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EFFECTS OF EMULSIFIER ON FEED PROCESS, FEED QUALITY, GROWTH PERFORMANCE, RELATIVE ORGAN WEIGHT AND FAT DIGESTIBILITY IN BROILER CHICKEN

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By

CHEAH YING SEE

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

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Dedicated to

My beloved family

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

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Chairman: Professor Loh Teck Chwen, PhD

Faculty: Agriculture

A feed production trial was conducted to study the effect of synthetic emulsifier and natural biosurfactant on feed process and quality of pelletized broiler feed. A corn-soy based broiler diet was formulated with fixed ratio 2:1 of oil-to-water with two types of emulsifiers, namely glyceryl polyethylene glycol ricinoleate synthetic emulsifier, and lysophosphatidylcholine natural biosurfactant. T1: Basal diet with no water and no emulsifier; T2: Basal diet with water and no emulsifier; T3: Basal diet with water and synthetic emulsifier glyceryl polyethylene glycol ricinoleate, which has been dispersed into an oil phase before added with water, pre-blended at 60 °C for 3 minutes to form a water-in-oil (w/o) emulsion; T4: Basal diet with water and a natural biosurfactant lysophosphatidylcholine as comparative treatment. The treatment diets were manufactured by a commercial feed mill. The electricity cost and meal temperature were measured during the process of milling. Composite samples were collected from different processed points, tested for physical properties, chemical stability and biostability of pelletized feed. Pellet quality of emulsifier supplemented diets was significantly ($P<0.05$) improved in crumble and pellet intact form. Correlation between emulsifier and pelletize processed cost was not observed in this present study. No deteriorate effect was observed in hydrolytic rancidity (AV), oxidation rancidity (PV), mold count, moisture content, water activity and water retention rate. However, percentage of starch gelatinization on pelletized feed was significantly ($P<0.0001$) improved in both types of emulsifier treated diets. These results demonstrated that the addition of emulsifier to broiler diet improved pellet quality to some extent although no significant difference between synthetic emulsifier and natural biosurfactant was observed.

In the second experiment, a randomized complete block design study with 2x3 factorial arrangements was conducted to evaluate the response of exogenous emulsifier on broiler

performance, relative organ weight and fat digestibility. A corn-soy based broiler diet was formulated with fixed ratio 2:1 of oil-to-water, supplemented with glyceryl polyethylene glycol ricinoleate (GPGR) synthetic emulsifier and lysophosphatidylcholine (LPC) natural biosurfactant. A total of 1,800 one-day-old Cobb 500 male broilers with nine treatments diet were adapted. T1: Basal diet with metabolizable energy (ME) 3,000 kcal/kg in starter (S) and 3,100 kcal/kg in grower (G); T2: Basal diet with ME 2,900 kcal/kg (S) and 3,000 kcal/kg (G); T3: Basal diet with ME 2,800 kcal/kg (S) and 2,900 kcal/kg (G); T4, T5 and T6 consisted of T1, T2 and T3 supplemented with GPGR; T7, T8 and T9 consisted of T1, T2 and T3 supplemented with LPC. The study was conducted 14 days for starter and 35 days for grower phase. The results of the experiment demonstrated that the effect of emulsifier on broiler performance was dependent on the ME level used in the diet formulations and ages of the bird. Emulsifier improved ($P<0.05$) FCR in starter phase at higher ME level, but was not significantly ($P>0.05$) improved at lower ME levels of diets. Correlation between emulsifier and low ME diet in FCR was not observed in this present study. AME and fat digestibility at all levels of ME were higher ($P<0.05$) in birds fed with emulsified diets. However, compensation effect to recover the energy value to control level was not found. Significant reduction ($P<0.05$) in liver fat, abdominal fat and digesta fat was observed in birds which consumed emulsified grower diets. However, no significant difference between synthetic emulsifier and natural biosurfactant was observed.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Sarjana Sains

KESAN PENGEMULSI KE ATAS PEMPROSESAN MAKANAN, KUALITI MAKANAN, PRESTASI PERTUMBUHAN, BERAT ORGAN RELATIF DAN NILAI CERNA LEMAK PADA AYAM PEDAGING

Oleh

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Satu kajian pengeluaran makanan ayam telah dijalankan untuk menyelidiki kesan pengemulsian sintetik dan biosurfaktan semula jadi pada pemprosesan makanan dan kualiti makanan ayam pedaging yang dipeletkan. Diet asas jagung-kacang soya ayam pedaging telah diformulasi dengan nisbah tetap 2:1, iaitu minyak-kepada-air dengan penggunaan dua jenis pengemulsi: gliserin polietilena glikol risinoleat pengemulsi sintetik dan lisofosfatidikolin biosurfaktan semula jadi. T1: Diet asas tanpa air dan tanpa pengemulsi; T2: Diet asas berair dan tanpa pengemulsi; T3: Diet asas berair dan pengemulsi sintetik gliserin polietilena glikol risinoleat, yang telah ditukarkan kepada fasa minyak sebelum ditambah dengan air, pra-campuran pada 60°C selama 3 minit bagi pembentukan emulsi air-dalam-minyak (w/o); T4: Diet asas berair dan biosurfaktan semula jadi lisofosfatidikolin digunakan untuk perbandingan rawatan. Kesemua rawatan diet telah dihasilkan oleh sebuah kilang pengeluaran makanan ternakan komercial. Kos elektrik dan suhu proses hasilan makanan juga diukur semasa pemprosesan di kilang. Komposit sampel telah diambil dari titik pemprosesan yang berbeza, untuk ujian sifat-sifat fizik, kestabilan kimia dan biostabiliti makanan yang dipeletkan. Kualiti pelet menunjukkan penambahbaikan yang signifikan ($P<0.05$) pada 'crumble' dan pelet yang ditambah pengemulsi. Korelasi antara pengemulsi dan kos penghasilan pelet tidak dilihat dalam kajian ini. Tiada kesan kemerosotan diperhatikan dari segi ketengikan hidrolitik (AV), ketengikan pengoksidaan (PV), kiraan kulapuk, kandungan lembapan, aktiviti air dan kadar retensi air. Walau bagaimanapun, peratusan penggelatinan kanji pada makanan yang dipeletkan menunjukkan peningkatan yang signifikan ($P<0.0001$) pada makanan yang dirawat dengan kedua-dua jenis pengemulsi tersebut. Keputusan ini menunjukkan bahawa penambahan pengemulsi kepada makanan ayam pedaging akan menambahbaik kualiti pelet pada suatu tahap tertentu walaupun tiada perbezaan yang signifikan didapati di antara pengemulsi sintetik dan biosurfaktan semula jadi.

Dalam kajian kedua, satu kajian rawak lengkap telah dijalankan dengan susunan faktorial 2x3 untuk menilai tindakbalas luaran emulsi terhadap prestasi ayam pedaging, berat organ relatif dan nilai cerna lemak. Diet ayam pedaging berasaskan jagung-soya telah diformulasi pada nisbah yang tetap, 2:1 iaitu minyak-kepada-air, ditambah dengan gliserin polietilena glikoli risinoleat (GPGR) emulsi sintetik dan lisofosfatidikolin (LPC) biosurfaktan semula jadi. Sejumlah 1,800 ekor anak ayam pedaging Cobb 500 jantan berumur sehari digunakan pada sembilan jenis rawatan diet iaitu T1: Diet basal dengan tenaga metabolisme (ME) 3,000 kcal/kg di peringkat pemula (S) dan 3,100 kcal/kg di peringkat pertumbuhan (G); T2: Diet basal dengan 2,900 kcal/kg (S) dan 3,000 kcal/kg (G); T3: Diet basal dengan ME 2,800 kcal/kg (S) dan 2,900 kcal/kg (G); T4, T5 dan T6 terdiri daripada T1, T2 dan T3 yang ditambah dengan GPGR; T7, T8 dan T9 terdiri daripada T1, T2 dan T3 yang ditambah dengan LPC. Kajian ini telah dijalankan selama 14 hari semua fasa pemula dan 35 hari semua fasa pertumbuhan. Hasil kajian menunjukkan kesan emulsi terhadap prestasi ayam pedaging bergantung kepada aras ME yang diformulasi pada diet dan umur ayam tersebut. Emulsi meningkatkan ($P<0.05$) kadat pertukaran makanan (FCR) dengan berkesan pada fasa pemula pada aras ME yang tinggi, tetapi tidak memberi kesan nyata ($P>0.05$) pada aras ME yang rendah. Korelasi antara emulsi dan ME yang rendah di dalam diet pada FCR tidak dilihat dalam kajian ini. AME dan nilai cerna lemak pada semua aras ME adalah tinggi ($P<0.05$) pada ayam yang diberi makanan beremulsi. Walau bagaimanapun, kesan untuk mengimbangi sejumlah tenaga pada aras kawalan tidak dilihat. Penurunan didapati sangat nyata ($P<0.05$) pada lemak di hati, lemak abdomen dan lemak digesta pada ayam yang mengambil makanan yang mengandungi emulsi pada fasa pertumbuhan. Walau bagaimanapun, tiada perbezaan yang signifikan di antara emulsi sintetik dan biosurfaktan semula jadi.

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

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AA	amino acid
Amp	ampere
AV	acid value
Aw	water activity
AME	apparent metabolizable energy
BW	body weight
BWG	body weight gain
cfu/g	colony-forming units per gram
CP	crude protein
CPO	crude palm oil
DCP	di-calcium phosphate
DM	dry matter
ERH	Equilibrium relative humidity
FCR	feed conversion ratio
FFA	free fatty acid
g	gram
GE	gross energy
h	hour
HLB	hydrophile-lipophile balance
kcal	kilo calorie
kg	kilogram
KOH	potassium hydroxide
kw	kilowatt
L:D	length to diameter ratio
ME	metabolizable energy
mg	milligram
ml	milliliter
mm	millimeter
O/W	oil-in-water
PDI	pellet durability index
PIT	phase-inversion temperature
PV	peroxide value
rpm	round per minute
SD	standard deviation
SEM	standard error of mean
T	tonne
U:S	unsaturated : saturated fatty acid ratio
Vol	voltage
WG	weight gain
W/O	water-in-oil

CHAPTER 1

INTRODUCTION

Poultry diets formulated in Malaysia are mainly corn-soy diet with minor inclusion of animal-by-products or plant-by-products, with a supplement of oil and fat as dietary energy. Among the dietary ingredients, a large proportion of cost is devoted to energy and protein. In order to maximize the profitability in least cost formulation, it is common to include cheap energy sources while maintaining optimum nutrient availability in the diet. However, inclusion of high fat or oil in the feed formulation may have a negative impact in feed processing (Attawong *et al.*, 2014). The effect of formulation on processing, especially pelleting might be overlooked by most of the nutritionists. They may focus in preserving feed formulation with a profitable margin, and do not consider much of the loss in pellet quality in order to have some extent of ingredient cost reduction. As a pellet becomes reduced in quality, it is prone to break into pieces when it is passed through handling systems (Fairfield, 1994).

They are many feeding management methods that are utilized to improve the quality of pellet feed. Besides the art of pelleting, feed formulation may include pellet binders to aid in keeping the pellet cohesive. Some nutritionists even include wheat grain in the diet to improve pellet binding ability (Winowiski, 1988; Skoch *et al.*, 1983). Adding water has been tried by many feed manufacturer as part of the feed formulation program to improve pellet quality. However, incompatibility between water and oil become a big challenge in feed manufacturing. The concept of emulsification was introduced as an innovative solution to overcome the related issue (Anonymous, 2012; Ziggers, 2012).

A series of commercial available emulsifiers have shown positive response in industrial feeding. It improves feed mill efficiency and focus on product quality through the emulsion effect at conditioner (Van der Heijden and de Haan, 2010). Depending on the types of emulsion, some emulsifiers are used to maximize the efficiency in feed process; some can even extend their functionality up to the gastrointestinal tract, enhance lipid digestibility and improve animal growth performance (Guerreiro Neto *et al*., 2011; Maertens *et al*., 2011). However, a parallel comparison between different types of emulsifier, exhibit the activity of a solely product throughout the whole chain of poultry industries, from feed manufacturing to farm animal performance have not being conducted. Thus, the general objective of this study was to identify the effectiveness of emulsifier in feed process, feed quality and growth performance of broiler chickens. The research project was conducted with specific objectives to determine,

1. the effect of emulsifier on feed process and energy saving in milling process.
2. the effect of emulsifier on quality of pelletized feed.
3. the effect of emulsifier on growth performance, relative organ weight and fat digestibility of broiler chicken.

The hypotheses of this project were:

1. Miscible of water and oil is possible in feed production with emulsion process.
2. Better feed palatability with emulsifier can be achieved by improving pelletized feed quality.
3. Exogenous emulsifier can enhance the utilization of dietary fat in broiler diet.

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