

UTILIZATION OF MORINGA SEEDS IN FOOD PROCESSING

By

AMIRA MOHAMED SHOKRY RIAD HASSANEN

B.Sc. Agric. Sc. (Food Industry), Cairo University, 1999

M.Sc. Agri. Sc. (Food Science and Technology), Ain Shams University, 2005

**A thesis submitted in partial fulfillment
of
the requirements for the degree of**

DOCTOR OF PHILOSOPHY

in

**Agricultural Science
(Food Science and Technology)**

**Department of Food Science
Faculty of Agriculture
Ain Shams University**

2012

الإستفاده من بذور المورينجا فى التصنيع الغذائى

أميره محمد شكرى رياض حسنين

بكالوريوس علوم زراعيه (صناعات غذائيه)، جامعة القاهره 1999
ماجستير علوم زراعية (علوم وتكنولوجيا الأغذية) - امعة عين شمس، 2005

العلوم الزراعية

(علوم وتكنولوجيا الأغذية)

قسم علوم الاغذية

كلية الزراعة

جامعة عين شمس

Approval sheet

**UTILIZATION OF MORINGA SEEDS IN FOOD
PROCESSING**

By

AMIRA MOHAMED SHOKRY RIAD HASSANEN

B.Sc. Agric. Sc. (Food Industry), Cairo University, 1999

M.Sc. Agri. Sc. (Food Science and Technology), Ain Shams University, 2005

This thesis for Ph.D. degree has been approved by:

Dr. Ahmed Nour El-Din Elias

Prof. Emeritus of Food Sciences, Faculty of Tourism and Hotel
Management, Helwan University.

Dr. Ibrahim Rizk Sayed Ahmed

Prof. Emeritus of Food Science and Technology, Faculty of
Agriculture, Ain Shams University.

Dr. Mohamed Mostafa Mohamed Abd El-Razik

Associate Prof. of Food Science and Technology, Faculty of
Agriculture, Ain Shams University.

Dr. Ahmed Yousif Gibriel

Prof. Emeritus of Food Science and Technology, Faculty of
Agriculture, Ain Shams University.

Date of Examination: 29 /5/ 2012

UTILIZATION OF MORINGA SEEDS IN FOOD PROCESSING

By

AMIRA MOHAMED SHOKRY RIAD HASSANEN

B.Sc. Agric. Sc. (Food Industry), Cairo University, 1999

M.Sc. Agri. Sc. (Food Science and Technology), Ain Shams University, 2005

Under the supervision of:

Dr. Ahmed Yousif Gibriel

Prof. Emeritus of Food Science and Technology, Department of Food Science, Faculty of Agriculture, Ain Shams University.
(Principal Supervisor)

Dr. Mohamed Mostafa Mohamed Abd El-Razik

Associate Prof. of Food Science and Technology, Department of Food Science, Faculty of Agriculture, Ain Shams University.

Dr. Fathi Abd El-Razik Ali

Prof. Emeritus of Food Technology, Agri-Industrialization Unit, Desert Research Centre.

ABSTRACT

Amira Mohamed Shokry Riad Hassanen: Utilization of Moringa Seeds in Food Processing. Unpublished Ph. D. Thesis, Department of Food Science, Faculty of Agriculture, Ain Shams University, 2012.

As the population grows, however, sources of food became more difficult to human. Also, recently, there has been an increasing interest and growing need for the search of new source of edible oil especially high-oleic vegetable oils, which have been demonstrated to reduce the risk of coronary heart disease. Therefore, the demand for high-oleic oils is increasing but there are only a few known sources available.

From such point of view this study was undertaken to evaluate the proximate analysis of *Moringa oleifera* L. seeds. The physical and chemical properties, the oxidative stability and fatty acid composition of *Moringa oleifera* L. (Moringa seed oil) were determined. The effect of adding Moringa seed oil concentration on the oxidative stability and sensory properties of cup cake and meatball manufacture during the storage period. The obtained data showed that:

Moringa seed was found to be rich in crude protein and fat which was 40.84% and 33.48%, respectively. Also *Moringa oleifera* L. seed contains crude fiber, ash and nitrogen free extract with 3.47%, 4.17% and 11.55%, respectively. *Moringa* seed oil had a very good physical quality including the refractive index, specific gravity, viscosity, smoke point and color represented in 1.4665, 0.9122 cm³/gm, 11776 CP, 207°C and 35Y, 3.6R, in respect. Also, *Moringa* seed oil was characterized with excellent chemical properties including acidity, saponification number, unsaponification matter, total tocopherols and total phenols which found to be 1.4%, 194.7%, 0.54%, 71.0 ppm and 466.8 ppm, in respect.

Moringa seed oil exhibited a very higher good oxidative stability where the peroxide value, TBA value at 532 nm, rancimate at 100°C and the specific extension at 232 and 270 nm were 5.44 meqO₂/kg, 0.874mg malonaldehyde/kg , 304.8 and 1.3720 and 0.1018, respectively.

Moringa seed oil was found to be contained a high content of oleic acid which represented 72.29% of the total fatty acid. Also, it contains 77.61% unsaturated fatty acid, 22.40% saturated fatty acid which it's considered to be a high ratio. The dominant saturated fatty acid was found to be Palmitic acid with 7.79% followed by Behenic acid with 6.87%.

The sensory evaluation of the prepared cup cakes proved that the replacement of shortening with 25% of *Moringa* seed oil have the highest overall acceptability scores and other sensory characteristics than the other replacement percentage.

Replacement of animal fat in preparing meatball samples with level of 25 and 50% of extracted *Moringa* seed oil caused a significant increase in the overall acceptability of the prepared meatball samples in comparison with the control samples containing 100% animal fat.

Key words: Aqueous enzymatic extraction, Cup cake, Fatty acid composition, Meatballs, *Moringa oleifera* seed oil, Physico-chemical characteristics, Oxidative stability.

ACKNOWLEDGMENT

All praises due to Allah, who blessed me with kind professors and colleagues, and gave me the support to produce this thesis.

I would like to express my deepest gratitude to **Prof. Dr. A.Y. Gibriel**, Professor of Food science and technology, Food Science Department, Faculty of Agriculture, Ain Shams University, for his kind supervision, carefully guidance, and great help through the investigation courses and during the preparation of manuscript.

Sincere appreciation to **Prof. Dr. F. Abd El-Razik Ali**, Professor of Food Science, Agri-Industrialization Unit, Desert Research Centre, for his plentiful advice, valuable help during the investigation and provided endless effort for me to complete this work. Deep thanks and gratitude to **Dr. M.M.M Abd El-Razik**, Professor of Food Science and Technology, Food Science Associate Department, Faculty of Agriculture, Ain Shams University, for his supervision, careful guidance during the laboratory work and every possible help he kindly offered during this investigation. Also, I would like to express a Sincere thanks to **Dr. A.M.A. Hozayen** Researcher of Food Science, Agri-Industrialization Unit, Desert Research Centre, for his guidance, kindly advice, continuous support and valuable help he offer in this investigation.

My deepest thanks extended to my dearest **Prof. Dr. M.Sh. Riad** Professor of Agriculture Agronomy, Faculty of Agriculture, Ain Shams University, for his supporting, advice and provided endless effort for me to complete this work. I would like to express many thanks **Dr. Nasr El-Bordeny**, Associate Professor, Animal production Department, Faculty of Agriculture, Ain Shams University, for his plentiful advice and his kind help during the laboratory work.

Sincere thanks to **Dr. F.O.F. Abou-Zaid**, Researcher of Food Science, Agri-Industrialization Unit, Desert Research Centre, for his cooperation and advice.

CONTENT

	Page
LIST OF TABLES	VI
LIST OF FIGURES	IX
1. INTRODUCTION	1
2. REVIEW OF LITERATURE	5
2.1. <i>Moringa oleifera</i> (history, uses and medicinal action)	5
2.2. The analysis of Moringa seeds	7
2.3. Extraction of Moringa seeds oil	11
2.3.1. Cold pressure extraction method	11
2.3.2. Solvent extraction method	12
2.3.3. Aqueous enzymatic extraction method	14
2.4. Effect of the refining process on the quality of Moringa seeds oil	15
2.5. The physical properties of Moringa seeds oil	16
2.6. The chemical properties of Moringa seeds oil	20
2.7. The oxidative stability of Moringa seeds oil	23
2.8. The fatty acid composition of Moringa seeds oil	27
2.9. The Uses of Moringa seeds oil in food processing	30
3. MATERIAL AND METHODS	34
3.1 Materials	34
3.1.1 <i>Moringa oleifera</i> seeds	34
3.1.2 The protease from <i>Bacillus sp</i>	34
3.1.3 Cup cake ingredients	34
3.1.4 Meatball ingredients	34
3.1.5 Reagents	34
3.2. Methods	35
3.2.1. Preparing <i>Moringa oleifera</i> seeds	35
3.2.2. Aqueous enzyme extraction of <i>Moringa oleifera</i> seeds oil	35
3.2.3. <i>Moringa oleifera</i> seed cake	35

II

	Page
3.2.4. The analysis of <i>Moringa oleifera</i> seeds, seed shell, seed kernel and seed cake	36
3.2.5. Physical properties of <i>Moringa oleifera</i> seeds oil.	36
3.2.5.1. Determination specific gravity	36
3.2.5.2. Determination of refractive index	36
3.2.5.3. Determination of viscosity	36
3.2.5.4. Determination of color	36
3.2.5.5. Determination of smoked point	37
3.2.6. Chemical properties of <i>Moringa oleifera</i> seeds oil	37
3.2.7. Oxidative stability of <i>Moringa oleifera</i> seeds oil	37
3.2.7.1. Peroxide value	37
3.2.7.2. Ultra-Violet absorption	38
3.2.7.3. Thiobarbituric acid value (TBA)	38
3.2.7.4. Rancimate induction period	38
3.2.8. Gas liquid chromatographic analysis of Moringa oil fatty acids.	39
3.2.9. Processing methods of Cup cake	40
3.2.9.1. Analysis of cup cake samples	41
3.2.9.2. Physical characteristics of cup cake samples	41
3.2.9.2.1. Volume	41
3.2.9.2.2. Weight	41
3.2.9.2.3. Specific volume	41
3.2.9.3. Determination of moisture content of cup cake samples during storage	42
3.2.9.4. Determination of staling rate of cup cake samples during storage	42
3.2.9.5. Oxidative stability of cup cake samples during storage	43
3.2.9.5. Sensory evaluation of cup cake samples	43

III

	Page
3.2.10. Processing methods of meatballs	44
3.2.10.1. Cooking loss of meatball samples during storage.	45
3.2.10.2. Oxidative stability of meatball samples during storage	45
3.2.10.3. Determination of free fatty acid	46
3.2.10.4. Sensory evaluation of meatball samples during storage	46
3.2.11. Statistical analysis	46
4. RESULTS AND DISCUSSION	47
4.1 Analysis of <i>Moringa oleifera</i> seeds	47
4.2 Physical parameters of extracted <i>Moringa oleifera</i> seed oil	50
4.2.1. Specific density	50
4.2.2. Refractive index	50
4.2.3. Viscosity	51
4.2.4. Smoked point	51
4.2.5. Color index	51
4.3 Chemical parameters of extracted <i>Moringa oleifera</i> seed oil	52
4.3.1. Acid value	52
4.3.2. Saponification number	53
4.3.3. Unsaponification matter	53
4.3.4. Total phenols content	54
4.3.5. Total Tocopherols	54
4.4. Oxidative stability of extracted <i>Moringa oleifera</i> seed oil	55
4.4.1. Peroxide value (POV)	55
4.4.2. Thiobarbituric acid (TBA) value	56
4.4.3. Ultra-Violet absorption	56
4.4.4. The induction period	57
4.5. Fatty acids composition	58

	Page
4.6. Effect of replacing shortening by extracted <i>Moringa oleifera</i> oil on cup cake quality	60
4.6.1. Analysis of prepared cup cake samples	61
4.6.2. Physical characteristics of prepared cup cake samples	64
4.6.2.1. Weigh of prepared cup cake samples	64
4.6.2.2. Volume of prepared cup cake samples	65
4.6.2.3. Specific volume of prepared cup cake samples	68
4.6.3. Acid value of prepared cup cake samples during storage period	68
4.6.4. The oxidative stability of prepared cup cake samples during storage period	70
4.6.4.1. Peroxide values (POV) of prepared cup cake samples during storage period	70
4.6.4.2. Thiobarbituric acid (TBA) value of prepared cup cake samples during storage period	73
4.6.5. Moisture content of prepared cup cake samples during storage period	75
4.6.6. The staling rate of prepared cup cake samples during storage period	76
4.6.7. The sensory evaluation of prepared cup cake samples	79
4.7. Effect of replacing animal fat in prepared meatballs by extracted <i>Moringa oleifera</i> oil	82
4.7.1. Cooking loss of prepared meatball samples during storage period	82
4.7.2. Oxidative stability of prepared meatball samples during storage period	85
4.7.2.1. Peroxide values (POV) of prepared meatball samples during storage period	85

	Page
4.7.2.2. Thiobarbituric acid (TBA) of prepared meatball samples during storage period	88
4.7.3. Acid value of prepared meatball samples during storage period	91
4.7.4. The sensory evaluation of prepared meatball samples during storage period	93
4.7.4.1. Appearance of prepared meatball samples during storage period	93
4.7.4.2. Color of prepared meatball samples during storage period	95
4.7.4.3. Odor of prepared meatball samples during storage period	98
4.7.4.4. Taste of prepared meatball samples during storage period	100
4.7.4.5. Tenderness of prepared meatball samples during storage period	102
4.7.4.6. Juiciness of prepared meatball samples during storage period	103
4.7.4.7. Overall acceptability of prepared meatball samples during storage period	105
5. SUMMARY	109
6. REFERENCES	115
ARABIC SUMMARY	

LIST OF TABLES

Table No.		Page
4.1	Analysis of <i>Moringa oleifera</i> seeds, seed kernel, seed shell and seed cake	48
4.2	Physical parameters of extracted <i>Moringa oleifera</i> seed oil	50
4.3	Chemical parameters of extracted <i>Moringa oleifera</i> seed oil	53
4.4	Oxidative stability of extracted <i>Moringa oleifera</i> seed oil	55
4.5	Fatty acids composition of extracted <i>Moringa oleifera</i> seed oil	59
4.6	Analysis of baked cup cake containing different amounts of Moringa oil	63
4.7	Physical characteristics of baked cup cake containing different amounts of Moringa oil	66
4.8	Acid values of baked cup cake containing different amounts of Moringa oil during storage period	69
4.9	Peroxide values of baked cup cake containing different amounts of Moringa oil during storage period	72
4.10	Thiobarbituric acid values of baked cup cake containing different amounts of Moringa oil during storage period	74
4.11	Moisture content of baked cup cake containing different amounts of Moringa oil during storage period.	75
4.12	Staling rate of baked cup cake containing different amounts of Moringa oil during storage period	77

VII

Table No.		Page
4.13	Freshness of baked cup cake containing different amounts of Moringa oil during storage period	78
4.14	Sensory evaluation of baked cup cake containing different amounts of Moringa oil	80
4.15	Cooking loss percentage of prepared meatball containing different levels of Moringa oil during storage period.	84
4.16	Peroxide value of prepared meatball containing different levels of Moringa oil during storage period.	87
4.17	Thiobarbituric acid of prepared meatball containing different levels of Moringa oil during storage period	90
4.18	Acid value of prepared meatball containing different levels of Moringa oil during storage period	92
4.19	Appearance of prepared meatball containing different levels of Moringa oil during storage period	94
4.20	Color of prepared meatball containing different levels of Moringa oil during storage period	97
4.21	Odor of prepared meatball containing different levels of Moringa oil during storage period	99
4.22	Taste of prepared meatball containing different levels of Moringa oil during storage period	101
4.23	Tenderness of prepared meatball containing different levels of Moringa oil during storage period	102

VIII

Table No.		Page
4.24	Juiciness of prepared meatball containing different levels of Moringa oil during storage period.	104
4.25	Overall acceptability of prepared meatball containing different levels of Moringa oil during storage period	106