UTILIZATION OF FOOD PROCESSING BY-PRODUCTS AS A SOURCE OF BIOACTIVE SUBSTANCES

By

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B.Sc.Agric.Sci. (Biochemistry), Fac. Agric., Ain Shams Univ., 2004

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Abstract

This investigation was carried out to study the utilization of food processing by-products as a source of bioactive components as anti-oxidants and anti-microbial substances from the selected by-products organic and aqueous extracts of pomegranate, four varieties of mango and peanut. The results showed the wide range of total phenolic contents among all by-products ranged 71.06 to 124.18 mg/100g while it was from 41.65 to 95.07 mg/100g in aqueous extracts. Pomegranate by-products contained the highest phenolic levels in both the organic and aqueous extracts. As for organic extracts of mango seed pulp were identified twenty phenolic compounds, vanillic acid, protocatechuic, 3- OH- tyrosol, ferulic acid, caffeine, benzoic acid, mangefrein and chlorogenic acid are the broadcast phenolic compounds in the four mango seed pulp and kernel varieties (Zebdeia, Suckkarri, Hindi, Taimor) as for aqueous extracts, also it was identified twenty phenolic compounds.

Antioxidant capacity of organic and aqueous by-products of four varieties of mango and one variety of peanut and pomegranate as assessed by four antioxidant assays: DPPH, ABTS, FRAP and inhibition of bleaching β-carotene-Linoleic acid the results revealed that organic extract systems are more anti-oxidants efficient than that aqueous extracts, mango seed pulp for four varieties had the highest anti-oxidant activity than that found for mango seed kernel in almost all varieties. Pomegranate peel represents the highest anti-oxidant activity for either organic or aqueous extracts. Peanut shell in both extracts represents the lowest values of the DPPH, ABTS, FRAP and inhibition of bleaching β-carotene-Linoleic acid assays. The oxidative stability of sunflower oil as control 0.01, 0.02, and 0.05 % of organic and aqueous extracts of pomegranate, peanut, and four varieties zebdeia, Suckkari, Hindi and Taimor of mango seed kernel and mango seed pulp using Rancimat method. The results indicated that all concentrations of organic extracts for the selected by-products under investigation gradually increased the induction period (time) of sunflower oil with different levels of the anti-oxidants effectiveness. In antimicrobial assay the organic extracts had shown better anti-microbial activity compared to aqueous extract.

Key words: Mango, pomegranate and peanut by-products, phenols, antioxidant activity, High Performance Liquid Chromatography (HPLC).

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CONTENTS

	page
INTRODUCTION	**1**
REVIEW OF LITERATURE	**5**
1. Problem of food processing by-products and its types	**5**
2. By-products of plant food processing as a source of functional compounds	**10**
3. Benefits of antioxidants	**11**
4. Antibacterial activity in different plants and its effect on human health	**16**
a. Bioactive components in mango seed kernel	**18**
b. Bioactive components in pomegranate peel	**28**
c. Traditional medicinal uses of pomegranate peel	**30**
d. Bioactivities of pomegranate peel ellagic acid and punicalagin	**31**
e.Nutraceutical properties of pomegranate peel extracts	**32**
f. Cardiovascular protective of pomegranate peel	**33**
g. Anti-cancer properties of pomegranate peel	**34**
h. Effect of pomegranates peel extracts on prostate and colon cancer	**35**
i. Effect of pomegranate peel extracts on melanogenesis/skin cancer	**35**
j. Antimicrobial potential of pomegranate peel extracts	**36**
5. Bioactive components in peanut husk	**38**
6. Rancimat Test (oxidative stability index)	**40**
7. Antimicrobial activity (Disc diffusion assay)	**42**
MATERIALS AND METHODS	**46**
RESULTS AND DISCUSSION	**57**
1. Antioxidants activity and capacity of the selected by-products	**57**
2. Ferric Reducing power assay(FRAP)	**59**
3. Inhibition of β-carotene-linoleic acid bleaching assay	**60**
3. Determination of total phenolics (Folin- Ciocalteau reagent)	**60**
4. Determination of total flavonoids (Aluminium chloride assay)	**62**
5. Phenolic compound composition by using HPLC	**65**
8. Oxidative stability (Rancimat Test)	**73**
9. Antibacterial activity (Disc Diffusion)	**82**
Conclusion	**91**
Summary	**93**
References	**101**
Arabic summary	

LIST OF TABLES

No.	Title	page
1	Retention times of the authentic polyphenols.....	55
2	Antioxidant capacity tested DPPH organic and aqueous by-products.....	57
2	Antioxidant capacity tested ABTS for selected organic and aqueous by-products.....	58
3	Antioxidant capacity tested FRAP for selected organic and aqueous by-products.....	59
4	Antioxidant capacity tested inhibition of bleaching ß-carotene linoleic acid and for selected organic and aqueous by-products.....	60
5	Total phenolics of organic and aqueous selected by-products extracts.....	61
6	Total flavonoid of organic and aqueous selected by-products extracts.....	63
7	Phenolic compound composition (% of total identified polyphenols) of selected organic extracts by-products by HPLC.....	65
8	Phenolic compound composition (% of total identified polyphenols) of selected aqueous extracts by-products by HPLC.....	71
9	Oxidative stability (Rancimt at 100 °C) of sunflower seed oil as affected by adding selected organic and aqueous by-product extracts.....	74
10	Antimicrobial activity of organic and aqueous extracts of selected by- products.....	84

LIST OF FIGURES

No.	Title	Page
1	General structure of the important flavonoid compounds in pomegranate peel.....	9
2	Pomegranate fruit and its anatomical components.....	29
3	General structure of the important phenolic compounds in pomegranate peel.....	33
4	Reaction of DPPH$^{\cdot}$ free radical with antioxidant.....	48
5	Standard curve of FRAP assay as ($FeSO_4.7\ H_2O$).....	49
6	Standard curve of (BHT) for DPPH$^{\cdot}$ assay.....	50
7	Standard curve of phenolic compounds.....	51
8	Standard curve of flavonoid compounds.....	52
9	HPLC chromatogram of authentic polyphenols.....	54
10	Chart of rancimat test of Suckkari and Taimor mango seed kernel aqueous extract.....	77
11	Chart of rancimat test of Suckkari and Hindi mango seed pulp aqueous extract.....	78
12	Chart of rancimat test of peanut shell organic extract.....	79
13	Chart of rancimat test of Hindi mango seed pulp.....	80
14	Chart of rancimat test shows different concentrations of BHT as standard of synthetic antioxidants at 100^{o}C.....	81
15	Percentage of inhibition of gram positive, gram negative bacterial strains exposed to bioactive extracts from selected by- products.....	86

INTRODUCTION

Antioxidants have a major role in our life and in human body; it can purify our body from free radicals. Free radicals have been shown to be harmful as they react with important cellular components such as proteins, DNA and cell membrane (Mantena *et al*. 2008). On the other hand, the body requires free radicals for immune system responses. However, an overload of these molecules had been linked to certain chronic heart diseases, liver and some form of cancers (Temple, 2000 and Prakash *et al*. 2007). Human body contains anti-free radical defense system, which includes antioxidant enzymes like catalase, peroxidase and superoxide dismutase and antioxidant compounds like ascorbic acid and tocopherol (Oke *et al*. 2009).

Reactive oxygen species (ROS) can be classified into superoxide ion (O_2^-), hydroxyl radical (OH^-). Free radicals generated in tissues have tendency to robe the electrons from other molecules in the surroundings in order to replace their own losses. This process leads to the damage of cell membranes, mitochondria, proteins, lipids, DNA etc; the main characteristic of an antioxidant is its ability to trap the free radicals. The primary sources of antioxidants are whole grains, fruits and vegetables. Plant antioxidants like vitamin C, vitamin E, carotene; phenolic acids have been recognized as having the potential to reduce disease risk.

An antioxidant (free radicals scavenger) is a compound that inhibits or delays the oxidation of substrates even if the compound is present in a significantly lower concentration than is the oxidized substrate. These free radical scavenger help in preventing stress

induced diseases such as melanoma cardiac disorders, diabetes mellitus, inflammatory and neurodegenerative diseases, cancer (Prakash *et al*. 2007; Jing *et al*. 2007). Vegetables are a good source of dietary antioxidants, such as vitamin C, vitamin E and ß- carotene. The antioxidative phytochemicals in grains, vegetables, fruits and medicinal plants have received increasing attention for their potential role in preventing human diseases (Pallauf *et al*. 2008).

Phenolic acids and flavonoids are considerably present in vegetables and fruits; thus they are an integral part of the human diet. Recently, they have received much attention since many epidemiological studies suggest that consumption of polyphenol-rich foods and beverages is associated with a reduced risk of cardiovascular diseases, stroke and certain forms of cancer (Kaur and Kapoor, 2006). These protective effects have partly been ascribed to the antioxidant properties especially of flavonoids. Costa *et al*. (2012).

Tropical countries produce a large amount of native and exotic fruit species which are potentially interested in the food industry. The nutritional and therapeutic values in these fruits are mainly due to the presence of bioactive compounds, especially polyphenols. The anthocyanins belong to the flavonoid family and represent a group of pigments responsible for most of the colors in fruits, leaves, flowers, stems and roots of plants. Several investigations have focused on the health benefits of consumption of red–black fruits, claiming these as natural sources of bioactive compounds with highly promising antioxidants and anti-inflammatory characteristics. Furthermore, the consumption of red–black berries brings a positive impact on several

chronic conditions, such as obesity, diabetes, cancer, cardiovascular and neuroses generative diseases. This section summarizes the foremost bioactive compounds and the health properties of mango varieties (Zebdia, Suckkari, Hindi and Taimor).

Flavanols, flavonols and anthocyanins are included in this group. Among flavanols, the most common in fruits are of the catechin and gallocatechin types and they may exist in the monomer form or can polymerize, giving rise to condensed tannins or proanthocyanidins.

For example many studies have demonstrated that mango contains a wide array of phytochemicals, but many species and cultivars have not been analyzed for these important compounds (Ravo *et al*. 2008). It is also known that vitamin C, an important compound of mango fruits, mango heavy metal ions reacts with singlet oxygen and other free radicals, and suppresses peroxidation, reducing the risk of arteriosclerosis, cardiovascular diseases, and some forms of cancer (Navarro *et al.* 2006). They are potent antioxidants and have free radical scavenging abilities. The antioxidant constituents are present in all parts of the plant such as bark, stalks, leaves, fruits, roots, flowers, pods, seeds (Baravalia *et al*. 2009; Kaneria *et al.*2009; Rajaei *et al.* 2010; Golivand *et al*. 2010).

Finally, the role of an antioxidant can be summarized as follows

- Antioxidants play an important role as health-protecting factor. Evidences show that the reactive oxygen species have been implicated in many diseases, like cancer, diabetes, atherosclerosis and heart diseases. Most of the antioxidant compounds in a diet are derived from plant sources belong to various chemical classes with

a wide variety of physical and chemical properties, various antioxidant activity methods have been used to monitor and compare the antioxidant activity.

AIM OF THE STUDY

By- products obtained after food processing still contain large amount of phenolic substances including flavonoids and phenolic acids which act as anti-radical and antioxidant activities. So they have potential nutritional and therapeutic effect depending on their bioavailability and metabolism.

Therefore, this study was aimed to evaluate the activity of bioactive components as antioxidants and anti-microbial from utilization of food processing by-products as well as to identify the most potential antioxidant compounds in them.

REVIEW OF LITERATURE

1- Problem of food processing by-products and its types

From economic and environmental points of view, adding value to agricultural and agro-industrial by-products is always desirable. Such residues are usually used for animal feed; however, the potentially valuable compounds they contain could be used to make high-value food products (Hu *et al*. 2009; Nandeesh *et al*. 2011; Elleuch *et al*. 2011). The amount of bio-waste produced by the food industry annually in the European Union is estimated at 37,000,000 ton (Commission of the European Communities, 2008). In 2011, FAO published a first report assessing global food losses and food waste (FAO 2011). This study estimated that each year, one-third of all food produced for human consumption in the world is lost or wasted. Grown but uneaten food has significant environmental and economical costs. Obviously, this food wastage represents a missed opportunity to improve global food security and to mitigate environmental impacts generated by agriculture. In addition, by 2050, food production will need to be 60 percent higher than in 2005/2007 (Alexandratos and Bruinsma, 2012), if production is to meet demand of the increasing world population. Making better use of food already available with the current level of production would help meet future demand with a lower increase in agricultural production.

To date, no study has analyzed the impacts of global food wastage from an environmental perspective, it is now recognized that food production, processing, marketing, consumption and disposal have important environmental externalities because of energy and

natural resources usage and associated greenhouse gas (GHG) emissions. Broadly speaking, the environmental impacts of food mostly occur during the production phase, These bio-wastes constitute an environmental problem because they contain large quantities of nitrogen and phosphorous and they also have high water content which makes them susceptible to modification by micro-organisms, with leach at formation and gas emission,one example is cereal by-products, which find applications in food as sources of dietary fiber (DF) (Hu *et al*. 2009; Nandeesh *et al*. 2011; Elleuch *et al.* 2011).

There are other examples of residues from agricultural processing fruits and vegetables, fruit by-products might also be utilized for their phenolic content and antioxidant properties as polyphenols or condensed tannins (proanthocyanidins) from a large number of fruit species have been used to enrich fruit extracts (Djilas *et al*. 2009).

Schieber *et al*. (2008) showed that fruit juices and derived products such as nectars and drinks have experienced growing popularity within the last years. Grapes and apples are the most important fruits in the temperate zone, while oranges, pineapples, bananas, watermelons and mangos are the predominant fruits of tropical and subtropical areas.

Among other reasons, the rise in consumption and export of processed fruit juices, pulps and concentrates may be attributed to better transportation and distribution systems, and improved cultivation and processing methods. Fruits from the temperate zone are usually characterized by a large edible portion and moderate amounts of waste materials such as peels, seeds and stones. In contrast, considerably

higher ratios of by-products arise from tropical and subtropical fruit processing (Askar, 1998).

Due to increasing production, disposal represents a growing problem since the plant material is usually prone to microbial spoilage, thus limiting further exploitation. On the other hand, costs of drying, storage and shipment of by-products are economically limiting factors. Therefore, agro-industrial waste is often utilized as feed or as fertilizer. However, demand for feed may be varying and dependent on agricultural yields. The problem of disposing by-products is further aggravated by legal restrictions (Schieber *et al*. 2008).

Thus, efficient, inexpensive and environmentally sound utilization of these materials is becoming more important (Lowe and Buckmaster, 1995). Especially since epidemiological studies have pointed out that consumption of fruits and vegetables imparts health benefits, e.g., reduced risk of coronary heart disease and stroke, as well as certain types of cancer.

Apart from dietary fiber, these health benefits are mainly attributed to bioactive compounds such as carotenoids, polyphenolics, tocopherols, vitamin C, and others. In most cases, the wasted by-products can present similar or even higher contents of bioactive compounds than the final product such as antioxidants, antimicrobial, colorants and thickener agents (Ayala-Zavala, 2010).

This review summarizes biological active compounds of berry fruits and their importance in relation to human health. The group of bioactive compounds consists of phenolic compounds, including anthocyanins, phenolic acids, stilbens, tannins, and carotenoids. Berries