

**COMPARISON OF THE GROWTH OF BROILER
CHICKEN FED ON FERMENTED AND
DRY CORN GRAIN
MEAL**

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ABSTRACT

Fermented corn grain is one of the new invention technologies in animal feed especially in Europe. It is known to be a good source of energy and can produce beneficial bacteria in colon that can help in nutrient absorption. An experiment was conducted to evaluate the effect of fermented corn grain on the growth of broiler chicks. Three experimental treatments were used in the study. Treatment 1 was a fermented corn grain mix with soy bean meal (SBM). Treatment 2 was a dry corn grain mix with SBM. Treatment 3 was a commercial grower feed which act as a control treatment in this experiment. Total 45 broiler chickens were randomly assigned to the three experimental treatments in a randomized complete block design (RCBD). Each treatment group was replicated three times with 5 birds per replicate. Results showed that feed intake, weight gain, average daily gain and feed conversion ratio (FCR) were significantly higher ($P < 0.05$) in birds fed fermented corn grain than dry corn. The results also indicated that the treatments had no significant ($P > 0.05$) effect on the carcass characteristics of the birds. The results of this experiment showed that feeding fermented corn grain gives a positive outcome on the growth of broiler chickens.

ABSTRAK

Penapaian kernel jagung merupakan salah satu ciptaan teknologi terkini dalam pengeluaran ternakan. Ianya dikenali dengan sumber tenaga yang baik dan dapat menghasilkan bakteria yang baik di dalam usus untuk menyerap nutrisi. Satu kajian telah dijalankan untuk mengenalpasti kesan tapai kernel jagung ke atas pertumbuhan ayam pedaging. Tiga rawatan berbeza telah digunakan dalam kajian ini. Rawatan 1 adalah kernel jagung yang telah ditapai selama 21 hari di campur dengan dedak kacang soya. Manakala rawatan 2 adalah jagung kering juga dicampur dengan dedak kacang soya. Rawatan 3 pula adalah makanan ayam komersial sebagai rawatan kawalan. Sebanyak 45 ekor ayam pedaging ditempatkan secara rawak ke atas ketiga-tiga rawatan tersebut dalam reka bentuk eksperimen RCBD. Setiap kumpulan rawatan diulang sebanyak tiga kali dengan 5 ayam dalam satu ulangan. Keputusan menunjukkan bahawa pengambilan makanan, berat badan, purata berat harian dan nisbah penukaran makanan mempunyai perbezaan yang tinggi ($P < 0.05$) terhadap ayam yang di beri tapai kernel jagung berbanding jagung kering. Keputusan eksperimen juga menunjukkan tiada perbezaan yang ketara ($P > 0.05$) terhadap berat karkas ayam. Eksperimen ini menunjukkan bahawa terdapat kesan positif terhadap pertumbuhan ayam pedaging yang diberi makan tapai kernel jagung.

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LIST OF SYMBOLS, UNITS AND ABBREVIATION

ANOVA	Analysis of variance
Cm	Centimeter
DCG	Dry Corn Grain
FCG	Fermented Corn Grain
FSA	Faculty of Sustainable Agriculture
g	Gram
Kg	Kilogram
SBM	Soybean Meal
T1	Treatment 1
T2	Treatment 2
T3	Treatment 3
UMS	Universiti Malaysia Sabah

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CHAPTER 1

INTRODUCTION

1.0 Background of study

In Malaysia, poultry business is one of the most important economic industries and also is widely known in the national and international market. Malaysia is largely self-sufficient in poultry meat production. Poultry is also the primary protein source for most of the world populations including Malaysia. Consumption is assumed to grow 1.4 million tons in the year of 2014 (USDA foreign agricultural service, 2014).

Poultry feed industry is related to primary agricultural production and forms an important component in the food chain. Poultry feeds are prepared in such a way that all vitamins, energy, minerals, protein, and other nutrients are present in the feed for proper health of the birds, egg production and growth. It is actually known as a complete feeds. Feed costs represent approximately 70% of total production costs (Kleyn, 1992). The inclusion of alternative ingredients in label chicken feeds aims at reducing feed costs, thereby making this kind of business more attractive to small farmers.

In poultry production, particularly in broiler production the main ingredient used in feeds as energy source is corn (*Zea mays*) which may accounts for 60% of the total feed amount and approximately 40% of feed cost (Zanotto *et al.*, 1996). Grain corn silage was first used in nearly every production of pigs in the area of Brazil and can reduce up to 20% reduction in the cost of feeds (Majowski, 2002). According to Costa *et al.* (1999) and Jobim *et al.* (2001), United States has conducted several studies that show the performance and economic benefits and advantages of using grain corn silage in the diet of ruminants.



The productivity of farm animals is greatly influenced by the nutrition. This is due to the fact that feeding cost is very high which accounts for more than 70 % of the total cost production (Esonu, 2001). However, farmers tend to feed their farm animals with poor quality feeds to reduce the feeding cost. This caused the economic to be deficit in terms of poultry production in most developing countries (Aletor, 1986). Hence the strategies for regulating the feed quality with low price are crucial to ensure improved utilization and performance of poultry.

Fermentation is a specialized biotechnological process with the potential to recycle some industrial feed or agro-industrial by-products into feed valuable for animals especially in developing countries. This process does not involve the use of chemicals and is easy to handle on farm or industrial scale. The benefit of this process is that it can decrease the anti-nutritional factors (Zhang *et al.*, 2006), improve the protein quality (Oduguwa *et al.*, 2007) and enhance nutrient digestibility (Kim *et al.*, 2007). Ahmed *et al.*, 2014 reported that broiler chickens fed with fermented feed by-products shows an improved growth performance and immunity. Furthermore, fermented feed nutrients can prevent fecal ammonia concentration (Awati *et al.*, 2005).

1.1 Problem statement

The production cost for feeding broiler is expensive, especially commercial feed and dry corn. The U.S. also exports about 60,000 tons of corn gluten feed and 50,000 tons of corn distiller by-products to Malaysia annually (Abdul Wahab, 2014). This in turn increased the poultry price due to the increase in the price of chicken feed. The main problem facing Malaysia livestock and poultry industry is lack of feed. Malaysia is still importing raw materials for animal feed such as corn and soybeans. Feeding of broiler in Malaysia depends on the importation of dry corn from other country such as Australia (Fatanah, 2012).

Feed cost have been identified as the largest single of cost in livestock production making up to 50% to 70% of total cost of production (Hoorman, 2012). About 1.2 billion ringgit a year of livestock feed and corn is imported (World Report, 2011). Malaysia imported 3.4 million tons of corn, 1.34 tons of soybean meal, and 572,000 tons of soybeans in 2013 (Abdul Wahab, 2014). In the line of the above,



fermentation of kernel corn as silage may be feasible and economical in warm and moist climates (Weinberg *et al.*, 2007) such as Malaysia to replace current feed which is dry corn. Therefore, it is important to study the effect of fermented corn kernel silage on the growth of broiler bird.

1.2 Significance of the study

The success of this proposed research will reduce the variable cost of feed for poultry and achieved maximum profits possible from poultry production. The positive result from this research can replace the dry corn with fermented corn grain as feed for broiler chickens since the cost of dry corn is high. This will also greatly help the farmers in Malaysia.

1.3 Objective

The objective of this study is to investigate the effect of feeding fermented corn grain on the growth performance of broiler chickens.

1.4 Hypotheses

- Ho: There is no significant effect on the growth and performance of broiler chickens fed with fermented corn grain compared with dry corn grain.
- H1: There is significant effect on the growth and performance of broiler chickens fed with fermented corn grain compared with dry corn grain.

CHAPTER 2

LITERATURE REVIEW

2.1 Background of corn

Corn, scientific name *Zea mays*, also known as maize or mielie/mealie, is one of the most successful cereal grasses of all time. Corn is primarily a source of animal feed, as well as food and seed and industrial including ethanol for fuel (EFF) (Sun, 2007). Corn is the principle energy source in poultry diets in most of the countries (Reddy *et al.*, 2001). It contains the highest amount of energy (ME 3350 kcal/kg) among cereal grains and is highly palatable (Reddy *et al.*, 2001). Natives to the Americas, it is believed that the native Americans developed this plant from a wild grass called teosinte, which had small kernels and were not closely packed as the present day corn. So, corn is considered to be an invention by humans, as this plant does not exist naturally in the wild.

Unlike white maize, yellow maize provides carotene and xanthophyll pigments for colouration of egg yolk, poultry fat and skin (Reddy, 2001). Corn grows in warm weather and usually matures in late summer. The stalks can grow between three feet (one meter) and 20 feet (six meters) tall, depending upon the cultivar. At one point, there were thousands of varieties of corn in production, but these numbers have since dwindled to less than one hundred hardy, predictable varieties with large fleshy kernels. Maize is also more susceptible for infestation with mycotoxin-production fungi than grains such as wheat, sorghum and millets (Reddy *et al.*, 2001).

2.2 Corn Nutritional Facts

Generally, a significant increase in the soluble fraction of a food is observed during fermentation. The quantity as well as quality of the food proteins as expressed by biological value, and often the content of water-soluble vitamins is generally increased, while the anti-nutritional factors show a decline during fermentation (Paredes-López &



Harry, 1988). Fermentation results in a lower proportion of dry matter in the food and the concentrations of vitamins, minerals and protein appear to increase when measured on a dry weight basis (Adams, 1990). The following table shows the chemical composition and nutritional value of corn grain:

Table 2.1: Chemical composition and nutritional value of corn grain

Proximate Analysis	Average value
Dry matter	87.2 % as fed
Crude protein	9.7 % DM
Crude fibre	2.6 % DM
NDF	13.2 % DM
ADF	4.4 % DM
Lignin	1.4 % DM
Ether extract	4.2 % DM
Ash	1.5 % DM
Starch	71.0 % DM
Total sugars	3.7 % DM
Gross energy	18.7 MJ/kg DM
Minerals	Average value
Calcium	0.7 g/kg DM
Phosphorus	3.4 g/kg DM
Potassium	4.3 g/kg DM
Sodium	0.1 g/kg DM
Magnesium	1.4 g/kg DM
Zinc	34 mg/kg DM
Copper	5 mg/kg DM
Amino acids	Average value (% protein)
Alanine	7.7
Arginine	5.1
Aspartic acid	7.1
Cystine	2.1
Glutamic acid	17.7
Glycine	4.3

Histidine	2.8
Isoleucine	3.6
Leucine	10.6
Lysine	3.0
Methionine	2.1
Phenylalanine	5.4
Proline	6.9
Serine	4.8
Threonine	3.6
Tryptophan	0.9
Tyrosine	2.3
Valine	4.4

Source: Animal feed resources information system, 2012

2.3 Broiler Chickens

Most of the chicken eaten today comes from broiler chickens – birds bred solely for meat. Poultry meat production, consisting of broiler meat, is expected to grow at a moderate of 2% in 2014, with production forecast at 1.44 million tons (World Poultry, 2014). Broilers grow very rapidly and have been selected for traits that are desirable for meat production. In terms of bird numbers, commercially bred broilers comprise 67%, while layers make up around 25% and breeders make up 8% of the total (World Poultry, 2014).

Peninsular Malaysia has about 3200 broiler farms, which includes, contract and independent farmers, as well as large vertically integrated farms (World Poultry, 2014). The type of birds and the housing methods are totally different from those of hens kept for egg production. In their natural environment, hens spend much of their time foraging for food. This means that they are highly motivated to perform species specific behaviours that are typical for chickens (natural behaviours), such as foraging, pecking, scratching and feather maintenance behaviours like preening and dust-bathing.

Table 2.2: Feeding requirements for broilers/roasters

Age (weeks)	Feeds (kg/bird)	Ration
0-3	1.0	21% Barnyard Starter or Medicated
4-5	1.5	19% Barnyard Starter or Medicated
6-market	1.3 kg per week	17% Barnyard Grower

Source: Champion Feed Services Ltd. (2010)

2.4 Fermentation Process

Campbell-Platt (1987) has defined fermented foods as those foods which have been subjected to the action of micro-organisms or enzymes so that desirable biochemical changes cause significant modification to the food. French chemist and microbiologist Louis Pasteur in the 19th century used the term fermentation in a narrow sense to describe the changes brought about by yeasts and other microorganisms growing in the absence of air (anaerobically); he also recognized that ethyl alcohol and carbon dioxide are not the only products of fermentation. The product can either be the cell itself which referred to as biomass production, a microorganisms own metabolite and a microorganisms foreign product (Brian Pumphrey & Christian Julien, 1996). However, to the microbiologist, the term "fermentation" describes a form of energy-yielding microbial metabolism in which an organic substrate, usually a carbohydrate, is incompletely oxidised, and an organic carbohydrate acts as the electron acceptor (Adams, 1990). Whichever definition used, foods submitted to the influence of lactic acid producing microorganisms is considered a fermented food.

Fermented foods can be classified in many different ways. Dirar (1993) says that in Southeast Asia the classification often is according to the kind of microorganism involved (Yokotsuka, 1982). Other classifications are based on commodity (Campbell-Platt, 1987) (Odunfa, 1988).

Table 2.3: The Process of Corn Silage Fermentation.

Day/stage	Process
1 (anaerobic)	<ul style="list-style-type: none"> • Cell respiration produces carbon dioxide (CO₂), heat and water • Temperature: 21°C • pH: 6.0
2 (anaerobic)	<ul style="list-style-type: none"> • Fermentation begins, producing acetic acid • Heating process begins to slow down • Temperature: 35°C • pH: 5.0
3 (anaerobic)	<ul style="list-style-type: none"> • Lactic acid production begins, acetic acid production continues • Temperature: 35°C • pH: 4.0
4-7 (anaerobic)	<ul style="list-style-type: none"> • Lactic acid produced, temperature drops • Temperature: 27-29°C • pH: 4.0
8-21 (anaerobic)	<ul style="list-style-type: none"> • Lactic acid produced, silage PH drops and stable • Temperature: 27-29°C • pH: 4.0
21 (stable)	<ul style="list-style-type: none"> • Bacterial fermentation stops, silage preserved until re-exposed to oxygen • Silage cools to ambient temperature • pH: 4.0

Source: FAO Electronic Conference on Tropical Silage

2.5 Fermented Feed Technology

Food fermentation is one of the methods of food processing and preservation that had been invented since many years ago. Man had been using microbes for food preparation for thousands of years and since then a lot of fermented foods has been produced (Achi, 2005).

In pig nutrition, liquid feed had been used by recycling of liquid products from the human food industry (Scholten *et al.*, 1999; Brooks *et al.*, 2003). This will greatly help the environment by reducing the need for disposal such as drying, disposal on land fill or burning (Scholten *et al.*, 1999).

However, liquid feed can be the medium for the introduction of pathogens unless careful steps are taken during storage and feeding to prevent their proliferation (Seal *et al.*, 2002). Contamination of liquid feed also can easily occur (Brooks *et al.*, 2001). But the liquid-feeding system is beneficial for weaner pigs for its capability of feeding ad libitum which has become the main interest. Therefore, the development in the use of lactic acid bacteria has been used to accelerate fermentation process as well as reducing contamination by pathogens (Beal *et al.*, 2002). It is also promising in other farm animals especially poultry (Heres *et al.*, 2003; Skrede *et al.*, 2003) and aquaculture (Refstie *et al.*, 2005).

Beal *et al.*, (2002) stated that a feed of pH of 3.8 to 4.0 can be achieved in lactic acid bacterial fermentation. The high lactic acid concentration and low pH value act to provide fermented feeds their antimicrobial activity. This allows them to fight against pathogens such as *Salmonell spp* (Geary *et al.*, 1996; van Winsen *et al.*, 2001; Beal *et al.*, 2002) and *Campylobacter spp* (Heres *et al.*, 2004).

2.6 Influence of fermentation length and conditions

The quality of fermented product is affected by the length of steeping feed ingredients, the fermentation conditions and also the type of feed substrates. Steeping time affects the activity of endogenous enzymes and the elimination of anti-nutrients within the grain. For example in weaner pigs, steeping of feed for 15 hours affects the growth and feed intake by the release and activation of endogenous enzymes in the grain (Choct *et al.*, 2004). The activation of the enzyme can occur on cell wall structures in the same way to exogenous feed enzymes (Choct *et al.*, 2004). The effect of steeping in liquid feeding can be observed when phytases in the pericarp of some grains could be activated by soaking (Brooks *et al.*, 2004). The availability of phosphorus, magnesium and calcium can be increased by soaking feed for 8 to 16 hours.

Fermentation of the protein rich substance has been observed to produce undesirable end-product that could affect the palatability of the feed such as biogenic amines (Canibe *et al.*, 2007). Some studies had shown that the free amino acids added to diets had been degraded during fermentation (Brooks *et al.*, 2003; Canibe *et al.*, 2007). However, the loss of lysine from fermented liquid feed was due to metabolism of lysine by *E.coli* (Niven *et al.*, 2006).

The main purpose of fermentation is to increase lactic acid concentration and to lower the pH. Temperature plays an important role in fermentation and low temperatures might produce insufficient fermentation end-products. Low temperature also encouraged the growth of yeast and produces ethanol (Brooks, 2008). Furthermore, cereal grain mix needs 7 days to reduce the pH to 4.0 at 10°C compared with only 5 days for 15 and 20° C. The most ideal temperature for fermentation is at 30°C compared with 35 and 40°C where there is no effect on lactic acid concentration but increased in the concentrations of acetic, butyric and ethanol (Beal *et al.*, 2005).

2.7 Purpose and benefits of food fermentation

The main benefit of fermentation process is the conversion of sugar and carbohydrates into beneficial end product. Steinkraus (1995) claims that the traditional fermentation of foods have several benefits which includes improvement of diet through enhancement of flavour, texture and aroma in food, extend shelf-life of food, increase food quality, improving digestibility and also nutrient availability, detoxification of anti-nutrient factor (ANF) through fermentation process.

Fermentation can produce essential nutrients or detoxified the anti-nutrients factor. Preservation can be done through fermentation since the process involved used up food energy and make the environment unsuitable for undesired microorganisms. For instance, in pickling, the dominant organism involved in the process produced acid which inhibits the growth of other microorganisms.

Fermentation also enhanced the foods by making it more edible by altering the chemical compounds. For example in poisonous plant like cassava that undergoes fermentation process has been converted into edible stuff. Coffee beans also undergo wet fermenting process rather than dry process (Battcock and Aza-Ali, 1998).

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