UNIVERSITI PUTRA MALAYSIA

THE EFFECT OF ZEOLITE AND PALM KERNEL CAKE (PKC) ON FECAL AMMONIA PRODUCTION AND HOUSE FLY POPULATION

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By

WIHANDOYO

Thesis Submitted in Fulfilment of the Requirements for the Degree of Doctor of Philosophy in the Faculty of Veterinary Medicine Universiti Putra Malaysia

November 2000

DEDICATION

For my beloved:

Sri Banun
Castri Pratidina
Restra Pindyawara

I was reminded of my school:

SD Pati Wetan, SMP Negeri I Pati, SMA Negeri Pati,
Fapet Sekip Unit II, Fapet Karangmalang, Pasca Sarjana UGM,
Animal Science and Veterinary Medicine UPM

Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for Degree of Doctor of Philosophy

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Chairman: Associate Profesor Kassim Hamid, Ph.D.

Faculty: Veterinary Medicine

Four experiments were conducted to evaluate the effect of zeolite and Palm Kernel Cake (PKC) on ammonia production and house fly *Musca domestica* L population.

In the first experiment, three periods of manure removal (every 30, 20 and 10 days or MR3, MR2 and MR1) with two cage densities (single and double birds or CD1 and CD2) were carried out. The low cage density and frequent manure removal decreased significantly ($P<0.01$) the ammonia (NH_3) production by the feces and fly larvae population in the manure, but had no effect on layer performance.

In the second experiment, three levels of zeolite (0, 6 and 12% ZD) in the diet and three levels of zeolite spread directly on the manure (0, 6 and 12% ZS of total daily feed intake) were tested. Incorporation of high levels of zeolite in the diets and zeolite spread on the manure decreased significantly ($P<0.01$) the fly larvae population, NH_3 production, water, pH, CP, Ca and P contents of manure.

Incorporation of high levels of zeolite in the diets affected the FCR, HDA and shell thickness, but did not influence chemical content of both egg albumen and yolk. Dietary zeolite also had no significant affect on tibial length, weight, Ca and P content.

In the third experiment, three levels of zeolite (0, 6 and 12%) and four levels of PKC (0, 12, 24 and 36%) were incorporated in the layer diets. Incorporation of high levels of PKC and zeolite decreased significantly ($P<0.01$) the fly larvae population, NH_3 production, fecal water content, and Ca, P and CP of the feces. Incorporation of high levels of PKC and zeolite significantly ($P<0.01$) increased FI, FCR HU, eggshell weight and thickness but decreased HDA. Crude protein and Ca of egg albumen and yolk contents increased in accordance with increasing levels of zeolite and PKC in the diets. The increasing levels of zeolite improved Ca but decreased the P content of egg shell, while the levels of PKC decreased shell Ca and P. Incorporation of high levels of PKC and zeolite in the layer diets increased the tibia and femur length but decreased tibial Ca and P contents. Increasing levels of PKC and zeolite in the layer diets increased Ca, P and cholesterol contents of blood plasma.

In the fourth experiment, three levels of zeolite (0, 1 and 2%) and three levels of PKC (0, 15 and 30%) were incorporated in the broiler diets. Incorporation of high levels of PKC and zeolite in the broiler diets reduced broiler performance (FI, body weight, carcass percentage and FCR). Increasing levels of zeolite significantly ($P<0.05$) decreased the cholesterol, Ca and P contents of blood plasma, Incorporation of high levels of PKC and zeolite were able to reduce NH_3, number of fly larvae and water content of manure. Palm kernel cake and zeolite could be used as a poultry feedstuff or a feed additive and zeolite was able to assist in reducing the ammonia production and house fly larvae population in the poultry feces.

Abstrak tesis yang dikemukakan kepada Senate Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah.

PENGARUH PENGGUNAAN ZEOLITE DAN ISIRONG KELAPA SAWIT (PKC) TERHADAP PENGELUARAN AMMONIA DAN POPULASI LARVA LALAT RUMAH DI DALAM NAJIS AYAM

Oleh

WIHANDOYO

November 2000

Pengerusi: Profesor Madya Kassim Hamid, Ph.D.

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Tiga penyelidikan telah dijalankan keatas ayam penelur dan satu penyelidikan keatas ayam pedaging untuk menilai kesesuaian penggunaan isirong kelapa sawit (PKC) sebagai bahan makanan dan zeolite sebagai bahan tambahan untuk pengawalan pencemaran kimia dan biologi (pengeluaran ammonia dan pembiakan larva lalat rumah *Musca domestica* L) didalam najis ayam.

Di dalam penyelidikan pertama, tiga jadual pembuangan najis ayam, iaitu setiap 30, 20 dan 10 hari sekali (MR3, MR 2 dan MR1) dan dua kepadatan sangkar ayam penelur iaitu satu dan dua ekor setiap sangkar (CD1 dan CD2) telah dijalankan. Kepadatan rendah ayam dalam sangkar dan kekerapan pembuangan najis memberi kesan yang bererti ($P<0.01$) dalam mengurangkan NH_3 dan larva lalat di dalam najis, tetapi tidak berkesan keatas pengeluaran ayam penelur (FC, HDA, FCR dan berat telur).

Pada kajian ke dua, telah di cuba tiga paras zeolite di dalam makanan (0, 6 dan 12%

ZD) dan tiga paras zeolite ditabur keatas najis (0, 6 dan 12% daripada jumlah makanan yang dimakan) telah dijalankan. Gabungan paras zeolite didalam makanan dan penaburan keatas najis mengurangkan dengan bererti ($P<0.01$) keatas populasi larva lalat, NH_3, kandungan air, pH, CP, Ca and P daripada najis. Gabungan paras zeolite yang tinggi didalam makanan menjejaskan FCR, HDA dan ketebalan kulit telur tanpa menjejaskan kandungan kimia di dalam putih dan kuning telur, juga keatas panjang, berat serta kandungan Ca dan P daripada tulang tibia.

Dalam kajian ketiga, tiga paras zeolite (0, 6 dan 12%) dan empat paras PKC (0, 12, 24 dan 36%) dicampurkan dalam makanan ayam penelur. Gabungan paras PKC dan zeolite didalam makanan mengurangkan dengan bererti ($P<0.01$) keatas populasi ulat lalat, NH_3, kandungan air, pH, CP, Ca and P daripada najis. Gabungan paras PKC dan zeolite didalam makanan meningkatkan dengan bererti ($P<0.01$) keatas FI, FCR, HU, berat dan ketebalan kulit telur, tetapi mengurangkan HDA. Kandungan CP dan Ca didalam putih dan kuning telur meningkat mengikut peningkatan paras zeolite dan PKC didalam makanan. Paras zeolite memperbaiki kandungan Ca dan mengurangkan P daripada kulit telur, sedang paras PKC mengurangkan kandungan Ca dan P daripada kulit telur. Gabungan paras zeolite dan PKC didalam makanan memperbaiki panjang tulang tibia dan femur tetapi mengurangkan kandungan Ca dan P. Peningkatan paras PKC dan zeolite meningkatkan plasma Ca, P dan kolesterol.

Dalam kajian keempat, telah dicuba tiga paras zeolite (0, 1 dan 2%) dan tiga paras PKC (0, 15 dan 30%) didalam makanan ayam pedaging. Gabungan paras PKC dan

zeolite didalam makanan ayam pedaging telah mengurangkan dengan bererti ($P<0.01$) prestasi ayam pedaging (FI, berat badan, % karkas dan FCR). Peningkatan paras zeolite didalam makanan telah mengurangkan dengan bererti ($P<0.05$) keatas plasma kolesterol, Ca dan P, tetapi berlawanan dengan PKC. Gabungan paras PKC dan zeolite telah berjaya mengurangkan NH_3, larva lalat dan kandungan air najis. Isirong kelapa sawit dan zeolite sebagai bahan makanan ayam atau sebagai bahan tambahan, dan zeolite juga mampu mengawal pengeluran ammonia dan populasi larva lalat rumah didalam najis ayam.

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LIST OF ABBREVIATION

ADF	Average Daily Feed intake
ADG	Average Daily Gain
AF	Aflatoxin
am	Ante meridian
ANOVA	Analysis of variance
AOAC	Association of Official Analysis of Chemistry
BW	Body Weight
^{o}C	Celcius
Ca	Calcium
CD	Cage Density
CE	Cholesterol Esterase
CEC	Cation Exchange Capacity
CF	Crude fiber
ChOD	Cholesterol Oxidase
cm	Centimeter
CP	Crude Protein
DCP	Dicalcium Phosphate
FCR	Feed Conversion Ratio
FC	Feed Consumption
FI	Feed Intake
g	Gram
g/d/h	Gram/day/hen
HDA	Hen Day Average
HU	Haugh Unit
kg	Kilogram
l	Liter
M	Molar
meq/g	Milli-equivalents per gram
ml	Milliliter

mm	Millimeter
mmol/l	Millimolar per liter
NH_3	Ammonia
nm	Nano meter
PKC	Palm Kernel Cake
PKM	Palm Kernel Meal
pm	Post meridian
ppm	Part per million
SAS	Statistic Analysis System
SSA	Synthetic Sodium Aluminoisilicate
SZ	Synthetic Zeolite
SZA	Sodium Zeolite A
TF	Tibia Femur
ZA	Zeolite A
µl	Micro liter

CHAPTER I

INTRODUCTION

The poultry industry in the Asia Pacific Region has achieved rapid growth of 10% per annum, producing 35% of the world's poultry meat and accounting for 40% of the egg consumption (Raghavan, 1997). Intensive poultry production in the next century will have to cope with the fact that as the world population continues to grow, land will become scarce and environmental cleanliness will become increasingly important. The development and form of the poultry industry reflect its objectives of providing eggs and poultry meat for human consumption. However, the poultry industry also has implications for the environment and for poultry welfare which may influence future changes (Appleby *et al*., 1992).

The development of modern, intensive layer production has required efficient usage of land area, and battery cages have become the choice for raising higher stocking densities of layers, because the size of the cage is an economic factor and will affect layer performance. The concentration of birds at higher stocking density, will create considerable problems of manure disposal and spread of diseases between farms (Strauch, 1987). In modern layer production systems, poultry are housed in high densities with, especially in high-rise cage-layer houses or narrow caged-layer houses, consequently, accumulations of large amounts of manure beneath the cages resulting in physical, chemical and biological pollution (dust, odor and house flies *Musca domestica,* L. breeding). This could lead to public nuisance and protest if not handled judiciously.

Other environmental issues related to the poultry industry are dust, ammonia, odors and pathogen (Rinehart, 1996). Studies, particularly in the US, have indicated that the powdery dust typically found in poultry consists of particles of feathers, feed, manure and dust. Analysis of the dust in the exhaust air from poultry houses in the US shows it to contain about 60% crude protein, 11% ash, 9% fat, 3% cellulose, and 17% other carbohydrates (Gowan, 1972).

Odor, especially ammonia (NH_3), is one of the chemical pollutants from the poultry industry, resulting from microorganism activities in which uric acid and undigested protein are degraded. Monteney (1996) stated that poultry produce manure containing uric acid, which is microbially converted to urea first before urea degradation and ammonia emission take place. Urea degradation, mainly taking place inside the animal houses, is catalyzed by the enzyme urease which is, produced by microorganisms that are present in the feces. This means that these microorganisms will also be present on the floor in poultry houses (Ketelaars and Rap, 1994). The ammonia emission process is strongly influenced by the chemical and physical conditions of surfaces where there is contact with air (Elzing *et al.*, 1992).

House flies (*Musca domestica* L) have become a constant problem of biological pollution on intensive poultry farms. Lysyk and Axtell (1986) reported that there were three species of house flies common in poultry production systems that is *Musca domestica* L, *Fannia canicularis* L and *Ophyra spp* (*Ophyra aenescens* and *Ophyra leucostoma* which are difficult to distinguish). Presence of flies can occur because manure is an excellent medium for fly breeding. Moon and Meyer (1985) stated that house flies frequently deposit their eggs in batches with