UNIVERSITI PUTRA MALAYSIA

EFFECTS OF PHYTASE, PHOSPHORUS, PROTEIN AND TEMPERATURE ON GROWTH, APPARENT NUTRIENT DIGESTIBILITY AND CARCASS CHARACTERISTICS OF BROILER CHICKANS

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FP 2005 15

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree Master of Agriculture Science

September 2005

Dedicated to

My beloved family & James

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the Degree of Master of Agriculture Science

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September 2005

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Feeding excessive dietary phosphorus (P) is not only expensive but would lead to environmental pollution and mineral binding. Phytase has been utilized extensively to break down the links between nutrients and the phytate ring, increasing nutrients availability, thus creating both economic and environmental advantages. High temperatures are detrimental to poultry performance. Since sophisticated cooling systems are costly, dietary protein manipulation is one of the corrective approaches to overcome the adverse effects of heat stress. The objectives of the present study were to investigate the effects of phytase, inorganic P, crude protein (CP), environmental temperature (T) and their two-way interactions on growth performance, apparent nutrient digestibility and carcass characteristics in broiler chickens.

Phytase supplementation by itself did not affect ($P>0.05$) the broilers' growth performance; bone, carcass characteristics, meat tenderness and water holding capacity. However, addition of P enhanced the birds' appetite, improved ($P<0.05$) FI, BWG and FCR. Increasing dietary CP decreased feed intake (FI) but enhanced

(P<0.05) body weight gain (BWG) and feed conversion ratio (FCR). Broilers in the lower T chamber had better growth rate than those in the warmer environment. Broilers given supplemental phytase and 23% CP diet performed better than their counterparts. Addition of P ameliorated the adverse effects of low dietary CP content or high T, indicating a significant (P<0.05) interaction. Increasing dietary CP content did not impair the growth performance of the broilers in the higher T chamber as reported probably because the elevation of T was not high enough to cause hyperthermia.

Phytase increased (P<0.05) the apparent digestibility of calcium (Ca) suggesting a higher release of Ca from the phytate mineral complex. As the dietary P level increased, apparent digestibilities for apparent metabolizable energy (AME) was decreased Ca, P and CP were increased (P<0.05). Apparent digestibility for P increased (P<0.05) but was *vice versa* for Ca as CP level increased. Elevating the environmental T reduced (P<0.05) the apparent digestibility for Ca and CP but increased (P<0.05) apparent P digestibility. Phytase x P effect was significant (P<0.05) on the apparent digestibility for Ca. Supplemental phytase with 23% dietary CP increased the apparent digestibility for P, indicating phytase and CP interaction (P<0.05). Birds fed with supplemental P and 23% CP diet utilized the P and CP more efficiently. Warm condition restored the deleterious effect of non supplemental P diets for P utilization.

Bone development improved (P<0.05) when P was added. Ash content was not affected (P>0.05) by dietary CP content while better (P<0.05) bone mineralization was observed from the birds in the lower T environment. P x CP interaction (P<0.05)

was noted on the bone strength, with increasing dietary P and CP levels effecting improved bone strength. Birds supplemented with P and kept in the cooler environment had stronger tibia than other birds, indicating P x T effect ($P<0.05$).

Supplemental phytase increased ($P<0.05$) serum P level and reduced alkaline phosphatase (ALKP) level. P deficiency resulted in increment in serum Ca and a decrease in serum P levels. An increased serum ALKP activity noted was in response to decreasing P level or CP content in the diet. Phytase x P effect was significant ($P<0.05$) on serum P and ALKP level. Phytase ameliorated the negative effect of low dietary CP level on the P availability. Birds fed supplemental P and 23% CP diet had higher serum P and lower ALKP level. Additional P and higher CP content in the diet restored the detrimental effects of high T on P utilization in broilers.

Supplemental P increased ($P<0.05$) carcass yield while 23% CP diet improved carcass characteristics and caused a reduction ($P<0.05$) in leaf fat. Broilers in the lower T environment had better carcass characteristics. Addition of phytase restored the low protein effect to increase leaf fat. For birds fed with supplemental P in the 23% CP diet, better carcass characteristics were observed, indicating P x CP effect ($P<0.05$). Birds kept in the lower T chamber and provided with P or 23% CP feed had heavier carcass components.

Broilers fed higher CP (23%) diet had tougher breast meat than those fed lower CP feed while more tender breast meat was obtained from the birds kept in the lower T chamber as compared to those kept in the higher T. WHC of the meat was affected by dietary P, CP and environmental T.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Pertanian Sains

KESAN-KESAN PHYTASE, FOSFORUS, PROTEIN DAN SUHU PADA PERTUMBUHAN, PENCERNAAN NUTRIEN NYATA DAN CIRI-CIRI KARKAS PADA AYAM PEDAGING

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Pemberian fosforus (P) secara berlebihan bukan sahaja mahal tetapi mengakibatkan pencemaran alam sekitar dan pengikatan mineral. Phytase digunakan secara meluas untuk memecahkan rantaian antara nutrien dan lingkaran phytate, meningkatkan kesediaadaan nutrien, menimbulkan kelebihan ekonomi dan persekitaran. Suhu yang tinggi merosakkan prestasi ayam. Sejak sistem penyejukan yang canggih adalah mahal, manipulasi protein dalam diet adalah salah satu pendekatan pemulihan untuk mengatasi kesan berlawanan ketegangan panas. Objektif penyelidikan ini adalah untuk mengkaji kesan-kesan phytase, inorganic forforus, protein kasar (CP), suhu persekitaran (T) dan interaksi dua hala pada prestasi pertumbuhan, pencernaan nutrien nyata dan ciri-ciri karkas dalam ayam pedaging.

Phytase secara tunggal tidak mengaruhi ($P>0.05$) prestasi pertumbuhan, ciri-ciri tulang dan karkas, keliatan dan daya muatan air (WHC) daging dalam kajian ini. Walau bagaimanapun, penambahan P meningkatkan selera ayam, memanfaatkan ($P<0.05$) pengambilan makanan (FI), penambahan berat badan (BWG) dan kadar pertukaran makanan (FCR). Peningkatan CP dalam diet mengurangkan FI tetapi

meningkatkan (P<0.05) BWG dan FCR. Ayam pedaging dalam bilik yang bersuhu rendah mempunyai kadar pertumbuhan yang lebih baik daripada mereka yang berada dalam persekitaran yang lebih panas. Ayam pedaging yang diberi penambahan phytase dan CP 23% dalam diet mempunyai prestasi yang lebih baik daripada ayam yang lain. Penambahn P memperbaiki kesan berlawanan kandungan CP dalam diet yang rendah atau suhu yang lebih tinggi, menunjukkan satu interaksi yang bererti (P<0.05). Peningkatan kandungan CP dalam diet tidak mengganggu prestasi pertumbuhan ayam pedaging dalam bilik yang bersuhu tinggi seperti yang dilaporkan kerana peningkatan suhu tidak cukup tinggi untuk mengakibatkan hipertermia.

Phytase meningkatkan (P<0.05) pencernaan nyata Ca, mengusulkan pembebasan kalsium (Ca) yang lebih tinggi daripada kompleks mineral phytate. Apabila tahap P dalam diet meningkat, pencernaan nyata untuk tenaga metabolik nyata (AME) menurun manakala Ca, P dan CP meningkat (P<0.05). Pencernaan nyata untuk P meningkat (P<0.05) tetapi berlawanan untuk Ca apabila tahap CP meningkat. Peninggian T persekitaran mengurangkan pencernaan nyata untuk Ca dan CP tetapi menambah (P<0.05) pencernaan nyata P. Kesan phytase x P adalah bererti (P<0.05) pada pencernaan nyata (P<0.05) untuk Ca. Penambahan phytase dalam diet 23% CP menambahkan pencernaan nyata untuk P, mengusulkan interaksi phytase dan CP (P<0.05). Ayam yang diberi P tambahan dan diet CP 23% menggunakan P dan CP dengan lebih cekap. Keadaan panas memulihkan kesan ketiadaan P dalam diet untuk penggunaan P.

Pertumbuhan tulang dimanfaatkan (P<0.05) apabila P ditambah. Kandungan abu tidak dipengaruhi (P>0.05) oleh kandungan CP dalam diet manakala mineralisasi

tulang yang lebih baik diperhatikan daripada ayam dalam persekitaran yang bersuhu rendah. Interaksi P x CP ($P<0.05$) telah diperhatikan pada kekuatan tulang, kekuatan tulang bertambah dengan peningkatan P dan tahap CP dalam diet. Ayam yang diberi P and dibela dalam persekitaran yang bersuhu rendah mempunyai tibia yang lebih kuat daripada ayam yang lain, mengusulkan kesan P x T ($P<0.05$).

Penambahan phytase meningkatkan ($P<0.05$) tahap serum P dan alkaline phosphatase (ALKP). Kekurangan P mengakibatkan peningkatkan Ca dan penurunan tahap P dalam serum. Penambahan aktiviti serum ALKP yang diperhatikan adalah sebagai reaksi terhadap penurunan tahap P atau kandungan CP dalam diet. Kesan phytase x P adalah bererti ($P<0.05$) pada serum P dan tahap ALKP. Phytase memperbaiki kesan negative tahap CP yang rendah dalam diet pada kesediaadaan P. Ayam yang diberi P dan diet CP 23% mempunyai P yang lebih tinggi dan ALKP yang lebih rendah dalam serum. Penambahan P dan kandungan CP yang lebih tinggi dalam diet memulihkan kesan suhu tinggi pada penggunaan P dalam ayam pedaging.

Penambahan P meningkatkan ($P<0.05$) hasil karkas manakala diet CP 23% memperbaiki ciri-ciri karkas dan mengakibatkan penurunan ($P<0.05$) lemak. Ayam pedaging dalam persekitaran bersuhu rendah mempunyai ciri-ciri karkas yang lebih baik. Untuk ayam yang diberi P tambahan dalam diet CP 23%, ciri-ciri karkas yang lebih baik diperhatikan, mengusulkan kesan P x CP ($P<0.05$). Ayam yang dibela dalam bilik bersuhu rendah dan diberi P atau CP 23% makanan mempunyai komponen karkas yang lebih berat.

Ayam pedaging diberi CP yang lebih tinggi (23%) mempunyai daging dada yang lebih liat manakala daging dada yang lebih empuk diperoleh daripada ayam yang dibela dalam bilik yang bersuhu rendah berbanding dengan ayam yang dibela dalam suhu yang lebih tinggi. WHC daging dipengaruhi oleh P, CP dan T persekitaran.

ACKNOWLEGEMENTS

I would like to express my profound gratitude to my supervisor, Associate Professor Dr. Liang Juan Boo, co-supervisors, Associate Professor Dr. Azhar Kasim and Associate Professor Dr. Hsia Liang Chou, for their guidance, concern, patience, friendship and constructive comments throughout the course of my study.

I wish to thank all the staffs and students from the Environment and Behavior Unit, Department of Animal Science, National Pingtung University of Science and Technology (NPUST) for their assistance, helpfulness and friendship. Not forgetting to express my appreciation to Mr Chang Yoong Nan and Ms Chang Nai Yu for their excellent guidance on laboratory techniques.

My deepest gratefulness then goes to Associate Professor Dr. Chen Xue Bin for his suggestion and advice. I would like to thank all my fellow friends especially Wang Yan and Wang Weishan from Department of Animal Science, UPM for their help and constant encouragement during my study. Many thanks are also extended to Mr Ahmad Shokri Bin Haji Othman, Nwe Nwe Htin and Bodee Khamseekhiew for their help and advice in statistical analysis.

Finally, my deepest gratitude goes to my dear parents and family for their understanding, financial and moral support. I also owe my thanks to my beloved James Li for his love, inspiration, moral encouragement throughout the duration of my study.

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ABBREVIATIONS

AA	amino acids
ALKP	alkaline phosphatase
AME	apparent metabolizable energy
aP	available phosphorus
BWG	body weight gain
Ca	calcium
CCD	couple charged device
Co	cobalt
CP	crude protein
Cu	copper
DBWT	de-blooded weight
DCP	dicalcium phosphate
DFWT	de-feathered weight
DM	dry matter
FCR	feed conversion ratio
Fe	iron
FI	feed intake
FTU	phytase unit
g	gram
GE	gross energy
GIT	gastro intestinal tract
h	hour
J	Joule

K	potassium
kcal	kilo calorie
kg	kilogram
kJ	kilojoule
LWG	live weight gain
LWT	live weight
MCP	monocalcium phosphate
ME	metabolizable energy
Mg	magnesium
mg	milligram
ml	milliliter
mmol	millimol
Mn	manganese
N	nitrogen
Ni	nickel
NPUST	National Pingtung University of Science and Technology
NRC	National Research Council
npP	non phytate phosphorus
P	phosphorus
PER	protein efficiency ratio
P_i	inorganic phosphorus
pP	phytate phosphorus
PU	phytase unit
SD	standard deviation
SEM	standard error of the mean