

# **IMPACT OF SOME POLLUTANTS ON THE SKIN AND COAT CHARACTERISTICS OF SHEEP RAISED IN SOME LOCATIONS AT EL-SALAM CANAL**

**A Thesis Submitted for the Award of  
The Degree of Doctor of Philosophy**

**In  
Zoology (Histology)**

**BY**

**NAGLAA SALEM BADAWY**

B.Sc. (Zoology – Chemistry), Ain Shams University

M. Sc. In Zoology (Histology). Faculty of Science,  
Ain Shams University

Supervision by

**Dr. Abdalla Mohamed Ibrahim**

Prof. of Zoology

Faculty of Science, Ain Shams University

**Dr. Aisha S. Abdou**

Professor and head of wool production  
and technology department,  
Desert Research Center

Department of Zoology

Faculty of Science

Ain Shams University

Cairo, Egypt

2011

تأثير بعض الملوثات علي خصائص جلد و غطاء الأغنام المرباة في بعض  
المناطق بترعة السلام

رسالة مقدمة

إلي

قسم علم الحيوان  
كلية العلوم جامعة عين شمس

للحصول على  
درجة دكتوراه الفلسفة في العلوم  
(في علم الحيوان-هستولوجي)

مقدمة من

نجلاء سالم بدوي

بكالوريوس علوم جامعة عين شمس  
ماجستير في العلوم كلية العلوم جامعة عين شمس

تحت إشراف

الأستاذ الدكتور عبد الله محمد إبراهيم  
أستاذ علم الحيوان غير المتفرغ كلية العلوم  
جامعة عين شمس

أ.د. عائشة سيد عبده

أستاذ ورئيس قسم إنتاج وتكنولوجيا الصوف  
شعبة الإنتاج الحيواني والدواجن  
مركز بحوث الصحراء

قسم علم الحيوان  
كلية العلوم جامعة عين شمس

٢٠١١

## **ACKNOWLEDGEMENT**

*First of all, thanks to Mighty GOD (ALLAH) for the continuous and persistent supply with patience and effort to produce this study.*

*I wish to express my deep gratefulness and appreciation to **Prof. Dr. Abdalla Mohamed Ibrahim**, Prof. of zoology and aquatic biology. Zool. Dept., Fac. of Science, Ain Shams University, for his kind supervision, valuable criticism and critical reading of the manuscript. His efforts are greatly acknowledged and deeply appreciated.*

*My sincere gratitude is also due to **Prof. Dr. Aisha S. Abdou** Professor and head of wool production and technology department, Animal Production Division, Desert Research Center for her able guidance, suggesting the point and valuable guidance. Her continuous encouragement, unlimited help and reviewing the manuscript, her efforts are greatly acknowledged and deeply appreciated.*

*I wish to express my sincere appreciation to all the professors and researchers who have helped me along the way with encouragement and discussion. To everyone helped me in tackling various problems during my study and for giving me the opportunity to conduct this research. Without their help and support, this work would not have been possible.*

*Thanks are due to all staff members and workers of Wool Production & Technology Department, Desert Research Center, who facilitated the practical part of this study through their sincere cooperation, especially **Mr. Sameh Taha**, for his help in the statistical analysis of data, and in the work of the computer and to **Mr. Eid M. Abd-El-Hady**, and **Dr. Eman Ezat** for their effort throughout the field work.*

*My thanks and deep appreciations are extended to **my late parents and to my husband, daughters and son** for their constant patience, encouragement and moral of support.*

## *Acknowledgement*

---

## **ABSTRACT**

### **“IMPACT OF SOME POLLUTANTS ON THE SKIN AND COAT CHARACTERISTICS OF SHEEP RAISED IN SOME LOCATIONS AT EL-SALAM CANAL”**

This study was carried out on thirty five adult Balady ewes that were randomly chosen from three different regions at El-Salam Canal North Sinai (10 ewes from both El Qantara Shark and Romana regions, and 15 ewes from Gelbana region) in both summer and winter seasons. Animals were kept under the prevailing environmental conditions and were usually allowed to go to pasture early in the morning and to return at sunset. On pasture, animals were fed on cultivated plants and drinking from El-Salam Canal water.

The present study was undertaken to investigate the chemical characteristics of the canal water used for irrigation, drinking and domestic purposes and to assess the levels of seven heavy metals (Cd, Cu, Fe, Mn, Mo, Pb and Zn) in such water, vegetation and blood serum to evaluate the effect of these parameters on the morphological structure, chemical composition and growth activity of different skin components of sheep raised in the three studied regions at El-Salam Canal.

Skin and fibre samples as well as water, plants and blood samples were taken twice a year, representing summer and winter seasons. The skin samples were taken from the mid-side region and the skin components were examined by histological and histochemical techniques.

The fibre samples were classified into four categories (Kemp, hetero, coarse and fine fibres).

Analysis of water samples revealed high levels of EC, TDS, Na, Mg, and Cl ions that exceed the permissible limits of **WHO (1993)**.

Concerning Cd, Cu, Mn ,Mo and Zn metals, all examined water samples had lower values than the permissible limits accounted by **WHO (2004)**. Meanwhile, Fe and Pb exceeded the permissible limits.

Samples also recorded lesser values than the recommended limits in irrigation water detected by **Crook (1996)** except Mo in Romana region in summer season.

Lower levels of copper metal were reported in the plant tissues of all the studied regions in winter season.

The increased salts in samples of drinking water resulted in significant decrease in the glucose level and inhibition in ALP activity in the serum of sheep but elevated total lipids. The presence of cadmium metal increased plasma glucose and decreased blood total protein and serum alkaline phosphatase enzyme, while the presence of Pb caused decreasing in blood total protein and increasing ALP enzyme. The elevated dietary copper in summer season caused significant increase in serum TL in animals at the three regions especially in Romana region.

The high level of salts in drinking water caused a decrease in all follicle dimensions. The histological measurements taken for sweat glands proved that their size increased significantly in summer than in winter.

As a result of increasing dietary concentrations of Mn in Romana and Gelbana regions, the content of carbohydrates in the two sheaths of both primary and secondary follicles recorded significant increase than in El-Qantara Shark region.

Increasing levels of dietary Zn caused high content of general protein and higher activity of ALP enzyme in the skin follicles of sheep.

Animals in Romana region which received high levels of salts in drinking water had a significant decrease in fibre diameter than those of the other two regions, while Gelbana region recorded the highest greasy fleece weight.

The percentage of coarse fibres increased in summer season, while the fine fibres showed an opposite trend. Also the coat of animals showed longest fibres in winter season compared with summer except kemp fibres.

The deficiency in copper metal caused a significant decrease in the mean number of fibre crimps/centimeter in El- Qantara Shark and Gelbana regions rather than in Romana region.

It can be concluded that the examined samples of El-Salam Canal water, plants, animals serum, skin and wool fibres from the examined areas include a variety of metal pollutants that need an urgent treatment and management.

**Key words:**

El-Salam Canal, water, plants, blood serum, sheep skin, wool follicles, wool fibres, sweat glands, histology, histochemistry.

<b>Contents</b>	<b>Page</b>
<b>Abstract</b>	
<b>CHAPTER I: INTRODUCTION AND AIM OF THE STUDY</b>	<b>1</b>
<b>CHAPTER II: REVIEW OF THE LITERATURE</b>	<b>5</b>
1- El-Salam Canal water	5
1.1. Routine analysis	5
1.2. Heavy metals	14
2- Heavy metals in plants	18
3- Heavy metals in animal's serum	30
4- Biochemistry of blood	36
4.1. Serum glucose	36
4.2. Serum total protein (TP)	37
4.3. Serum total lipids (TL)	39
4.4. Serum alkaline phosphatase enzyme (ALP)	39
5- General anatomy of the skin	40
5.1. Histological structure of the skin	40
5.2. Histochemical investigations of sheep skin	49
6- Heavy metals in animal's skin	53
7- Wool fibres	56
8- Heavy metals in wool fibres	64
<b>CHAPTER III: MATERIALS AND METHODS:</b>	<b>69</b>
1- Study area	69
2- El-Salam Canal project description	70
3- Water samples	72
3.1. Routine analysis	72
3.2. Heavy metals analysis	73
4- Forage sampling	73
5- Study animals	75
5.1. Serum samples	75
5.1.1. Serum heavy metals	76
5.1.2. Biochemistry of serum	75
5.1.2.1. Glucose in serum	75



<b>Contents</b>	<b>Page</b>
<b>5.1.2.2.</b> Total protein in serum	76
<b>5.1.2.3.</b> Total Lipids in serum	76
<b>5.1.2.4.</b> Alkaline phosphatase in serum	76
<b>5.2.</b> Skin and wool samples	77
<b>5.2.1.</b> Skin samples	77
<b>5.2.2.</b> Wool samples	78
<b>5.2.3.</b> Greasy fleece weight	79
<b>6-</b> Statistical analysis	79
<b>CHAPTER IV: RESULTS</b>	80
<b>1-</b> Analysis of El-Salam Canal water	80
<b>1.1-</b> Routine analysis	80
<b>1.2-</b> Heavy metals	84
<b>2-</b> Plant analysis	87
<b>3-</b> Serum analysis	90
<b>3.1-</b> Heavy metals in sheep serum	90
<b>3.2-</b> Serum biochemical parameters	93
<b>3.2.1.</b> Glucose	93
<b>3.2.2.</b> Total protein	93
<b>3.2.3.</b> Total lipids	94
<b>3.2.4.</b> Alkaline phosphatase	95
<b>4-</b> Skin of sheep	95
<b>4.1.</b> Types of the wool follicles	95
<b>4.1.1.</b> Secondary to primary follicles ratio (S/P ratio)	96
<b>4.1.2.</b> The Bulb	96
<b>4.2.</b> Follicle dimensions	97
<b>4.2.1.</b> External diameter of primary and secondary wool follicles	98
<b>4.2.2.</b> Internal diameter of primary and secondary wool follicles	99
<b>4.2.3.</b> Wall thickness of the primary and secondary wool follicles	100
<b>4.3.</b> Glands of the skin	100
<b>4.3.1.</b> Sweat glands	100

<b>Contents</b>	<b>Page</b>
<b>4.3.2.</b> Sebaceous glands	101
<b>4.4.</b> Histochemistry of the wool follicles and glands	102
<b>4.4.1.</b> General carbohydrates (PAS reaction)	102
<b>4.4.2.</b> General proteins	104
<b>4.4.3.</b> Alkaline phosphatase enzyme	106
<b>5-</b> Wool fibres	108
<b>5.1.1.</b> Fibre diameter of the primary and secondary wool follicles	109
<b>5.1.2.</b> Medulla thickness	110
<b>5.2.</b> Fibre type ratio	111
<b>5.2.1.</b> Kemp fibres:-	111
<b>5.2.2.</b> Hair or coarse and hetero fibres	111
<b>5.2.3.</b> Fine or wool fibres	113
<b>5.3.</b> Number of crimps/cm	114
<b>5.4.</b> Greasy fleece weight	114
<b>CHAPTER V: DISCUSSION</b>	221
<b>CHAPTER VI: SUMMARY AND CONCLUSION</b>	243
<b>CHAPTER VII: REFERENCES</b>	249
الملخص العربي	١
المستخلص	أ

## LIST OF TABLES

No	Title	Page
Table (1):	Types of forages collected from the three studied regions during summer season.	74
Table (2):	Types of forages collected from the three studied regions during winter season.	75
Table (3):	Chemical analysis (ppm) of water samples at the three different regions of El-Salam Canal during summer and winter seasons.	115
Table (4):	Chemical analysis of some heavy metals (ppm) in water samples at the three different regions of El-Salam Canal during summer and winter seasons.	119
Table (5):	Analysis of variance of concentrations of some heavy metals in plant tissues at the three different regions of El-Salam Canal during summer and winter seasons.	122
Table (6):	Mean concentrations ( $\pm$ SE) of some heavy metals (ppm) in plant tissues at the three different regions of El-Salam Canal during summer and winter seasons.	123
Table (7):	Analysis of variance of concentrations of some heavy metals in serum samples from sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	126
Table (8):	Mean concentrations ( $\pm$ SE) of some heavy metals (ppm) in serum samples from sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	127
Table (9):	Analysis of variance of concentrations of serum chemistry from sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	130

<b>No</b>	<b>Title</b>	<b>Page</b>
Table (10):	Mean values of serum biochemistry ( $\pm$ SE) for sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	131
Table (11):	Analysis of variance of the secondary to primary follicles (S/P) ratio in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	138
Table (12):	Mean values ( $\pm$ SE) of the ratio of secondary to primary follicles (S/P) in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	139
Table (13):	Analysis of variance for different factors affecting the DNA values in the bulb of the Primary and secondary wool follicles in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	144
Table (14):	Seasonal distribution of DNA in the bulb of the primary and secondary wool follicles in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons (expressed as percentages of optical density values).	145
Table (15):	Analysis of variance for different factors affecting the primary follicle dimensions, fibre diameter and medulla thickness in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	150
Table (16):	Analysis of variance for different factors affecting the secondary follicle dimensions and fibre diameter thickness in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	151

<b>No</b>	<b>Title</b>	<b>Page</b>
Table (17):	Mean values of external diameter of both primary and secondary wool follicles ( $\mu\text{m} \pm \text{SE}$ ) in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	153
Table (18):	Mean values of internal diameter of both primary and secondary wool follicles ( $\mu\text{m} \pm \text{SE}$ ) in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	154
Table (19):	Mean values of wall thickness of both primary and secondary wool follicles ( $\mu\text{m} \pm \text{SE}$ ) in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	156
Table (20):	Analysis of variance for different factors affecting the sweat gland thickness of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	158
Table (21):	Mean values of the sweat glands thickness ( $\mu\text{m} \pm \text{SE}$ ) in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons	159
Table (22):	Analysis of variance for different factors affecting the general carbohydrate values in the outer and inner root sheaths of both primary and secondary wool follicles in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	164
Table (23):	Seasonal distribution of general carbohydrates in the outer and inner root sheaths of primary and secondary wool follicles in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons (expressed as percentages of optical density values).	165

<b>No</b>	<b>Title</b>	<b>Page</b>
Table (24):	Analysis of variance for different factors affecting the general carbohydrate values in the sweat and sebaceous glands in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	171
Table (25):	Seasonal distribution of general carbohydrates in the sweat and sebaceous glands in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons (expressed as percentages of optical density values).	172
Table (26):	Analysis of variance for different factors affecting the general protein values in the primary and secondary wool follicles in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	177
Table (27):	Seasonal distribution of general proteins in the outer and inner root sheathes of the primary and secondary wool follicles in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons (expressed as percentages of optical density values).	178
Table (28):	Analysis of variance for different factors affecting the general protein values in the sweat and sebaceous glands in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	184
Table (29):	Seasonal distribution of general proteins in the sweat and sebaceous glands in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons (expressed as percentages of optical density values).	185

<b>No</b>	<b>Title</b>	<b>Page</b>
Table (30):	Analysis of variance for different factors affecting the alkaline phosphatase activity in the outer and inner root sheathes of the primary and secondary wool follicles in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	190
Table (31):	The alkaline phosphatase activity in the outer and inner root sheathes of the primary and secondary wool follicles in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons (expressed as percentages of optical density values).	191
Table (32):	Analysis of variance for different factors affecting the alkaline phosphatase activity in the sweat and sebaceous glands in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	197
Table (33):	The alkaline phosphatase activity of the sweat and sebaceous glands in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons (expressed as percentages of optical density values).	198
Table (34):	Analysis of variance for different factors affecting the primary fibre diameter and medulla thicknesses in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	202
Table (35):	Analysis of variance for different factors affecting the secondary fibre diameter thickness in the skin of sheep raised at the three different regions of El-Salam Canal during summer and winter seasons.	203