

**LOCAL CANOLA MEAL AS AN ALTERNATIVE
FOR SOYBEAN MEAL IN BROILER DIETS**

By

AHMED SAAD MOHAMMED ABD ELHAMEED
B.Sc. Agric. Sci. (Animal Production), Fac. Agric., Cairo Univ., 2002
M. Sc. Agric. Sci. (Poultry Production), Fac. Agric., Cairo Univ., 2014

THESIS

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

DOCTOR of PHILOSOPHY

In

**Agricultural Sciences
(Poultry Production)**

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

2022

Format Reviewer

**Vice Dean of Graduate Studies
Prof.Dr/ Ayman Yehia Amin**

Name of Candidate: Ahmed Saad Mohammed **Degree:** Ph.D.
Title of Thesis: Local Canola Meal as an Alternative for Soybean Meal in Broiler Diets
Supervisors: Dr. Abdallah Ali Ghazalah
Dr. Ahmed Mohamed El-Kaiaty
Dr. Hady Fathy Abbas
Department: Animal Production **Branch:** Poultry Production
Date: 18 /08/2022

ABSTRACT

The present study focused on the nutritional evaluation of local canola meal (LCM) compared with soybean meal (SBM) as well as on the nutritional impact of feeding LCM to broilers in addition to the possibility of improving its utilization by using enzymes. LCM contained lower crude protein (35.98 vs. 50.92%); more ether extract (EE) (10.35 vs. 1.69%), and crude fiber (12.58 vs. 3.60) on dry matter basis. LCM contained more inhibitor contents like phytic acid (2.13 vs. 1.29%) as compared to SBM whereas it had 22.47 $\mu\text{mol/gm}$ glucosinolates. Comparable with SBM, LCM had a lower apparent and true metabolizable energy than that of SBM (1.75 vs. 2.28 Kcal/g) and (2.39 vs. 3.12 Kcal/g), respectively. The calculated protein replacement value of LCM was 92.22%. Compared with SBM, LCM had nearly similar true amino acids availability (109.56 vs. 109.06) on average. Two feeding experiments were conducted, in the first, LCM protein replaced SBM protein at 0, 30, 60, and 90% for 39 days feeding trial. The results showed no significant differences in productive performance parameters among control, 30% and 60% treatment groups, while, at 90% replacement level, all values decreased. The 90% replacement level showed an increase in relative weight of thymus, bursa, and thyroid as well as thyroid hormones. However, LCM had no effect on serum haemagglutination inhibition (HI) titer against Newcastle disease (ND). LCM significantly decreased serum cholesterol content while increased HDL, compared to the control. In the second experiment, two different enzymes being phytase (phy) and xylanase (xyl) were applied aimed to improve utilization of the high replacement level of LCM (90%). The results indicated significant improving of all productive performance parameters with enzyme treatments but still lower than the control. The high level of LCM with either phy or xyl+phy enzyme had significantly higher HI titer against ND. In conclusion, the presence of essential nutrients implies that LCM could be utilized as a safe protein in poultry diets with no detrimental effect on growth performance. Economically, LCM can be used to replace up to 60% of SBM protein without negative effects on growth and immune response of broilers.

Keywords: canola meal, broilers, evaluation, performance, immunity.

LIST OF ABBREVIATIONS AND INITIALS

AD	Apparent digestibility
ADF	Acid detergent fiber
ADL	Acid detergent lignin
AFs	Aflatoxins
ALP	Alkaline Phosphatase
ALT	Alanine transaminase
AME	Apparent metabolizable energy
AMEn	Nitrogen corrected apparent metabolizable energy
AOAC	Association of Official Analytical Chemists
AST	Aspartate transaminase
BD	Basal diet
BW	Body weight
BWG	Body weight gain
CBC	Complete blood count
CF	Crude fibre
CFU	Colony forming units
CM	Canola meal
CP	Crude protein
DM	Dry matter
EE	Ether extract
EI	Economic indicator
FCR	Feed conversion ratio
Fig.	Figure
GE	Gross energy
GGT	Gamma-glutamyl transferase
GLS	Glucosinolates
Hb	Hemoglobin
HCT	Hematocrit
HDL	High-density lipoprotein cholesterol

IB	Infectious bronchium
IU	International unit
Kcal	Kilo calorie
LCM	Local canola meal
LDL	Low-density lipoprotein cholestrol
MCV	Mean Corpuscular Volume
MDA	Malondialdehyde
ME	Metabolizable energy
MR	Mortality rate
ND	Newcastle Disease
NDF	Neutral detergent fiber
NDV	Newcastle disease virus
NFE	Nitrogen free extract
NRC	National research council
Ns	Non-significant
NSP	Non-starch polysaccharides
OM	Organic matter
Phy	Phytase enzyme
PLT	platelet blood count
RBCs	Red blood cells
RCFF	Regional Center for Food and Feed
RSM	Rapeseed meal
SBM	Soybean meal
SFA	Saturated fatty acids
SRBCs	Sheep red blood cells
T₃	Triiodothyronine
T₄	Thyroxine
TME	True metabolizable energy
UFA	Unsaturated fatty acids
Xyl	Xylanase enzyme

CONTENTS

	Page
INTRODUCTION	1
REVIEW OF LITERATURE	5
1. Rapeseed	5
a. History.....	5
b. Canola.....	8
2. Canola meal	10
a. Production.....	11
b. Chemical composition.....	11
1. Protein and amino acids.....	14
2. Fat.....	16
c. Antinutritional factors in canola meal.....	16
1. Dietary fiber.....	16
2. Glucosinolates.....	18
3. Thiocyanates.....	21
4. Isothiocyanates.....	22
5. Nitriles.....	22
6. Tanins.....	23
7. Phytic acid.....	24
8. Sinapine.....	26
d. Nutritive values of canola meal.....	27
1. Energy.....	27
2. Amino acid digestibility of canola meal for broiler chickens.....	30
3. Evaluation of protein quality.....	32
e. Canola meal inclusion in poultry diets.....	32
1. Effects of canola meal on broiler performance.....	34
2. Effects of canola meal on carcass and meat characteristics of broilers.....	37
3. Exogenous enzymes.....	40
a. Use of enzymes in poultry diets contains CM.....	42
b. Response of broilers to CM diets with or without xylanase, phytase and their combination.....	45
MATERIALS AND METHODS	49

CONTENTS (continued)

	Page
RESULTS AND DISCUSSION	69
1. Chemical and biological evaluation of local canola meal (LCM)	69
a. Proximate analysis.....	69
b. Amino acids (AA).....	75
c. Biological evaluation.....	76
2. Utilization of local canola meal (LCM) in broiler diets	82
a. The first experiment: Use of local canola meal (LCM) to replace soybean meal (SBM) in broiler diets.....	82
1. Productive performance.....	82
2. Nutrient digestibility.....	85
3. Immune response and lymphoid organs.....	87
4. Blood biochemical parameters.....	89
5. Fatty acids profile of carcass meat and caecum microbial content.....	95
6. Hematological parameters.....	98
7. Relative organs weight.....	99
8. Effect of LCM on histopathological changes in some organs.....	102
a. Liver.....	102
b. Spleen.....	105
c. Bursa of Fabricius.....	106
d. Thymus.....	108
9. Economic study.....	110
b. The second experiment: nutritional impact of local canola meal (LCM) with or without enzymes on performance, immune response and economic indicator of broilers.....	111
1. Productive performance.....	112
2. Effect of LCM with or without enzymes on immune responses.....	125
a. Haemagglutination Inhibition (HI) titer against Newcastle disease virus.....	125
b. Immune response to Sheep Red Blood Cells injection (SRBCs).....	127

3. Economic study.....	127
CONCLUSION	130
SUMMARY	131
REFERENCES	140
ARABIC SUMMARY	

LIST OF TABLES

No.	Title	Page
1.	Chemical and nutritive composition of canola meal compared to soybean meal (%; 10% moisture basis)	12
2.	Protein and amino acid contents of canola meal (% dry matter)	15
3.	Poultry true digestibility coefficients of some key essential amino acids in canola meal and soybean meal.....	31
4.	Inclusion levels of canola meal (CM) in poultry diets.....	33
5.	Experimental design for the first experiment.....	57
6.	Experimental design for the second experiment.....	58
7.	Composition and calculated analysis of the experimental diets.....	59
8.	Vaccination program.....	61
9.	Proximate analysis as fed (%) of local canola meal (LCM) compared to soybean meal (SBM).....	70
10.	Anti-nutritional factors of local canola meal (LCM) compared to soybean meal (SBM).....	73
11.	Essential amino acid (EAA) composition (%), chemical score (CS), limiting amino acid (LAA) and essential amino acid index (EAAI) of local canola meal (LCM) compared to soybean meal (SBM), based upon egg albumin as standard.....	77
12.	Gross energy (GE), apparent and true metabolizable energy (AME and TME) values (Kcal/g) of local canola meal (LCM) and soybean meal (SBM) and the protein replacement value (PRV) (%) of LCM from SBM.....	79
13.	True amino acids availability (TAAA) of local canola meal (LCM) compared to soybean meal (SBM) (%).....	81
14.	Effect of replacing Soybean meal protein by local canola meal protein on productive performance.....	83
15.	Effect of replacing of Soybean meal protein by local	

canola meal (LCM) protein on nutrients digestibility at 39 d of age.....	86
16. Effect of replacing of Soybean meal protein by local canola meal protein on immune response and lymphoid organs.....	88
17. Effect of replacing of Soybean meal protein by local canola meal protein on liver and kidney function parameters.....	91
18. Effect of replacing of Soybean meal protein by local canola meal protein on biochemical parameters.....	93
19. Effect of replacing of Soybean meal protein by local canola meal protein on parameters of thyroid activity.....	94
20. Effect of replacing soybean meal protein by local canola meal protein on fatty acids profile of carcass meat (% of total fatty acids)	96
21. Effect of replacing soybean meal protein by local canola meal protein on cecum microbial content (log ₁₀ CFU/g digesta).....	98
22. Effect of replacing soybean meal protein by local canola meal protein on CBC.....	99
23. Effect of replacing of Soybean meal protein by local canola meal protein on relative organs weights.....	100
24. Effect of dietary supplementation with different levels of local canola meal on feed cost, net revenue, economic indicator (EI) and relative EI of broiler chickens.....	110
25. Effect of replacing 90% of Soybean meal protein by local canola meal (LCM) protein with or without enzyme on productive performance of broiler chicks from 0-14 days of age.....	113
26. Effect of replacing 90% of Soybean meal protein by local canola meal (LCM) protein with or without enzyme on productive performance of broiler chicks from 15-28 days of age.....	117
27. Effect of replacing 90% of Soybean meal protein by local canola meal (LCM) protein with or without enzyme on productive performance of broiler chicks from 29-39 days of age.....	118
28. Effect of replacing 90% of Soybean meal protein by local canola meal (LCM) protein with or without enzyme on	

productive performance of broiler chicks from 0-39 days of age.....	121
29. Effect of replacing 90% of Soybean meal protein by local canola meal (LCM) protein with or without enzyme on immune response.....	126
30. Effect of high dietary level of local canola meal (LCM) with or without enzyme supplementation on feed cost, net revenue, economic indicator (EI) and relative EI of broiler chickens.....	128

LIST OF FIGURES

No.	Title	Page
1.	Progression in worldwide production of rapeseed meal adapted from (Soyatech, 2012)	9
2.	Canola oil extraction process adapted from (Baquero <i>et al.</i> , 2011).....	10
3.	Hydrolysis of glucosinolates by the enzyme myrosinase and their different hydrolysis adapted from (Pal Vig <i>et al.</i> , 2009).....	19
4.	Chemical structure of Phenyl-thiocyanate C ₇ H ₅ NS adapted from (Chemspider, 2013).....	22
5.	Chemical structure of Isothiocyanates C ₄ H ₅ NS adapted from (Pubchem, 2013).....	22
6.	Chemical structure of tannic acid C ₇₆ H ₅₂ O ₄₆ adapted from (Schofield <i>et al.</i> , 2001).....	23
7.	Structure of Phytic acid and its possible interactions with minerals, proteins and starch (Thompson, 1986).....	25
8.	Liver of control group showing mild degenerative changes of hepatocyte (X100).....	103
9.	Liver of 30% LCM group showing thrombus formation (X100).....	104
10.	Liver of 60% LCM group showing hyperplasia of bile ductulus and necrobiotic changes of hepatocytes (X200).....	104
11.	Liver of 90% LCM group showing thickening of portal blood vessels with thrombus formation, hyperplasia of bile ductules with hepatocellular degeneration (X100).....	104
12.	Spleen of control group showing multifocal lymph depletion with mild thickening of splenic capsule (X100)...	105
13.	Spleen of 30% LCM group showing multi focal lymphocytic depletion with mild capsular thickening (X100).....	105
14.	Spleen of 60% LCM group showing multifocal and defuse lymphoarlic depletion with capsular thickening (X100).....	106

15. Spleen of 90% LCM group showing defuse lymphocytic depletion and thickening of splenic blood vessels (X100).....	106
16. Bursa of control group showing no pathogenic lesions (X50).....	107
17. Bursa of 30% LCM group showing no pathogenic lesions (X100).....	107
18. Bursa of 60% LCM group showing mild depletion of lymphoid follicles, mild thickening of inter follicular edema (X100).....	107
19. Bursa of 90% LCM group showing moderate lymphocytic depletion, atrophy in some lymphoid follicle due to inter follicular edema and connective tissue thickening (X100)...	108
20. Thymus of control group showing no pathogenic lesions (X50).....	108
21. Thymus of 30% LCM group showing no pathogenic lesions (X100).....	109
22. Thymus of 60% LCM group showing mild depletion (X200).....	109
23. Thymus of 90% LCM group showing degeneration of Island of Langerhans (X200).....	109