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EVALUAYION OF SOME FOOD PROCESSING WASTES AS SOURCES OF DIETARY FIBERS

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ABSTRACT

This work was a trial to utilize the most important wastes remaining after the processing of grape , mango , peach and tomato fruits as source of dietary fibers .The obtained results reveal that all tested peel had high values of water and fat absorption and no foaming stability values as well as fruits peel had adequate amounts of minerals and are considered as sufficient sources of minerals for human nutrition. Grape peel had noticeable amounts of calcium and iron (1517.72 and 87.27 mg / 100 gm , respectively) while, tomato and peach peel had the highest contents of zinc (157.37 and 67.33 mg / 100 gm , respectively). Tomato and mango peel had the highest contents of total carotenoids (4392.74 and 3852.01 mg/100 gm, respectively) compared with those of the peach and grape . Peach and mango peel residues had the highest amounts of total dietary fibers (TDF) (76.320 and 62.687% ,respectively) Peach peel had the highest content of pectin (soluble dietary fibers) (39.712 %) , which recorded more three folds (12.147 %) than mango peel pectin content . This means that peach peel can be used as a new commercial source for production of pectin compared with citrus peel and apple pomace. Moreover, total dietary fibers of all tested fruits peel ranged from 55.886 to 78.06 % on dry weight basis . This leads to the possibility to convert some waste materials such as grape , mango , peach and tomato peel to beneficial materials with high nutritional and functional properties . Also , this will improve the environmental ecology of industry by recycling its by-products and decrease the problems of pollution from the industrial wastes . Utilization of these wastes will be solve one of the environmental pollution problems in food industries .

Finally , it could be concluded that the four sources used in this study are considered as rich sources of dietary fibers .

Keywords : Food processing wastes, Dietary fibers, Grape pomace , Mango peel , Peach peel , Tomato peel .

INTRODUCTION

Grape, mango, peach and tomato are the most important fruits and vegetables grown in Egypt. The average total annual cultivated area with these fruits in the year 2004 were 159929, 130349, 79199 and 464491 feddans producing annually, 1275288, 375461, 332020 and 7640818 tons for grape, mango, peach and tomato, respectively (Anon, 2005). During processing and preparation of these products , large quantities of wastes are discarded and disposal of these waste materials becomes difficult and causes serious problems . Peel are the most important wastes remaining after the processing of these fruits .These wastes represent about 30 – 50 % of the fresh fruits. The pomace wastes represent about 20 %, 7-24% ,11-16% and 10-15 % of the original weight of the grape, mango, peach and tomato fruits, respectively (Abou-Rayan *et al.*,1998, Wu *et al.*, 1993, El-Adawy, 1992 and Sogi and Bawa, 1998). Many investigators demonstrated that these wastes are rich sources of dietary fibers (Grigelmo-Miguel *et al.*

,1999). Valiente *et al.* (1995) and Abou Rayan *et al* . (1998) found that grape skin residues had high neutral detergent fibers content (40.04%) and acid detergent fibers content was (4.64 %) . Hemicellulose , cellulose and lignin contents were 5.4% , 17.24% and 22.29% , respectively. Thus , grape skin is a good source of dietary fibers and can be used in some food applications. Larrauri *et al.* (1996) suggested that mango peel may be considered as a source of fruit dietary fibers of excellent quality, which had soluble dietary fibers (281 gm / kg) and the insoluble dietary fibers content was 434 gm / kg . These characteristics indicated that mango peel is a good source of tropical fruit fibers . Grigelmo-Miguel and Martin-Belloso (1999) and Grigelmo-Miguel *et al.* (1999) indicated that peach dietary fibers showed a higher WHC (12.6 gm water / gm fibers) than that of bran and had a higher OHC than 1 gm oil / gm fibers. Moreover, Pagán and Ibraz (1999) reported that the average of water holding capacity (WHC) value was 3.9 gm water / gm, total dietary fibers content were 54.2 -57% , soluble dietary fibers and insoluble dietary fibers were 19.1-18.5% and 35.4-38.5 % , respectively for both fresh and stored peach pomaces . Claye et al. (1995) noticed that the hemicellulose was the major component in tomato fibers (36.5 %) followed by cellulose (19.7 %) and lignin (13.8 %), respectively . So , they suggested that there is a good potential for hemicellulose and cellulose of tomato fibers as food ingredients, as bulking agent , in food products formulations . Due to their gelling behavior , these soluble dietary fibers (pectin) may decrease the rate of gastric empting and influence small intestinal transit time . Blood cholesterol can be lowered using well fermented fiber types that produce relatively high viscosity and epidemiological evidence supports relationship between higher dietary fibers intake and reducing the risk of cardiovascular disease . Some evidence also suggests an inverse relationship between dietary fibers and hypertension , another known risk factor for cardiovascular disease (Tungland and Meyer, 2002 and El-Bastawesy and Hareedy , 2004).

Therefore, this work was a trial to utilize some food industries wastes namely, grape, mango, peach and tomato, which represent plentiful amounts, as untraditional sources of dietary fibers.

MATERIALS AND METHODS

Materials:

Food processing wastes (peel) obtained after juice extraction of four raw materials namely , grape , mango, peach and tomato peel were used in this investigation .

- Peel of red grape fruits (*Vitis vininfera*) was obtained from the Egyptian Vineyards and Distilleries Company in Gianaclis , Alexandria , Egypt .
- Peel of mango fruits (*Mangifera indica , L.*) variety Balady was obtained from Nile Company for Agricultural Industries, Aga , Egypt.
- Peel of peach fruits (*Prunus persica*) variety Clingestone. (Sultani) was obtained from an orchard near Kaluobia Governorate , Egypt .

- Peel of tomato fruits *(Lycopersicun esculentum)* was obtained from Egyptian Canning Company (Best), Meniat Samannud , Aga , Dakahlia Governorate , Egypt.
- All chemicals (analytical grade) were purchased from Elgomhouria Pharmaceutical Co., Cairo , Egypt.

Methods:

1. Preparation of raw materials :

The grape pomace (peel and seeds) were separated after drying in an air circulated oven at 60°C by sifting through manual sieve . Tomato pomace (peel and seeds) was separated manually after drying in an air circulated oven at 40°C .

Peel used in this study were washed by tab water and dried in an air circulated oven at 60°C for 12 hrs to moisture content less than 10% . The obtained dried materials were milled using Braun mill machine , sieved through 21 mesh screen , packaged in polyethylene bags and stored in refrigerator (-4 ±1°C) for analysis .

2. Analytical Methods :

2.1. Physical properties:

Water and oil- holding capacity (WHC , OHC) were determined according to the methods described by Mongeau and Brassard (1982) .

Bulk density (BD) was determined according to the method described by Toma *et al.* (1979) . The emulsification capacity (EC) of dried samples was determined according to the method described by Yasumatsu *et al.* (1972).

Foam capacity (FC) and foam stability (FS) were determined according to the methods of Lawhon *et al.* (1972) .

2.2.Chemical properties:

Moisture , ash , protein , crude fat , crude fibers and total dietary fibers contents and hydrocyannic acid were determined according to the methods described by the AOAC (2000) . Available carbohydrates and energy values contents were calculated according to James (1995) . Minerals (Na , K , Ca , Mg , Fe and Zn) were determined after dry ashing according to the method described by the AOAC (2000) using Atomic absorption (Perkin – Elmer , Model 3300, USA). Tannins were determined according to the method described by Ranganna (1979) . Phytic acid was determined according to the method described by Wheeler and Ferrel (1971) .

Neutral detergent fibers (NDF) , acid detergent fibers (ADF), hemicellulose, cellulose and lignin were determined in grape , mango , peach and tomato peel according to the methods described by Georing and Van Soest (1970). Total pectic substances of peel were determined , as calcium pectate, according to the method described by Ranganna (1979).

Chlorophyll a , chlorophyll b and total carotenoids were determined according to the methods described by Dere *et al.* (1998). Lycopene content was determined according to Ranganna (1979).

RESULTS AND DISCUSSION

Components of some fresh fruits and vegetables :

Four kinds of fruits namely , grape (*Vitis vinifera*) , mango (*Mangifera indica*) , peach (*Prunus persica L.*) and tomato (*Lycopersicon esculentum*) were studied to estimate its components. Data presented in Table (1) reveal that pulp , peel and seeds represented 80.50% , 11.13 % and 5.87% for grape ; 54 % , 28% and 18% (9.4 outer shell + 8.6 kernel) for mango ; 89.07% , 1.10% and 9.83% (6.73 outer shell + 3.10 kernel) for peach and 92.157% , 5.621% and 2.222% for tomato of whole fruit weight , respectively. Mango had the highest pomace content (46 %) followed by grape (17 %) , peach (10.93 %) and tomato (7.843 %) of whole fruit weight , in a descending order . The results are in good agreement with those of Larrauri *et al.*(1996) , Sogi (2001) and Sukker (2001).

Table (1) : Components of some fresh fruits and vegetables .

Fruits and vegetables / Components %	Grape	Mango	Peach	Tomato
Pulp	80.50±2.76	54.00±3.71	89.07±1.53	92.16±1.92
Peel	11.13±0.74	28.00±0.12	1.10±0.14	5.62±0.54
Seed	5.57± 0.25	18.00±1.45	9.83±0.48	2.22±0.17
Pomace *	17.00±99	46.00±1.57	10.93±62	7.84±0.71
Other parts	2.50±0.14	-	-	-

* Pomace = peel + seed .

Functional properties of fruit and vegetable peel :

It is well known that the physical and functional properties of dietary fibers have the greatest effect on their functions in food and physiological action in the body. Therefore , some physical and functional properties of grape, mango , peach and tomato peel such as water holding capacity (WHC), oil holding capacity (OHC) , bulk density (BD) , emulsification capacity (EC) , foaming capacity (FC) and foaming stability (FS) were determined and the results are presented in Table (2) . The results indicate that peach peel had the highest value of water holding capacity (9.649 gm / gm) followed by tomato , mango
and grape peel (9.406 , 7.876 and 7.862 gm / gm, respectively) in a descending order . The values of WHC of all tested materials were higher than that of wheat bran (5.03 gm / gm) , which considered as the common source of dietary fibers (Chen *et al* . , 1988) .

Oil holding capacity (OHC) of tomato had the highest value (2.530) , meanwhile , grape , mango and peach OHC gave 1.763 , 1.231 and 1.070 gm oil / gm sample , respectively (Table , 2). The results of bulk density (BD) reflect the differences among the tested samples . The lowest BD was found for the tomato peel (0.193 gm / cm^3) , meanwhile , mango peel had the highest value of bulk density (0.741). On the other hand, grape and peach peel BD values were 0.540 and 0.672 gm / cm^3, respectively. This property depends on the structural characteristics of each material as the particle size and its distribution (Larrauri *et al*. , 1994) . The aforementioned results of WHC , OHC and BD are in accordance with those reported by Grigelmo-Miguel *et al* . (1999). Also , the results in Table (2) show that peach peel had the highest emulsification capacity (56.923%) , while mango péel had the lowest value (10.784%) . EC of grape and tomato peel were 46.666 and 23.256% , respectively . Concerning the foaming capacity (FC) and the foaming stability (FS) , results in Table (2) reveal that all tested samples showed no foaming properties .

Generally , from the data presented in Table (2) , it could be clearly observed that all tested peel had high values of water and fat absorption but no foaming stability values . This may be due to their high contents of protein and carbohydrates , and its low tannin and phytic acid contents . This will be discussed in details in results pointed in Table (3) .

Table (2) : Some functional properties of fruit and vegetable peel .

parameters / Peel	WHC (gm water/ gm sample)	OHC (gm oil / gm sample)	Bulk density (gm / cm³)	EC (%)	FC	FS
Grape	7.862	1.763	0.540	46.666	0.00	0.00
Mango	7.876	1.231	0.741	10.784	0.00	0.00
Peach	9.649	1.070	0.672	56.923	0.00	0.00
Tomato	9.406	2.530	0.193	23.256	0.00	0.00

E. C. (Volume of emulsion layer / total volume)

Chemical properties of fruit and vegetable peel :

From the data presented in Table (3) , it could be noticed that , the moisture contents of all tested materials were found to be under 10 % . This moisture content avoids the growth of micro-organisms . The results in the same table show that grape peel had 12.433 % ash , 9.461 % protein 0.34% fat , 12.825% crude fibers and 55.994 % carbohydrates . These results are in agreement with those reported by Abou Rayan *et al* . (1998) except for crude fibers and carbohydrates contents which were 32.90 % and 41.55 % , respectively . Also , data in Table (3) show that mango peel contained 4.051 % ash , 3.247 % protein , 6.704 % fat , 15.359 % crude fibers and 61.408 % carbohydrates .The results of fat and crude fibers contents are in accordance with those reported by Hafez (2003) , while mango peel protein content is slightly higher than the values reported by the same author who found that protein and ash contents of mango peel on dry weight basis were 0.33% and 2.70% , respectively . Concerning the gross chemical composition of peach peel , data in the same table show that peach peel had 2.861 % ash , 7.951 % protein , 2.125 % fat , 21.24 % crude fibers and 57.310 % carbohydrates on dry weight basis. These results are in agreement with those reported by Grigelmo-Miguel and Martin-Belloso (1999), Grigelmo-Miguel *et al.* (1999) and Pagan and Ibraz (1999). Tomato peel contained 3.319 % ash, 16.106 % protein, 6.469 % fat, 53.932% crude fibers and 13.740 % carbohydrates on dry weight basis. These results are in accordance with those reported by Lasztiti *et al.* (1986) and Agiba (1995). Generally, from the aforementioned data , it could be concluded that tomato peel had approximately the highest crude fibers, protein and fat contents as well as grape peel which had the highest ash content compared with those of the fruit's peel . Total carbohydrates contents of mango , peach and grape peel were the highest values (61.408, 57.310 and 55.994 % , respectively) compared with those of tomato peel (13.740 %) (Table 3). As shown in the same table , the most energy values of grape , mango peach and tomato peel were between 177.605 to 318.956 Kcal / gm dry matter .

Table (3) : Gross chemical composition of fruit and vegetable peel.

Peel / Constituents%	Grape	Mango	Peach	Tomato
Moisture content	8.947	9.231	8.512	6.384
Ash	12.433	4.051	2.861	3.319
Protein	9.461	3.247	7.951	16.106
Fat	0.340	6.704	2.125	6.469
Crude fibers	12.825	15.359	21.241	53.982
Available carbohydrates	55.994	61.408	57.310	13.740
Energy value K cal / gm dry matter	264.900	318.956	280.169	177.605
Tannins	1.481	4.143	0.00	0.00
Phytic acid	0.000	0.000	0.000	0.000
HCN	0.000	0.000	0.000	0.000

*(on dry weight basis)

Some antinutritional substances in grape , mango , peach and tomato peel were also determined to evaluate these wastes as safety food ingredients for human utilization and the results are presented in Table (3). Data in Table (3) show that mango peel had the highest value of tannin (4.143 %) followed by grape peel (1.481%) . On the other hand no tannin was detected in peach and tomato peel . No phytic and hydrocyanic acids contents were detected in the all tested materials.

Generally, from the aforementioned data it could be concluded that grape , mango , peach and tomato peel would be useful in the food industries as safety food ingredients for human utilization .

Minerals content of some fruit and vegetable peel :

The minerals content of grape , mango, peach and tomato peel were determined and the obtained results are presented in Table (4). Sodium and magnesium contents of all tested fruits peel ranged from 40.664 to167.611 and 29.754 to 145.256 mg / 100 gm. , respectively . Potassium content of all tested fruits peel was found in a large amounts than those of other minerals that, ranged from 237.214 to 603.999 mg / 100 gm . Calcium , iron and zinc contents of all tested fruits peel were found in a large and sufficient portion . Grape peel had the highest contents of calcium and iron (1517.721 mg / 100 gm and 87.264 mg / 100 gm , respectively). As recorded in Table (4) , tomato and peach peel had the highest contents of zinc (157.367 and 67.328 mg / 100 gm dry matter , respectively). These results are higher than those reported by Alvarado *et al.* (2001) and Helmy (2001) .

Finally , from the data presented in Table (4) , it could be concluded that , all tested fruits peel had adequate amounts of minerals and could be considered a sufficient sources of minerals for human nutrition .

Table (4) : Minerals content of some fruit and vegetable peel.

Peel / Minerals	Grape	Mango	Peach	Tomato
Sodium	١٠٢,٧٧٢	٤٠,٦٦٤	١٦٧,٦١١	٩٥,٣٨٦
Potassium	٥٠٥,٤١٨	٢٣٧,٢١٤	٣٣٤,٦٥٧	٦٠٣,٩٩٩
Magnesium	٧٦,٠٧٠	٨٨,٦٦٦	٢٩,٧٥٤	١٤٥,٢٥٦
Calcium	١٥١٧,٧٢١	٦٢٣,٢٠٦	٢٨٣,٠٠٣	٤٠١,٦٢١
Iron	٨٧,٢٦٤	٨,٤٢٢	٢٣,٥٧٣	٣١,٥٤٠
Zinc	٦٠,٢٨٧	٣٧,٥٢٠	٦٧,٣٢٨	١٥٧,٣٦٧
Ash content%	12.433	4.051	2.861	3.319

(mg / 100 gm dry matter)

Dietary fibers components of grape , mango , peach and tomato peel :

Grape , mango , peach and tomato peel dietary fibers were fractionated to determine their different components and their potentiality as commercial sources. Cellulose, hemicellulose, lignin, pectin and the percentage of neutral detergent fiber (NDF) , acid detergent fibers (ADF) and total dietary fibers (TDF) are presented in Table (5). As recorded in the same table, tomato peel had the highest values of NDF (67.950 %), ADF (67.128 %), cellulose (21.735 %), CF (53.982 %) and TDF (78.060 %) on dry weight basis, whereas, pectin content of tomato peel was found in a moderate amount (9.758 %) (Table, 5). Tomato total dietary fibers content was 65.9 % being higher than that reported by Claye *et al.* (1995). These results reveal that most of tomato dietary fibers were insoluble fibers. The grape peel residue showed higher NDF, ADF and hemicellulose contents (45.981, 38.666 and 7.315 %, respectively) than those of mango and peach peel. On the other hand , the grape residue had slightly lower concentration of pectin compared with those determined in the other fruits peel. So, most of the grape dietary fibers content were insoluble fibers . The results of dietary fiber fractions of grape peel are near to those reported by Abou Rayan *et al.* (1998). Peach and mango peel residues had the highest amounts of TDF (76.320 and 62.687 % , respectively). Total dietary fibers content of mango peel is in accordance with those reported by Hafez (2003) while lower than the value detected by Larrauri *et al.* (1996) . The results in Table (5) reveal that peach peel had the highest content of pectin (soluble dietary fibers) (39.712 %) which recorded more three folds (12.147 %) than mango peel pectin content. From the aforementioned data, it could be concluded that peach peel may be used as a new commercial source for production of pectin compared with citrus peel and apple pomace , which produced 24.04 and 14.42 % pectin yield, respectively with high quality properties and were considered the main sources of commercial production of pectin (El-Bastawesy, 1999). Peach total dietary fibers were higher than those reported by Pagán and Ibraz (1999) , who found that peach pomace had 54.2 – 57.0 % total dietary fibers .

Generally , total dietary fibers of all tested fruits peel ranged from 55.886 to 78.060 % on dry weight basis . These results reveal that , it could be possible to convert some waste materials such as grape , mango , peach and tomato peel to food ingredients with high nutritional and functional properties . Also , this will improve the environmental ecology of industry by recycling its by-products and decrease the problems of pollution from industrial wastes .

Table (5): Dietary fibers fractions of grape , mango , peach and tomato peel.

Dietary fibers fraction% / Peel	Grape	Mango	Peach	Tomato
Crude fibers	12.825	15.359	21.241	53.982
N. D. F.	45.981	24.474	38.022	67.950
A. D. F.	38.666	18.509	31.831	67.128
Cellulose	17.905	13.187	14.951	21.735
Hemicellulose	7.315	5.966	6.192	o.821
Lignin	20.762	5.321	16.880	45.393
Pectin	3.033	12.147	39.712	9.758
Total dietary fibers	55.886	62.687	76.320	78.060

*(on dry weight basis)
N.D.F.= Neutral Detergent Fibers
A.D.F.= Acid Detergent Fibers

Carotenoids content in fruits peel :

Carotenoids play a great role in protection the body against oxidizing agents , mutagens and carcinogens (El-Seesy and Hamed 1998) . From the results are shown in Table (6) , it could be observed that tomato peel had the highest contents of chlorophyll a and b (10.04 and 12.76 mg / 100 gm) compared with those of the other fruits peel . Peach and mango peel had moderate amounts of both chlorophyll a and b (3.77 and 7.97 mg / 100 gm , respectively . As shown in Table (6) , the results contents reveal that tomato and mango peel had the highest contents of total carotenoids (4392.74 and 3852.01 mg / 100 gm , respectively) compared with those of the peach and grape . From these results it could be concluded that tomato peel contains six times as much peach peel as total carotenoids (707.36) and eight folds of grape peel contents (553.28 mg / 100 gm) (Table , 6). The results obtained are similar to those reported by Gross (1987) , who found that the total carotenoids content in grape and peach peel ranged from 1.0 to 3.5 and 4.7 to 9.0 µg / g, respectively on fresh weight basis depending on ripening stage. Hamed (2000) reported that mango processing wastes (Balady variety) contained 5.6 gm / 100 gm of total carotenoids of which beta-carotene was the predominant fraction among seven fractions of carotenoids. Lycopene is the predominant carotenoid in fresh tomato and tomato processing peel . As recorded in Table (6) , the lycopene content of tomato peel was 157.531 mg / 100 gm. These results are near to those reported by Radwan *et al* . (2004) who found that tomato peel content represented 138.87 mg / 100 gm of fruit weight on dry weight basis.

Table (6) : Total carotenoids content of grape , mango , peach and tomato peel.

Peel / Carotenoids*	Grape	Mango	Peach	Tomato
Chlorophyll a	1.551	0.306	3.767	10.040
Chlorophyll b	1.059	7.971	1.469	12.764
Lycopene	ND	ND	ND	157.531
Total carotenoids	553.279	3852.001	707.357	4392.738

* (mg / 100 gm on dry weight basis).
ND = Not determined

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تقييم بعض مخلفات التصنيع الغذائي كمصدر للألياف الغذائية

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أجريت هذه الدراسة بهدف الاستفادة من بعض مخلفات مصانع حفظ الأغذية و خاصة مخلفات ثمار العنب و المانجو و الخوخ و الطماطم كمصدر للألياف الغذائية . و قد خلصت الدراسة إلى أن كل القشور تحت الاختبار كان لها قدرة عالية على مسك الزيت و الماء و لم يكن لها قدرة على تكوين رغوة أيضا' كل قشور الفواكه تحت الدراسة احتوت على كميات كافية من العناصر المعدنية و التي تعتبر مصدرا كافيا للعناصر المعدنية اللازمة لتغذية الإنسان حيث احتوت على كمية ملحوظة من الكالسيوم و الحديد (١٥١٧,٧٢ و ٨٧,٢٧ مجم / ١٠٠ جم ، على الترتيب) و احتوت قشور الطماطم و الخوخ على أعلى كمية من الزنك (١٥٧,٣٧ و ٦٧,٣٣ مجم / ١٠٠ جم ، على الترتيب) . قشور الطماطم و المانجو تحتوى على أعلى كمية من الكاروتينات الكلية (٤٣٩٢,٧٤ و ٣٨٥٢,٠١ مجم / ١٠٠ جم ، على الترتيب) مقارنة بكل من الخوخ و العنب (٧٠٧,٣٥٧ و ٥٥٣,٢٧٩ مجم / ١٠٠ جم ، على الترتيب) . قشور الخوخ و المانجو احتوت على أعلى كمية من الألياف الغذائية الكلية (٧٦,٣٢٠ و ٦٢,٦٨٧ ٪ ، على الترتيب) و أيضا احتوت قشور الخوخ على أعلى نسبة من البكتين (الألياف الغذائية الذائبة) (٣٩,٧١٢ ٪) و التي تمثل ثلاثة أمثال محتوى قشور المانجو من البكتين (١٢,١٤٧ ٪) لذلك قشور الخوخ ربما تستخدم كمصدر تجارى لانتاج البكتين مقارنة بكل من قشور الموالح و تفل التفاح . جميع قشور المخلفات تحت الدراسة تحتوى على نسبة عالية من الألياف الغذائية حيث تراوحت من ٥٥,٨٨٦ إلى ٧٨,٠٦ ٪ على أساس الوزن الجاف فهي تعتبر مصدرا غنيا للألياف الغذائية وهذا يشجع على إمكانية تحويل بعض هذه المخلفات وخاصة قشور العنب و المانجو و الخوخ و الطماطم إلى مواد مفيدة ذات خواص تغذوية و وظيفية جيدة بالإضافة إلى الدور المهم التي تلعبة هذه المواد في علاج العديد من الأمراض. أيضا يؤدى ذلك إلى تحسين الظروف البيئية عن طريق إعادة استخدام هذه المخلفات مما يؤدى إلى تقليل مشاكل التلوث الناتجة عن تكدس هذه المخلفات .