

**EVALUATION OF SOME FOOD PLANT WASTES
AS A SOURCE OF NUTRIENTS AND THEIR RE-
USES IN FOOD PURPOSES.**

By

EMAD ABD ELRHMAN MOHAMED

B.Sc. Agric., (Food Science and Technology) Fac. of Agric.,
Ain Shams Univ.(1987)

THESIS

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

Of

MASTER OF SCIENCE

In

**AGRICULTURAL SCIENCES
(Food Science and Technology)**

**Department of Food Science and Technology
Faculty of Agriculture, Cairo
Al-Azhar University**

**1435 A.H
2014 A.D**

APPROVAL SHEET
NAME: EMAD ABD ELRHMAN MOHAMED
TITLE: EVALUATION OF SOME FOOD
PLANT WASTES AS A SOURCE OF
NUTRIENTS AND THEIR RE-USES IN
FOOD PURPOSES.

THESIS
Submitted in Partial Fulfillment of the
Requirements for the Degree

Of
MASTER OF SCIENCE

In
AGRICULTURAL SCIENCES
(Food Science and Technology)

Department of Food Science and Technology
Faculty of Agriculture, Cairo
Al-Azhar University
1435 A.H
2014 A.D

Approved by:

Prof. Dr. MOHAMED MAGDY MOSTAFA

Professor of Food Science and Technology, Faculty of Agriculture, Ain - Shams University.

Prof. Dr. MOHAMED SHAHAT SALEM

Professor and Head of Food Science and Technology, Dept., Faculty of Agriculture, Cairo, Al-Azhar University.

Prof. Dr. GAMAL ROWAYSHID H. ISMAIL

Professor of Food Science and Technology, Faculty of Agriculture, Cairo, Al-Azhar University

Prof. Dr. MOSTAFA ABOU AL-FADEL MOHAMED.....

Professor of Food Science and Technology, Faculty of Agriculture, Cairo, Al-Azhar University

Date: 31/3/2014 A.D

Date: 30/5/1435 A.H

**TITLE: EVALUATION OF SOME FOOD
PLANT WASTES AS A SOURCE OF
NUTRIENTS AND THEIR RE-USES IN
FOOD PURPOSES.**

NAME: EMAD ABD ELRHMAN MOHAMED

THESIS

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

Of

MASTER OF SCIENCE

In

**AGRICULTURAL SCIENCES
(Food Science and Technology)**

**Department of Food Science and Technology
Faculty of Agriculture, Cairo
Al-Azhar University**

1435 A.H

2014 A.D

Supervision Committee:-

Prof. Dr. ALAA EL-DEIN SALAMA MOHAMED

Professor of Food Science and Technology, Faculty of Agriculture, Cairo, Al-Azhar University

Prof. Dr. GAMAL ROWAYSHID H. ISMAIL

Professor of Food Science and Technology, Faculty of Agriculture, Cairo, Al-Azhar University

Prof. Dr. MOSTAFA ABOU AL-FADEL MOHAMED.....

Professor of Food Science and Technology, Faculty of Agriculture, Cairo, Al-Azhar University

Prof. Dr. AKILA SALEH HAMZA

Supervisor of Regional Center for Food and Feed, Agricultural Research Center, Egypt

CONTENTS

	Page
LIST OF TABLE	VII
LIST OF FIGURES	IX
LIST OF ABBREVIATION	XI
1- INTRODUCTION	1
THE AIM OF THE WORK	7
2-REVIEW OF LITERATURE	9
2-1.Healthy benefits of pomegranate fruit	9
2-2.Pomegranate by-products in pomegranate fruit	12
2-3.Pomegranate by-products (peels and seeds) as source of natural antioxidant	14
2-4.Multiple uses of pomegranate by-products in food technology and human nutrition	20
2-4-1. Utilization of pomegranate fruit peels in food technology and human nutrition	20
2-4-1-1. pomegranate fruit peels as antioxidant agent	20
2-4-1-2. pomegranate fruit peels as antimicrobial agent.....	28
2-4-1-3. Biological evaluation of pomegranate fruit peels ...	34
2-4-1-4. Healthy benefits of pomegranate fruit peels	35
2-4-2. Utilization of pomegranate seeds in food technology and human nutrition	36
2-4-2-1.Composition and fatty acids profil of pomegranate fruit seeds (PFS) oil	36
2-4-2-2. Pomegranate fruit seeds (PFS) oil as antioxidant...	41
2-4-2-3.Biological function and healthy benfits of pomegranate fruit seeds (PFS) oil	44
2-5. The applications of Pomegranate fruit processing by-products in food processing	50
2-5-1. Utilization of Pomegranate fruit processing by-products as antioxidant agent in meat products	50

	Page
2-5-2. Utilization of Pomegranate by-products as antioxidant in edible oil	56
3-MATERIALS AND METHODS	58
3-1. Materials	58
3-1-1. Pomegranate fruits	58
3-1-2. Burge ingredients.....	58
3-1-3. Sunflower oil	58
3-1-4. Chemical and Reagents	59
3-2. Methods	59
3-2-1. Technological methods	59
3-2-1-1. Preparation of pomegranate fruit peels (PFP) powder	60
3-2-1-2. Preparation of pomegranate fruit seeds (PFS)..... powder	60
3-2-1-3. Extraction of pomegranate fruit seeds (PFS) oil.....	61
3-2-1-4. Extraction of phenolic compound from pomegranate peel	61
3-2-1-5. Technological applications of utilization of pomegranate fruits processing wastes in Technological processing of food production and preservation.....	61
3-2-1-5-1. Incorporation of pomegranate fruit peels (PFP) powder by- product into beef burger formula	61
(a). Preparation of defatted soybean flour (DSF) Pomegranate fruit peels (PFP) powder blends.....	62
(b). Preparation of Beef burger containing the pomegranate fruit peels (PFP) powder and their formulation	62
(c). Cooking of beef burger patties.....	63
3-2-1-5-2. Using of pomegranate fruit peels extract (PFPE).. as natural antioxidant agent in refined sunflower seeds (RSFS) oil.....	65

	Page
3-2-1-5-3. Using of pomegranate fruit seeds (PFS) oil as natural agent antioxidant in refined sunflower seeds (RSFS) oil.....	65
3-2-2. Analytical Methods.....	66
3-2-2-1. Physical analysis	67
3-2-2-1-1. Determination of Water holding capacity (WHC)..	67
3-2-2-1-2. The pH value measurement.....	67
3-2-2-1-3. Calculation of cooking loss percent	68
3-2-2-1-4. Determination of diameter shrinkage	68
3-2-2-2. Chemical analysis.....	69
3-2-2-2-1. Gross chemical composition.....	69
3-2-2-2-1-1. Moisture content.....	69
3-2-2-2-1-2. Crude protein content	69
3-2-2-2-1-3. Crude lipids content.....	69
3-2-2-2-1-4. Ash content	69
3-2-2-2-1-5. Crude fiber content	69
3-2-2-2-1-6. Total carbohydrates	70
3-2-2-2-2. Determination of amino acids composition	70
3-2-2-2-3. Determination of fatty acids composition	72
3-2-2-2-4. Determination of Minerals content	73
3-2-2-2-5. Determination of vitamins content	73
3-2-2-2-5-1. Determination of vitamin B ₁ and vitamin B ₂ contents.....	73
3-2-2-2-5-2. Determination of vitamin C (<i>L</i> -Ascorbic acid) content.....	75
3-2-2-2-5-3. Determination of vitamin E (- <i>tocopherol</i>).....	76
3-2-2-2-5-4. Determination of vitamin A (- Carotene).....	76
3-2-2-2-5-5. Determina of the total phenolic compounds.....	77
content.....	78
3-2-2-2-3. Total volatile basic-nitrogen (TVB-N) content.....	78
3-2-2-2-4. Determination of trimethylamin nitrogen (TMA-N) content	79
3-2-2-2-5. Determination of thiobarbituric acid (TBA).....	79

	Page
3-2-2-2-6. determination of the oxidative Stability (Rancimat induction period)of refined sunflower seeds (RSFS) oil	80
3-2-3. Microbiological Examination	81
3-2-4. Sensory evaluation of produced beef burgers.....	82
3-2-5- Statistical analysis	82
4-RESULTS AND DISCUSSION	83
4.1. Pomegranate Fruit Fractions Weight and the Physical Description of Prepared Pomegranate By-Products; Fruits Peel (PFP) Powder and Seeds (PFS) Powder and Their Yields.....	83
4.1.1. Pomegranate fruit fractions weight_.....	83
4.1.2. Physical description of prepared pomegranate fruit processing by- products, pomegranate fruit peels (PFP) powder and pomegranate fruit seeds (PFS) powder, and their yields	85
4.2. Nutritional and Chemical Evaluation for Pomegranate (<i>Punica granatum L.</i>) Fruit Peels (PFP) and Seeds (PFS) Powder By- Products.....	88
4-2-1. Gross chemical composition of produced pomegranate fruit peels (PFP) powder and seeds (PFS) powder.....	88
4-2-2. The nutritional protein quality of produced pomegranate fruit peels (PFP) and (PFS) seeds powder.....	90
4.2.3. Fatty Acids profile of Produced Pomegranate Seeds Oil	93
4.2.4 Minerals content of produced pomegranate fruit peels (PFP) and seeds (PFS) powder.....	96
4.2.5 Vitamins content of produced pomegranate fruit peels (PFP) and seeds (PFS) powder.....	98
4.2.6 Polyphenol fractions content of produced pomegranate fruit peels (PFP) powder.....	99
4-3. The Technological Application of Pomegranate By Products in Food Processing By Incorporation of Pomegranate Fruit Peels (PFP) Powder in Beef Burger Production	100

	Page
4-3-1. Gross chemical composition of beef burger trails as effected by the incorporation of pomegranate fruit peels (PFP) powder and frozen storage conditions (at - 18±2°C) for 90 days.....	100
4-3-2. The most important physical quality properties of produced beef burger trials as affected by the incorporation of pomegranate fruit peels (PFP) powder and frozen storage_ conditions (at -18±2°C for 9o days).....	107
4.3.2.1. The pH value of produced beef burger trials.....	111
4.3.2.2. Water holding capacity (WHC) of produced beef burger trials	112
4.3.2.3. Cooking loss % of beef burger.....	114
4.3.2.4. Shrinkage value(%) of produced beef burger tarils..	116
4-3-3. The most important chemical quality properties of produced beef burger trials as affected by the incorporation of pomegranate fruit peels (PFP) powder and frozen storage conditions (at-18±2°C for 90 days).....	117
4.3.3.1. Total volatile basic – nitrogen (TVB-N) content of produced beef burger trials.....	120
4.3.3.2. Trimethylamine-nitrogen (TMA-N) content of produced beef burger trials.....	122
4.3.3.3. Thiobarbituric acid (TBA) value of produced beef burger trials.	124
4.3.4. Microbiological quality aspects of produced beef burger trials as affected by the incorporation of pomegranate fruit peel (PFP) powder and frozen storage conditions (at -18±2°C for 90 days).....	127
4.5.3. Sensory quality properties of produced beef burger trials as affected by the incorporation of pomegranate fruits peel (PFP) powder and frozen storage conditions (at -18±2°Cfor 90 days).....	133
4.4. The Technological Application of Pomegranate Fruits ProcessingWastes by the incorporation of Pomegranat Fruit Peels (PFP) Extract and	136

	Page
Pomegranate fruit Seeds (PFS) Oil into the Refind sunflower (RSF) oil to Inhance its the Oxidative Stability	
4.4.1. Effect of the incorporation of pomegranate fruit (PFP) peels phenolics extract at different levels on the Oxidative stability criteria of refined sunflower (PFS) oil.....	138
4.4.2. Effect of incorporation of pomegranate fruit seeds (PFS) oil on the oxidative stability criteria of refined sunflower seeds (RSF) oil.....	140
5- SUMMARY	143
6- REFERENCE	153

LIST OF TABLES

No.	Table	Page
Table (1) :	Formulation of beef burger by using different replacement levels of pomegranate fruit peels (PFP) powder instead of defatted soybean flour (DSF).	64
Table (2) :	Pomegranate fruit fraction weight.	83
Table(3):	Physical description of prepared pomegranate by- products ; pomegranate fruit peels (PFP) powder and pomegranate fruit seeds (PFS) powder and their yields.	86
Table (4) :	Gross chemical composition (% , on dry weight) of pomegranate fruit peels (PFP) and seeds (PFS) powder .	89
Table (5) :	Amino acids composition of pomegranate fruit peels (PFP) and seeds (PFS) powder compared with the reference protein pattern of FAO/WHO.	91
Table (6) :	Fatty acids composition of the extracted pomegranate fruit seeds oil.	93
Table (7) :	Minerals content (mg/100g dry matter) of pomegranate fruit peels (PFP) and seeds (PFS) powder.	96
Table (8) :	Vitamins content (mg/100g) of pomegranate fruit peels (PFP) and seeds (PFS) powder.	98
Table (9) :	Polyphenol fractions content of pomegranate fruit peels (PFP) powder.	99
Table (10) :	Chemical composition of produced beef burger as affected by the incorporation level of pomegranate fruit peels (PFP) powder into the product and frozen storage conditions at - 18±2°C for 90 days.	103

Table (11):	The most important physical quality properties of produced beef burger trials as affected by the incorporation pomegranate fruit peels (PFP) powder and frozen storage conditions (at-18±2°C for 90 days).	108
Table (12) :	The most important chemical quality properties value (on wet weight basis) of produced beef burger trials as affected by the incroporation of pomegranate fruit peels (PFP) powder and frozen storage condition (at-18±2°Cfor90 days).	118
Table (13):	Microbiological quality aspects (log cfu/g) of produced beef burger trials as affected by the incorporation level of pomegranate fruit peels (PFP) powder and frozen storage conditions (at -18±2°C for 90 days).	129
Table (14) :	Sensory evaluation scores for the organoleptic quality properties produced beef burger trials as affected by the incorporation of pomegration fruits peel (PFP) powder and frozen storage conditions (at -18±2°C for 90 days).	134
Table (15):	The oxidative stability criteria of refined Sunflower (RSF) oil treated with different levels of pomegranate fruit peels (PFP) phenolics extract.	139
Table (16) :	The oxidative stability criteria of refined Sunflower (RSF) oil treated with different levels of pomegranate fruit seeds (PFS) oil .	141

LIST OF FIGURES

No.	Figure	Page
Fig.(1)	Plan of the present research.	59
Fig.(2)	Analytical methods applied in the present study that analyzed in present research.	66
Fig.(3)	The PH value of beef burger produced as affected by addition levels of the pomegranate fruit peels (PFP) powder and frozen storage conditions (at- $18\pm 2^{\circ}\text{C}$ for 90 days).	109
Fig.(4)	Water holding capacity (WHC) % of beef burger produced as affected by addition levels of the pomegranate fruit peels (PFP) powder, and frozen storage conditions (at- $18\pm 2^{\circ}\text{C}$ for 90 days).	109
Fig.(5)	Cooking loss % of beef burger produced as affected by addition levels of the pomegranate fruit peels (PFP) powder, and frozen storage conditions (at- $18\pm 2^{\circ}\text{C}$ for 90 days).	110
Fig.(6)	Shrinkage value of beef burger produced as affected by addition levels of the pomegranate fruit peels (PFP) powder, and frozen storage conditions (at- $18\pm 2^{\circ}\text{C}$ for 90 days).	110
Fig.(7)	Total volatile basic nitrogen TVB-N value (mg/100g) of beef burger produced as affected by addition levels of the pomegranate fruit peels (PFP) powder, and frozen storage conditions (at $-18\pm 2^{\circ}\text{C}$ for 90 days).	119
Fig.(8)	Trimethylamine-nitrogen (TMA-N) content (mg/100g) of beef burger produced as affected by addition levels of the pomegranate fruit peels(PFP) powder, and frozen storage conditions (at $-18\pm 2^{\circ}\text{C}$ for 90 days).	119
Fig.(9)	Thiobarbituric acid (TBA) value (mg malonaldehyde / kg) of beef burger produced as affected by addition levels of the	120

No.	Figure	Page
	pomegranate fruit peels (PFP) powder, and frozen storage conditions (at $-18\pm 2^{\circ}\text{C}$ for 90 days).	
Fig.(10)	Total bacterial count (TBC) (log cfu /g) of beef burger produced as affected by different addition levels of pomegranate fruit peels(PFP) powder, and frozen storage conditions (at $18\pm 2^{\circ}\text{C}$ for 90 days).	130
Fig.(11)	Psychrophilic bacteria (log cfu /g) of beef burger produced as affected by addition levels of pomegranate fruit peels (PFP) powder, and frozen storage conditions(at $-18\pm 2^{\circ}\text{C}$ for 90 days).	130
Fig.(12)	Coliform group (log cfu /g) of beef burger produced as affected by addition levels of pomegranate fruit peels (PFP) powder, and frozen storage conditions (at $18\pm 2^{\circ}\text{C}$ for 90 days).	131
Fig.(13)	The oxidative stability certeria of refined Sunflower seeds oil treated with different level of pomegranate fruit peels (PFP) phenolic extract.	139
Fig.(14)	The oxidative stability criteria of refined Sunflower (RSF) oil treated with different levels of pome- granate fruit seed (PFS) oil.	141

LIST OF ABBREVIATION

%	Percentage
°C	Centigrade degree
AOAC	Association of Official Analytical Chemistry
AACC	American Association of Cereal Chemists
FAC	Food and Agriculture Organization
WHO	World Health Organization
WHC	Water holding Capacity
PFPE	Pomegranate fruit peels extract
PFP	Pomegranate fruit peels
PFS	Pomegranate fruit seeds
PFPE	Pomegranate fruit peels extract
Cfu	Colony forming unit
TVB-N	Total volatile basic-nitrogen
TMA-N	Trimethylamine – nitrogen
TBA	Thiobarbituric acid
Kg	Kilogram
-fatty acids	Omega – Fatty acids
g	Gram
Fig.	Figure
Ed.	Editor
<i>et al.</i>	And others
HPLC	High Performance Liquid Chromatography
ml	Millitier
ppm	Part per million
mg	Microgram

L	Liter
h	Hour
SFA_s	Saturated fatty acids
MLIFA_s	Monounsaturated fatty acids
PLIFA_s	Polyunsaturated fatty acids
IAA_s	Indispensable amino acids
A.S	Chemical score of indispensable amino acid
M_±SE	Mean _± standard Error
LSD	Last Significant Difference