UTILIZATION OF WASTE GENERATED DURING PROCESSING OF SOME FRUIT AND VEGETABLE JUICES

By

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B.Sc. Agric. Sci. (Food Science), Fac. Agric., Cairo Univ., 2004

THESIS
Submitted in Partial Fulfillment of the Requirements for the Degree of

MASTER OF SCIENCE

In

Agricultural Sciences
(Food Science)

Department of Food Science
Faculty of Agriculture
Cairo University
EGYPT

2013

APPROVAL SHEET

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SUPERVISION SHEET

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Title of Thesis: Utilization of Waste Generated During Processing of Some Fruit and Vegetables Juices
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ABSTRACT

The present work was conducted to study the physical and chemical properties of wastes (solids and liquids) generated during processing of some fruits and vegetables (kernels and peels of mango, peels and pulp of orange, kernels and pomace of apricot and strawberry pomace). Phytochemicals profiles and dietary fiber composition of dried solid wastes was determined as well as evaluation of their antioxidant activity. In addition, the utilization of solid wastes as a value added products (source of dietary fiber in biscuits, pectin, coloring and clouding agents, antifungal effect and essential oils) were evaluated. The results indicated that dried apricot kernel had the highest amount of crude protein content (19.18%), fat content (44.94%) and crude fiber content (16.63%). It is also cleared that; dried apricot pomace significantly had the highest value of ash content (5.49%), total soluble sugars (44.54%), reducing sugars (20.11%) and non-reducing sugars (24.43%). Concerning the phytochemicals profiles, the results revealed that, dried mango kernel and dried strawberry pomace significantly contained the same amount of total phenol. Dried mango kernel and dried orange pulp significantly contained the highest amount of total flavonoids. It is also noticed that, dried orange peel and dried apricot pomace significantly contained the highest amount of carotenoids. Moreover, dried apricot pomace and dried mango peel significantly contained highest amount of ascorbic acid. However, dried mango peel had the highest level in antioxidant activity. The dried state of mango peels and orange peels were utilized for their use in the preparation of biscuits. Wheat flour was replaced at 0, 5, 10, 15 and 20% by dried peels of mango and orange separately. The sensory evaluation of biscuits showed that the taste and odor of biscuits containing dried mango peels up to 10% were significantly accepted as compared to control. While biscuits containing dried orange peel at 5% was significantly accepted as compared to control**.** The results also indicated that, the using of methanolic extracts of dried solid wastes had antifungal effect against *Aspergillus niger*, *Fusarium solani*, *Aspergillus paraseticus* and *Aspergillus flavus*. Moreover, the results showed that, the percent of fungal inhibition increased by increasing the extract concentration. A complete growth inhibition (100%) of *Fusarium solani* and *Aspergillus flavus* was achieved by using 1250 ppm of dried state of mango kernel extract or apricot pomace extract or strawberry pomace extract. Meanwhile, dried orange peel extract caused 100% inhibition for *Aspergillus flavus* at the same concentration. Moreover, results showed that orange peels produced color units by 9 folds and cloud units by 17 folds more than those produced from orange juice. So, such orange peel could be used as a source of coloring and clouding agents. Concerning the evaluation of wastewater generated during juice processing the results indicated that, wastewater of strawberry juice processing had the highest value in BOD_5, COD and TDS followed by wastewater of mango, apricot and orange juices.

Key words: Wastes; Phytochemicals, dietary fiber, TFC, ascorbic acid, Antioxidant activity, coloring and clouding agents and wastewater.

DEDICATION

I would like to dedicate this work to my dear beloved parents, may Allah protect them. Their endless love and high expectations on me have constantly empowered me to overcome difficulties and frustrations in my career. Whenever, I needed them, they were always there to patiently listen to me and give me encouragement. I also want to thank my brothers and sisters, who have always encouraged and supported me.

I would also like to dedicate this work to my beloved wife Reham, who provides me with unlimited care; support and encouragement that I need to achieve my goal and success.

Lastly, I dedicate this work to my dearest daughter Remas, who was patient and endured living in foreignness and suffered as a result of not spending sufficient time with her during the period of my study.

ACKNOWLEDGMENT

Firstly, many thanks to Allah for his blessing, mercy and grace to complete my thesis successfully.

Looking back, I am surprised and at the same time very grateful for all I have received throughout these years. It has certainly shaped me as a person and has led me where I am now. All these years of study are full of such gifts.

Special thanks and appreciation to ***Dr, Sobhy M. Mohsen*** *Professor of Food Science, Faculty of Agriculture, Cairo University, for the continuous support of my study and research, patience, motivation, enthusiasm, immense knowledge, endless encouragement, keen supervision, planning this study, valuable advices, generous and continuous support throughout the work and correcting my thesis.*

Deep thanks to ***Dr. Mohamed H. Aly,*** *Associate Professor of Food Science, Faculty of Agriculture, Cairo University, for his endless encouragement, sincere help, his noble supervision, scientific advises, guidance through the study, and revision the manuscript of this thesis*

I wish to express my sincere thanks, deepest gratitude and appreciation to ***Dr. Hans Schnitzer*** *Professor of Engineering, Graz University, Austria*

Special thanks are extended to all staff members in Food Science Department, Faculty of Agriculture, Cairo University, for their help and support.

My sincere gratitude and appreciation goes to my dear colleagues and friends, who have assisted and supported me throughout the most rigorous phase of my research with their expertise, wisdom, and friendship.

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INTRODUCTION

Waste materials generated from food processing and foodservice facilities can present difficult treatment problems since they contain large amounts of organic components. Wastes from different food processes (freezing, dehydration, meat processing, poultry, and seafood, vegetables & fruits processing) can produce distinct off odors and heavy pollution of water and environment unless they have a proper treatment. Improper waste disposal is hazardous to humans and aquatic forms of life.

Waste disposal from food-processing and food service facilities can present a hazard because of the high content of organic and inorganic matter as well as pathogenic microorganisms. A waste disposal survey is needed to identify the quantity of waste materials and waste characteristics.

According to the Food and Agriculture Organization, roughly one-third of the edible parts of food produced for human consumption were lost or wasted globally. This amount accounted about 1.3 billion ton/year and reflected not only the food processing wastes, but also the food losses. The latest term was accounted for the decrease in edible food mass that discarded or degraded in different stages of food supply chain like production, postharvest handling, processing, distribution and consumption (Gustavsson *et al*., 2011).

The Egyptian Ministry of Environmental Affairs (2009) reported that the amount of generated solid waste was nearly 75 million tons and the generated municipal waste was about 20 million tons annually. In

Egypt, municipal waste thus represented only 25 per cent of the generated solid waste with daily generation of 55 thousand tons.

Treatment and disposal technologies such as sanitary landfilling, composting and incineration could be as recent technology in Egypt and having been introduced over the past two decades. Crude open dumping is the most common practice and dumpsites commonly set a light to reduce the volume of accumulating waste, hence adding to the air pollution caused by the uncovered dumped waste itself. The practice of sanitary landfilling is still in its infancy in Egypt. However, controlled tipping has been successfully adopted in a number of cases.

Wastewaters from food plants contain variable amounts of suspended and soluble solids, which must be reduced to an acceptable level before discharging into natural bodies of water. Suspended solids could be removed readily by a primary treatment method, such as screening, filtration, sedimentation, or centrifugation. A variety of equipments are available for solids/liquid separation, and their selection depends on the economics and the size of the operation. Soluble solids in wastewater include inorganic ions and relatively small organic molecules. In food wastewaters, the soluble organic substances were the most important group from the pollution standpoint. These substances include sugars, organic acids, and alcohols expressed as chemical oxygen demand (C.O.D.) or biological oxygen demand (B.O.D.). The soluble organic substances (C.O.D. and B.O.D.) must be reduced to a low value (less than 100 mg/l) before the effluent was discharged. This reduction was usually accomplished by a secondary treatment method, which was essentially a biological oxidation process,

utilizing natural microorganisms and atmospheric oxygen (Saravacos and Iredale, 1971).

The fruit and vegetable processing industry is a major enterprise in Egypt, occupying a significant place in food supply. This industry has been identified as an important Contributor to the pollution of water especially when large industrial establishments are involved as well as solid waste. Fruit and vegetable wastes (FVW) are produced in large quantities in markets and constitute a source of pollution and nuisance in municipal landfills because of their high biodegradability.

Fruit and vegetable wastes (FVW) in the past, often have been dumped or used without treatment for animal feed or as fertilizers.

Nevertheless, discharging of wastes does not account the potentiality of re-utilizing them in the food chain. For this reason, the term (food by products) is increasingly used among the related scientists in order to notify that food wastes are ultimate substrates for the recapture of functional compounds and the development of new products with a market value. Food wastes could consider as a source of valuable nutraceuticals and the valorization of fruit by-products as a source of phytochemicals i.e. phenols and carotenoids. Fruit by-products could also be applied as natural food or beverage preservatives since they extended the shelf-life of the product by delaying the formation of off flavors and rancidity (Sonja *et al*., 2009).

Agro industrial wastes are rich in dietary fibers, appreciable amounts of colorants and antioxidant compounds or other bioactive compounds with positive health effects. Thus, new aspects concerning the use of these wastes for production of value added compounds (food

additives or supplements with high nutritional value) have gained increasing interest. These products as value added compounds could reduce the processing costs and at the same time reduce the environmental pollution.

In Egypt and in many Mediterranean countries, major quantities of the fruit processing waste such as peels, seeds, pulps and pomace were not further processed. Some attempts were made to use these residues as livestock feed, although their low nutritional value allowed only limited success. Other applications included the extraction of pectin, the recovery of essential oils, the production of clouding or thickening agents, and the purification of carotenoids to obtain natural pigments suitable for food or juice coloring, therefore, the present work was carried out to study:

1- The state of different wastes (either liquid or solid) generated during the processing of mango, orange, apricot and strawberry juices.
2- The identification, treatment and evaluation of the solid and liquid waste fractions characteristics.
3- The utilization of the separated wastes for the production of value added compounds such as (phenolic compounds, flavonoids, ascorbic acid, fiber sources and tannins).
4- The industrial use of these compounds in some food products.

REVIEW OF LITERATURE

1. Fruits Processing wastes

With the increase in production of processed fruit products, the amount of fruit wastes generated was increased enormously. Sudhakar and Maini (1999) found that large amounts of these wastes posed the problem of disposal without causing environmental pollution. These wastes could be effectively disposed by manufacturing useful by-products from them.

Pandey *et al*. (2000) reported that solid wastes usually originated from pre-treatment (washing and sorting), consisted of damaged fruits, stems and stalks. A major source of solid waste generation was the pressing process, in which peels, seeds, pulps were separated from the fruit juice. A large unused potential in the juice processing wastes, contained a sizeable amount of healthy substances, such as flavonoids, colors and pectins

a. Mango juice processing waste

Mango (*Mangifera indica* L.), which belongs to the family Anacardiaceae, is one of the most cultivated fruit in the world. Several million tons of mango wastes were produced annually from processing. It was reported that about 20% of mango fruits were processed into different products such as puree, nectar, leather, pickles and canned slices, among others, which had worldwide popularity (Loelillet, 1994).

The kernel inside the seed represented from 45% to 75% of the seed and about 20% of the whole fruit (Arogba, 1997). Moreover, Soong and Barlow (2004) reported that during processing of mango,