

EFFECT OF DESERT ENVIRONMENTAL FACTORS ON THE QUALITY OF SOME FRESH MEATS AND THEIR PRODUCTS

By

ENGY FAYZ ZAKI

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

M.Sc. Agric. Sc. (Food Technology), Cairo University, 2007

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

DOCTOR OF PHILOSOPHY

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

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

2013

EFFECT OF DESERT ENVIROMENTAL FACTORS ON THE QUALITY OF SOME FRESH MEATS AND THEIR PRODUCTS

By

ENGY FAYZ ZAKI

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

M.Sc. Agric. Sc. (Food Technology), Cairo University, 2007

Under the supervision of:

Dr. Ahmed Youssief Gibriel

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

Dr. Mohamed Farag Khallaf

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

Dr. Samir Sayed Abou El –Ezz

Prof. Emeritus of Animal Physiology, Department of Animal
Physiology, Desert Research Center, Ministry of Agriculture and
Land Reclamation.

Approval Sheet

EFFECT OF DESERT ENVIRONMENTAL FACTORS ON THE QUALITY OF SOME FRESH MEATS AND THEIR PRODUCTS

By

ENGY FAYZ ZAKI

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

M.Sc. Agric. Sc. (Food Technology), Cairo University, 2007

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

Dr. Sobhy Mohamed Mohsen

Prof. Emeritus of Food Technology, Faculty of Agriculture, Cairo
University.

Dr. Yehia Abd El - Razik Heikal

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

Dr. Ahmed Youssief Gibriel

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

Dr. Mohamed Farag Khallaf

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

Date of Examination: / / 2013

CONTENTS

	Page
LIST OF TABLES	VI
LIST OF FIGURES	VIII
1. INTRODUCTION	1
2. REVIEW OF LITERATURE	4
2.1. Effect of feeding on carcass traits and sheep meat quality	4
2.1.1. Carcass traits of sheep	4
2.1.2. Chemical properties of sheep meat	6
2.1.2.1. Proximate composition	6
2.1.2.2. Fatty acids profile of sheep meat	8
2.2. The effect of feeding on physical properties of sheep meat	12
2.2.1. pH	12
2.2.2. Tenderness	13
2.2.3. Cooking loss	14
2.2.4. Color	15
2.3. Effect of frozen storage on chemical properties of meat products	17
2.3.1. Proximate composition	17
2.3.1.1. Moisture loss	17
2.3.1.2. Protein loss	17
2.3.2. T.B.A. value of meat products	18
2.4. Effect of frozen storage on physical properties of meat products	19
2.4.1. Water holding capacity of meat products	19
2.4.2. Plasticity of meat products	20
2.4.3. Tenderness of meat products	20
3. MATERIALS AND METHODS	21
3.1. Materials	21
3.1.1. Location	21
3.1.2. Animals and experimental design	21
3.1.3. Slaughtering and carcass evaluation	22

3.1.4. Processing of meat products	22
3.1.5. Preparation of sheep burger	22
3.1.6. Preparation of sheep sausage	23
3.2. Methods	24
3.2.1. Chemical analysis	24
3.2.1.1. Chemical composition	24
3.2.1.2. Measurement of lipid oxidation	24
3.2.1.3. Extraction of fatty acids	24
3.2.1.3.1. Lipid extraction	24
3.2.1.3.2. Separation of fatty acids	24
3.2.1.3.3. Preparation of diazomethane	25
3.2.1.3.4. Methylation of fatty acids with diazomethane	25
3.2.1.3.5. Source of standard fatty acids	26
3.2.1.3.6. Identification and determination of fatty acids by gas liquid chromatography (GLC)	26
3.2.1.4. Extraction of volatile compounds of meat	26
3.2.1.4.1. Extraction of volatile compounds of meat	26
3.2.1.4.2. Gas chromatography and gas chromatography-mass spectrometry (GC-MS)	26
3.2.2. Physical analysis	27
3.2.2.1. pH value	27
3.2.2.2. Water holding capacity and plasticity	27
3.2.2.3. Cooking procedure and cooking measurements	28
3.2.2.3.1. Cooking yield (%)	28
3.2.2.3.2. Cooking loss (%)	28
3.2.2.3.3. Fat retention (%)	28
3.2.2.3.4. Moisture retention (%)	28
3.2.2.4. Shrinkage measurements	28
3.2.2.4.1. Reduction in diameter (%)	28
3.2.2.4.2. Reduction in thickness (%)	29
3.2.2.4.3. Shrinkage (%)	29
3.2.2.5. Tenderness determination	29

3.2.2.6. Color measurement	29
3.2.3. Sensory evaluation	30
3.2.4. Hemo biochemical measurements	30
3.2.5. Statistical analysis	30
4. RESULTS AND DISCUSSION	31
4.1. Blood biochemical changes of sheep as affected by two feeding levels	31
4.2. Carcass characteristics of sheep as affected by two feeding levels	33
4.2.1. Carcass traits	33
4.2.2. Carcass composition	33
4.2.3. Carcass measurements	36
4.2.4. Non - carcass components	36
4.2.5. Composition of leg tissues of sheep fed two feeding levels	39
4.3. Chemical properties of sheep meat as affected by two feeding levels	40
4.3.1. Proximate composition	40
4.3.2. Fatty acid composition of sheep meat as affected by two feeding levels	41
4.3.3. Volatile compounds of sheep meat as affected by two feeding levels	43
4.4. Physical and chemical properties of sheep meat as affected by two feeding levels	47
4.5. Color measurements of sheep meat as affected by two feeding levels	51
4.6. Sensory evaluation of sheep meat as affected by two feeding levels	52
4.7. Changes in chemical properties of sheep burger as affected by two feeding levels and frozen storage at -18°C for three months	53
4.7.1. Changes in proximate composition	53
4.7.1.1. Changes in moisture content	53

4.7.1.2. Changes in protein content	53
4.7.1.3. Changes in fat content	55
4.7.1.4. Changes in ash content	55
4.7.2. Changes in thiobarbituric acid (T.B.A.)	56
4.8. Changes in physical properties of sheep burger as affected by two feeding levels and frozen storage at -18°C for three months	56
4.8.1. Changes in water holding capacity (W.H.C)	56
4.8.2. Changes in plasticity	59
4.8.3. Changes pH	59
4.8.4. Changes in shear force	59
4.8.5. Color measurements of sheep burger	62
4.9. Changes in cooking parameters of sheep burger as affected by two feeding levels and frozen storage at -18°C for three months	64
4.9.1. Changes in cooking loss and cooking yield %	64
4.9.2. Changes in moisture retention and fat retention %	64
4.10. Changes in shrinkage measurements of sheep burger as affected by two feeding levels and frozen storage at -18°C for three months	68
4.11. Sensory evaluation of sheep burger as affected by two feeding levels and frozen storage at -18°C for three months	71
4.12. Chemical properties of sheep sausage as influenced by two feeding levels and during frozen storage at -18°C for 3 months	73
4.12.1. Proximate composition	73
4.12.1.1. Moisture content	73
4.12.1.2. Protein content	73
4.12.1.3. Ash content	75
4.12.1.4. Fat content	75
4.12.1. 5.Changes in T.B.A. value of sheep sausage during frozen storage at -18°C for 3 months	75

4.13. Physical properties of sheep sausage as influenced by two feeding levels and frozen storage at -18°C for 3 months	77
4.13.1. Water holding capacity (W.H.C.)	77
4.13.2. Plasticity	77
4.13.3. pH value	79
4.13.4. Tenderness	79
4.13.5. Color measurements of sheep sausage	82
4.13.6. Cooking parameters of sheep sausage as influenced by two feeding levels and frozen storage at -18°C for 3 months	82
4.13.6.1. Cooking loss and cooking yield % of sheep sausage	82
4.13.6.2. Moisture retention of sheep sausage	84
4.13.6.3. Fat retention of sheep sausage	84
4.13.7. Shrinkage measurements of sheep sausage as influenced by two feeding levels and frozen storage at -18°C for 3 months	88
4.14. Sensory evaluation of sheep sausage as influenced by two feeding levels and frozen storage at -18°C for 3 months	88
5. SUMMARY	93
6. REFERENCES	101
ARABIC SUMMARY	

LIST OF TABLES

NO.	Title	Page
١	The recipe of burger made from treated sheep meat	22
٢	The recipe of sausage made from treated sheep meat	23
٣	Blood biochemical measurements of sheep as affected by two feeding levels	32
٤	Initial and final body weight and carcass traits of sheep fed on two feeding levels	34
5	Carcass composition of sheep fed on two feeding levels	35
٦	Carcass measurements of sheep fed on two feeding levels	37
٧	Non - carcass components (organs and offal) of sheep fed on two feeding levels	38
٨	Composition of leg tissues of sheep fed on two feeding levels	39
٩	Proximate composition (on fresh weight basis) of sheep meat as affected by two feeding levels	40
١٠	Fatty acid composition (% of total fatty acids) of sheep meat as affected by two feeding levels	42
١١	Volatile compounds % of sheep meat as affected by two feeding levels	44
١٢	Physical and chemical properties of sheep meat as affected by two feeding levels	48
١٣	Color measurements of sheep meat as affected by two feeding levels	51
١٤	Sensory evaluation of sheep meat as affected by two feeding levels	52

١٥	Effect of feeding level and frozen storage period on proximate composition of sheep burger	54
١٦	Effect of feeding level and frozen storage period on T.B.A. value (mg malonaldehyde/kg) of sheep burger	57
١٧	Effect of feeding level and frozen storage period on physical properties of sheep burger	58
١٨	Color measurements of sheep burger as affected by two feeding levels and frozen storage	63
١٩	Effect of feeding level and frozen storage period on cooking parameters of sheep burger	65
٢٠	Effect of feeding level and frozen storage period on shrinkage measurements of sheep burger	69
٢١	Effect of feeding level and frozen storage period on sensory evaluation of sheep burger	72
٢٢	Effect of feeding level and frozen storage period on proximate composition of sheep sausage	74
٢٣	Effect of feeding level and frozen storage period on T.B.A. value (mgMAD/kg) of sheep sausage	76
٢٤	Effect of feeding level and frozen storage period on physical properties of sheep sausage	78
٢٥	Color measurements of sheep sausage as affected by two feeding levels and frozen storage	83
٢٦	Effect of feeding level and frozen storage period on cooking parameters of sheep sausage	85
٢٧	Effect of feeding level and frozen storage period on shrinkage measurements of sheep sausage	89
٢٨	Effect of feeding level and frozen storage period on sensory evaluation of sheep sausage	92

LIST OF FIGURES

No	Title	Page
1.	Fatty acids % of sheep meat as affected by two feeding levels	42
2.	Water holding capacity of sheep meat as affected by two feeding levels	48
3.	Cooking loss % of sheep meat as affected by two feeding levels	49
4.	Cooking yield % of sheep meat as affected by two feeding levels	49
5.	T.B.A. value of sheep meat as affected by two feeding levels	50
6.	Changes in T.B.A value of burger samples during frozen storage at -18°C for 90 days	57
7.	Changes in W.H.C. of burger samples during frozen storage at -18°C for 90 days	60
8.	Changes in plasticity of burger samples during frozen storage at -18°C for 90 days	60
9.	Changes in shear force value of burger samples during frozen storage at -18°C for 90 days	61
10.	Changes in cooking loss (%) of burger samples during frozen storage at -18°C for 90 days.	66
11.	Changes in cooking yield (%) of burger samples during frozen storage at -18°C for 90 days	66
12.	Changes in moisture retention (%) of burger samples during frozen storage at -18°C for 90 days	67
13.	Changes in fat retention (%) of burger samples during frozen storage at -18°C for 90 days	67
14.	Changes in reduction in diameter (%) of burger samples during frozen storage at -18°C for 90 days	70
15.	Changes in reduction in thickness (%) of burger samples during frozen storage at -18°C for 90 days	70

16.	Changes in shrinkage (%) of burger samples during frozen storage at -18°C for 90 days	71
17.	Changes in T.B.A. value of sausage samples during frozen storage at -18°C for 90 days	76
18.	Changes in W.H.C. of sausage samples during frozen storage at -18°C for 90 days	80
19.	Changes in plasticity of sausage samples during frozen storage at -18°C for 90 days	80
20.	Changes in tenderness of sausage samples during frozen storage at -18°C for 90 days	81
21.	Changes in cooking loss (%) of sausage samples during frozen storage at -18°C for 90 days	86
22.	Changes in cooking yield (%) of sausage samples during frozen storage at -18°C for 90 days	86
23.	Changes in moisture retention (%) of sausage samples during frozen storage at -18°C for 90 days	87
24.	Changes in fat retention (%) of sausage samples during frozen storage at -18°C for 90 days	87
25.	Changes of reduction in width (%) in sausage samples during frozen storage at -18°C for 90 days	90
26.	Changes of reduction in length (%) in sausage samples during frozen storage at -18°C for 90 day	90
27.	Changes of shrinkage (%) in sausage samples during frozen storage at -18°C for 90 day	91

ACKNOWLEDGEMENT

I would like to express my great appreciation to **Prof. Dr. Ahmed Youssief Gibriel**, Professor of Food Science and Technology, Faculty of Agriculture, Ain Shams University, for his direct and effective supervision of the study and for his valuable and continuous share in the preparation of this investigation.

I wish to express my deepest gratitude and sincere thanks to **Prof. Dr. Mohamed Farag Khallaf**, Professor of Food Science and Technology, Faculty of Agriculture, Ain Shams University for his stimulating supervision, guidance, persistence, providing facilities and valuable help for writing and correcting the manuscript without unfailing help, this work could not have been done.

My deepest gratitude indebtedness and appreciation are deserved to **Prof. Dr. Samir Sayed Abou El-Ezz**, Professor of Animal Physiology, Desert Research Center, Ministry of Agriculture and Land Reclamation for his close supervision, guidance, kind advice, persistence and sacrificing his time and effort in surmounting the obstacles and providing all work requirements.

I am greatly indebted to **Dr. Ahmed Asker**, Associate Professor of Animal Nutrition, Desert Research Center, Ministry of Agriculture and Land Reclamation for his guidance and help in providing the facilities needed to perform this study.

ABSTRACT

Engy Fayz Zaki: Effect of Desert Environmental Factors on the Quality of Some Fresh Meats and Their Products. Unpublished Ph.D. Thesis, Department of Food Science, Faculty of Agriculture, Ain Shams University, 2013.

Twenty-two adult Barki sheep, approximately 4 years of age with an average body weight of 36 kg were used in this experiment. Feed intake level was given as a 100 or 50% of the maintenance requirements for animals on an adequate constant plane of nutrition based on a mixed forage-concentrate diets. Three animals were randomly chosen for slaughtering, round cuts were collected. Samples were divided into two portions, the first portion was used for physical, chemical and sensory analysis as fresh meat, while the second portion was used for burger and sausage processing.

Feeding level did not affect the empty live weight, hot carcass weight and dressing percentage and carcass composition of sheep. No significant difference found in proximate composition due to feeding level. The total fatty acids content of meat from control group was higher than restricted one. W.H.C. value of control group was lower ($P < 0.05$) than restricted. Also restricted group had higher plasticity value than control group but not significant. No significant differences in pH value of sheep meat from control group and restricted group were detected. No significant difference were found in L, a, b and chroma of sheep meat fed on different feeding levels. Meat of restricted group was significantly higher in appearance and flavor scores than meat from control. Nevertheless, no significant differences were found in other sensory attributes (texture, juiciness, tenderness and overall acceptability).

The moisture content of all burger samples decreased by increasing frozen time. Protein content of all burger samples decreased significantly as the time of frozen storage increased. All burger samples tended to increase in its fat and ash content during frozen period. The T.B.A. value

of burger in both control and restricted samples were significantly increased as the time of frozen storage increased. WHC significantly decreased as the time of frozen storage increased in all burger samples. pH values were significantly decreased after 45 days of storage in all burger samples but no significant differences were found in pH value at 90 days of storage. Shear force value of burger samples significantly increased after 90 days of storage. There was stability in burger color during frozen storage in all burger samples. The cooking loss of all burger samples was significantly increased as the time of frozen storage increased. Moisture retention decreased as the time of frozen storage increased. The shrinkage % increased as the time of frozen storage increased. Frozen storage caused a significant decrease in all sensory attributes of burger from control and restricted group.

The moisture content decreased in all sausage samples during storage. Significant decreasing in protein content was observed in all sausage samples during frozen storage. Fat content in all sausage samples was increased as the time of frozen storage increased. T.B.A value of sausage from both control and restricted groups was significantly decreased after 45 days of storage and significantly increased after 90 days of storage. Water holding capacity was decreased as the time of frozen storage increased in all sausage samples. There was a decrease in plasticity during frozen storage in all sausage samples. A significant decrease in tenderness (higher shear force value) in all sausage samples was observed as the time of frozen storage increased. Fat retention decreased as the time of frozen storage increased. Shrinkage % increased as the time of frozen storage increased. Frozen storage caused a significant decrease in all sensory attributes except juiciness of sausage from control and restricted groups.

Keywords: Sheep, Diet, Meat, Carcass, sheep burger, sheep sausage.