BANANA (*Musa sp.*) PEELS AS A SOURCE OF PECTIN AND SOME FOOD NUTRIENTS

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ABSTRACT

Banana peels from two varieties William and Maghrabi represent 40% of all weight of banana fruit. Chemical composition (moisture (90.88, 90.76%), total solid (9.12, 9.24), crude protein (5.21, 6.68%), ether extract (5.52, 6.96%), ash (13.84, 12.44%), lignocellulose (49.14, 41.31%), pectin (12.77, 13.03%), available carbohydrates (26.29, 19.58%) and total carbohydrates (75.43, 73.92%)**.** As well as the optimum condition for pectin extraction are temperature (90-95°C), time (60 min), pH (2) and tested as gelling agent in fig jam preparation. The properties of pectin such as degree of esterification are between (62.43 to 64.11%), equivalent weight are between (738.08 to 751.57) and methoxyl content are between (5.69 to 6.66%) for William and Maghrabi respectively. Finally, it could be concluded that banana peels are a good sources of pectin and some food nutrients such as minerals, sugars and dietary fibers.

Key words: *banana peels*, *pectin,* degree of esterification, methoxyl content

INTRODUCTION

Banana is one of the most extensively consumed fruit in the world that represent about 40% of the world trade in the fruits **(Singanusong *et al*., 2013)**. It is the second largest product fruit after citrus, contributing about 16% of the world's total fruit production. It is one of the most widely grown tropical fruits, cultivated over 130 countries. Plant has an origin from India and Eastern Asia (Malaysia and Japan) and some varieties are found to be genetically linked with some species from Africa **(Mohapatra *et al*., 2010).**

The fruit protected by its peel which is discarded as waste after the inner fleshy portion is eaten. Besides being used fresh, banana is used also processed into many products such as juice, jams, chips, puree pulps powder, biscuits …etc. **(Zhang *et al*., 2005).** Global production of banana is estimated to be around 48.9 million tons**.** According to Food and Agriculture Organization of the United Nation **(FAO, 2008),** Egypt ranking number 18 with a production of 1.144.717 tons of banana in year 2013. Besides, significant quantities of banana peels equivalent to 40% of the total weight fresh banana are generated as a waste product in industries producing banana based products **(Tcehobanoglous *et al*., 1993).** At present, these peels are not being used for any other purposes and are mostly dumped as solid waste at large expense. It is thus significant and even essential to find application for these peels as they can contribute to real environment problems **(Zhang *et al.,* 2005).** Banana peels are a rich source of total dietary fibers (43.2-49.7%), starch (3%), crude protein (6-9%) and crude lipids (3.8-11%). Banana peels dietary fibers are a good source of lignin (6-12%), pectin (10-21%), cellulose (7.6-9.6%), hemicellulose (6.4-9.4) and galacturonic acid. Banana peels characterized by their polyunsaturated fatty acids (linoleic and α- linolenic acids), essential amino acids (valine, leucine, phenylalanine and threonine), and minerals such as K, P, Ca and Mg **(Emaga *et al.,* 2007 and 2008a).** Moreover, **Nagarajaiah and jamuna (2011)** stated that banana peels had good antioxidative components and activity, where the polyphenol of three varieties of banana were in the range of 200- 850 mg equivalent of tannic acid / 100g and free radical scavenging activity (62-90%). From food waste can improve the overall economics of processing units. Too reduce the environmental problem, banana peels can be used as base material for pectin extraction**.** Many researchers focused on extraction of pectin **(Qiu *et al*., 2010).**

Tapping into the trend for alternative source of pectin, **Emaga *et al.* (2008b)** reported that pectin extraction from banana peels could find application as a gelling agent. It is used in food, industry, as gelling agent. In general, the largest use of pectin is in manufacture of jellies. About 85% of the commercial pectin on the world is to make jelly and similar products **(Madhav and Pushpalatha, 2002).**

The aim of the present study is to evaluate banana peels as a waste from the two varieties named William and Maghrabi are cultivated in Egypt as a source of pectin and some food nutrients.

MATERIALS AND METHODS

Raw materials:

Good quality riped banana (*Musa sp*) fruits of the same ripeness stage (more yellow than green, number 6) of the varieties Maghrabi and William were chosen**.** The samples were obtained from Peco Eltahrir Farm, El-Behira governorate, Egypt, during May, 2015. These varieties were the great production and availability of banana in Egypt**.** About 10 kg from each variety of banana fruits were used**.** The average weight of each individual fruit was (200-250g) for the Maghrabi variety and (150-200g) for the William one. Fig fruits used for jam prepared were obtained from the local market of Kafr El-Sheikh city, Egypt**.**

Chemicals and Solvents:

All the Chemicals and solvents used in this study were purchased from El- Gomhoria Company for Chemicals and Drugs, Tanta city, Egypt**.** All the chemicals and solvents were of analytical grade**.**

Analytical methods:

Proximate chemical composition of banana peels:

Moisture, crude Protein, Ether extract, ash and crude fibers were determined according to the methods outlined in **A.O.A.C (2005).** Total carbohydrates content was calculated by subtracting protein, ether extract and ash from the total mass of 100, as reported by **Tadrus (1989).**

All the forenamed determinations were done in triplicates and the results were expressed as average on dry weight basis**.** Minerals were determined using Spectrophotometer (Jenway, 6100) according to the method described in the **A.O.A.C. (2005).**

Determination of cellulose, hemicellulose and lignin:

Cellulose and hemicellulose were determined according to the method described by **Chahal *et al*. (1979).** Lignin in banana peels was also determined according to the method described by **Fahmi (1984).**

Determination of total, reducing and non-reducing sugars:

The total sugars content of banana peels was determined using the Anthrone method as described by **Weiner, (1978).** The method of **Miller (1959)** was carried out for determining the reducing sugars of banana peels using dinitrosalicylic acid reagent (DNS)**.** The intensity of color was measured at wavelength 575 nm**.**

Preparation of banana peels for pectin extraction:

Fresh banana fruit of the two above mentioned varieties, were first washed with water and the peels were manually separated from the fruit flesh and cut into smaller pieces for easy drying**.** After that, the peels were boiled in water at 100°C for 1-2 minutes to inactivate pectin enzymes**.** Boiling step was immediately followed by cooling in running tap water in order to stop the effect of prolonged heating which may lead to degradation of pectin and to remove substantial quantities of impurities**.** The peels were hard pressed to release the excess of water**.** The peels were dried in an electric oven at 60º C±1 for 24 h**.** Then, the samples were weighted and ground using grinder and passed through a 35 mesh sieve screen**.** The powder samples were stored in polyethylene plastic bags at -18°C till use for analysis

Pectin extraction:

Pectin was extracted according to the method described by **Emaga *et al*. (2008b)**.

Some chemical and physical properties of banana peels pectin:

The degree of esterification (DE) was assessed by direct titrimetric method described by **Jiang *et al*. (2005).** The pH of banana peel pectin was measured using pH meter (GLP21, made in UE). The equivalent weight was assessed by **Owens *et al*. (1952).** Determination of methoxyl content was done using the **Ranganna's** method **(1995).**

Application of pectin extracted from banana peels:

Figs jam preparation:

To compare the extracted banana peels pectin from either commercially used citrus pectin as a gelling agent or control without any addition of pectin, these were utilized in fig jam processing**.** Fresh fig fruits were washed thoroughly and chopped into small pieces**.** The chopped fruits were then weighted. Sucrose was added with ratio 45 sucrose to 55% fruits**.** The mixture was processed in cooking pan with constant and stirring to avoid scorching**.** When the soluble solids reached 60% the dissolved pectin at 0.5, 1.0 and 1.5% levels was dissolved in 30 ml hot water then, added to the jam**.** Commercial pectin, 1% was added to the sample prepared with commercial pectin, whereas pectin was not added to the standard jam**.** An amount of 0.2% citric acid was added as soon as the mixture reached 65 °Brix. Heating was stopped at 68 °Brix and jams were immediately poured in jars**.**

Sensory evaluation of fig jam:

Sensory evaluation of fig jam samples were carried out through evaluating color, taste, odor, texture, appearance and overall acceptability as described by **Guichard *et al*. (1991).** The samples were served to 20 panelists from the staff members of the Food Technology Department, Faculty of Agriculture, Kafrelsheikh University**.** Score card and description sheet were designated to describe the excellent criteria of each of the jams quality characteristics**.** Panelists were asked to give numerical values for the jam characteristics, ranging from 1 to 20 where excellent (20-18), very good (16-12) fair (10-8) and not accepted (6 - 4)**.**

Statistical analysis:

The obtained data were statistically analyzed using General Linear model procedure adapted by statistical package for the Social Sciences **(SPSS, 1997)** for user's Guide Duncan Multiple Range Test was used to test the difference among means **(Duncan, 1995).**

RESULTS AND DISCUSSION

Proximate chemical composition of banana peels:

The Proximate chemical composition of William and Maghrabi banana peels were determined and the results are presented in Table (1)**.** Data given in Table (1) showed that peels of two above named verities of banana contain varying contents of crude protein, fat, ash, crude fibers and total carbohydrates**.** However, the obtained results showed no significant difference in the moisture content of fresh William and Maghrabi peels**.** The moisture content of peels of William and Maghrabi varieties of banana were 90.88% and 90.76%; respectively**.** Peels from Maghrabi variety characterized by its higher crude protein that reached 6.68%, ether extract was 6.96% and crude fibers were 41.31% compared to William banana peels (5.21%, 5.52% and 36.37 % for the three abovementioned components; respectively)**.** However, the peels of William banana variety had more ash content (13.84%) than that of Maghrabi variety (12.44%)**.** Data given in Table (1) showed that significant difference was observed of crude protein, ash, ether extract and crude fibers between William and Maghrabi banana peels**.**

Table (1): The proximate chemical composition of banana peels powder (% on dry weight basis)

Components / Variety	Banana varieties		
	William	Maghrabi	Sig
Moisture	90.88	90.76	NS
Total solids	9.12	9.24	NS
Crude protein	5.21	6.68	**
Ether extract	5.52	6.96	**
Ash	13.84	12.44	**
Lignocellulose••	49.14	54.34	*
Crude fibers	36.37	41.31	*
Pectin	12.77	13.03	N.S
Available carbohydrates	26.29	19.58	**
Total carbohydrates•	75.43	73.92	*

NS**:** indicate not significant
* and ****:** indicate significant at $p< 0.05$, $p<0.01$; respectively.
• Total carbohydrate (crude fibers are included) was calculated by difference.
••Lignocellulose composed of crude fibers + pectin**.**

The data in Table (1) indicate that the peels of banana could be a good source of total carbohydrates and crude fibers**.** The fibers content also indicate that the peels of banana could help treat constipation and improve general health and well-being**.** These results are in close agreement with (**Essien *et al.,* 2005; Emaga *et al.,* 2007 and 2008a; Nagarajaian and prakash 2011; Ighodaro, 2012; Singanusong *et al.,* 2014; Awedem *et al.,* 2015).**

Nagarajaiah and Prakash (2011) found that moisture content of peels of three different verities of banana, namely: Pachabale, Yelakkibale and Nendranbale and were 88.66%, 88.20% and 82.60%; respectively. Also, protein content, ether extract, ash and total carbohydrates in the same varieties of banana peels ranged from (4.60 to 7.76), (5.13 to 11.26), (8.98 to 12.96), and from (9.80 to 41.90); respectively. **Sanchez *et al.* (2014)** reported that the moisture, ash and protein contents of banana peels were 86.30, 11.19 and 5.62%**;** respectively.

Minerals composition of banana peels:

Data given in Table (2) show minerals content of banana peels. Data gives the composition of 5 (macro) elements: phosphorus, potassium, calcium, magnesium and sodium, as well as 4 of (micro) elements: iron, manganese, zinc and copper in banana peels of both William and Maghrabi varieties**.** Data obtained by **Akinyoye, (1991**) showed that the concentration of potassium in banana peels to be high, a matter like that in banana fruit**. Mohapatra *et al*. (2010)** showed that banana fruits are not only a rich source of carbohydrates, antioxidants, but also a good source of minerals, especially potassium and iron; thus, it is an ideal food for weaning mother and infant**.** The results in Table (2) showed that the potassium content in banana peels showed to be the highest among the 9 determined minerals**.** Maghrabi variety had almost twice (7602.75 mg **/** 100g) of potassium than in William variety (3812.50 mg / 100g)**.** The results also revealed that the phosphorus content in banana peel of William variety was high (1346.56 mg / 100g) and was about 6 times of its content in the peels of Maghrabi variety (225.10 mg / 100g)**.** The minerals content of banana from William variety were also higher in calcium (462.50 mg / 100g) as twice as in Maghrabi variety (239.90 mg / 100g), sodium content in William peels was higher (54.92 mg / 100g) than that of Maghrabi variety reached 15.50 mg / 100g**.**

Table (2): Minerals composition of banana peels (mg / 100g of dry weight)

Sample / Elements	Banana varieties	
	William	Maghrabi
Macro-elements		
Phosphorus (P)	1346.56	225.10
Potassium (K)	3812.50	7602.75
Calcium (Ca)	462.50	239.90
Magnesium (Mg)	138.50	184.66
Sodium (Na)	54.92	15.50
Micro-elements		
Iron (Fe)	47.75	35.88
Zink (Zn)	1.55	1.80
Manganese (Mn)	1.47	1.25
Copper (Cu)	0. 83	0.00

It could be noted from the same Table that, iron content in William variety higher (47.75 mg /100g) than that of Maghrabi variety (35.88 mg /100g)**.** While, Zn and Mn were nearly similar in two variety**.**

Copper was not detected in Maghrabi variety, while recorded 0.83 mg /100g in William variety. Calcium and phosphorus are very important in formation of strong bones and teeth, for growth, normal liver and cell metabolism (**Rolfe *et al.,* 2009). Davey *et al.* (2009)** found that iron and zinc are present in higher concentration in banana peels compared to pulps. On the other hand, banana peels from Maghrabi variety showed to have higher contents of magnesium (184.66 mg /100g) and zinc (1.80 mg /100g) compared to William variety (138.50 and 1.55 mg /100g) for magnesium and zinc, respectively. The differences in minerals content of the two tested varieties could be attributed to difference in soil conditions (soil type and minerals content) as well as different environmental conditions (**Wilson, 1987; Swenner, 1990).** However, the contributions in literature for the elements content of banana peels varied considerably.

The obtained minerals content of banana peels agreed with those found by **Nagarajaiah and Jamuna (2011).**

Lignocelluloses components of banana peels:

It cleared from the results obtained in Table (3) that, the lignocellulose components of banana peels from Maghrabi variety presented somewhat more percentages than those obtained from the banana peels of William variety. The cellulose content showed to have the highest value among all components which represents 29.75% and 30.46% of the total contents of lignocellulose of banana peels from William and Maghrabi varieties, respectively. Hemicellulose was the second which represented 26.58 and 26.81% of total contents of lignocellulose of both varieties of banana peels; respectively. **Sanchez *et al*. (2014)** obtained values of 11.45%, 25.52% and 9.82% for cellulose, hemicellulose, and lignin in banana peels, respectively.

Table (3): Lignocellulose content of banana peels (calculated on dry weight basis)

Variety / Component	Banana varieties				
	William		Maghrabi		Sig
	%	% of total	%	% of total	
Cellulose	14.62	29.75	16.55	30.46	**
Hemicellulose	13.06	26.58	14.57	26.81	*
Lignin	8.69	17.68	10.19	18.75	*
Pectin	12.77	25.99	13.03	23.98	N.S
Total	49.14	100	54.34	100	

NS: indicate not significant
* and ** indicate significant at $p < 0.05$, $p < 0.01$; respectively.
Cellulose, hemicellulose and lignin are called crude fibers.

Total sugars, reducing and non-reducing sugars of banana peels:

The results obtained for total, reducing and non-reducing sugars content of banana peels from William and Maghrabi varieties are listed in Table (4). The obtained results indicate that reducing sugars (as glucose and fructose) levels were predominate in banana peels of both William and Maghrabi verities. The reducing sugars of William variety amounted 8.60%, which is higher than that of Maghrabi variety (5.58%). The data showed that the reducing sugars of banana peels from William variety is more by 1.5 times than that in the Maghrabi variety. The same trend can be observed for total sugars. The total sugars of banana peels from William variety as shown in Table (4) accounted to 11.50%, a matter of 1.36 times than their value in Maghrabi variety. However, the value of non-reducing sugars content was nearly the same in both the two varieties and accounted of 2.90 and 2.89%, respectively.

Table (4): Total, reducing and non-reducing sugars contents of banana peels

Sample / Sugars	Banana varieties		
	William	Maghrabi	Sig
Total sugars	11.50	8.47	**
Reducing sugars	8.60	5.58	*
Non-reducing sugars•	2.90	2.89	NS

NS: indicate not significant.
* and ** : indicate significant at $p < 0.05$, $p < 0.01$; respectively.
• Non- reducing sugars were calculated by difference between total sugars and reducing sugars.

Giovani *et al.* (2009) found that sucrose levels were higher than those of glucose and fructose levels in early stage. Then it decreased during the subsequent stages of ripening. They obtained values of 9.59, 7.39 and 2.20% for total, reducing and non-reducing sugars of banana at more green than yellow (stage3) ripening stage; respectively. While, at stage 6 of ripening (completely yellow) total, reducing and non-reducing sugars recorded about 12.88, 8.36 and 4.52%; respectively. On the other hand, at stage 8 of ripening (yellow with more brown specks) the previous components were 15.56, 12.45 and 3.20%, respectively. On the other hand **Hussein *et al.* (2015)** obtained much lower values of total reducing and non-reducing sugar of banana peels. These value were, 2.14, 1.56 and 0.58; respectively.

Pectin extraction conditions from banana peels:

Different conditions of extraction such as temperature, pH and extraction time were carried out to evaluate the optimum conditions of pectin extraction from banana peels. Extraction of pectin from peels was carried out at (90-95ºC) and different pH values (1.35 - 2.0) and time (60min) and the results are given in Table (5). From data shown in Table (5) it could easily observed that the highest yield of pectin was 12.77% and 13.21% from peels of William and Maghrabi varieties, respectively. When, extraction conditions were adjusted at pH 1.5, 2.0 and temperature 90-95 °C for 60 min.

Table (5): Pectin extraction yield (%) from banana peels at temperature (90-95 °C), time (60 min) and different pH

Treatments	Extraction conditions			Yield of pectin•		
	Temp. (^{o}C)	Time(min)	pH	William	Maghrabi	Sig
T1	90-95	60	1.35	11.43^{b}	12.91^{a}	**
T2				9.00^{d}	11.09^{bc}	**
T3			1.50	12.77^{a}	13.03^{a}	NS
T4			1.60	9.39^{cd}	11.22^{bc}	*
T5			1.70	10.93^{bc}	10.83^{bc}	NS
T6				10.08^{cd}	$10.\ 83^{b}$	*
T7				10.77^{bc}	12.19^{ab}	*
T8			2.00	12.73^{a}	13.21^{a}	NS
T9				11.39^{b}	10.43^{c}	NS

•Yield of pectin calculated as dry weight basis.
NS: indicate not significant.
* and ** indicate significant at p< 0.05, p<0.01; respectively.
Means of treatments having the same right case letters within a row are not significantly different (P<0.05).

Some physical and chemical properties of extracted pectin:

The data in Table (6) showed some physical and chemical properties of pectin extracted from banana peels. Data given in Table (6) showed that, no significant difference was observed of moisture content in pectin extracted from two varieties; both of them in pectin around 4%. Also, pH of extracted pectin was nearly similar. But, degree of esterification in pectin was differed significantly between William and Maghrabi varieties which recorded 62.43 and 64.11%; respectively.

Table (6): Some physical and chemical properties of pectin extracted from banana peels

Sample Property	•Pectin from banana peels		
	William	Maghrabi	Sig
Moisture content (%)	4.31	4.08	NS
Ash content (%)	6.22	7.45	**
Degree of esterification (%)	62.43	64.11	**
pH	3.41	3.39	NS
Equivalent weight	738.09	751.57	**
Methoxyl content (%)	5.69	6.66	**
Color	Brown	Light brown	

•Yield of pectin calculated as dry weight basis.
NS: indicate not significant.
* and ** indicate significant at p< 0.05, p<0.01; respectively.

Equivalent weight of extracted pectin was differed significantly, which recorded about 738.09 and 751.57 for William and Maghrabi; respectively. **A**pparent also from the same Table (6) that ash and methoxyl contents in Maghrabi variety was higher than that of William variety. Furthermore, color of pectin from William was brown; while was light brown in Maghrabi variety. **Castillo-Israel *et al*. (2015**) obtained much high values of ash and moisture from Saba banana peels which reached 10 and 11%; respectively. Equivalent weight of pectin is indicator of its jelly-forming ability, with high molecular weight pectin having better ability (**Vaclavik and Christian, 2008**).

The equivalent weight of pectin extracted from orange, sweet lime, papaya peel powder using hydrochloric acid and citric acid was found to be 625.1, 416.1, 555.1, 333.4, 357.1 and 263.2; respectively. Likewise, the results obtained by **(Suman *et al.,* 2015)** for methoxyl content was also in close agreement (7.03%) with that of Maghrabi banana peels (6.66%). Methoxyl content of extracted pectin varied from 0.2-12% depending on the source and mode of extraction (**Aina *et al.*, 2012**). The Methoxyl group of pectin play a great role in pectin solubility and gelling power properties, since its presence in high percentage decrease the polarity of pectin molecules **(Kertesz, 1951).** The obtained are nearly similar to the results obtained by other researchers. **Castillo-Israel *et al*. (2015**) found that degree of esterification of ripe and unripe Saba banana peels was 63.37 and 75.03%; respectively.

Evaluation of banana peels pectin as gelling agent in fig jam:

Sensory properties of jam have a great importance to measure consumer attitudes and their influence on food choice and acceptability **(Hussein *et al.,* 2015).** Therefore, the extracted banana peels pectin was used as gelling agent in fig jam. Three concentrations of extracted banana peels pectin (0.5, 1.0 and 1.5%) as well as the standard pectin with that of commercial citrus pectin (1%) and the control fig jam without addition of pectin, were sensory evaluated and the results are presented in Table (7). From obtained data and focusing on texture of processed jams, it was clear to observe that the lowest numerical score was given to the jam prepared without any pectin (control jam). The control had a score of 14.00 for texture compared to that prepared with commercial pectin which had a score of 15.90.

The addition of the extracted banana peels pectin in prepared jam caused more improvement in the texture of jams and was proportional to increasing the level of addition of all banana peels pectin jams. The jam with added 0.5% of banana peels pectin was given a score of 14.60% for its texture, followed by jam with added 1% of banana peels pectin which had a score of 15.70 and finally the jam prepared with added 1.5% of banana peels pectin with a numerical score of 16.00.

Table (7): Sensory evaluation of fig jam processed with banana peels pectin

Attributes Sample	**Color**	**Taste**	**Odor**	**Texture**	**Appearance**	**Overall acceptability***
Control	14.40[c]	15.20a	16.00[a]	14.00[c]	15.90[a]	15.10[ab]
Commercial pectin (1%)	14.00[c]	14.46[b]	15.10[b]	15.90[a]	16.00[a]	15.09[ab]
Banana peels pectin (0.5%)	16.10[a]	14.13[b]	14.60[b]	14.60[b]	15.30[b]	14.94[bc]
Banana peels pectin (1%)	15.20[b]	15.60[a]	14.80[b]	15.70[a]	15.00[b]	15.26[a]
Banana peels pectin (1.5%)	14.60[bc]	13.60[c]	14.60[b]	16.00[a]	14.80[b]	14.72[c]

*Overall acceptability is the sum of score for color, test, odor, , texture and appearance divided by 5.

Value followed by the same letter are not significantly differ at $p<0.05$.

A matter which is indicates that jam samples were affected by using pectin.

From the same Table (7), it could be observed that good taste of fig jam was obtained at 1% addition of banana peels pectin, which characterized with its higher score (15.60), followed by jam of control (15.20) and the jam with commercial citrus pectin (14.46). The lowest score for taste was obtained for sample prepared with using 1.5% of banana peels pectin (13.60) followed by that of 0.5% of banana peels pectin (14.13). The score for odor of the jam samples was at its highest value for control jam (16.00) followed standard jam. The odor of jam prepared with banana peels pectin was found to be lower than either control (16.00) or commercial pectin (15.10). The odor score for both 0.5% banana peels pectin and 1.5% had the same score (14.60), while a higher score (14.80) was recorded for using 1% banana peels pectin.

The results concerning the color of samples indicated that, with exception of banana peels pectin at 0.5%, the other two samples are more brighten (lighter in color) than either control or with commercial pectin**.** It could be also noted that the color of tested jams increased as a result of increase the levels of added pectin. The highest score for appearance was obtained for jam with commercial pectin (16.00), followed by control (15.90), whereas the appearance scores for jam prepared with banana peels pectin decreased as a function of increasing the levels of added pectin and valued 15.30, 15.00 and 14.80 for using 0.5, 1.0 and 1.5%; respectively.

Overall acceptability of jam with commercial pectin was the highest (15.09), followed by control (15.10), while the overall acceptability of jam prepared with banana peels pectin was found to be slightly lower than those of control or the standard jams. Generally, it could be concluded that banana peels pectin could be valuable and a good source for low-priced food components**.** Sensory evaluation showed that jam prepared with using 1% banana peels pectin characterized by its higher taste, odor, texture and overall acceptability scores compared to either o.5% or 1.5% addition of banana peels pectin. The properties imparted by 1% of banana peels pectin such as, color, taste, odor, texture and overall acceptability were somewhat, not distinguishable as compared with that of commercial citrus pectin and although the statistical analysis showed that the differences in quality attributes for the standard jam and that of 1% addition of banana peels pectin were significant**.** It could be said that when applied to fig jam as gelling agent, at 1.0% concentration no significant differences between commercial citrus pectin in terms of sensory properties were detected. Banana peels can be a potential source of pectin for food application**.**

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الملخص العربى

قشور الموز كمصدر للبكتين وبعض العناصر المغذية

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تمثل قشور الموز للأصناف وليم والمغربي 40% من وزن الموز الكامل. المكونات الكيميائية لقشور الموز تتمثل في الاتي (الرطوبة 90.88 - 90.76 ,المواد الصلبة الكلية 9.12-9.24 البروتين الخام يمثل 5.21 - 6.68 المستخلص الأثيري 5.52- 6.96, الرماد 13.84- 12.44, الليجنوسيليلوز49.14-54.34, الالياف الخام 36.37 - 41.31, البكتين 12.77- 13.03, الكربوهيدرات المتاحة 26.29- 19.58, الكربوهيدرات الكلية 75.43- 73.92 بالإضافة الى ذلك كانت الظروف المثلى لاستخلاص البكتين هي على درجة 90 - 95م° في زمن 60 دقيقة وعلى pH (2). وتم قياس الخواص الجيلية في انتاج مربى التين وكذلك تم تقدير خواص البكتين لكلا من الموز الوليم والمغربي وكانت درجة الاسترة هي (62.43 - 64.11), الوزن المكافئ (738.09- 751.57), والمثيوكسى (5.69- 6.66) وذلك للموز الوليم والمغربي على الترتيب. في النهاية نوصى بالاستفادة من قشور الموز كمخلفات للتصنيع الغذائي حيث تعتبر مصدر جيد للبكتين وبعض العناصر المغذية.