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EFFECTS OF DIETARY SPENT PINK GUAVA MESOCARP ON EGG QUALITY OF CAGED AND FREE-RANGE LAYERS

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EFFECTS OF DIETARY SPENT PINK GUAVA MESOCARP ON EGG QUALITY OF CAGED AND FREE-RANGE LAYERS

By

TEOH JIA YI

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

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

EFFECTS OF DIETARY SPENT PINK GUAVA MESOCARP ON EGG QUALITY OF CAGED AND FREE-RANGE LAYERS

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October 2014

Chairman: Associate Professor Azhar Kasim, DVM, MS, PhD
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Pink guava is known to contain high levels of lycopene, a carotenoid that have one of the highest antioxidant activities. Lycopene was also indicated to produce good pigmentation in egg yolk. Feeding studies on laboratory animals using spent pink guava mesocarp (SPGM), which contains lycopene, indicated that SPGM has high antioxidant properties, has lipid–lowering effect and prevented obesity. There is no information regarding the effect of dietary SPGM on other animals such as laying hens. Therefore two studies were conducted to evaluate the SPGM product and its effect on the performance and egg quality of the layer chicken. In the first study, nutrient profiles and lycopene content of three batches of SPGM from different fruit harvesting dates were evaluated and were found to be consistent among batches. The second study was a 9-week feeding trial using a total of 90 ISA Brown layer chicken aged 30 weeks under two management systems. Treatment diets consisted of (i) control diet (without SPGM); (ii) diet with 2.5% SPGM, (iii) diet with 5% SPGM; (iv) diet with 7.5% SPGM, and (v) diet with 10% SPGM. The SPGM used were in dried form. Inclusion of 5% to10% SPGM in layer chicken diet significantly ($p<0.05$) improved feed intake, Feed Conversion Ratio (FCR), egg production, egg weight, eggshell weight, eggshell thickness, Haugh unit, egg mass, and egg yolk color, regardless of the cage system or free-range system. Yolk color score (based on DSM Yolk Color Fan) improved with SPGM inclusion. The SPGM dietary inclusion from 5% to 10% of SPGM registered yolk color score of up to 6 and 8 for cage rearing and free-ranging, respectively. Lycopene content in egg yolk increased linearly with increased in SPGM inclusion in the diet. Eggs from hens fed with SPGM had a significant lower cholesterol ($p<0.05$) content compared to the control group. It is concluded that feeding layer hens with SPGM enriched the eggs with lycopene besides improving the yolk color score. These eggs are also lower in cholesterol and SPGM-based eggs can become an alternative health product.

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KESAN PEMAKANAN MESOKARP JAMBU BATU MERAH YANG DIPERAP KEPADA KUALITI TELUR AYAM PENELUR DALAM SANGKAR DAN PENTERNAKAN BEBAS

Oleh

TEOH JIA YI

Oktober 2014

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Jambu batu merah diketahui mengandungi tahap lycopene, sejenis karotenoid yang mempunyai aktiviti antioksidan yang tertinggi. Lycopene juga telah dilaporkan dapat menghasil pigmentasi yang baik dalam kuning telur. Kajian pemakanan ke atas haiwan makmal menggunakan mesokarp jambu batu merah yang diperap (SPGM), yang mengandungi lycopene, menunjukkan bahawa SPGM mempunyai ciri-ciri antioksidan yang tinggi, mempunyai kesan merendahkan lemak dan mencegah obesiti. Tidak ada maklumat mengenai kesan SPGM dalam pemakanan ke atas haiwan lain seperti ayam penelur. Oleh itu, dua kajian telah dijalankan untuk menilai produk SPGM dan kesannya terhadap prestasi dan kualiti telur ayam penelur. Dalam kajian pertama, profil nutrien dan kandungan lycopene dalam tiga kelompok SPGM dari tarikh penuaian buah yang berbeza telah dinilai dan didapati konsisten antara ketiga-tiga kumpulan. Kajian kedua adalah percubaan pemakanan selama 9 minggu menggunakan sejumlah 90 ayam penelur *ISA Brown* berusia 30 minggu, dalam dua sistem penternakan yang berbeza. Makanan eksperimen terdiri daripada (i) diet kawalan (tanpa SPGM) (ii) makanan dengan 2.5% SPGM, (iii) makanan dengan 5% SPGM; (iv) diet dengan 7.5% SPGM, dan (v) diet dengan 10% SPGM. SPGM yang digunakan adalah dalam bentuk kering. Penambahan SPGM 5% sehingga 10% dalam makanan ayam penelur secara ketaranya ($p<0.05$) meningkatkan pengambilan makanan, FCR, pengeluaran telur, berat telur, berat kulit telur, ketebalan kulit telur, unit Haugh, massa telur dan warna yolka, tanpa mengira sistem penternakan dalam sangkar atau sistem penternakan bebas. Skor warna kuning (berdasarkan DSM Kipas Kekuningan Warna Yolka) bertambah baik dengan penambahan SPGM. SPGM yang ditambah ke dalam pemakanan pada tahap 5% sehingga 10% berdaftar skor warna kuning nombor 6 dan 8 untuk penternakan dalam sangkar dan penternakan bebas masing-masing. Kandungan lycopene dalam yolka meningkat secara linear dengan peningkatan penambahan SPGM dalam makanan. Telur daripada ayam yang memakan SPGM mempunyai kandungan kolesterol yang lebih rendah ($p<0.05$) berbanding dengan kumpulan kawalan. Kesimpulannya makanan ayam penelur dengan penambahan SPGM meningkatkan paras lycopene dalam telur, di samping meningkatkan skor warna kuning yolka. Oleh sebab telur ini adalah lebih rendah kolesterol, telur berasaskan SPGM boleh menjadi produk kesihatan alternatif.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

%	Percentage
ß	Beta
ADF	Acid Detergent Fiber
AIDS	Acquired Immunodeficiency Syndrome
Am	*ante meridiem*
AOAC	Association of Official Analytical Chemists
Atm	Atmosphere
C 14:0	Myristic acid
C 16:0	Palmitic acid
C 16:1 n-9	Palmitoleic acid
C 18:0	Stearic acid
C 18:1 n-9	Oleic acid
C 18:2 n-6	Linoleic acid
C 18:3 n-3	α-Linolenic acid
^{o}C	Degree Celsius
cal	Calorie
cm	Centimeter
cm^2	Centimeter square
cm^3	Centimeter cube
CO_2	Carbon dioxide
CP	Crude Protein
DM	Dry Matter
EC	European Commission
EU	European Union
FAO	Food and Agriculture Organization of United Nation
FCR	Feed Conversion Ratio
FID	Flame Ionization Detector
g	Gram
g/h/d	Gram per bird per day
g/L	Gram per liter
GC	Gas – Liquid Chromatography
GE	Gross Energy
GMO	Genetic Modified Organism
GLM	General Linear Model
H_o	Haugh Unit
H_2SO_4	Sulphuric Acid
HDL	High Density Lipoprotein
HIV	Human Immunodeficiency Virus
HPLC	High Performance Liquid Chromatography
Kcal	Kilo Calories
Kcal/g	Kilo Calories per gram
Kg	Kilogram
L	Liter
LDL	Low Density Lipoprotein
m^2	Meter square
ME	Metabolizable Energy
mg	Milligram
mg/g	Milligram per gram

mg/yolk	Milligram per yolk
ml	Milliliter
mm	millimeter
MPa	Mega Pascal
MSE	Mean Square Error
N	Nitrogen
Na_2CO_3	Sodium Carbonate
NDF	Neutral Detergent Fiber
nm	Nanometer
NRC	National Research Council
PM	Post Meridiem
RM	Ringgit Malaysia
Rpm	Rate per minute
SE	Standard Error
SPGM	Spent Pink Guava Mesocarp
t	ton
t/day	ton per day
THF	Tetrahydrofuran
µg/g	Microgram / gram
µm	Micrometer
UK	United Kingdom
VLDL	Very Low Density Lipoprotein
v/v	Volume per volume
w/v	weight per volume
w/w	weight per weight
YCF	Yolk Colour Fan

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C 18:0	Stearic acid
C 18:1 n-9	Oleic acid
C 18:2 n-6	Linoleic acid
C 18:3 n-3	α-Linolenic acid
^{o}C	Degree Celsius
cal	Calorie
cm	Centimeter
cm^2	Centimeter square
cm^3	Centimeter cube
CO_2	Carbon dioxide
CP	Crude Protein
DM	Dry Matter
EC	European Commission
EU	European Union
FAO	Food and Agriculture Organization of United Nation
FCR	Feed Conversion Ratio
FID	Flame Ionization Detector
g	Gram
g/h/d	Gram per bird per day
g/L	Gram per liter
GC	Gas – Liquid Chromatography
GE	Gross Energy
GMO	Genetic Modified Organism
GLM	General Linear Model
H_o	Haugh Unit
H_2SO_4	Sulphuric Acid
HDL	High Density Lipoprotein
HIV	Human Immunodeficiency Virus
HPLC	High Performance Liquid Chromatography
Kcal	Kilo Calories
Kcal/g	Kilo Calories per gram
Kg	Kilogram
L	Liter
LDL	Low Density Lipoprotein
m^2	Meter square
ME	Metabolizable Energy
mg	Milligram
mg/g	Milligram per gram

mg/yolk	Milligram per yolk
ml	Milliliter
mm	millimeter
MPa	Mega Pascal
MSE	Mean Square Error
N	Nitrogen
Na_2CO_3	Sodium Carbonate
NDF	Neutral Detergent Fiber
nm	Nanometer
NRC	National Research Council
PM	Post Meridiem
RM	Ringgit Malaysia
Rpm	Rate per minute
SE	Standard Error
SPGM	Spent Pink Guava Mesocarp
t	ton
t/day	ton per day
THF	Tetrahydrofuran
µg/g	Microgram / gram
µm	Micrometer
UK	United Kingdom
VLDL	Very Low Density Lipoprotein
v/v	Volume per volume
w/v	weight per volume
w/w	weight per weight
YCF	Yolk Colour Fan

CHAPTER 1

INTRODUCTION

Poultry feeds are generally agricultural-based. The ingredients that make up the conventional poultry feeds are basically feed grains such as corn, wheat and barley, and from agriculture by-products such as soybean meal, rice bran and wheat middling (Gomez, 1982).

The rising prices of grains, especially corn and soybean, have escalated the prices of poultry feeds and poultry products. Thus, possible alternatives include the usage of non-conventional or less known agricultural by-products. Malaysia is not spared from this effect since more than 80% of poultry feed ingredients are imported. Thus, the use of agro by-products is necessary and is very much dependent on the quality, availability, cost and inclusion level.

It is known that palm kernel by-products such as palm kernel expeller can be included, with amounts less than 20% (Mardhati *et al*., 2011) in broiler and layer chicken diets. In the case of eggs, dietary inclusion of these by-products did not affect the external and internal quality of eggs (Onwudike, 1988).

Malaysia has other potential by-products that have not been used as animal feed ingredients. One of the potential by-products is spent pink guava mesocarp (SPGM). The SPGM is the main by-product of the pink guava beverage plant. Since SPGM contains lycopene (Padula and Rodriguez-Amaya, 1986), it is possible that inclusion of SPGM in poultry diets may contribute to the development of healthy meat and eggs. Therefore, a study was conducted to evaluate the effect of dietary inclusion of SPGM on layer chicken performances.

Many studies have focused on using tomato waste as a lycopene and antioxidant source in the development of functional food such as eggs (Kong, 2011). However, there is no documented report on SPGM in the development of livestock feeds or feed supplements. Presently, SPGM are disposed by burying it in pits. In line with zero waste policies in agriculture (Zero Waste Europe, 2009), it is more environmental friendly and more beneficial to turn this waste into a high value product.

The availability of this SPGM from a local source prompted this study, which may have impact on the poultry industry as well as the potential usage of SPGM. Therefore, the objectives of this study were:

1. To determine the nutrient profile consistency of SPGM from different batches of production and,

2. To evaluate the performance and egg quality of hens fed with different levels of dietary SPGM under two management systems.

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