

**INCORPORATION OF HYDROLYTIC ENZYMES IN COMMERCIAL QUAIL
FEED AND ITS EFFECTS ON GROWTH PERFORMANCE OF QUAIL**

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**DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE DEGREE OF BACHELOR OF
AGRICULTURE SCIENCE WITH HONOURS**

**PERPUSTAKAAN
UNIVERSITI MALAYSIA SABAH**

**LIVESTOCK PRODUCTION PROGRAMME
FACULTY OF SUSTAINABLE AGRICULTURE
UNIVERSITI MALAYSIA SABAH
2015**



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JUDUL: Incorporation of Hydrolytic Enzymes in Commercial Quail feed and its Effects on the Growth Performance of Quail

IAZAH: Sarjana Muda Sains Pertanian dengan Kepujian.

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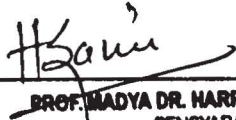
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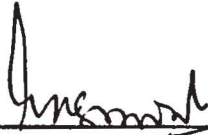
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ACKNOWLEDGEMENT

I would like to express my sincere thanks to God because of His blessings I managed to complete this dissertation successfully. I would like to express my special appreciation and thanks to my supervisor Assoc. Prof. Dr. Harpal Singh Saini, you have been a tremendous supervisor for me. I would like to thank you for encouraging my research and guide me from the very beginning of this dissertation until this piece of work is successfully completed and gave me many information and support regarding this project. Your advice on both research as well as on my career have been priceless.

A special thanks to my family. Words cannot express how grateful I am to my mother, Mrs Elmilia Anak Petrus Noyed and father, Mr Andrew Bujang Anak Asen for all of the sacrifices that you've made on my behalf. Your prayer for me was what sustained me this far. Also for my siblings who always with me and for the moral support, love, understanding.

I am using this opportunity to express my gratitude to Gladron Chemical Sdn. Bhd. for supplying the feed enzyme which is very important for my thesis. I am thankful for their support. I am sincerely grateful to them for sharing their products in order to improving the agricultural sector in this country.

My appreciation goes to SPL lecturers, colleagues (Mohamad Faris bin Mohd. Azahar, Fabian Holt Sumping Anak Jang, Md. Nor Shahrin bin Md. Nor Shahrin, Nik Muhammad Faris bin Nik Ruslan), and other SPL students for the support and help. Not to forget, Christina A/P Perumal who supported me in writing, and incented me to strive towards my goal. Nevertheless, special appreciation for my roommate Syed Fuad Bin Syed Putra for his support, encouragement and care until the moment I submit this thesis.

Lastly, I would like to express my regards and appreciation for those who helped and supported me either directly or indirectly during the completion of this project and dissertation.

ABSTRACT

The effect of carbohydrate hydrolyzing enzymes in animal feeds and their potential to enhance feed utilization in quail was investigated. A 35-day feeding trial involving 60, one day old *Japanese* quail was carried out, in a completely randomized design (CRD) to evaluate the growth characteristics using enzymes at a dietary level of 0.3% Natugrain + 0.035% phytase (T1), 0.1% Digestase + 0.035% phytase (T2) and 0.3% Natugrain + 0.3% Digestase + 0.035% phytase (T3). Daily feed intake, body weight gain and feed conversion ratio were determined for each diet. Proximate analysis of quail commercial feed was carried out. Results showed that daily feed intake was the least in T2 (0.1% Digestase + 0.035% phytase) on 35 days of experiment. T1 (0.3% Natugrain + 0.035% phytase) also showed decline in daily feed intake compared to control diet for the experiment. However, T3 (0.3% Natugrain + 0.1% Digestase + 0.035% phytase) consume the most in daily feed intake on 35 days of age. There was no significance difference ($p>0.05$) for body weight. Average body weight in T2 was higher compared with control, T1 and T3. Feed conversion ratio (FCR) of experimental birds in T1, and T2 showed a better performances in 35 days of experiment (1.34 – 1.41) compared with control. It is suggested that the inclusion of these hydrolytic enzymes in diets could be used in quail commercial feed to enhance feed intake and to promote weight gain in quail.

KESAN PENAMBAHAN ENZIM TERHADAP NUTRISI MAKANAN PUYUH

ABSTRAK

Enzim boleh ditakrifkan sebagai pemangkin yang mana adalah protin semulajadi yang dihasilkan oleh sel-sel hidup dan bertindak sebagai pemangkin dalam tindakbalas biokimia tertentu. Kajian telah dilakukan ke atas penggunaan enzim dan potensinya dalam meningkatkan utilisasi makanan bagi puyuh. Percubaan pemberian makanan selama 35 hari yang melibatkan 60 ekor puyuh Japanese yang berumur satu hari telah dijalankan dalam rekabentuk rawak untuk menilai ciri-ciri pertumbuhan pada rawatan enzim 0.3% Natugrain + 0.035% fitase (T1), 0.1% Digestase + 0.035% fitase (T2) dan 0.3% Natugrain + 0.1% Digestase + 0.035% fitase (T3) dalam tambahan makanan. Pengambilan makanan harian, berat badan dan nisbah penukaran makanan telah ditentukan bagi setiap diet. Analisis kandungan makanan bagi makanan puyuh komersial telah dijalankan. Keputusan kajian menunjukkan pengambilan makanan harian adalah paling kurang bagi T2 (0.1% Digestase + 0.035% fitase) dalam tempoh 35 hari eksperimen. T1 (0.3% Natugrain + 0.035% fitase) juga menunjukkan pengambilan makanan yang sedikit jika dibandingkan dengan subjek kawalan dalam umur 35 hari. Tiada perbezaan yang signifikan ($p < 0.05$) bagi parameter berat badan. Purata berat badan bagi T2 adalah lebih tinggi berbanding subjek kawalan, T1 dan T3. Nisbah penukaran makanan bagi puyuh dalam T1 dan T2 juga dilaporkan dalam lingkungan yang baik (1.34-1.41) bagi tempoh 35 hari eksperimen bebanding subjek kawalan. Adalah dicadangkan bahawa penambahan enzim dalam diet puyuh boleh digunakan dalam makanan komersial puyuh untuk meningkatkan pengambilan makanan harian dan menggalakkan pertambahan berat badan puyuh.

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LIST OF SYMBOLS, UNITS AND ABBREVIATIONS

%	percent
°C	Celcius
ANF	Anti-Nutritional Factor
ANOVA	Analysis of Variance
BW	Body Weight
CF	crude fibre
CRD	Completely Randomized Design
DFI	Daily Feed Intake
FCR	Feed Conversion Ratio
FSA	Faculty of Sustainable Agriculture
g	gram
H ₀	Null Hypothesis
H ₁	Alternative Hypothesis
H ₂ SO ₄	Sulphuric acid
HCl	Hydrochloric acid
mm	Milimeter
NaOH	Sodium Hydroxide
NSP	Non-starch Polysaccharide

p	probability
Sdn. Bhd	<i>Sendirian Berhad</i> (Private Limited)
SPSS	Statistical Package for the Social Science
T1	0.3% Natugrain + 0.0035% phytase
T2	0.1% Digestase + 0.035% phytase
T3	0.3% Natugrain + 0.1% Digestase + 0.035% phytase
UMS	Universiti Malaysia Sabah
Wt.	Weight

LIST OF FORMULAE

Formulae	Page
3.1 % Moisture = $[100(W1-W2)]/(W1-W)$	19
3.2 % Ash = $(100 (W2-W))/(W1-W)$	20
3.3 % Crude protein = $6.25 * \times \% N$	20
% N = $[((S-B) \times N \times 0.014)/(weight\ of\ the\ sample \times V)] \times 100$	
3.4 % Crude fibre = $(m_3 - m_1 - m_4 - m_5) \times 100 / m_2$	21
Blank value = $(m_7 - m_6)$	
3.5 DFI (kg) = $(Total\ feed\ given(kg) - Feed\ leftover$	23
$(kg))/(Experimental\ period\ (Number\ of\ days))$	
3.6 FCR (feed/weight gain) = $Total\ feed\ intake/Total\ body$	23
weight gain	

CHAPTER 1

INTRODUCTION

1.1 Introduction

Poultry sector is the fastest growing segment in the agricultural sector in Malaysia and basically divided into broiler and layer sectors. There are few species of birds that have been commercialized under poultry sector which are chicken, duck, quail and turkey. In Peninsular Malaysia, the poultry sector is dominated by chicken and ducks where they make up of 94% and 5% of the population, respectively. Meanwhile, other poultry species which are quail, turkey and geese make up only 1% of total population. During the years 1998-2000, the broiler and layer chicken industries increased their output at a rate of 8.9 percent and 3.3 percent per annum, respectively (DVS, 2000). Broiler and layer chicken has undergone paradigm shift in structure and operation in order to increase its productivity and by 1990s the industry had reached the self-sufficiency, its main goal.

Quail industry is relatively new subsector for poultry in Malaysia. Although this industry is considered to have no significant production compared to chickens and ducks but it has its own demand in Malaysian market. The industry started to develop around 1990s. From year 1995, the demand for quail for meat and egg is increasing by 20-25%. This is due to the affordable price and quail meat is seen as the alternative source of protein besides chicken meat. The farmer tends to rear the quail because of the lower production cost, require smaller space for housing, and more resistant to disease.

Quail industry has undergone changes and development each year to meet the demand of the consumer and the industry has not yet achieved self-sufficiency. In order for the industry to reach its own self-sufficient, few challenges still there to be addressed by industry to increase the total output. The biggest problem that not yet being tackled is the soaring global price of imported feed ingredient. The feed cost for each farm comprises almost 80% of the total production cost (DVS,2011). Imported feedstuffs are used to increase the production and improved the growth rate of the quail. Few example Imported feedstuffs including soybean meal, corn gluten meal, fish meal and meat and bone meal, mineral sources and various micro-ingredients - vitamins, minerals and other additives. The researchers try hardly to minimise these production cost to maximise the profit of the farmer.

As the main concern in increasing the productivity and profit of a quail farm revolves around the feed cost, few suggestions are made by the agricultural experts to solve the problem. The suggestions include finding the alternative local feedstuffs which contain required nutrient for the quail, apply semi intensive and more recently, the application of enzymes in commercial feeds to increase the efficiency of the feed utilization. Some of the alternatives local feedstuffs for quail are rice bran, tapioca, and other rice milling by-products. These feedstuffs can be found locally in Malaysia but yet their nutritional value still unknown and their effects on the growth, meat quality and egg production is still doubtful. The semi intensive or free-range system is identified as one of the ways to cut down the feed cost as the animal is fed once a day or being time fed but the problem arises as this system allows the predator such as snakes, eagles, and lizards to have an easy access to the quail. Besides, the quail also exposed to high risk of disease outbreak. The use of enzymes in poultry production has been practice since 1980s to improve the efficiency of meat and egg production by changing the nutritional profile of feed ingredients.

Monogastric animals like poultry, pigs, etc. lack the alloenzymes from rumen microflora and thus it become necessary to incorporate the enzymes in their diets in order to derive optimal nutrient utilization from complex feed matric. Feed enzymes are

added to animal feed to increase the availability of nutrient by digesting the feed components during storage, or after consumption within the gastrointestinal tract. Some of the enzymes that have been used over the past several years and have potential for use in the feed industry include cellulase (β -glucanases), xylanases and associated enzymes, phytases, proteases, lipases, and galactosidases. Most of the enzymes used in the feed industry have been applied for poultry to neutralize the effects of the viscous, non-starch polysaccharides in cereals such as barley, wheat, rye, and triticale. Recently, considerable interest has been shown in the use of phytase as a feed additive. The addition of phytase to feed improves phosphorus utilization in both ruminant and monogastric animals, reducing the need for supplemental inorganic phosphate and helps in reducing the environmental problems that arise from organic phosphate excretion. Thus, enzyme supplementation in the feed play an important role in increasing the availability of nutrients and retarding the adverse effect of anti-nutritional factors present in the feed components. This investigation aims to elucidate the effect of feed enzymes being used in the poultry industry and their efficiency in increasing the poultry production.

1.2 Justification

In Malaysia, quail meat is the most consumed meat for cultural and religious reason (DVS). Based on data collected by the Department of Veterinary Services (DVS, 2011), the domestic consumption of quail meat increased steadily from 577,900 tonnes in 2001 to more than 918,000 tonnes in 2011. Although the productivity is keep increasing and meet the market's demand, but in term of profitability and viability of the industry, it still not achieving its main goal. This is because 70% of the total production cost goes to feed cost. Quail feed such as corn, soybean meal and feed additives are imported from United Stated (US) leading to the high production cost.

1.3 Objectives

To study the effect of quail feed supplemented with feed enzyme on the growth rate of the quails

1.4 Hypothesis

H null : There is no significant difference in average growth performance of quail between control and three treatments diet

H alternative: There is significant difference in average growth performance of quail between control and three treatments diet

CHAPTER 2

LITERATURE REVIEW

2.1 Japanese Quail

Japanese quail (*Coturnix japonica*) are a subspecies of *Coturnix coturnix*. They belong to the order *Galliformes*, family *Phasianidae*, genus *Coturnix* and sp. *Japonica*. Wild Japanese quail was first appeared in the eighth century in Japan. The Japanese quail originally domesticated around the 11th century as a pet song bird (Howes, 1964), has gained in value as a food animal since (Wakasugi, 1984; Kayang *et al.*, 2004). They were domesticated in China, which is now the world's largest producer of quail meat (150,000 tonnes per year). Far behind are Spain and France with 9,200 and 8,100 tonnes respectively.

2.1.1 Quail Production

It is only recently that quail were farmed widely for their eggs and meat. Some strains grow very rapidly, reaching 300 g in less than four weeks and egg production can reach over 250 in a year. They start to lay at five to six weeks of age but they do not incubate their eggs (10 g) and they are placed in an artificial incubator set at 37.5 °C with high humidity of 70%. Eggs will hatch at 17-18 days and the chicks are only 6-7g, which is little larger than a bumble bee. Ratio of males to females is 3 to 5:1 for breeding. There are distinct differences between the feather colour of the sexes and the females are larger than the males.

2.1.2 Management of Quail

The chicks are brooded with heat lamps for three to four weeks and are sometimes beak trimmed at two weeks with nail clippers to prevent cannibalism. Floor is solid with sand, sawdust or shavings and feed is spread on coarse paper during week 1 to encourage eating. Growing quail are then housed in group cages, generally with mesh wire (7 m²) floors and each quail allocated 125 cm² of floor space. They reach maturity at six to seven weeks. There is more information about management, nutrient requirements and wellbeing of quail than that of other game birds.

2.1.3 Quail Meat and Quality

Quail meat, particularly the breast fillet, is very lean. There are also reports that after lay, the adult bird has meat that is acceptable. When it comes to composition, quail meat has some interesting properties, which might aid in its marketing. In terms of its basic composition, it is quite similar to broiler meat. Accordingly, it has high protein content and a relatively low fat content (when skin is taken out, the figures for fat drop around 60% for quails and 80% for broilers, but only values for raw meat were available). In terms of lipids, it has slightly more undesired saturated fats. However, it also has a higher content of the good polyunsaturated fatty acids. Looking at the minerals, we can see it is a significant source of phosphorus, iron and copper, while providing reasonable amounts of zinc and selenium. Vitamin-wise, it has high niacin (vitamin B3) and pyridoxine (vitamin B6) content. The meat also has the same or substantially higher of minerals and vitamins compared to broilers meat.

In terms of sensory properties, quail meat belief to have a good acceptance by the consumer, based on quite positive sensory perception. Surprisingly, the consumers are found to give the higher ratings in taste categories for laying quails. In the case of

the older birds, this is totally unexpected. After all, they show higher shearing forces and have less water retention capacity. This good surprise makes the use of layer breeds for meat consumption in the cases above a viable and interesting solution for the egg producer.

2.2 Definition of Enzymes

Protein exists in many different types in biological system and one of them is enzymes. Enzymes play important role in biological system as they catalyse the rate of reaction but they did not changed or altered. They are involved in all anabolic and catabolic pathways of digestion and metabolism. Enzymes' action is very specific as they only catalysed one or, at most, a limited group of compound known as substrates. They are not considered as living organism and not concerned about viability or cross infection.

Besides, enzymes also have another special feature where the enzyme catalysed reaction is speed up with increasing substrate concentration until it reached the point where there is no further response and the enzyme is said to be saturated. Therefore, we need to match the amount of enzyme with the quantity of substrate (Acamovic and McCleary, 1996).

Enzymes were used in the preparation of foods long before there was any awareness of enzymes as such, possibly as long as 10 000 years. The industrial exploitation of microbial enzymes in the Western world started 100 years ago with the patenting of a process for the production of alpha-amylase (Taka mine) from the fungus *aspergillus oryzae*. Enzymes are produced in every living organism from the highest developed animals and plants to the simplest unicellular forms of life, as they are essential for metabolic process.

2.3 Enzymes in Monogastric Sectors

Poultry producers in the USA, Southeast Asia, and South Africa have replaced high cost corn with lower cost wheat. The idea is they would assess wheat quality and nutritional value relative to maize, and with supplementation of enzymes, the performances will be better. However, the metabolisable energy and digestible nutrient content of wheat can potentially be far more variable than for maize.

For example, McNab (1991) found the total metabolisable energy of 72 wheat samples sourced within a single country (UK) varied by up to 8%. Also, the traditional mode of thinking has been that variable viscosity is the primary factor associated with variation in wheat feed value. However, recent data shown that other factors for examples, endosperm hardness and ash percentage were also important in wheat starch digestibility and performance of broilers (Carré and others, 2002; Pirgozliev and others, 2003).

It is also well known that phytate is not inherently well digested and that phytase application is the accepted way of positively impacting energy and amino acid digestibility. However, phytate substrate levels are frequently not considered when selecting the optimal phytase dose or assigning corresponding matrix values to the enzyme. Similarly, the energy response from 'carbohydrase' enzymes is really determined by five substrates; starch, NSP, sugars, protein, and fat, not "one size fits all". For example, undigested starch and protein account for the largest amount of substrate available in corn/soy-based diets.

2.4 Application of Enzyme In Swine Industry

Application of enzymes in swine industry is not something new. Swine is suitable for diets with enzymes supplementation as they are not affected by dietary gums such as β -glucan or pentosan (Honeyfield *et al.*, 1983). A high-viscosity hullless barley that has

consistently given substantial growth depression in young chicks gave comparatively good results when fed to pigs (Bhatti *et al.*, 1979).

Pigs differ physiologically from young chicks where their digesta has a higher water content. Since β -glucan-induced viscosity related to concentration, simple dilution can essentially eliminate the viscosity problem, and the associated constraints on luminal diffusion. β -Glucan is also highly digestible in the ileum of pigs (Graham *et al.* 1986), apparently more digestible than starch (Graham *et al.* 1989) suggesting the presence of an endogenous β -glucanase. Dietary β -glucanase resulted only in a small improvement in ileal starch (92.6-94.3%) and β -glucan digestibility (95.1-91.1%; Graham *et al.* 1989). The source of the endogenous β -glucanase has not been identified; presumably it is of microbial and/or feed origin. Some β -glucan degradation also appears to occur in the stomach, although again it has not been resolved whether this reflects enzymic or acid hydrolysis.

There are also anatomical differences between swine and poultry which explain why pigs do not appear to suffer from digestive disturbances attributable to dietary β -glucan. The crop in poultry provides a comparatively ideal environment for enzyme activity, at least for enzymes with pH optima in the 4-5 range. The stomach of the pig is a more hostile environment, with the pH considerably lower (Kidder and Manners 1978). Here activity of most fungal enzymes would be suboptimal and activity of many bacterial enzymes would be questionable at best. The presence of proteolytic enzymes and the lengthy residence time in the pig's stomach would appear to challenge the survivability of the most robust enzymes.

Research results concur with this evaluation - responses with pigs have tended to be low and inconsistent. Some improvement in growth and feed conversion (as well as digestible energy and protein) has been reported in pigs fed barley diets (Newman *et al.* 1980, 1983; Bedford *et al.* 1992) in response to enzyme supplementation. While the entire field of research is open to the criticism of poorly defined enzyme sources.

In some cases at least α -glucanase sources successful for poultry had little effect on swine (Thacker et al. 1988, 1989, 1992b). Attempts to verify that any response is in fact real by digestibility studies have generally been inconclusive.

Rye has also been evaluated in growing/finishing hog diets with and without pentosanase. Pigs fed rye gain consistently less than those fed barley. However, dietary enzyme, even at addition rates substantially higher than similar experiments with chicks, was unable to restore weight gain to that of the barley control diets (Thacker et al. 1991, 1992a). It appears that enzymes are not particularly effective for rye. In fact, Bedford et al. (1992) found pentosanase supplementation of rye diets tended to increase viscosity of the small intestine contents, suggesting pentosan solubilization was occurring at a greater rate than xylanolytic hydrolysis.

It seems that the most likely application would be in weanling pig diets where pancreatic enzyme production may be limiting (Lindemann et al. 1986), which is consistent with industry practice. One final point to note is that most research trials have been conducted with older pigs. In studies with weanling pigs fed barley, both daily gain and feed conversion were moderately improved (but not significantly) with enzyme treatment (Thacker et al. 1992b) and in one case a reduction in post-weaning diarrhoea was reported (Inborr and Ogle 1988).

2.5 Enzymes in Poultry Nutrition

Enzymes started being used in animal feed as a consequence of consistent increase in the price of feed ingredients. In most of the developing country, cheaper and nonconventional feed ingredient have to be used which contain higher percentage of

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