the same table, degree of esterification (DE%) was ranged from 33.76 to 59.93% and viscosity and Sh.st, which are very effective on gelling power, were the higher values for blend 3, which contained 40% ShP (104.66 c.P.s. and 62.79 Pa). On the other hand, blend 5 had the lowest values of viscosity 52.62 c.P.s. and Sh. st 32.20 Pa, respectively. Molecular weights of pectin extracted from different blends showed insignificant difference, but for blend 5, which contained 40% OP, Mol. wt. was decreased to 73.25 x $10^3$ dalton compared with other four blends (Table 2).

Total neutral sugars contents for the five blends varied from 0.88 to 2.59%. Blend 2 was three folds more than blend 1, but other blends (3, 4 and 5) were approximately in similar values. This was found to be very low when compared to pectins from apple pomace, citrus wastes and values from approved of Codex (David, 1987; Allam, 1988; Phatak *et al.*, 1988; Hwang *et al.*, 1992 and Ayyad, 1997).

**2. Statistical data analysis:**

The number given in Table (3) indicated the correlation coefficient for various blends of different citrus peel and apple pomace, which pectin was extracted under the same conditions. Positively correlation at level 0.01 between viscosity and Sh.st and there are positively significant at level 0.05 between viscosity and Mol. wt, also between Sh. st and Mol. wt.

**3. Effect of extraction methods on physio-chemical properties of pectin extracted from various blends of citrus peel and apple pomace:**

Many treatments were performed to obtain pectin products with optimum physio-chemical properties, using various methods of extraction. The optimum methods for pectin extraction were selected which showed the best properties of pectin extracted from citrus peel and apple pomace before blending and the results illustrated in Table (4).

**Table (3): Correlation coefficients among pH, viscosity, shear stress, AUA and Mol. Wt of pectin extracted from various blends for citrus peel and apple pomace.**

| | pH $X_1$ | Viscosity $X_2$ | Shear stress $X_3$ | AUA $X_4$ | Mol. Wt. $X_5$ |
|---|---|---|---|---|---|
| $X_1$ | | -0.409 | -0.412 | -0.429 | -0.167 |
| $X_2$ | -0.409 | | 1.000** | 0.036 | 0.880* |
| $X_3$ | -0.412 | 1.000** | | 0.044 | 0.876* |
| $X_4$ | -0.429 | 0.036 | 0.044 | | -0.443 |
| $X_5$ | -0.167 | 0.880* | 0.876* | -0.443 | |

Tailed significant (* 0.05, ** 0.01).

For blend 1, which contained the high percentage of AP (40%), extracted with HCl at pH 2, 80°C for 120 min, it was clear that PY raised to 16.26% after modification of extraction method, but moisture and ash contents were reduced compared with the pectin extracted with the former method (Table 2).

Equivalent weight, Meth. %, acetyl value, AUA% and DE% were increased to 752, 10.36%, 0.27%, 79.79% and 69.12%, respectively (Table 4).

The modification of extraction method had a significant effect on most of physio-chemical properties of the pectin produced. It could be noted in these experiments that viscosity and Mol. wt. were high record values, they were 228.12 c.P.s. and 117.75 x $10^3$ dalton, respectively.

Pectin yield (PY) in blend 2 was reduced to 12.67%, comparing with PY in blend 3 (17.75%) than that of the same blend in Table (2). Also, data in Table (4) cleared that blends 2 and 3, which gave pectin with higher values for Equ. wt., Meth. %, acetyl value and DE% (730 & 699, 10.23 & 10.11%, 0.22% & 0.25% and 67.89% & 67.52%, respectively) than those of pectin extracted from the same blends before modifying the extraction method.

Galacturonic acid content (AUA%) in these pectin extracted from these methods had a slightly decreased values (80.38 and 80.38%, respectively) than those of pectin from the same blends in Table (2). On the other hand, blends 2 and 3 had the highest values of viscosity, Mol. wt. and Sh. st compared with those of other blends before and after using the modified methods of extraction.

Also, from the data illustrated in Table (4), it could be observed that blend 4 had lower values in moist. %, ash %, acetyl value and viscosity than before the modification of extraction method. The low molecular weight of pectin extracted from blend 4 caused a marked decrease in viscosity and shear stress values of this pectin. But, the modification of extraction method resulted in remarkable increase in PY 20.16%, Equ. wt. 578, Meth. 9.77%, AUA 81.55% and DE 61.15% compared with the same blend in Table (2).

**Table (4): Effect of various extraction methods on physio-chemical properties of five various blends of citrus peel and apple pomace.**

| Properties | Samples* | | | | |
|---|---|---|---|---|---|
| | Extraction conditions | | | | |
| | 1 | 2 | 3 | 4 | 5 |
| Yield of pectin (%) | 16.26 | 12.67 | 17.75 | 20.16 | 16.90 |
| Moisture content (%) | 5.94 | 4.85 | 7.20 | 6.92 | 4.40 |
| Ash (%) | 0.080 | 0.055 | 0.095 | 0.120 | 0.310 |
| Alkalinity of ash (%) | 60.0 | 60.0 | 0.00 | 10.0 | 18.0 |
| pH of 1% solution | 3.5 | 3.3 | 3.4 | 3.4 | 3.3 |
| Methoxyl content (%) | 10.36 | 10.23 | 10.11 | 9.77 | 10.20 |
| Equivalent weight | 752 | 730 | 699 | 578 | 699 |
| Acetyl value (%) | 0.27 | 0.22 | 0.25 | 0.08 | 0.30 |
| DE (%) | 69.12 | 67.89 | 67.52 | 61.15 | 67.16 |
| AUA (%) | 79.79 | 80.38 | 80.38 | 81.55 | 80.38 |
| Mol. Weight (dalton) | 117.75 x $10^3$ | 129.35 x $10^3$ | 124.87 x $10^3$ | 80.54 x $10^3$ | 114.09 x 103 |
| Viscosity (c.P.s.) | 228.12 | 330.08 | 289.83 | 69.77 | 209.32 |
| Shear stress (Pa) | 136.85 | 198.03 | 173.88 | 41.86 | 125.58 |

*** Samples (Extraction conditions):**
**1. pH 2.0 with HCl, 80°C for 120 min.**
**2. pH 1.6 with HCl, 80°C for 60 min.**
**3. pH 1.6 with HCl, 80°C for 60 min.**
**4. pH 1.6 with nitric, 90-95°C for 30 min.**
**5. pH 1.6 with nitric, 84°C for 60 min.**

From the same table, it is obvious that blend 5, containing 40% OP, extracted by nitric acid (pH 1.6 at 84°C for 60 min.) produced pectin with remarkable increase in PY, ash %, Equ. wt., Meth %, acetyl value and DE% Table (4), compared with those of pectin extracted from the same blend (5), before modification of extraction method (Table 2).

The higher the molecular weight, the higher viscosity and Sh. st. for blend 5, but the moist % and AUA % were a slightly decreased (Table 4). Finally, it can be concluded from the result illustrated in Tables (2 and 4) that there are many factors affecting on pectin production and its characteristics. These factors include the variety of citrus peel wastes and apple pomace, the percentage of each peel in the blend and method of extraction. It is noteworthy that those mentioned factors have a great influence on optimizing the conditions suitable for pectin production. It can be recognized that the modification of extraction methods can improve the physio-chemical properties of pectin extracted from citrus peel and apple pomace blends.

**4. Statistical data analysis:**

Table (5) showed the data obtained from various blends of citrus waste and apple pomace by different methods of extraction. As can be seen the major positively significant correlation coefficient was between viscosity, Sh. st and Mol. wt. at level 0.01.

**Table (5): Correlation coefficients among pH, viscosity, shear stress, AUA and Mol. wt. of pectin extracted from various blends for citrus peel and apple pomace by different methods.**

| | PH $X_1$ | Viscosity $X_2$ | Shear stress $X_3$ | AUA $X_4$ | Mol. Wt. $X_5$ |
|---|---|---|---|---|---|
| $X_1$ | | -0.258 | -0.258 | -0.220 | -0.192 |
| $X_2$ | -0.258 | | 1.000** | -0.718 | 0.981** |
| $X_3$ | -0.258 | 1.000** | | -0.718 | 0.981** |
| $X_4$ | -0.220 | -0.718 | -0.718 | | -0.827 |
| $X_5$ | -0.192 | 0.981** | 0.981** | -0.827 | |

Tailed significant (* 0.05, ** 0.01).

**5. Neutral sugars in pectin extracted from various blends of citrus peel and apple pomace:**

The neutral sugars (NS) composition of pectins extracted from five blends of citrus peel and apple pomace, determined using the HPLC procedure was presented in Table (6). No difference between total neutral sugars for all blends was observed except blend 4, which had a slightly lower neutral sugars content (4.24%). These values were very higher than those of the same blends in Table (2). The increasing in total NS% may be due to the modification of extraction method, but all values were lower than the results given by Garleb *et al.* (1991), Hwang *et al.* (1992) and Ros *et al.* (1996). Fig. (1) illustrated the chromatogram of standard sugars. The individual monosaccharides obtained by acid hydrolysis of five studied blends as shown in Figs. (2, 3, 4, 5 and 6) were rhamnose, xylose, arabinose, mannose, glucose and galactose. The major neutral monosaccharides detected in all blends present in highest concentration were rhamnose, galactose and arabinose (Table 6). Arabinans, galactans and arabinogalactans could serves as components of the pectic substances and as the source of arabinose and galactose. Rhamnose was component of rhamnogalacturonan, the backbone of the pectic polymer (Dey and Binson, 1984). The higher content of rhamnose in these blends, especially blends 1, 2 and 3 (2.487, 0.819 and 0.864%, respectively) explain strongly the increasing in viscosity values of pectins extracted from these blends (Table 2) compared with other studied pectins.

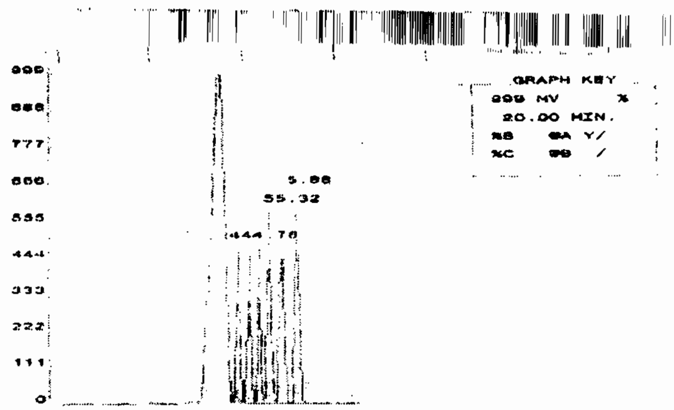


Fig. (1): HPLC chromatogram of standard sugars. (1. Rhamnose, 2. Xylose, 3. Arabinose, 4. Mannose, 5. Glucose and 6. Galactose).

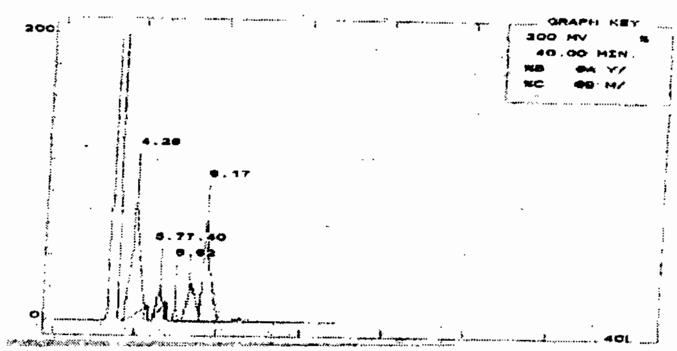


Fig. (2): HPLC chromatogram of neutral sugars composition of pectin extracted from various blends of citrus peel and apple pomace. Blend (1).

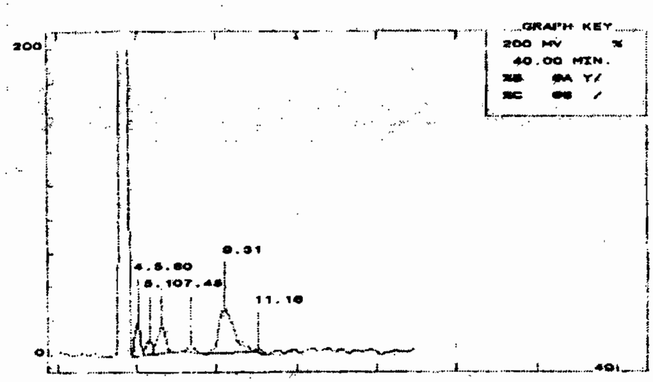


Fig. (3): HPLC chromatogram of neutral sugars composition of pectin extracted from various blends of citrus peel and apple pomace. Blend (2).

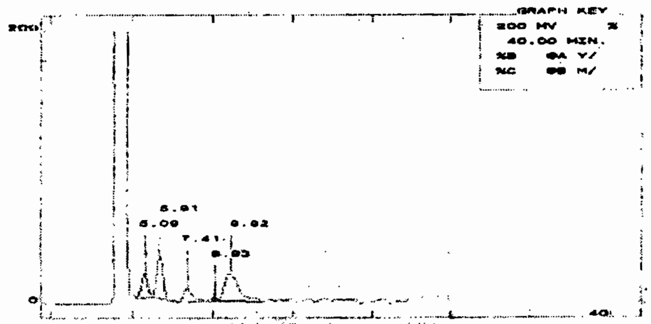


Fig. (4): HPLC chromatogram of neutral sugars composition of pectin extracted from various blends of citrus peel and apple pomace. Blend (3).

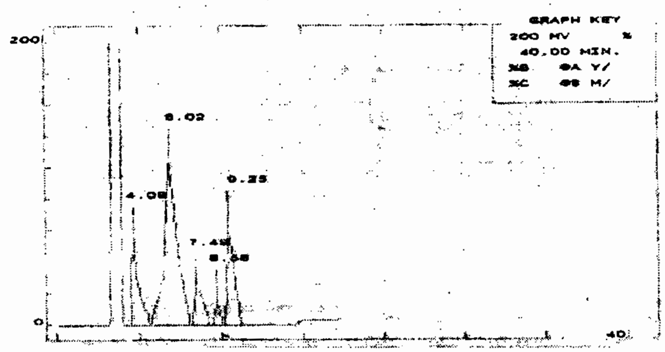


Fig. (5): HPLC chromatogram of neutral sugars composition of pectin extracted from various blends of citrus peel and apple pomace. Blend (4).

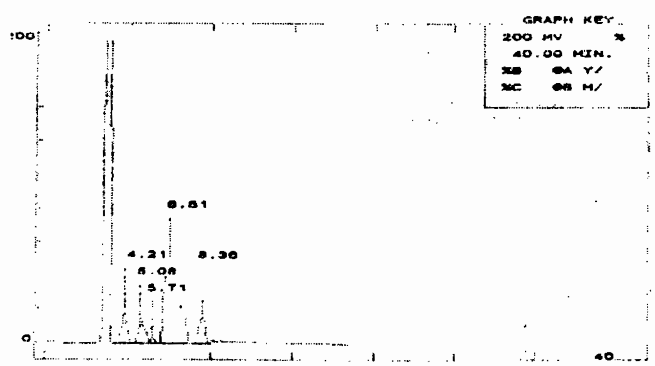


Fig. (6): HPLC chromatogram of neutral sugars composition of pectin extracted from various blends of citrus peel and apple pomace. Blend (5).

**Table (6): Neutral sugars composition of pectins extracted from five various blends of citrus peel and apple pomace.**

| Sugars % | Blends | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Rhamnose | 2.487 | 0.819 | 0.864 | 0.635 | 0.549 |
| Xylose | 0.247 | 0.526 | 1.561 | 2.423 | 0.462 |
| Arabinose | 0.076 | 0.983 | 0.719 | 0.365 | 0.053 |
| Mannose | 0.807 | 0.259 | 0.108 | 0.109 | 3.874 |
| Galactose | 1.873* | 3.032* | 2.288* | 0.707 | 0.542 |
| Total % | 5.490 | 5.620 | 5.540 | 4.240 | 5.480 |

* Glucose + Galactose.

Also, xylose was found in the highest concentration in blends (3 and 4) and mannose was very high in blend 5 (Figs. 4, 5 and 6).

Xylomannans have been shown to be associated with pectic material and could in part, explain the presence of xylose and mannose in the pectic substances (Selvendran and O'Neill, 1987). No glucose could be detected in blends (4 and 5) and this may be due to the interference of glucose with galactose in both blends (1, 2 and 3).

**6. Effect of various blends pectin levels on sensory properties of fig jam:**

The produced pectins from different blends were used in making fig jam in concentrations of 0.05, 0.1 and 0.2%. Sensory properties of fig jam was studied and the results are presented in Table (7).

**Table (6): Effect of various blends pectin levels on sensory properties of fig jam.**

| Sample / Sensory properties | Con-trol | Blend 1 | | | Blend 2 | | | Blend 3 | | | Blend 4 | | | Blend 5 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pectin level (%) | | | | | | | | | | | | | | | |
| | 0.0 | 0.05 % | 0.1 % | 0.2 % | 0.05 % | 0.1 % | 0.2 % | 0.05 % | 0.1 % | 0.2 % | 0.05 % | 0.1 % | 0.2 % | 0.05 % | 0.1 % | 0.2 % |
| Texture 20° | 6.52 | 16.5 | 17.13 | 18.13 | 15.2 | 15.7 | 17.1 | 16.3 | 16.8 | 17.1 | 17.4 | 17.9 | 18.0 | 16.8 | 17.2 | 17.1 |
| Color 20° | 16.55 | 17.75 | 17.0 | 17.38 | 16.52 | 16.6 | 16.69 | 16.5 | 16.5 | 17.3 | 17.0 | 16.0 | 17.4 | 16.6 | 17.2 | 16.7 |
| Flavor 20° | 14.5 | 16.5 | 15.26 | 17.0 | 15.8 | 16.8 | 15.8 | 15.0 | 14.8 | 15.8 | 14.8 | 14.0 | 15.6 | 15.8 | 15.6 | 15.0 |
| Taste 20° | 15.68 | 18.5 | 16.0 | 17.0 | 16.4 | 16.6 | 16.8 | 17.0 | 15.6 | 16.0 | 16.0 | 15.2 | 15.8 | 17.2 | 16.4 | 14.8 |
| Brightness 20° | 15.44 | 17.42 | 16.0 | 17.14 | 16.0 | 15.2 | 16.4 | 15.6 | 16.0 | 17.0 | 16.2 | 14.8 | 15.8 | 15.6 | 17.0 | 16.2 |
| Overall 100 ° | 67.79 | 86.67 | 81.39 | 86.65 | 79.92 | 80.9 | 82.79 | 80.4 | 79.9 | 83.2 | 81.4 | 77.9 | 82.6 | 82.0 | 83.4 | 79.8 |

**6.1. Pectin from blend (1):**

The results presented in Table (7) indicated that texture and flavor of fig jam had the highest scores (18.13 and 17.00, respectively) at pectin level 0.2%. Generally, overall score for pectin of blend 1 (86.67%) was obtained at concentration of 0.05%.

**6.2. Pectin from blend (2):**

Good taste and brightness (16.18 and 16.40, respectively) were at level of 0.2% pectin compared with that of control sample. Generally, overall score of sensory properties (82.79%) was showed by using pectin from blend (2) at concentration of 0.20% (Table 7).

**6.3. Pectin from blend (3):**

From Table (7), it was observed that level of 0.20% pectin gave high grades for texture, colour, flavor and brightness (17.10, 17.30, 15.8 and

17.00, respectively). The high overall score for blend (3) was 83.20%, which was obtained at level 0.20% of pectin (Table 7).

**6.4. Pectin from blend (4):**

Table (7) showed the superior texture, color and flavor similar in blend (3), with pectin level of 0.20%, which resulted in the highest values of sensory properties. The overall score of this type of pectin was 82.60% at level 0.20% of pectin.

**6.5. Pectin from blend (5):**

Level of 0.1% pectin produced jam with excellent texture, color and brightness with highest grade (Table 7). The highest overall score (83.40%) was obtained at the same level.

## REFERENCES


Allam, H. T. (1988). Studies on extraction of pectin from fruit waste. M. Sc. Thesis, Food Sci. and Tech., Suez Canal Univ., Egypt.

A.O.A.C. (1990). Association of Official Analytical Chemists. Official Methods of Analysis. Benjamin Franklin Sta., Washington, D. C. U.S.A.

Ayyad, K. M. (1997). Factors contributing to the gelling properties of pectin. The 3rd Alex. Conf. of Food Sci. and Technol., Alex. March 1-3, 1997.

Baker, R. A. (1994). Potential dietary benefits of citrus pectin and fiber. Food Technol., 48(11): 133-139.

Binder, H. (1980). Separation of monosaccharides by HPLC. Comparison of ultraviolt and refractive index detection. J. Chromatogr., 189: 414-420.

Christensen, P. E. (1954). Methods of grading pectin in relation to the molecular weight (intrinsic viscosity) of pectin. Food Res., 19: 163.

David, S. R. (1987). Food Polysaccharides. Food Biochemistry & Nutritional Value Chap. 2 : 60-116. Copublished in the United States with John Wiley & Sons, Inc. New York, 1987.

Dey and Brinson (1984). Plant Cell Walls. Adv. Carbohydr, Chem. Biochem., 42: 265-382.

El-Bastawesy, A. M. (1993). Chemical and technological studies on lime fruits and its by-products. M. Sc. Thesis, Fac. of Agric., Mansoura Univ..

El-Bastawesy, A. M. (1999). Studies on Pectin. Ph. D. Thesis, Fac. of Agric., Mansoura Univ.

El-Nawawi, S. A. and Shehata, F. R. (1987). Extraction of pectin from Egyptian orange peel. Factors affecting the extraction. Biol. Wastes, 24(4): 281-290.

FAO (1996). FAO Production Yearbook, vol. 50, 1996.

Garleb, K. A.; Bourquin, L. D. and Fahey, G. C. (1991). Galacturonate in pectic substances from fruits and vegetables: Comparison of anion exchange HPLC with pulsed amperometric. Detection to standard colorimetric procedure. J. Food Sci., 56(2): 423-426.

Gomez, K. A. and Gomez, A. A. (1984). Statistical procedures of Agricultural Research, 2nd Ed. John Wiley and Sons. Inc. PP. 82, Philippine.

Hwang, L.; Roshdy, T. H.; Kontominas, M. and Kokini, J. L. (1992). Comparison of dialysis and metal precipitation effects on apple pectins. J. Food Sci. 27(5): 1180-1184.

Anon (1959). Committee on Pectin Standardization. Pectin Standardization Food Tech., 13: 496.

Jonson, C. M. (1945). Ind. Eng. Chem. Aual. Edu., 17, 321. (C. F. Rangana, 1977).

Ma, E.; Cervera, Q. and Mejia-Sanchez, G. M. (1993). Integrated utilization of orange peel. Bioresource Technology, 44(1): 61-63.

May, C. D. (1990). Industrial pectins: Sources, production and application. Carbohydr. Polymers, 12: 79.

Phatak, L.; Change, K. C. and Brown, G. (1988). Isolation and characterization of pectin in sugar-beet pulp. J. Food Sci., 53(3): 830-833.

Ros, J. M.; Schols, H. A. and Voragen, A. G. (1996). Extraction, characterization and enzymatic degradation of lemon peel pectins. Carbohydr. Res., 282(2): 271-284.

Selvendran, R. R. and O.Neill, M. A. (1987). Isolation and analysis of cell walls from plant material. Meth. Of Biochem. Anal., 32: 25.

Smith. F.; Michel, O; Gilles, K. A.; Hamilton. J. K. and Rebers, P. A. (1956). Colorimetric method for determination of sugars and related substances. Analytical Chemistry, 28(3): 450-456.

Turki, M. A.; Attia, N. Y.; Khalil, A. R. A. and Saad, S. M. (1988). Chemical evaluation of some plant pectins. J. Agric. Sci. Mansoura Univ., 13(1): 393-399.

Weniger, M.; Haog-Bierrurier, B.; Rohmer, M. and Anton, R. (1978). Acid hydrolysis of flavoid glycosides plants. Medica, 33: 170.

## دراسات على البكتين:

## ١ – دراسات فزيوكيميائية وتكنولوجية على البكتين المستخلص من خلطـات مـن قشور الموالح وتفل التفاح وتطبيقاته

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تهدف هذه الدراسة إلى إمكانية إستخلاص البكتين من خلطات مختلفة من قشور الموالح وخاصة ( الليمون الأضاليا – البرتقال البلدى – الجريب فروت – الشادوك بالإضافة إلى تفل التفاح ودراسة الظـروف المثلى لإستخلاص البكتين من هذه الخلطات للحصول على أعلى ناتج منه ذو صفات جـودة عاليـة . هـذا بالإضافة إلى إلى إستخدام البكتين الناتج فى صناعة مربى التين وذلك بتركيزات مختلفة وقد خلصت الدراسة إلى

١- زيادة كمية البكتين الناتج من الخلطات المختلفة والمستخلص باسـتخدام الظـروف المثلـى المناسـبة لإستخلاص أعلى مكون فى الخلطة عن الناتج بإستخدام ظروف إستخلاص واحدة لجميع الخلطات حيث إرتفعت نسبته من ١٢,٠٣-١٤,٩١% إلى ١٢,٦٧-٢٠,١٦% .

٢- إرتفعت مجموعات الميثوكسيل فى جميع الخلطات من ٨,٦٦ – ٩,١٥% إلى ٩,٧٧ – ١٠,٣٦%

٣- تراوحت نسبة حمض الجلاكتيورونيك من ٧٩,٧٩% إلى ٨١,٥٥% ولم يكن هناك فروق جوهرية بين جميع الخلطات .

٤- إرتفعت قيم كل من اللزوجة ، shear stress إلى أعلى قيمة لها لكل مـن الخلطـات ١ ، ٢ ، ٣ ، ٥ بينما إنخفضت فى الخلطة رقم ٤ ( ٦٩,٧٧ سم بواز / ث و ٤١,٨٦ بسكال ، على الترتيب ) .

٥- إرتفع الوزن الجزيئى للبكتين المتحصل عليه فى جميع الخلطات ماعدا الخلطة رقم ٤ والتـى إنخفـض فيها الوزن الجزيئى إلى ٨٠,٥٤ × ١٠^٤ دالتون .

٦- إرتفع محتوى السكريات الكلية فى جميع الخلطات عند الإستخلاص بالظروف المثلى لأعلى مكون فـى الخلطة عند إستخلاصها تحت ظروف إستخلاص واحدة ، كانت السكريات الرئيسية فى جميع الخلطات هى سكر الرامينوز والجلاكتوز والأرابينوز وأرتفع المانوز بصورة واضحة فى الخلطة رقم ٥ .

٧- أظهر البكتين المستخلص فى الخلطة رقم ١ أعلى صفات حسية عند إستخلاصه بتركيـز ٠,٠٥% فـى صناعة مربى التين ، أما الخلطات ٢ ، ٣ ، ٤ ، ٥ حصلت على أعلى درجات مـن درجـات التقيـيم الحسى عند إضافة البكتين بتركيز ٠,٢% مقارنة بالعينة الكنترول وبذلك أمكن الإستفادة مـن مخلفـات مصانع حفظ الأغذية خاصة قشور الموالح وتفل التفاح فى إنتاج مادة البكتين ذات الأهمية الإستراتيجية وبمواصفات جودة عالية .