Improving vegetable protein diets for broiler chickens

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LIST OF ABBREVIATIONS

AOAC	Association of Official Analytical Chemists
AEC	Animal Ethics Committee
AME	Apparent metabolizable energy
ANF	Anti-nutritive factor (s)
ANOVA	Analyses of variance
APAF	Australian Proteome Analysis Facility
AP	Animal Protein /Alkaline Phosphatase
Arg	Arginine
BSE	Bovine spongiform encephalopathy
CA	Chymotrypsin amidase
CP	Crude protein
CF	Crude fibre
CM	Canola meal
CSM	Cottonseed meal
-CHO	Carbohydrates
CRD	Complete Randomized Design
CEC	Council of European Community
D/d	Day (s)
DE	Digestible energy
DCP	Dicalciumphosphate
DM	Dry matter
DCe	Digestibility coefficient of energy

DF	Dietary fibre
DMRT	Duncan's multiple range test
DSO	Degummed soybean oil
DMSO	Dimethyle sulphoxide
EE	Ether extract
EU	European Union
EDTA	Ethylenediaminetetraacetic Acid
FAO	Food and Agriculture Organization
FCR	Feed conversion ratio
FI	Feed intake
GE	Gross energy
GM	Genetically modified
GIT	Gastro-intestinal tract
g	Gram
GEI	Gross energy intake
h	Hour (s)
HP	Heat production
HCN	Hydrocyanic acid
HPLC	High performance liquid chromatography
His	Histidine

ICP	Inductive coupled plasma
ICP-AES	Inductive coupled plasma atomic-emission spectrometry
IIe	Isoleucine
kj	Kilo joule
K_{RE}	Efficiency of meatbolizable energy (ME) use for energy retention
K_{REf}	Efficiency of ME use for lipid/fat retention
K_{REp}	Efficiency of ME use for protein retention
kg	Kilogram
LW	Live weight
LWG	Live weight gain
LTS	Latency-to-sit
Lys	Lysine
Leu	Leucine
ME	Metabolizable energy
MEI	Metabolizable energy intake
Met	Methionine

min	Minute (s)
mm	Millimetre
MJ	Mega joule
MOPS	3-[*N*-morpholino] propanesulfonic Acid
MQ	MilliQ water
MBM	Meat and bone meal
NRC	National Research Council
NS	Non-significant
NSPs	Non-starch polysaccharides
NSW	New South Wales
NE	Net energy
NEp	Net energy for production
P	Probability/phosphorus
Phe	Phenylalanine
RE	Energy retention
RE_f	Energy retained as fat
RE_p	Energy retained as protein
SEM	Standard error of means

SBM	Soybean meal
TiO_2	Titanium dioxide
TME	True metabolizable energy
Trp	Tryptophan
Thr	Threonine
TTA	Total tibia ash
UPLC	Ultra performance liquid chromatography
UNE	University of New England
USDA	United States Development Association
USA	United States of America
UK	United Kingdom
UL	Ultra-violet
VP	Vegetable protein
Val	Valine

LIST OF PUBLICATIONS

Journal papers:

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M. A. Hossain, A. F. Islam and P. A. Iji (2011). Effect of all-vegetable diets on leg abnormalities of broiler chickens. ***Proceedings of the Nutrition Society of Australia, Queenstown, New Zealand,* 35: 82.**

M. A. Hossain, A. F. Islam and P. A. Iji (2011). Performance of broiler chickens fed diets based on all-vegetable ingredients. ***Recent Advances in Animal Nutrition–Australia, Armidale, Australia,* 18: 99-100.**

SUMMARY OF THE THESIS

This project was conducted with a view to assess the potential and to improve vegetable protein (VP) diets for broiler chickens. Productivity, litter quality, meat yield characteristics, visceral organ development, leg bone development, energy utilization, dietary manipulation strategies, and feed selection were investigated in order to determine the nutritive value of these diets for broiler chickens. In this regard, biological trials were conducted on male Cobb 500 and Ross 308 broiler chicks from day-old to 21 or 35d of ages in each case. All feed was provided to the birds *ad libitum* in cold-pelleted form, and each experiment was conducted in environmentally controlled housing. The research findings of each experimental chapter, including review of literature have been presented in manuscript format for presentation at conferences or journal publication. This summary provides an outline of the dissertation and an overview of the key findings of the research study.

Chapter 1 describes the background information and highlights the aims and objectives of the study. Chapter 2 is a literature review examining the nutritive value of poultry feed ingredients and effects of vegetable/animal protein diets on broiler production. This also covered the constraints, feasibility, nutrient digestibility, enzyme efficacy, energy utilization, leg bone development, bone mineralization, litter and meat quality, and strategies of improving VP diets for broiler production.

In Chapter 3, the comparative performance, with respect to growth response, litter quality, meat yield traits, leg bone development, and nutrient digestibility of broilers fed on vegetable or animal protein diets was assessed. The variables of productivity of broilers investigated in this study were significantly different between AP or VP diets. Birds fed on AP diets had better gross responses (feed intake, weight gain and feed conversion ratio) than those on VP diets.

Excreta pH, ammonia concentration, and mortality of birds were not influenced by treatment, but VP diets compromised with litter quality through increased moisture in the excreta of birds, when compared to the AP diets. Almost all the meat yield traits of broilers assessed in this study (on 35d) were similar except for abdominal fat content. Birds grown on VP diets had lower fat content in the carcasses than those on AP diets. Birds on AP diets had better leg bone quality than those on VP diets.

Higher bone breaking strength plus longer standing time (determined by a latency-to-sit test) were obtained in the birds fed AP diets. Bone mineralization was almost similar in both diet groups except for total tibia bone ash (TTA), Fe and Cu contents. The concentrations of TTA, Fe and Cu were significantly higher on birds fed AP diets. Gross energy and starch digestibility was not affected by any treatment, but ileal protein digestibility was significantly higher on AP diets than in the birds fed on VP diets.

Chapter 4 presents the results of gross responses and energy utilization of broilers fed diets based on VP or AP diets. Gross response of broilers in terms of feed intake (FI), live weight (LW) and feed conversion ratio (FCR) was better on AP diets than on VP diets. Apparent metabolizable energy (AME), protein intake, heat production (HP) and efficiencies of energy for gross energy, protein, and fat retention were not influenced by treatment in this study. However, ME intake, fat intake, net energy for production (NEp), whole body energy content, fat and protein retention were significantly better on birds fed on AP diets than those on the VP diets.

Chapter 5 focuses on direct comparison between the two key VP ingredients-soybean and canola meals when fed with or without microbial enzymes. Feed intake on CM diets was significantly higher than on the SBM diets. Birds fed on SBM diets achieved improved FCR at 21d, compared

to the birds fed on CM diets. Birds gained similar live weight fed on both diets to 35d. The ileal digestibility of most of the indispensable amino acids (histidine, threonine, lysine, valine, iso-leucine, and phenylalanine) measured at 21d was improved in birds on the supplemented diets, while the digestibility of most amino acids at 35d was unaffected by supplemental enzymes. Although lysine digestibility was significantly higher in birds on SBM diets, histidine was not, but was higher in CM diets measured at 21d. The digestibility of threonine, lysine, valine, iso-leucine, and leucuine was significantly higher in SBM diet than in CM diet at 35d, although the digestibility of the remaining amino acids was similar at this stage. The digestibility of Zn, Ca, Mg and P was identical in both diet groups; K, Mn and Cu digestibility was significantly improved in enzyme-treated diets at 21 days. The effects of diets on mineral digestibility at 21d, enzyme activities and tissue protein contents of supplemented diets assessed on 21d, as well as the digestibility of mineral in supplemented diets measured at 35d was unaffected by the test diets. The digestibility of Cu, Zn, and Mg was significantly higher on the CM diets, but not Ca which was higher in birds on the SBM diet at 35d. Only the activity of maltase was different between the two different test diets, but this effect was not due to microbial enzyme supplementation.

Chapter 6 presents the effects of combined or choice feeding systems of birds to assess the growth response and feed selection by broilers fed on AP or VP diets. The results of combined feeding approach showed that significantly better growth was obtained by the birds fed on AP diets than in VP diets at initial stages (7 and 14d) only. Later, overall gross response along with other characteristics (tissue protein growth, digestive enzyme efficiency, visceral organ and leg bone development) of birds were unaffected between treatment groups (21 days), regardless of

what diet the birds were fed on the first 7 days post-hatch. The results of feed selection test revealed that birds preferred CM to SBM diets when given a choice.

The overall research findings from this project are discussed in Chapter 7, along with concluding remarks and recommendations for the poultry industry, and areas of future research were identified. The results generally showed that plant protein quality can be enhanced by dietary supplementation with microbial enzymes. Sources of vegetable protein for non-ruminant animal feeds are numerous and varied, with considerable opportunities for further diversifications and substitutions. More research is needed on alternative sources of protein for optimum and economic poultry production before many of the opportunities can be exploited in practice.