INVESTIGATION OF ENERGY PARTITIONING IN MODERN BROILER CHICKENS

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Khaldoun Shatnawi

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ABSTRACT

Studies were conducted to estimate the energetic efficiencies for fat deposition from different energy sources (carbohydrate, protein, soybean oil and tallow) and to determine the maximum protein deposition (Pdmax) and minimum body lipid to protein ratio (minL/P) of the modern broiler chickens. Energetic efficiencies for fat deposition were assessed by feeding birds extra energy from different energy sources when protein was limiting in the diet. Comparison of birds slaughtered before and after the dietary treatments were applied allowed the determination of the energy retained as fat or protein. In the first experiment (Chapter 3), the energetic efficiencies of fat deposition from vegetable oil and starch were estimated to be 0.82 and 0.69, respectively. In the second experiment (Chapter 4), the energetic efficiencies of fat deposition were estimated to be 0.93 from soybean oil and 0.90 from tallow, but there was no significant difference between soybean oil and tallow. In the third experiment (Chapter 5), the efficiency of energy deposition as fat from non-essential amino acid intake was calculated to be 0.63.

In the fourth experiment (Chapter 6), the Pdmax and minL/P were determined by feeding diets not limited for protein with varying energy levels. The maximum daily protein deposition was predicted at 22 g/day. According to broken-line model, the rate of protein deposition increased when the apparent metabolisable energy intake above maintenance requirement (AMEIp) increased up to the break point of 1.2 MJ/day. Further increases of AMEIp did not lead to an increase in protein deposition rate whereas the fat deposition rate sharply increased. The body weight and energy intake affect the L/P ratio. Across all treatment groups, the minimum value of L/P ratio was observed at 0.31 for birds fed 1 MJ/day of AMEIp at 4 kg live body weight.

From the knowledge of net energy requirements and considering the efficiency of metabolisable energy for fat and protein deposition from all experiments, a simple mechanistic growth model was developed for modern broilers (Chapter 7). The model simulates the daily growth of broilers and it was able to predicting the broiler performance and carcass composition under a variety of nutritional conditions. Moreover, the model was evaluated with a range of experimental data (Chapter 8) and prediction values were in close agreement with observed values. The relative prediction errors were 3.8% and 7.3%, for prediction of slaughter live body weight for dependent and independent dataset, respectively.

In conclusion, the efficiencies of energy utilisation for fat deposition varied depending on energy sources with the highest values for soybean oil and tallow followed by starch and the lowest for protein. Modern broilers have an upper limit for protein deposition (22 g/day). The body weight and energy intake affect the L/P ratio and the minimal L/P ratio was observed at 0.31. The mechanistic growth model based on energy partitioning concepts can be a tool to predict the carcass composition and broiler performance and can deal adequately with the complexity of nutritional factors.

The finding of this thesis is that the broiler performance can be improved by formulating the diet to maximise the protein deposition with minimum fat deposition. The maximum protein deposition can be achieved when the birds consumed 1.2 MJ/day of AMEIp or 2.5 MJ/day of AME intake, further energy intake will deposited as lipid.

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Publications

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List of Abbreviations

AA	Amino acid
ADE	Apparent digestible energy
ADG	Average daily gain
AHP	Activity heat production
AME	Apparent metabolisable energy
AMEg	Apparent metabolisable energy for gain
AMEi	Apparent metabolisable energy intake
AMEIfpd	Apparent metabolisable energy intake free of energy for protein deposition
AMEIp	Apparent metabolisable energy intake for production
AMEn	Nitrogen corrected apparent metabolisable energy
ANOVA	Analysis of variance
CP	Dietary crude protein
CPi	Dietary crude protein intake
DCP	Digestible crude protein
DCPi	Digestible crude protein intake
DFCP	De-feathered carcass protein
DFCPf	De-feathered carcass protein final
DFCPi	De-feathered carcass protein initial
DFCW	De-feathered carcass weight
DFCWf	De-feathered carcass weight final
DFCWi	De-feathered carcass weight initial
DM	Dry matter
EAA	Essential amino acids
EE	Ether extract
EEP	Energy from excess protein intake
ER	Energy retention
ERF	Energy retention fat
ERP	Energy retention protein
EUBP	Energy from unbalanced protein
FA	Feed allowance
FI	Feed intake
FE	Feather energy retention
FHP	Fasting heat production
Fd pot	Potential body fat
Ff	Fat deposition from fat intake
FI	Feed intake
Fp	Fat deposition of unbalance/excess protein intake
Fs	Fat deposition from starch intake
g	Gram
GE	Gross energy
HI	Heat increment
HP	Heat production
IDBP	Ideal digestible balance protein
IDBP(AA)	Ideal digestible balance protein for each amino acid
IDBPI	Ideal digestible balance protein intake
k	Efficiency of metabolisable energy utilisation

kf	Efficiency of metabolisable energy utilisation for fat deposition
kf_f	Efficiency of metabolisable energy utilisation for fat deposition from digestible fat
kf_N	Efficiency of metabolisable energy utilisation for fat deposition from protein
kf_s	Efficiency of metabolisable energy utilisation for fat deposition from digestible starch
kf_{so}	Efficiency of metabolisable energy utilisation for fat deposition from soybean oil
Kf_t	Efficiency of metabolisable energy utilisation for fat deposition from tallow fat
k_g	Efficiency of metabolisable energy utilisation for weight gain
km	Efficiency of metabolisable energy utilisation for maintenance
kp	Efficiency of metabolisable energy utilisation for protein deposition
kJ	Kilo Joule
LBW	Live body weight
LBWf	Final live body weight
LBWi	Initial live body weight
L/P ratio	Lipid to protein ratio
ME	Metabolisable energy
MEm	Metabolisable energy for maintenance requirement
minL/P	Minimum lipid/protein ratio
MJ	Mega joule
N	Nitrogen
NEAA	Non-essential amino acids
NE	Net energy
NEp	Net energy for production
NRC	National research council
Pd	Protein deposition
PDI	Pellet durability index
Pdmax	Maximum protein deposition
Pg	Protein for body weight gain
Pm	Maintenance protein requirement
TME	True metabolisable energy