

الآية

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قال تعالى:

وَأَنْزَلْنَا إِلَيْكَ الْكِتَابَ بِالْحَقِّ مُصَدِّقًا لِمَا بَيْنَ يَدَيْهِ مِنَ الْكِتَابِ وَمُهَيْمِنًا عَلَيْهِ فَاحْكُم بَيْنَهُمْ
بِمَا أَنْزَلَ اللَّهُ وَلَا تَتَّبِعْ أَهْوَاءَهُمْ عَمَّا جَاءَكَ مِنَ الْحَقِّ لِكُلِّ جَعَلْنَا مِنْكُمْ شِرْعَةً
وَمِنْهَا جَا ۖ وَلَوْ شَاءَ اللَّهُ لَجَعَلَكُمْ أُمَّةً وَاحِدَةً وَلَكِنْ لِيَبْلُوَكُمْ فِي مَا آتَاكُمْ ۖ فَاسْتَبِقُوا
الْخَيْرَاتِ ۚ إِلَى اللَّهِ مَرْجِعُكُمْ جَمِيعًا فَيُنَبِّئُكُمْ بِمَا كُنْتُمْ فِيهِ تَخْتَلِفُونَ (٤٨)

صدق الله العظيم

سورة المائدة الآية 48

Dedication

To,,,

The spirit of our father

Our mother

Our children

Our brothers and sisters,

Our Teachers,

Our friend,

And

For all who stand beside me and help me to come to this level.

Acknowledgment

I would like to express my special appreciation and thanks to my Supervisor Dr. Ali [Elnaeim](#) Musa, who had spent efforts and time in supervising this work. Thanks are also extended to my co. Supervisor Dr. Dr. SheikEldeenBushra.

My appreciation is extended to following:

Sudan University of Science and Technology (Leather Industrial Incubator), National Center for Research, White Nile industries Co. Ltd, and Central Laboratory for Technical Services and CalibrationSudanese Electricity Distribution Company Ltd and all their help and support.

TABLE OF CONTENTS

	TITLE	Page No
	الاية.....	i
	DEDICATION.....	ii
	ACKNOWLEDGEMNTS	iii
	TABLE OF CONTENTS.....	iv
	LIST OF TABLES.....	ix
	LIST OF FIGURES.....	xi
	ABSTRACT.....	xii
	ARABIC ABSTRACT	xiii
	LIST OF APPREVIATION.....	xiv
Chapter One	INTRODUCTION	1
1	INTRODUCTION	1
1.1	Background	1
1.2	History of Leather Manufacturing in Sudan.....	5
1.3	SCOPE OF WORK	9
1.4	The Objective of This Study.....	9
Chapter Two	LITERATURE REVIEW.....	10
2.1	Hide and skin reception and storage	10
2.1.1	Sorting	10
2.1.2	Trimming	
2.1.3	Curing and storage	10
2.2	Bearmhouse processing.....	11
2.2.1	Soaking	12
2.2.2	Unhairing and liming of bovine hides.....	13
2.2.3	Painting and liming of sheepskins.....	13
2.2.4	Fleshing	14
2.2.5	Splitting	14
2.2.6	Deliming.....	15
2.2.7	Bating	16
2.3	Tanyard processing	16

2.3.1	Degreasing	17
2.3.2	Pickling	17
2.3.3	Tanning	18
2.3.4	Draining, horsing, samming, and setting.....	20
2.3.5	Shaving	21
2.4	Post-tan processing	21
2.4.1	Neutralisation	22
2.4.2	Bleaching	22
2.4.3	Retanning	22
2.4.4	Dyeing	23
2.4.5	Fatliquoring	23
2.4.6	Drying	24
2.5	Dry finishing operations.....	24
2.6	Tannage	28
2.6.1	Vegetable tannage.....	28
2.6.2	Mineraltannage	32
2.6.2.1	Chromium tannage.....	33
2.6.2.2	Aluminum tannage.....	36
2.6.2.3	Zirconium tannage.....	
2.6.2.4	Titanium tannage.....	39
2.6.2.5	Sulphurtannage.....	40
2.6.2.6	Iron tannage.....	40
2.6.3	Aldehyde tannage.....	41
2.6.3.1	Formaldehyde tanning.....	41
2.6.3.2	Glutaraldehydetannage.....	42
2.6.4	Polymerstannage.....	42
2.6.5	Fatty substances tannage.....	43
2.6.5.1	Chamoistannage.....	43
2.6.5.2	Fatty alcohol sulphatetannage.....	43
2.6.5.3	Sulphochloridestannage.....	43
2.6.6	synthetictannage.....	44
2.6.6.1	Auxiliary	44
2.6.6.2	syntans.....Combination or	45
2.6.6.3	retanningsyntans.....	46
2.7	Replacement syntans.....	47
	Combination tannin.....	
2.8	Tannins.....	51
2.8.1	Nature of tannins.....	51
2.8.2	Tannin type.....	53

2.8.2.1	Hydrolysable tannins.....	53
2.8.2.2	Condensed tannins (Proanthocyanidins).....	56
2.9	Commonly used vegetable tanning materials.....	60
2.10	Garad(Acacia nilotica).....	61
2.10.1	Description of garad(Acacia nilotica).....	61
2.10.2	Uses of garad (Acacia nilotica).....	62
2.10.3	Chemical composition and nutritional value of Acacia Nilotica.....	63
2.11	Manufacture of Tannin Extracts.....	65
2.11.1	Selection of raw materials	66
2.11.2	Size reduction- crushing and grinding	66
2.11.3	Leaching (Extraction of Tannins).....	68
2.11.4	Settling and Filtration	68
2.11.5	Concentration (evaporation).....	68
2.11.6	Bleaching	69
2.11.7	Solid Extract	69
2.11.8	Powder Extract	69
2.11.9	Packaging	70
2.12	Occupational Health and Safety from tannery.....	70
2.12.1	Chemical Hazards.....	71
2.12.2	Chemical Storage and Handling.....	71
2.12.3	Biological Hazards.....	71
Chapter Three	MARERIALS AND METHODS	75
3.1	Raw materials.....	75
3.2	Analysis of Tannin.....	75
3.2.1	Preparation of Sample for Analysis.....	75
3.2.2	Determiation of moisture.....	76
3.2.3	Determiation of total solid.....	77
3.2.4	Determiation of total soluble.....	77
3.2.5	Determiation of insoluble.....	77
3.2.6	Determiation of non- tans.....	78
3.2.7	Determiation of tannin matter absorbable by hid powder.....	79
3.2.8	Determiation of pH.....	79
3.3	Preparation of 70% Methanol garad bark Extract ...	79
3.3.1	Fractionation of 70% Methanol garad bark Extract	80
3.4	Garad bark Combination Tanning.....	80
3.4.1	Materials.....	80

3.4.2	Aqueous Extraction of Tannin from Garad barks.....	80
3.4.3	Preparation of Basic Aluminum Sulphate Solution.	81
3.4.4	Garad bark Based Combination Tanning Trials	81
3.4.5	Determination of Shrinkage Temperature.....	87
3.4.6	Analysis of Spent Liquor.....	88
3.4.6.1	Chemical oxygen demand (COD).....	88
3.4.6.2	Biochemical oxygen demand (BOD).....	89
3.4.6.3	Total dissolved solids (TDS).....	90
3.4.7	Visual Assessment of the Crust Leather.....	90
3.4.8	Physical Testing	91
3.4.8.1	Preparation for Physical Testing (Conditioning).....	91
3.4.8.2	Tensile strength	91
3.4.8.3	Percent elongation at break.....	92
3.4.8.4	Tear strength.....	92
3.4.8.5	Grain crack strength and distension at grain crack.....	93
3.4.8.6	Measurement of leather softness.....	
3.4.9	Chemical Analysis of Leather.....	93
3.4.9.1	Preparation of Sample.....	94
3.4.9.2	Moisture content	94
3.4.9.3	Determination of oils and fats	95
3.4.9.4	Determination of water soluble.....	95
3.4.9.5	Hide substance.....	96
3.4.9.6	Determination of total ash content of leather.....	98
3.4.9.7	Determination of the degree of tannage.....	98
3.5	Investigation of Talhas Retanning Agent.....	99
3.5.1	Materials.....	99
3.5.2	Aqueous Extraction of Tannin from Grade barks.....	99
3.5.3	Garad bark Based Retanning Trials.....	99
3.5.4	Determination of Shrinkage Temperature.....	100
3.5.5	Analysis of Spent Liquor.....	101
3.5.6	Visual Assessment of the Crust Leather.....	101
3.5.7	Physical Testing	101
3.5.8	Chemical Analysis of Leather.....	101

Chapter Four	RESULTS AND DISCUSSIONS.....	102
4.1	Analysis of tannin and non-tannin of Garad Bark.....	102
4.2	Combination Tanning Systems Using Garad bark	103
4.2.1	Garad bark -Aluminum Combination	103
4.2.1.1	Tanning.....Optimization of Combination Tanning Systems Using Garad bark and Aluminum.....	103
4.2.1.2	105
4.2.1.3	Analysis of spent liquor.....	106
	Organoleptic properties of experimental and control	107
4.2.1.4	Leather.....	108
4.2.1.5	Strength characteristics of crust leathers.....	109
4.2.2	Chemical analysis of the crust leather	109
4.2.2.1	Garad bark Zinc Combination Tanning (Zinc oxide).....	109
	The shrinkage temperature of leathers.....	109
4.2.2.2	Analysis of spent liquor.....	110
4.2.2.3	Organoleptic properties of experimental and control	111
4.2.2.4	Leather	112
4.2.2.5	Strength characteristics of crust leathers.....	114
	Chemical analysis of the crust leather.....	114
4.3	Investigation of Garad barks as Retanning Agent.....	114
4.3.1	Shrinkage Temperature.....	115
4.3.2	Analysis of spent liquor.....	116
4.3.3	Tactile properties of sunt (garad bark) retanned leathers	117
	Physical Strength Characteristics of Garad bark Retanned	118
4.3.4	Leathers.....	120
4.3.5	Chemical Analysis of the Crust Leather.....	120
4.4	Evaluation cost of Garad bark	121
Chapter Five	CONCLUSIONS AND RECOMMENDATIONS	121
5.1	CONCLUSIONS.....	123
5.2	RECOMMENDATIONS.....	124
	REFERENCES.....	130
	LIST OF PUBLICATION.....	

LIST OF TABLES

Table NO	Title	Page No
1.1	Estimate of animal population plus annual growth rate (2002-2013).....	7
1.2	Hides and skins production in million (2002- 2012).....	8
2.1	classification of plant tannins.....	53
2.2	The Mean content (g/100g DW) composition of the mature dry seeds of <i>A. Nilotica</i> from Hormozgan Province, Iran.....	64
2.3	Proximate analysis of <i>A. Nilotica</i> from Hormozgan Province, Iran.....	65
2.4	Effluent levels for tanning and leather finishing.....	73
3.1	Formulation of Garad bark-Aluminum combination tanning system for pickled goat skin to produce Upper Leather....	82
3.2	Formulation of aluminum- Garad bark tanning system (experimental) for pickled goat skin to produce Upper Leather... 83	83
3.3	Formulation of control Garad bark tanning system Upper Leather.....	84
3.4	Formulation of Garad bark- zinc combination tanning system for pickled goat skin to produce Upper Leather	85
3.5	Formulation of zinc- Grade bark tanning system for pickled goat skin Upper Leather.....	86
3.6	Formulation of Post-tanning process for control and experimental leathers.....	87
3.7	Formulation of Post-tanning process of wet blue.....	100
4.1	Tannin analysis of Garad bark.....	102
4.2	Shrinkage temperature n of control and experimental tanning	104
4.3	Characteristic of spent liquor for control and experimental ...	105

4.4	Physical strength characteristics of experimental and control crust leathers.....	108
4.5	Chemical Analysis of crust leather of experimental and control.....	108
4.6	Shrinkage temperature of control and experimental tanning processes	109
4.7	Characteristic of spent liquor for control and experimental post tanning trials.....	110
4.8	Physical strength characteristics of experimental	112
4.9	Chemical Analysis of crust leather of experimental and control	113
4.10	Shrinkage temperature of crust leathers retanned with Garad bark and wattle.....	114
4.11	Characteristic of spent liquor for control and experimental post tanning trials.....	115
4.12	Visual evaluation of the general characteristics of crust leathers with Garad bark and wattle.....	117
4.13	Physical strength characteristics of crust leathers retanned using Garad bark and wattle.....	118
4.14	Chemical characteristics of the Crust Leathers retanning using Garad bark and wattle.....	119

LIST OF FIGURES

Figure NO	Title	Page No
2.1	Process flow sheet for conventional leather processing...	27
2.2	GRAPH A: Coordinate covalent linkage of chromium complex with the polypeptidic chain of the skin collagen; GRAPH B: Olation and oxolation process.....	35
2.3	Titanium and skin collagen bone	39
2.4	The Nerodol synthesis of syntans.....	44
2.5	The Novolac synthesis of syntans.....	46
2.6	Schematic model of the semi-metal tanning interactions	49
2.7	Gallic acid.....	53
2.8	β - 1,2 ,3 4, 6- pentagalloy- O- D glucopyranose.....	55
2.9	structure of flavonoids.....	57
2.10	Structure of epicatechin and catechin (Flavan- 3- ols)	59
2.11	Process block diagram for the manufacture of vegetable tannin extracts.....	67
4.1	Graphical representations of organoleptic properties of experimental and control leather.....	106
4.2	Graphical representations of organoleptic properties of experimental and control leather.....	111
4.3	Graphical representations of organoleptic properties of experimental and control leather.....	116

ABSTRACT

The aim of this study is the application of garad barks (*Acacia nilotica*) as local tanning material for the production of upper leather. Garadbark which was located at City of El Geneina (West Darfur State) and El Jaili (Khartoum State), was analyzed for tannins, non-tannins, total soluble, Total solid and %Moisture.

Phytochemical investigations of garad bark widely distributed in Sudan have been carried out. Analysis of Garad bark gave the following values: tannin 23%, non-tannins 14%, total soluble 37%, total solid 41.45%, insoluble 54.35,moisture 8.65%, pH 5.5.

The combination of vegetable tannins with metal salts has been used for thousands of years. In the present study, a combination tanning system based on garad bark has been studied. It was seen that the combination tanning using garad bark 20% with aluminum (2% Al_2O_3), (9% ZnO) resulted in leathers with shrinkage temperature more than the control (garad bark tanned) leather. The physical and chemical characteristics of experimental leather are comparable to control leathers. The experimental leathers are softer than the control leathers. Combination tanning system using 20% garad bark - 2% Al_2O_3 is found to be better compared with other combination tanning systems.

Garad bark as alternative retanning agent for mimosa using wet blue has been studied. Most organoleptic properties of the experimental leathers produced from garad bark extract are better than control produced from wattle. However, softness property is better in the case of wattle retanned leather and the physical strength properties are comparable with matched pair control leather. Therefore using garad bark appears to be a good alternative for the retanning processes. Besides being technically feasible, retanning garad bark is also economically viable as the cost of the garad bark extract is cheaper.

ARABIC ABSTRACT

ملخص الدراسة

تهدف هذه الدراسة الي استخدام لحاء شجرة القرض المتوفرة في مدينة الجنيبة بولاية غرب دارفور ومدينة الجيلي بولاية الخرطوم لانتاج جلود الوجه. وقد تم تحليل لحاء شجرة القرض لتحديد نسبة المواد الدابغة والمواد غير الدابغة والمواد الكلية الذائبة.

أجريت هذه التحاليل لمعرفة المكونات الكيميائية في لحاء شجرة القرض التي توجد بكميات كبيرة في السودان. وقد اعطت نتيجة التحاليل للحاء شجرة القرض القيم التالية: مادة دابغة 23%، المواد غير الدابغة 14% والمواد الذائبة الكلية، 37%، المواد الصلبة الكلية 41.45%، المواد الذائبة 54.35%، الرقم الهيدروجيني يعادل 5.5.

الدباغة المختلطة بين المواد الدابغة النباتية والاملاح المعدنية قد استخدمت منذ الاف السنين.في هذه الدراسة ، تم استخدام نظام دباغة مختلطة بين مزيج المستخلص المائي للحاء القرض ومحلول كبريتات الألمونيوم وكبريتات الزنك لانتاج جلود وجه وقد لوحظ أن الدباغة المختلطة باستخدام لحاء القرض 20% مع الألومنيوم (2% Al_2O_3)، والزنك (9% ZnO) نتج عنه جلود ذات درجة حرارة انكماش أكثر من جلود التحكم (جلد مدبوغ بلحاء القرض). الخصائص الفيزيائية والكيميائية للجلود التجريبية قابلة للمقارنة مع جلود التحكم للجلود التجريبية هي افضل من ناحية الملمس من جلود التحكم. ووجد ان ان الدباغة المختلطة باستخدام المستخلص المائي للحاء القرض 20% , 2% Al_2O_3 يكون أفضل مقارنة مع أنظمة الدباغة المختلطة الأخرى .

وقد تم استخدام المزيج المستخلص المائي للحاء القرض في عمليات إعادة الدباغة لجلود الكروم المدبوغ اللينة (Wet blue) . وجد ان معظم الخواص الحسية للجلود التجريبية المنتجة من مستخلص لحاء القرض هي أفضل من جلود التحكم المنتجة باستخدام الميموسا، ومع ذلك فإن خاصية النعومة تكون أفضل في حالة الجلود المعاد دباغتها بالميموسا ، والخصائص الفيزيائية لجلود التحكم والتجريبية متطابقة . ان استخدام لحاء القرض يبدو بديلاً جيداً لعمليات إعادة الدباغة . إلى جانب كونه مجدياً من الناحية الفنية ، فإن إعادة الدباغة بلحاء القرض أمر قابل للتطبيق اقتصادياً أيضاً تكلفة مستخلص لحاء القرض أرخص.

LIST OF ABBREVIATIONS

BOD₅ = Biochemical Oxygen Demand

COD = chemical Oxygen Demand

TDS = Total Dissolve solids

Ts = Shrinking temperature

TLC = thin Layer Chromatography

PC = paper Chromatography