Preparation and Evaluation of Some Citrus Wastes to Use in Preparing Functional Foods

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ABSTRACT

Proximate composition, functional properties, and some bioactive components such as polyphenols, ß-carotene and dietary fibers of free seed wastes of orange, grapefruit and mandarin juice extraction were determined. The effect of steaming, water blanching and drying processes of the mixture of the above wastes on the previous properties and compounds was also examined. Polyphenols, ß-carotene, ether extract, nitrogen free extract, bulk density and emulsifying capacity were decreased, while dietary fiber, crude fiber, ash and water, oil holding capacities of the citrus free seed wastes mixture were increased after treating with steaming or water blanching before drying. Meanwhile crude protein and pH of such wastes mixture were increased after steaming and decreased after water blanching. Due to it's good functional properties and considerable levels of the bioactive components, 2% of the previous wastes mixture were added during preparing beef burger. The panelists showed a good acceptable of the sensory properties of this product.

INTRODUCTION

Citrus is one of the most important crops in the world. Its world production was over 88 x 10^6 ton in 2003. Nearly third of this amount was used for processing (Izquierdo and Sendra, 2003). According to Martinez-Pascual and Fernandez-Carona (1980) citrus fruits had nearly 60-65% peel, 30-35% segment pulp and 0-10% seeds. The worldwide industrial citrus wastes were more than 15 x 10^6 tons as estimated by Cohn and Cohn (1997). Because some of these wastes are rich in some bioactive compounds such as dietary fibers, polyphenols, carotenes, flavonoids ... etc, they can use in developing new natural ingredients to use in preparing functional foods (Fernandez-Lopez *et al.*, 2004 and Figuerola *et al.*, 2005). The dietary fibers (DF) of citrus wastes contained a balance ratio of soluble and insoluble components, as well as high water and oil holding capacities (Larrauri, 1999). Such wastes are also rich in flavonoids, polyphenols and carotenes, the components which exert high health promoting effects (Nagy and Attaway, 1992 and Fernandez-Lopez *et al.*, 2004).

Therefore, this work was carried out to determine the proximate composition, functional properties, polyphenols, ß-carotene and dietary fibers of some free seed orange, grapefruit and mandarine juice processing wastes. To prepare a dried mixture of the previous wastes, the effect of steaming, water blanching and drying of such wastes on their previous compounds and characteristics was also investigated. Influence of addition 2% of such wastes to replace 2% of minced meat on the sensory properties of the prepared beef burger patties was also evaluated.

MATERIALS AND METHODS

Materials:

Sweet and sour oranges, grapefruits and mandarin as well as minced lean beef meat, beef tallow, onion, salt and spices mixture were brought from the local market at Alexandria City, Egypt.

Methods:

Technological methods:

Preparation of free seed citrus juice extraction wastes: Fig (1) illustrates the steps for preparing these wastes.

Beef burger preparation: Beef burger was formulated by mixing 67.5% lean beef minced meat with 7.5% beef tallow, 4% minced onions, 2% salt, 1.5% spices mixture and 17.5% cold water as described by El-Akary (1986). 2% of the lean beef meat was replaced by free seeds citrus juice extraction wastes mixture to prepare burgers rich in dietary fiber and bioactive components. The burger patties were cooked by roasting in hot air oven at 140 ± 1°C until the core temperature reached to 72°C before presenting for sensory evaluation.

Analytical methods: Moisture, crude protein, ether extract, ash and crude fiber of the prepared dried free seed citrus juice wastes and their mixture were analyzed according to the methods described in AOAC (1995). Nitrogen free extract (NFE) content was calculated by difference. Bulk density was measured using Prakongpan *et al.*, (2002) procedures. Meanwhile determination of soluble dietary fibers were carried out as reported by Susheelamma and Rao (1978), after removing proteins with cold trichloroacetic acid

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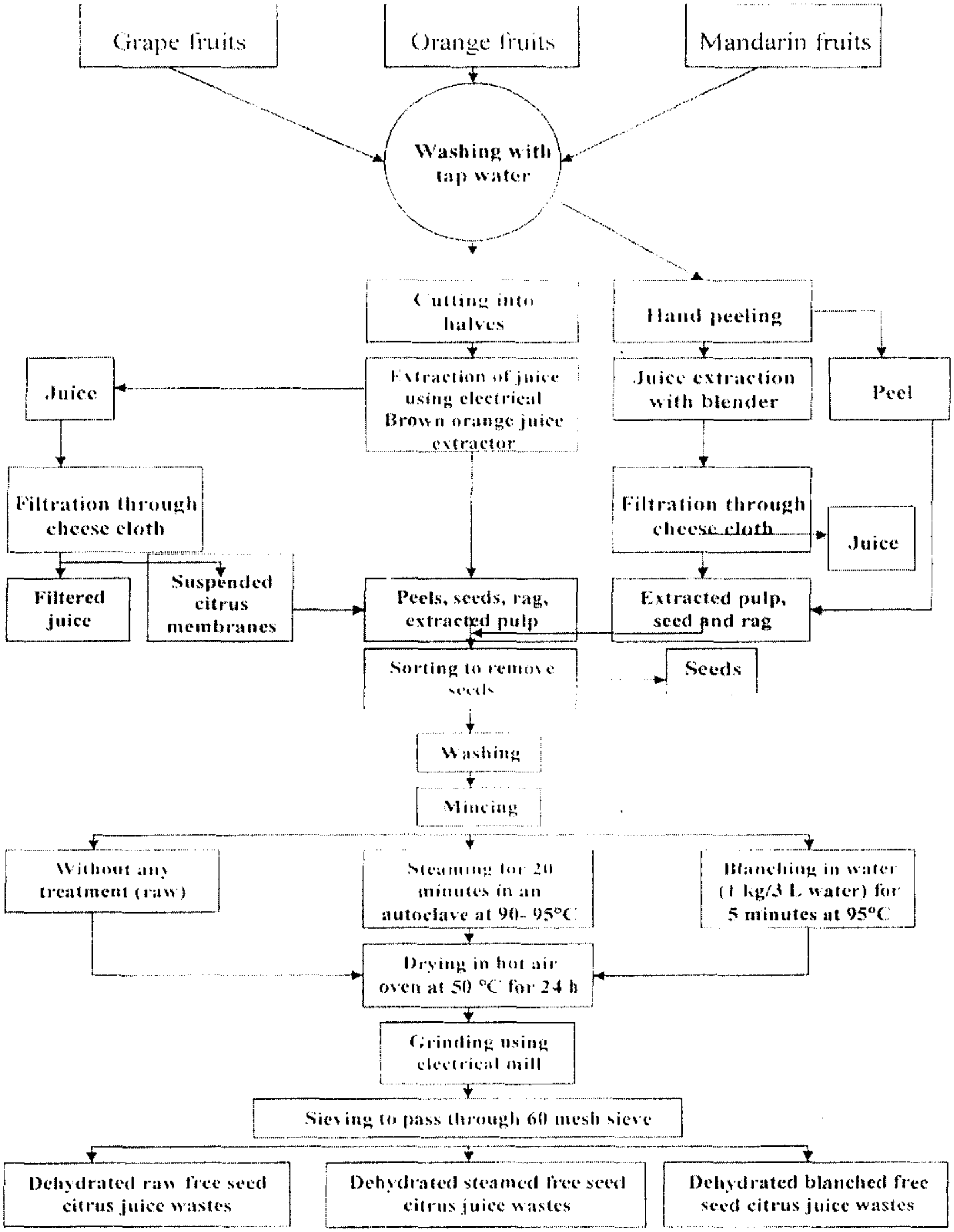

Fig1. Flow sheet of preparing dried free seed citrus juice wastes

(TCA),soluble fibers were precipitated with acetone,dialysed in distilled water for 72 hrs and dried at 50°C in air oven.

The TCA precipitate was treated with 0.2 N NaOH until pH was 11.5 then left for one hour to solubilize the protein and centrifuged at 10.000 xg for 20 min. The extraction was repeated twice. The resulted centrifuged residue was washed with distilled water and dried as mentioned above to estimate the insoluble fibers (Ravindran and Palmer, 1990). ß-carotene was colorimetrically determined at 436 nm. according to the procedure outlined by Rangana (1977). The pH value of the slurry of 1:4 g/g dried free seed citrus juice wastes to distilled water was determined as mentioned by Lario *et al.*, (2004) using a digital Cyber Scan pH meter 500 (Eutch Cybermetics PTE LTD). Water holding capacity (WHC) and oil holding capacity (OHC) were determined following the methods described by Ang (1991). Emulsifying capacity was determined according to Katsuharu *et al.*, (1972).

Organoleptic methods: The roasted burgers were subjected for organoleptic analysis using 10 panelists of Food Technol. Lab., Food Technol. Research Inst., Agriculture Research Center of Sabahia, Alexandria, Egypt. The panelists were asked to judge the appearance, colour, odour, taste, texture and overall acceptability using nine hedonic rating scall as described by Kramer and Twigg (1970).

Statistical analysis: Stander deviation and analysis of variance of the data were calculated using the methods described by Steel and Torrie (1980).

RESULTS AND DISCUSSIONS

Polyphenols, ß-carotene and dietary fibers of some citrus free seed wastes and their mixtures:

As seen in Table (1) there were differences in polyphenols, ß-carotene, soluble, insoluble and total dietary fibers content among the free seed citrus juice wastes according to the species of citrus. Wastes of grape fruits contained the highest content of polyphenols, total, soluble and insoluble dietary fibers as well as the lowest level of ß-carotene comparing to the other studied wastes of citrus. Mandarin free seed juice wastes were higher in polyphenols, and ß-carotene, very lower in total, soluble and insoluble dietary fibers comparing to that of oranges. Also within oranges, wastes of free seed juice of sweet orange were higher in polyphenols, ß-carotene, total and insoluble dietary fibers as well as lower in soluble dietary fiber comparing to that of sour orange. According to Balasundram *et al.*, (2006) peels of citrus are rich source of total phenoleics. Results of Gorinstein *et al.*, (2001) showed that total phenoleics content was 15% higher in lemons, oranges and grapefruits peels than the peels of other fruits. Because such wastes are usually accumulated together during citrus juice extraction in food plants and also to reduce the differences between their bioactive compounds, a mixture of equal quantity of each of these wastes from each citrus species was prepared in this study as stated in materials and methods section. This mixture was subjected either to steaming process or water blanching before drying to reduce it's drying time and packed density. The influence of such treatments on the content of polyphenols, ß-carotene and dietary fibers on the aforementioned wastes was studied and the results were tabulated in Table (2). Both processes, steaming and/or water blanching, caused a significance reduction in polyphenols and ß-carotene in addition to a noticeable rise in total, soluble and insoluble dietary fibers of the citrus wastes mixture. The previous changes were more pronounced for water blanched waste mixture than steamed one. The reduction in polyphenols and ß-carotene was 31.68 and 35.85% for steamed waste mixture, 65.59 and 75.09% for water blanched one, respectively. Such reductions were mainly due to the influence of the used treatments on the degradation and hydrolysis of polyphenoles and ß-carotene. Removal of moisture during drying in addition to the reduction in the last previous compounds and water soluble maters in blanching water caused an apparent increase in total dietary fibers content and it's soluble and insoluble factions. According to Bibi *et al.*, (2002) ß-carotene was 2.59 g/100 g in the peel of citrus. Such caroteinoids are important as natural antioxidant materials. Gorinstein *et al.*, (2001) stated that dietary fiber is often consisted of soluble and insoluble fractions.

Proximate composition of the mixture of free seed citrus juice wastes:

As shown in table (3), the highest component of the mixture of free seed citrus juice wastes was nitrogen free extract (NFE) followed by crude fibers, ether extract, protein and ash, respectively. According to the results reported in the literature, crude protein, ether extract and ash levels ranged from 4.46 to 10.2, 0.89 to 3.24% and 2.6 to 3.9% in free seed citrus wastes, respectively. (Grigelmo-Miguel and Martin-Belloso, 1998; Chau and Huang, 2003; Figuerola *et al.*, 2005 and Larrea *et al.*, 2005) Steaming or water blanching of the free seed citrus wastes mixture before drying led to a high significance reduction in it's content of ether extract (20.72– 47.67%) and also a significance lower in it's level of NFE (2.12–4.43%). The effect of water blanching on the reduction of the previous two

Table 1. Total polyphenols, ß-carotene and dietary fibers of the free seed citrus juice wastes*

Free seed citrus juice wastes of :	Polyphenoles (mg/100 g)	ß-Carotene (g/100 g)	Dietary fibers(g/100 g)		
			Total	Soluble	Insoluble
Sour orange	$206.72^{a} \pm 11.46$	$2.65^{b} \pm 0.10$	$49.35^{b} \pm 0.57$	$1.31^{b} \pm 0.27$	$48.04^{b} \pm 0.49$
Sweet orange	$298.98^{b} \pm 11.01$	$3.15^{c} \pm 0.04$	$56.57^{a} \pm 0.48$	$0.79^{c} \pm 0.04$	$55.78^{a} \pm 0.30$
Grapefruits	$538.06^{d} \pm 17.93$	$2.26^{a} \pm 0.03$	$57.67^{a} \pm 0.64$	$1.72^{a} \pm 0.24$	$55.95^{a} \pm 0.34$
Mandarin	$365.82^{c} \pm 10.94$	$4.25^{d} \pm 0.02$	$40.07^{c} \pm 0.53$	$0.75^{c} \pm 0.04$	$39.32^{c} \pm 0.46$

*On dry weight basis
In a column, means having the same common superscript letter are not significantly different at 5% level.

Table 2. Effect of steaming, blanching and drying on polyphenols, ß-carotene and dietary fibers of the free seed citrus juice Wastes mixture*

Mixture of free seed citrus juice wastes	Polyphenols (mg/100 g)	ß-Carotene (g/100 g)	Dietary Fibers (g/100 g)		
			Total	Soluble	Insoluble
Dehydrated raw wastes (DRW)	$255.79^{c} \pm 8.06$	$2.65^{c} \pm 0.03$	$51.98^{a} \pm 0.42$	$0.98^{a} \pm 0.05$	$51.00^{a} \pm 0.28$
Dehydrated steamed wastes (DSW)	$174.75^{b} \pm 1.32$	$1.70^{b} \pm 0.04$	$67.44^{b} \pm 0.50$	$4.01^{c} \pm 0.11$	$63.43^{b} \pm 0.35$
Dehydrated blanched wastes (DBW)	$88.02^{a} \pm 5.11$	$0.66^{a} \pm 0.02$	$76.68^{b} \pm 0.57$	$1.66^{b} \pm 0.07$	$75.02^{c} \pm 0.43$

*On dry weight basis
In a column, means having the same common superscript letter are not significantly different at 5% level.

Table 3. Effect of steaming, water blanching and drying on proximate composition of the free seed citrus juice wastes mixture*

Component (%)	Free seed citrus juice wastes mixture		
	Dried	Steamed and dried	Water blanched and dried
Crude prolein	5.87^{a} ± 0.11	5.45^{a} ± 0.38	6.86^{b} ± 0.12
Crude fiber	10.06^{c} ± 0.07	14.40^{b} ± 0.26	17.37^{a} ± 0.29
Ether extract	12.02^{c} ± 0.10	9.53^{b} ± 0.08	6.29^{a} ± 0.05
Ash	4.14 ± 0.05	4.15 ± 0.03	4.39 ± 0.19
Nitrogen free extract (NFE)	67.91^{c} ± 0.11	66.47^{b} ± 0.48	64.90^{a} ± 0.52

*On dry weight basis

In a raw, means having the same common superscript letter are not significantly different at 5% level.

Table 4. Bulk density and some functional properties of free seed citrus juice wastes mixture

Properties	Free seeds citrus juice wastes mixture		
	Dried	Steamed and dried	Water blanched and dried
Bulk density (g/ml)	0.72^{c} ± 0.01	0.68^{b} ± 0.01	0.57^{a} ± 0.00
WHC (g water/g sample)[1]	3.94^{a} ± 0.14	7.51^{b} ± 1.13	8.18^{b} ± 0.60
OHC (g oil/g sample)[2]	0.96^{a} ± 0.18	1.30^{b} ± 0.04	1.49^{b} ± 0.08
Emulsifying capacity (%)	0.45^{c} ± 0.04	0.39^{b} ± 0.02	0.32^{a} ± 0.01

In a raw, means having the same common superscript lettesr are not significantly different at 5% level.

1-WHC; Water holding capacity.

2-OHC; Oil holding capacity.

Table 5. Sensory properties of beef burger paties free and containing free seed citrus juice wastes mixture

Beef burger	Appearance	Colour	Odour	Taste	Texture	Overall acceptability
Control*	Very acceptable	Acceptable	Very acceptable	Very acceptable	Very acceptable	Very acceptable
Containing 2% free citrus waste mixture in :						
Dried form	Very acceptable	Acceptable	Acceptable	Acceptable	Very acceptable	Very acceptable
Steamed and dried	Very acceptable	Acceptable	Very acceptable	Very acceptable	Very acceptable	Very acceptable
Water blanched and dried	Very acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Very acceptable

*Free from free seeds citrus juice wastes mixture components was nearly double that occurred after steaming process. This means that heat treatment or steaming and water blanching liberated the oil from their cells and leached it out as well as helped in the hydrolysis of NFE into low molecular weight compounds easily removed them. Such reduction caused a significant and apparent increase in crude fibers of the free seed citrus juice waste mixture. Meanwhile, ash did not significantly affected and protein of water blanched wastes was significantly increased. This may attributed to the balance between the rate of the reduction due to heat treatments and of the apparent increase due to the lower of ether extract and NFE after treating wastes with steaming or water blanching and drying.

Functional properties (FP) and Bulk density:

Functional properties depend on the chemical and physical structure of the protein and polysaccharides of the wastes (Femenia *et al.*, 2000). Data in Table (4) showed that heat treatment of the mixture of free seed citrus juice extraction wastes either by steaming or water blanching before drying caused a significance reduction in its bulk density, emulsifying capacity and an increase in it's WHC and OHC. These changes were more clear for the water blanched wastes than steamed one. The increase of crude fibers and the reduction of ether extract (see, Table 3) after water blanching or steaming of these wastes caused an increase in their particle size after grinding and sequentially a reduction in their bulk density and emulsifying capacities. On the other side, the increase in the protein, crude fibers, and the removal of low molecular weight of NFE especially free sugars after steaming or water blanching of these wastes increased their binding sites of water and oil. This led sequentially to increase their water and oil holding capacities. Rodriguez *et al.*, (2006) mentioned that heat treatment caused a modification on the composition and structure of fiber components. Larrauri, (1999) showed that removal of sugars increased the WHC of citrus juice wastes. Results of Robertson *et al.*, (2000), Lario *et al.*, (2004) and Garau *et al.*, (2007) indicated that OHC of citrus fiber varied from 0.9 to 6.5 g oil/g fiber. The wide range of the WHC and OHC may be attributed to the available numbers and nature of the water and oil binding sites in such fibers (Gordon, 1989, and Girgelmo-Miguel and Martin-Belloso, 1999).

Sensory properties of beef burger patties containing 2% free seed citrus juice waste mixture:

Evaluation of appearance, colour, odour, taste, texture and overall acceptability are presented in Table (5). The panelists did not detect any odd flavour when free seed citrus juice wastes were added (2%) to beef burger patties and their acceptance for the other different sensory properties of beef burger patties ranged from acceptable to very acceptable. They did not detect any differences in such properties between the control and those containing 2% steamed dried free seed citrus juice wastes.

According to the above results, utilization of citrus wastes did not only added an economical value for citrus fruits, and reduced the environmental pollution from such materials which are rich in organic matter, but also, enhance the nutritional value of foods by adding healthy bioactive materials namely, dietary fibers, ß-carotenes polyphenols and flavonoides, to food products.

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الملخص العربي

إعداد وتقييم بعض مخلفات الموالح لاستخدامها في إعداد أغذية وظيفية

وفاء علي عبد الرحمن أمين، سامية عبد الله خليل كشك

تم تقدير كل من التركيب الكيماوى، الخواص الوظيفية وبعض المركبات النشطة حيويا مثل المواد الفينوليه،البيتا كاروتين والالياف الغذائية لمخلفات عصير ثمار البرتقال الحامضى والسكرى والجريب فروت واليوسفى الخالية من البذور بالأضافة الى دراسة تأثير عمليات السلق بالماء والمعاملة بالبخار والتجفيف على مكونات وخواص مخلوط المخلفات المذكورة سابقا. وأوضحت النتائج انخفاض كل من المواد الفينوليه والبيتاكاروتين والمستخلص الاثيرى والمستخلص الخالى من النتروجين وكثافة الكتلة و القدرة الأستحلابية، وارتفاع الالياف الغذائية,الالياف الخام,الرماد والقدرة على الارتباط بالماء والزيت نتيجة معاملة مخلوط مخلفات الموالح الخالى من البذور بالسلق فى الماء او البخار بينما ارتفع محتوى البروتين وكذلك رقم الـ pH لهذه المخلفات بعد المعاملة بالبخار وانخفضا بعد السلق بالماء . ونظرا لجودة الخواص الوظيفية وارتفاع محتوى مخلوط هذه المخلفات من المركبات النشطة حيويا تم اضافتها بنسبة ٢% الى رقائق اللحم البقرى (الهامبورجر) وأكدت نتائج اختبارات التذوق الحسى تقبل المحكمين الجيد لهذا المنتج وخلوة من أى نكهة غريبة.