

Abstract and aknowledge PHD.doc

CONTENTS.doc

complete thesis AbbreviationPHD15.11.2011.doc

arabic summary.doc

أستمارة معلومات.doc

الصفحات العربى الغير مرقمة و الملخص العربى.doc

**USING ORANGE INDUSTRY BY PRODUCTS AS  
ENERGY SOURCE WITH DIFFERENT PROTEIN  
SOURCES IN RATIONS OF GROWING LAMBS**

**By**

**SOAD IBRAHIM IBRAHIM EL-NAGGAR**

**B.Sc. Agric. Sci. (Animal Production), Fac. Agric., Cairo Univ., ١٩٩٧**

**M.Sc. Agric. Sci. (Animal Nutrition), Fac. Agric., Cairo Univ., ٢٠٠٧**

**THESIS**

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

**DOCTOR OF PHILOSOPHY**

**In**

**Agricultural Sciences  
(Animal Production)**

**Department of Animal Production  
Faculty of Agriculture  
Cairo University  
EGYPT**

**٢٠١١**

**APPROVAL SHEET**

**USING ORANGE INDUSTRY BY-PRODUCTS AS  
ENERGY SOURCE WITH DIFFERENT PROTEIN  
SOURCES IN RATIONS OF GROWING LAMBS**

**Ph.D. Thesis  
In  
Agric. Sci. (Animal Production)**

**By**

**SOAD IBRAHIM IBRAHIM EL-NAGGAR**

**B.Sc. Agric. Sci. (Animal Production), Fac. Agric., Cairo Univ., ١٩٩٧**

**M.Sc. Agric. Sci. (Animal Nutrition), Fac. Agric., Cairo Univ., ٢٠٠٧**

**APPROVAL COMMITTEE**

**Dr. AHMED ZAKI MEHREZ .....**  
**Professor of Animal Nutrition, Fac. Agric., Elmansoura University**

**Dr. ABD EL-RAHMAN MAHMOUD ABD EL-GAWAD .....**  
**Professor of Animal Nutrition, Fac. Agric., Cairo University**

**Dr. SABBAH MAHMOUDM ALLAM .....**  
**Professor of Animal Nutrition, Fac. Agric., Cairo University**

**Dr. ALI MOHAMED ALI .....**  
**Associate Professor of Animal Nutrition, Fac. Agric., Cairo University**

**Date:     /     / ٢٠١١**

**SUPERVISION SHEET**

**USING ORANGE INDUSTRY BY-PRODUCTS AS  
ENERGY SOURCE WITH DIFFERENT PROTEIN  
SOURCES IN RATIONS OF GROWING LAMBS**

**Ph.D. Thesis  
In  
Agric. Sci. (Animal Production)**

**By**

**SOAD IBRAHIM IBRAHIM EL-NAGGAR**  
B.Sc. Agric. Sci. (Animal Production), Fac. Agric., Cairo Univ., ١٩٩٧  
M.Sc. Agric. Sci. (Animal Nutrition), Fac. Agric., Cairo Univ., ٢٠٠٧

**SUPERVISION COMMITTEE**

**Dr. SABBAH MAHMOUD ALLAM**  
Professor of Animal Nutrition, Fac. Agric., Cairo University

**Dr. ALI MOHAMED ALI**  
Associate Professor of Animal Nutrition, Fac. Agric., Cairo University

**Dr. GAMAL ABD EL-LATEIF ABOU-WARD**  
Researcher Professor of Animal Nutrition, National Research Center

**Name of Candidate:** Soad Ibrahim Ibrahim El-Naggar    **Degree:** Ph.D.  
**Title of Thesis:** Using Orange Industry By-Products as Energy Source with  
Different Protein Sources in Rations of Growing Lambs.  
**Supervisors:** Dr. Sabbah Mahmoud Allam  
Dr. Ali Mohamed Ali  
Dr. Gamal Abd El-Lateif Abou-Ward  
**Department:** Animal Production    **Branch:** Animal Nutrition  
**Approval:** ٧ / ١٢ / ٢٠١١

## ABSTRACT

Thirty growing Rahmany male lambs (٥-٦ months old and weighed in average ٧٨,٩±٥,٩ Kg) were randomly assigned according to their body weight into six feeding groups (٥ in each). The effect of replacing ٥٠ % corn grains by the same amount of dried orange industry by-product (DOP), with different protein sources, with and without yeast addition on the performance of growing lambs through growth trial for ١٢٠ days was studied followed by digestibility trials on adult sheep. Six experimental rations, total mixed ration, consist of ٣٠ % alfalfa hay: ٧٠ % concentrate feed mixture were used in this experiment, the first three rations contained soybean meal (٤٤ % CP) as protein source plus corn grains as energy source (R<sup>١</sup>), or ٥٠ % corn replaced by the same amount of DOP (R<sup>٢</sup>) or R<sup>٢</sup> plus ٣ g/h/d. yeast (*Saccharomyces cerevisiae*) (R<sup>٣</sup>), while, the other three rations contained corn gluten meal (٦٤ % CP) as protein source plus corn grains (R<sup>٤</sup>) or ٥٠ % corn replaced by the same amount of DOP (R<sup>٥</sup>) or R<sup>٥</sup> plus ٣ g/h/d. yeast (R<sup>٦</sup>). The results showed that there were no significant differences in all nutrients digestibility and nutritive value as TDN among animals fed R<sup>١</sup>, R<sup>٢</sup> and R<sup>٣</sup>. Animals fed rations R<sup>٥</sup> or R<sup>٦</sup> significantly ( $P < ٠,٠٥$ ) improved all nutrients digestibility compared with other rations, while those fed R<sup>٣</sup> or R<sup>٦</sup> improved digestibility of EE compared with R<sup>٢</sup> or R<sup>٥</sup>, respectively. There was a significant ( $P < ٠,٠٥$ ) improvement of the nutritive value for R<sup>٥</sup> as TDN and DCP by (٧,٦٧ and ٥,٨٢ %) and (٦,٧٨ and ٤,٤٨ %) respectively compared with R<sup>٢</sup> and R<sup>٤</sup>, respectively. Ruminal pH, ammonia nitrogen and total volatile fatty acid had the normal curve for all treatments. Rations contained DOP significantly ( $P < ٠,٠٥$ ) increased rumen acetate and decreased propionate and also, increased microbial protein synthesis and decreased pathogenic bacteria compared with rations contained ١٠٠ % corn grains. Blood parameters were generally unaffected by treatments and were in normal range. Average daily gain was significantly ( $P < ٠,٠٥$ ) improved for lambs fed ration R<sup>٥</sup> compared with other rations. Animals in R<sup>٢</sup> had the lowest feeding cost being ٩,٧١ followed by R<sup>٥</sup> had ٩,٩٥ L.E / Kg gain, respectively. It is concluded that ٥٠ % corn grains could be replaced by DOP in growing lambs rations supporting the growth of ruminal microbes and enhance feed conversion and reduce feed cost L.E / Kg gain.

**Key words:** Dried orange industry by-products, corn grains, soybean meal, corn gluten meal, yeast, growing lambs.

## **DEDICATION**

*I dedicate this work to whom my heart felt thanks; to my mother, my late father, my father -in-law, my brothers and sisters, my husband, my lovely daughters, son and all my family for their support, encouragement, help and creating a good atmosphere during the time of this study.*

## **ACKNOWLEDGEMENT**

*First of all thanks are due to our merciful "ALLAH" for his continuous help through my study and my life.*

*I am extremely grateful and greatly indebted to **Dr. Sabbah Mahmoud Allam** Professor of Animal Nutrition, Faculty of Agriculture, Cairo University for his kind supervision and kind help during the course of this work, providing me with all facilities to come to the end of this research and directing me in writing the thesis.*

*My deepest gratitude and appreciation are due to **Dr. Gamal Abd El-Lateif Abou Ward** Research Professor of Animal Nutrition, National Research Center for his kind supervision, co-operation, valuable help and providing the facilities and support during this work.*

*I wish to express my sincere thanks to **Dr. Mohamed Tawilla** Assistant Research Professor of Animal Nutrition, National Research Center for his help during the course of study.*

*I wish to express my sincere thanks, deepest gratitude and appreciation to **Dr. Ali Mohamed Ali** Associate Professor of Animal Nutrition, Faculty of Agriculture, Cairo University for his kind supervision, co-operation and directing me in writing the thesis.*

*Many thanks for **Dr. Hoda El Hosseiny** and **Dr. Salah Kamal**, Animal production Research Institute for their help and providing facilities during the digestibility trials in Animal House of their Institute.*

*Deep thanks for my friends for all the support they lovingly offered along the period of my post graduation.*

*Grateful appreciation is also extended to all staff members of the Animal Nutrition Department, Faculty of Agriculture, Cairo University.*

## LIST OF ABBREVIATIONS

<b>ADF</b>	Acid detergent fiber
<b>ADG</b>	Average daily gain
<b>ADL</b>	Acid detergent lignin
<b>ALT</b>	Alanine transaminase
<b>AST</b>	Aspartate transaminase
<b>BU</b>	Blood urea
<b>CF</b>	Crude fiber
<b>cfg/g</b>	Colony forming units per gram
<b>CGM</b>	Corn gluten meal
<b>CP</b>	Crude protein
<b>DCP</b>	Digestible crude protein
<b>DE</b>	Digestible energy
<b>DM</b>	Dry matter
<b>DMI</b>	Dry matter intake
<b>DOP</b>	Dried orange industry by-product
<b>EE</b>	Ether extract
<b>FBW</b>	Final body weight
<b>FN</b>	Fecal nitrogen
<b>GOT</b>	Glutamic-oxaloacetic transaminase
<b>GPT</b>	Glutamic-pyruvic transaminase
<b>IBW</b>	Initial body weight
<b>Kg</b>	Kilogram
<b>L.E.</b>	Egyptian pound
<b>ME</b>	Metabolizable energy
<b>meq</b>	milliequivalent
<b>mg/dl</b>	Milligram per deciliter
<b>MJ</b>	Mega joule
<b>MN</b>	Microbial nitrogen
<b>MPS</b>	Microbial protein synthesis
<b>NB</b>	Nitrogen balance
<b>NDF</b>	Neutral detergent fiber
<b>NDSF</b>	Neutral detergent-soluble fiber
<b>NEI</b>	Net energy intake
<b>NFE</b>	Nitrogen free extract
<b>NH<sub>4</sub>-N</b>	Ammonia nitrogen
<b>OM</b>	Organic matter



<b>RL</b>	Rumen liquor
<b>SBM</b>	Soybean meal
<b>SP</b>	SoyPlus, expeller soybean meal
<b>TDN</b>	Total digestible nutrients
<b>TG</b>	Total gain
<b>TL</b>	Total lipid
<b>TP</b>	Total protein
<b>TVFA's</b>	Total volatile fatty acids
<b>U/ml</b>	Unit per milliliter
<b>UN</b>	Urinary nitrogen
<b>YC</b>	Yeast culture

# CONTENTS

	Page
<b>INTRODUCTION.....</b>	1
<b>REVIEW OF LITERATURE.....</b>	4
1. Production of orange industry by-product.....	4
2. Chemical analysis and nutritive value of citrus industry by-product.....	5
3. Comparative between orange industry by-product and corn as a source of energy in ruminant rations.....	7
4. Effect of protein degradation on animal performance...	8
5. Impact of using yeast on the utilization of ruminant rations .....	9
6. Effect of using dried orange industry by-product in ruminant rations on nutrient digestibility.....	11
7. Effect of using dried orange industry by-product in ruminant rations on nitrogen balance.....	13
8. Effect of using dried orange industry by-product in ruminant rations on rumen liquor parameters.....	13
a. Rumen pH.....	13
b. Rumen ammonia nitrogen .....	15
c. Rumen total volatile fatty acids .....	16
9. Effect of using dried orange industry by-product in ruminant rations on animal performance.....	18
a. Body weight gain.....	18
b. Feed intake.....	20
c. Feed conversion.....	22
10. Effect of using dried orange industry by-product in ruminant rations on microbial protein synthesis.....	22
11. Effect of using dried orange industry by-product in ruminant rations on pathogenic bacteria.....	23
12. Effect of using dried orange industry by-product in ruminant rations on blood parameters.....	24
13. Effect of using dried orange industry by-product in ruminant rations on feed cost.....	25
<b>MATERIALS AND METHODS.....</b>	26
<b>RESULTS AND DISCUSSION.....</b>	34

١. Chemical composition of the ingredients and experimental rations.....	٣٤
٢. Digestibility trials.....	٣٧
a. Nutrients digestibility and nutritive value.....	٣٧
b. Nitrogen utilization.....	٤٣
c. Rumen parameters.....	٤٥
(١) The pH values.....	٤٥
(٢) Ruminal ammonia nitrogen.....	٤٨
(٣) Ruminal total volatile fatty acids and fractions.....	٤٩
٣. Microbial protein synthesis.....	٥٣
٤. Pathogenic bacteria.....	٥٤
٥. Lamb's performance.....	٥٧
a. Live weight gain.....	٥٧
b. Feed intake.....	٦٢
c. Feed conversion.....	٦٣
٦. Blood plasma parameters.....	٦٥
a. Alanine transaminase and aspartate transaminase activities.....	٦٥
b. Total protein.....	٦٥
c. Total Lipids.....	٦٨
d. Creatinine.....	٦٨
e. Urea.....	٦٩
f. Uric acid.....	٧٠
g. Cholesterol.....	٧١
٧. Economical evaluation.....	٧٢
٨. Conclusion.....	٧٢
٩. Recommendation.....	٧٤
SUMMARY.....	٧٥
REFERENCES.....	٧٩
ARABIC SUMMARY	

## LIST OF TABLES

No.	Title	Page
١.	Formulation of the experimental rations as total mixed ration.....	٢٧
٢.	Chemical composition of feed ingredients.....	٣٤
٣.	Chemical composition of the experimental rations as total mixed ration.....	٣٦
٤.	Nutrients digestibility and nutritive values of the experimental rations.....	٣٨
٥.	Nitrogen balance for adult sheep fed the experimental rations.....	٤٣
٦.	Effect of feeding experimental rations on rumen parameters of adult sheep.....	٤٦
٧.	Effect of experimental rations on ruminal volatile fatty acids fraction of adult sheep.....	٥٢
٨.	Amount of microbial protein in rumen liquor and count of <i>E. coli</i> and <i>salmonella</i> in the feces of lambs fed	٥٥
٩.	Live body weight changes and average daily gain of lambs fed the experimental rations through the experimental	٥٨
١٠.	Dry matter intake and feed conversion of lambs fed the experimental rations.....	٦٢
١١.	Mean values of blood constituents recorded for lambs fed the experimental rations.....	٦٧
١٢.	Economical evaluations of the experimental rations.....	٧٣

## LIST OF FIGURES

No.	Title	Page
١.	Effect of feeding experimental rations on DM, OM and CP digestibility.....	٣٩
٢.	Effect of feeding experimental rations on EE, CF and NFE Digestibility.....	٣٩
٣.	Total digestible nutrients of the experimental rations.....	٤٠
٤.	Digestible crude protein of the experimental rations.....	٤٠
٥.	Nitrogen balance of adult sheep fed the experimental rations.....	٤٤
٦.	Effect of feeding experimental rations on means value of ruminal pH.....	٤٧
٧.	Effect of feeding experimental rations on means value of ruminal ammonia nitrogen.....	٤٨
٨.	Effect of feeding experimental rations on means value of ruminal total volatile fatty acids.....	٥٠
٩.	Effect of the experimental rations on microbial protein synthesis.....	٥٦
١٠.	Live body weight changes of lambs fed the experimental rations (R <sup>١</sup> , R <sup>٢</sup> and R <sup>٣</sup> ) through the experimental period.....	٥٩
١١.	Live body weight changes of lambs fed the experimental rations (R <sup>٤</sup> , R <sup>٥</sup> and R <sup>٦</sup> ) through the experimental period.....	٥٩
١٢.	Average daily gain of lambs fed the experimental rations.....	٦٠

١٣.	Dry matter intake of lambs fed the experimental rations.....	٦٣
١٤.	Feed conversion of lambs fed the experimental rations.....	٦٤
١٥.	Plasma alanine transaminase and aspartate transaminase activities of lambs fed the experimental rations.....	٦٧
١٦.	Plasma total protein of lambs fed the experimental rations...	٦٧
١٧.	Plasma total lipids of lambs fed the experimental rations.....	٦٨
١٨.	Plasma creatinine of lambs fed the experimental rations.....	٦٩
١٩.	Blood urea of lambs fed the experimental rations.....	٧٠
٢٠.	Plasma uric acid of lambs fed the experimental rations.....	٧١
٢١.	Plasma cholesterol of lambs fed the experimental rations.....	٧٢
٢٢.	Effect of experimental rations on feed cost.....	٧٣

## INTRODUCTION

Feeding by-products of crops and food processing industries to livestock is a practice as old as the domestication of animals by human. It has two important advantages (Grasser *et al.*, 1990), these being to diminish dependence of livestock on grains that can be consumed by human (which was almost certainly the primary original reason), and to eliminate the need for costly waste management programs (which has become very important in recent years as the world human population has increased and the amount of crop and food by-product has increased, particularly in developed countries).

In Egypt, the continuous increases in feed costs specially corn grains, locally produced or imported from abroad as a source of energy for human (biofuel), led to search for other alternative feedstuffs or by-products to be used as energy source in animal rations.

Citrus pulp is a by-product from citrus processing plants that produce juice, contains remaining peel, pulp, seeds, and rag of the citrus family (e.g., orange, lemons and grapefruit). It is the main by-product from the citrus-processing industry that is used as a feedstuff for ruminants.

Dried citrus pulp is typified (Arthington *et al.*, 2002 and Bampidis and Robinson, 2006) by high concentrations of pectin (22 to 40%) and approximately 8% TDN and relatively low concentrations of CP ( $7.2 \pm 0.2\%$ ), which are similar to grains, fat ( $3 \pm 1.0\%$ ), NDF ( $19.3 \pm 1.3\%$ ), and ADF ( $16.9 \pm 2\%$ ; DM basis). Citrus pulp is high in digestible fiber, which makes it an excellent energy supplement. Pectin is the predominant carbohydrate in dried citrus pulp, and it is quickly