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EFFECTS OF SUPPLEMENTING BAKER'S YEAST (Saccharomyces cerevisiae) AND YEAST GLUCAN ON GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY AND MEAT QUALITY OF BROILER CHICKEN

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By

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May 2017

Chairman : Associate Professor Anjas Asmara Samsudin, PhD
Faculty : Agriculture

Increasing concerns regarding overuse of antibiotics in broiler has promoted extensive investigation into alternatives to the use of sub-therapeutic antibiotics such as the used of yeast products. *Saccharomyces cerevisiae*, which is also known as "Baker Yeast" is rich in crude protein (40-45%) and vitamin B complex. Yeast products have been widely reported as successful growth promoter in poultry industry. There is no relevant information on the meat quality parameter, abdominal fat in broiler fed with yeast, and also blood profile parameter in broiler chicken. Therefore, these parameters need to be investigate for additional information on the effects of yeast products on broilers. The purpose of this study was to compare the levels of baker's yeast and to study the effects of non-antibiotic feed additives, that is baker's yeast and yeast glucan on broiler performance. The first experiment involved a total of 200 a day-old broilers (Cobb 500) and were randomly divided into five treatments, four replicates with 10 birds each. The treatments were T1: control; T2: 0.1% baker's yeast; T3: 0.2% baker's yeast; T4: 0.4% baker's yeast; and T5: 0.8% baker's yeast. For the second experiment, 200 a day-old broilers were randomly divided into four treatments, five replicates with 10 birds each. The treatments were T1: control; T2: probiotic (best level of baker's yeast from first experiment); T3: prebiotic (MacroGard® yeast glucan); and T4: antibiotic (virginiamycin). The individual body weight and feed intake were recorded weekly, and at day 42, the chickens were slaughtered to determine carcass quality, collection of ileal and ceacal digesta, blood collection, and gut morphology. For the first experiment, data on performances, nutrient digestibility, carcass characteristics, bacteria count, and gut morphology were collected, whereas for the second experiment, data on performances, nutrient digestibility, meat quality, bacteria count, gut morphology, and blood profile were collected. The results of this experiment showed that addition of baker's

yeast (probiotic) and yeast glucan (prebiotic) to broiler's feed improved body weight compared to control diet. Similar result was also observed in the feed conversion ratio, where both baker's yeast and yeast glucan showed the lowest FCR followed by control treatment. However, carcass dressing rates were not affected by the non-antibiotic feed additives. The nutrient digestibility by the broiler improved when baker's yeast and yeast glucan were fed to the birds. Addition of both baker's yeast and yeast glucan to broiler's feed had improved the tenderness of the broiler's meat and gut morphology of the broiler ($P<0.05$). Other than that, baker's yeast had improved immunity through WBC reduction. In addition, baker's yeast and yeast glucan supplementation had reduced the abdominal fat content of the birds. Moreover, the inclusion of baker's yeast in broiler's feed has enhanced the population of beneficial bacteria such as *Lactobacillus* spp. and reduced the colonization of pathogenic bacteria such as *E*. *coli*. It has been concluded that baker's yeast has improved the performance of the broiler chicken. Thus, these can be used as antibiotic alternatives in broilers feed.

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

KESAN SUPLEMENTASI YIS ROTI (*Saccharomyces cerevisiae*) DAN YIS GLUKAN TERHADAP PRESTASI TUMBESARAN, KADAR PENYERAPAN NUTRIEN, DAN KUALITI DAGING AYAM PEDAGING

Oleh

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Kebimbangan yang meningkat berikutan penggunaan antibiotik yang berlebihan dalam industri ayam pedaging telah menarik minat penyelidik dalam mencari alternatif lain untuk menggantikan pengunaan antibiotik kepada penggunaan produk yis. *Saccharomyces cerevisiae*, yang dikenali sebagai "yis roti" kaya dengan protein mentah (40-45%) dan vitamin B kompleks. Ekstrak yis telah dilaporkan secara meluas sebagai pemangkin tumbesaran dalam industri poltri. Tidak ada maklumat yang relevan mengenai parameter kualiti daging, lemak di bahagian abdomen dalam ayam pedaging yang telah diberi makan yis, dan juga profil darah parameter dalam ayam daging. Tujuan kajian ini adalah untuk mengkaji kesan tahap yis roti dan kesan terhadap alternatif makanan tambahan bukan antibiotik, iaitu yis roti terhadap prestasi ayam pedaging. Untuk eksperimen pertama, sebanyak 200 ekor anak ayam berumur satu hari (Cobb 500) secara rawak telah dibahagikan kepada lima kumpulan diet, empat kumpulan kecil bagi setiap kumpulan diet dengan sepuluh ekor anak ayam untuk setiap kumpulan kecil. Antara kumpulan dietnya ialah T1: diet tanpa yis roti; T2: 0.1% yis roti; T3: 0.2% yis roti; T4: 0.4% yis roti; dan T5: 0.8% yis roti. Untuk eksperimen kedua, sebanyak 200 ekor anak ayam berumur satu hari (Cobb 500) secara rawak telah dibahagikan kepada empat kumpulan diet, lima kumpulan kecil bagi setiap kumpulan diet dengan sepuluh ekor anak ayam untuk setiap kumpulan kecil. Antara kumpulan dietnya ialah T1: diet tanpa makanan tambahan; T2: probiotik (tahap terbaik yis roti dari eksperimen pertama); T3: prebiotik (MacroGard® yis glukan); dan T4: antibiotik (virginiamycin). Berat badan dan pengambilan makanan individu telah dicatat setiap minggu, dan pada hari ke-42, ayam disembelih untuk pemeriksaan karkas, pengumpulan digesta ilea dan sekum, pengumpulan darah, dan pemeriksaan morfologi usus. Untuk experimen pertama, data terhadap prestasi, penghadaman nutrien, ciri-ciri karkas,

bilangan bakteria, dan usus morfologi telah dikumpulkan, manakala untuk eksperimen kedua, data terhadap prestasi, penghadaman nutrien, kualiti daging, bilangan bakteria, usus morphologi, dan profil darah telah dikumpulkan. Hasil keputusan daripada eksperimen ini menunjukkan bahawa dengan mencampurkan yis roti (probiotik) dan yis glukan (prebiotik) ke dalam makanan ayam pedaging, ia telah menjadikan peningkatan berat badan ayam pedaging menjadi bertambah baik berbanding diet tanpa makanan tambahan. Begitu juga dengan data dari nisbah penukaran makanan, dimana nilai makanan tambahan yis roti dan yis glukan adalah terendah berbanding diet tanpa makanan tambahan. Walau bagaimanapun, kadar persalinan karkas tidak terjejas dengan menggunakan alternatif makanan tambahan bukan antibiotik. Penghadaman nutrien oleh ayam pedaging bertambah baik dengan pemberian yis roti dan yis glukan. Penambahan yis roti dan juga yis glukan ke dalam makanan ayam pedaging telah memperbaiki kelembutan daging ayam pedaging dan usus morfologi ayam pedaging ($P<0.05$). Selain daripada itu, yis roti meningkatkan imuniti melalui pengurangan tahap sel darah putih. Tambahan pula, yis roti dan yis glukan berpotensi untuk mengurangkan sisa lemak oleh sebab pengurangan kandungan lemak yang berlaku di kawasan perut ayam pedaging. Selain itu, penambahan yis roti dalam makanan ayam pedaging telah meningkatkan populasi bakteria berfaedah seperti *Lactobacillus* spp. dan mengurangkan populasi bakteria berbahaya seperti *E. coli*. Ini telah disimpulkan bahawa yis roti mampu meningkatkan prestasi ayam pedaging. Oleh itu, yis roti boleh digunakan sebagai alternatif kepada penggunaan antibiotik dalam makanan ayam pedaging.

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I certify that a Thesis Examination Committee has met on 8 May 2017 to conduct the final examination of Nabila binti Mohamaddin on her thesis entitled "Effects of Supplementing Baker's Yeast (*Saccharomyces cerevisiae*) and Yeast Glucan on Growth Performance, Nutrient Digestibiltiy and Meat Quality of Broiler Chicken" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to the Senate of the 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

AGP	Antibiotic growth promoter
CF	Crude fiber
CFU	Colony forming unit
CP	Crude protein
DFM	Direct feed microbial
DM	Dry matter
DMD	Dry matter digestibility
DNA	Deoxyribonucleic acid
EE	Ether extract
FCR	Feed conversion ratio
FOS	Fructooligosaccharides
g	Gram
GE	Gross energy
GIT	Gastrointestinal tract
GOS	Galactooligosaccharides
H_2SO_4	Sulphuric acid
Hb	Haemoglobin
HCl	Hydrochloric acid
hr	Hour
IMO	Isomalto oligosaccharides
kg	Kilogram
LAB	Lactic acid bacteria
MCHC	Mean corpuscular haemoglobin concentration

MCV	Mean corpuscular volume
ME	Metabolizable energy
Min	Minute
ml	Milliliter
mJ / kg	Millijoule per kilogram
µl	Microliter
µm	Micrometre
mm	Millimetre
MOS	Mannaoligosaccharides
N_aOH	Sodium hydroxide
NDOs	Non-digestible oligosaccharides
NE	Necrotic enteritis
OM	Organic matter
PCV	Packed cell volume
qPCR	Quantitative real-time polymerase chain reaction
RBC	Red blood cell
SAS	Statistical analysis software
SC	*Saccharomyces cerevisiae*
SCFA	Short chain fatty acid
SE	Standard error
sec	Second
SOS	Soy oligosaccharides
spp	Subspecies
VFA	Volatile fatty acid

WBC	White blood cell
XOS	Xylooligosaccharides

CHAPTER 1

INTRODUCTION

Poultry has become one of the fastest growing segments of the agriculture sector in terms of production. Feed is the biggest contributor and accounts for more than half of the total production cost. The major aim of this industry is to produce the maximum, with minimum input, like other agriculture sector. The cost of poultry feed ingredients and compounded feed has constantly increase over the years and causing the rise in production cost. Thus, effective and balanced feeding is the most important requisite to boost up the poultry production economically. The inclusion of feed additives such as antibiotic, has led to residual effect of antibiotic resistant bacteria in eggs and meat, and eventually lead to various health hazards to consumers. Therefore, the best way to overcome this problem is the use of feed additives such as probiotics or prebiotics for better and safe production (Bidarkar *et al.*, 2014).

Probiotic are single or mixed culture of beneficial live microorganisms, that when introduced into the animals will efficiently improved the properties of beneficial bacterial that naturally inhibit the gastrointestinal tract (GIT) of the animals. They are also known as DFM (direct feed microbial). The term 'probiotic' was first introduced by Parker (1974) as "microorganisms or substances, which contributes to the intestinal microbial balance". Fuller (1989), explained probiotic as a live microbial feed supplement, which positively improved the host intestinal bacteria. In opposite with antibiotics, probiotics enhance life of the microbes, whereas antibiotics kill the microbes.

Species that are mostly used in probiotic preparations are *Streptococcus thermophiles, Enterobacteria faecalis*, *Enterococcus faecium*, *Toulopsis sphaerica, Streptococci* spp.*, Saccharomyces cerevisiae, Lactobacillus bulgaricus, L. casei, L. salvarius, L. acidophilus, L. helveticus, L. plantarum, L. Faecium,* and *Bifidobacteria species* (Simon *et al.,* 2001). Supplying the poultry with probiotics have shown to improve immune system, protein utilization, feed conversion ratio (FCR), reduce pathogenic bacteria and strengthen the non-pathogenic bacteria population in the gastrointestinal (GIT) system. Other than that, unicellular fungi and yeast products are also known for their fermentative ability. Feeding of non-pathogenic bacteria to the poultry can beneficially stimulate the immune system. Probiotic such as yeast can trigger several enzymes such as protease, cellulose, amylase, lipase, together with B complex vitamins in the medium in which they grow. Others benefits of feeding probiotic to broiler is it improved the intestinal tract health, enhanced protein utilization, reduced colonization of harmful bacteria in GIT of broiler, improved animals feed conversion ratio (FCR), and also improved nutrient synthesis.

Animals feed supplements have been used widely in livestock and poultry farming to improve growth performance, feed efficiency, and they are primarily of disease prevention nature like antibiotics, prebiotics, probiotics, and metabolites.

In recent years, consumers tend to be more aware and special attention have been paid for the safety of animal's feed products consumption. The application of antibiotic growth promoters (AGP) may develop some pathogen resistance (Phillips *et al.*, 2004). Since early 2006, the European Union prohibited the use of antibiotics as growth promoter (Patterson and Burkholder, 2003). Nowadays, modern broiler production in an intensive system with automation in feed and water delivery and with environmental control, huge number of birds can be reared in one house. Regarding to the increased bacterial resistance to antibiotics in human, it has triggered an increase in community and organizational attention in rejecting sub-therapeutic use of antibiotics in livestock (Patterson and Burkholder, 2003). Unfortunately, due to the elimination of this sub-therapeutic level of antibiotic in livestock, it might exposed the livestock with infectious disease and eventually will reduce the performance of the livestock, thus, according to Halloran, (2012), antibiotic have led to a dramatic reduction in illness and death from infectious diseases. Thus, this has led the industry to look for other alternative supplements that can replace antibiotics as a growth promoter and disease prevention.

In contrast with probiotics, the definition of prebiotics is they are not microorganisms. They are actually source of nourishment for existing intestinal microflora, promoting natural growth and replication. Prebiotics is an indigestible feed ingredients that benefit the host by selectively enhance the activities of one or many number of microorganisms in the host GIT, thus, beneficially improved the animals health (Gibson and Roberfroid, 1995). A prebiotic is a selectively fermented ingredient that gives changes, in both the activity in the gastrointestinal microbiota and the composition which gives benefits to the animals (FAO/WHO, 2002). Oligosaccharides, soluble fiber, and sugar molecules of three to six chains are commonly one identified as prebiotics.

To my knowledge, there is no relevant information on the meat quality parameter, abdominal fat in broiler fed with yeast, and also blood profile parameter in broiler chicken. Therefore, these parameters need to be investigate for additional information on the effects of yeast products on broilers.

1.1 Research Hypothesis

The supplementation of baker's yeast and yeast glucan to broilers will influence the growth performance, nutrient absorption, and improve carcass characteristic, and also will decrease the population of pathogenic bacteria in the intestinal tract of broiler.

1.2 Objectives

I. To evaluate the effect of supplementing different levels of *Saccharomyces cerevisiae* on the nutrient digestibility performance, carcass characteristic, gut morphology and *Lactobacillus* spp. count in broiler's ileum.

II. To determine the effect of supplementing *Saccharomyces cerevisiae* as a probiotic and yeast glucan as a prebiotic on the nutrient digestibility, performance, carcass characteristics, meat quality, *Lactobacillus* spp. and *E.coli* count, gut morphology, and blood hematology of broiler chicken.

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