PERFORMANCE OF BROILER FED WITH FERMENTED CORN KERNEL SILAGE

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ABSTRACT

A field experiment was conducted at the Faculty of Sustainable Agriculture (FSA) in Universiti Malaysia Sabah (UMS), Sandakan, from September to November 2016. The study was carried out to investigate the performance of broiler fed with fermented corn kernel silage. The experimental design used in this experiment was by using randomized complete block design (RCBD). Two treatments were used for this experiments, which include fermented corn kernel silage (FCKS) (T2) and dry corn (T2). A total of 36 broilers were used for both treatments. Each of the treatment have 18 broilers in which each treatment has three cages with six broilers in each cage. Data and observation were taken daily for two weeks starting from day 21 until day 35. Feed were given twice daily in which in the morning and at dusk. Results showing that dry matter (DM) basis for dry corn was 97.36% while FCKS with 20.99%. The body weight gain for broilers for dry corn was heavier with mean of 458.33g than FCKS with mean of 344.44g. Dry corn has the higher mean value of feed intake (560.28g) when compare with FCKS (203.01g) when calculated in DM basis. For average daily gain (ADG), the mean calculation showed that dry corn had the higher ADG than FCKS. However, FCKS give lower mean of feed conversion ratio with the value of 1.45 when comparing with dry corn (3.02). In the case of carcass weight, FCKS had heavier carcass weight than dry corn. The last parameter taken which was weight of feather, the result showed that T2 has heavier mean of feathers weight than T1. From the result obtained, it can be known that FCKS was better than dry corn by comparing the FCR and feed intake when calculated in DM basis.

ABSTRAK

Kajian lapangan ini telah dijalankan di Fakulti Pertanian Lestari (FSA) di Universiti Malaysia Sabah (UMS), Sandakan dari September hingga November 2016. Kajian ini telah dijalankan untuk menyiasat prestasi ayam pedaging yang diberi makan dengan kernel jagung silaj yang ditapai. Reka bentuk eksperimen yang digunakan dalam eksperimen ini adalah dengan menggunakan rawak reka bentuk blok lengkap (RCBD). Dua rawatan telah digunakan untuk eksperimen ini, termasuklah kernel jagung silaj yang ditapai (FCKS) (T1) dan jagung kering (T2). Sebanyak 36 ayam pedaging telah digunakan untuk kedua-dua rawatan. Setiap rawatan mempunyai 18 ayam pedaging di mana setiap rawatan mempunyai tiga sangkar dengan enam ayam daging dalam setiap sangkar. Data dan pemerhatian diambil setiap hari selama dua minggu bermula dari hari 21 sehingga hari 35. Makanan diberi dua kali sehari di mana pada waktu pagi dan pada waktu senja. Keputusan menunjukkan bahawa asas bahan kering (DM) untuk jagung kering adalah 97,36% manakala FCKS dengan 20.99%. Kenaikan berat badan badan ayam daging untuk jagung kering adalah lebih berat dengan min 458.33g daripada FCKS dengan min 344.44g. jagung kering mempunyai nilai min yang lebih tinggi daripada pengambilan makanan (560.28g) apabila dibandingkan dengan FCKS (203.01g) apabila dikira dalam asas DM. Untuk purata kenaikan berat harian (ADG), pengiraan min menunjukkan bahawa jagung kering mempunyai ADG yang lebih tinggi daripada FCKS. Walau bagaimanapun, FCKS memberikan min yang lebih rendah daripada nisbah penukaran makanan dengan nilai 1.45 apabila membandingkan dengan jagung kering, 3,02. Dalam kes berat karkas, FCKS mempunyai berat karkas lebih berat daripada jagung kering. Parameter terakhir yang diambil iaitu berat bulu, hasilnya menunjukkan bahawa T2 mempunyai min yang lebih berat daripada berat bulu daripada T1. Dari keputusan yang diperolehi, ia boleh diketahui bahawa FCKS adalah lebih baik daripada jagung kering dengan membandingkan pengambilan FCR dan suapan yang apabila dikira dalam asas DM.

CONTENT

LIST OF SYMBOLS, UNITS AND ABBREVIATIONS

FSA	Faculty of Sustainable Agriculture
UMS	Universiti Malaysia Sabah
%	Percentage
SPSS	Statistical Product and Service Solution
g	gram
kg	kilogram
RCBD	Randomized Complete Block Design
ADG	Average Daily Gain
FCR	Feed Conversion Ratio
DM	Dry Matter
SEM	Standard Error Mean
FCKS	Fermented Corn Kernel Silage

LIST OF FORMULAE

Feed intake= Weight of feed before feeding – weight of feed after feeding (excess feed)

$$\textbf{ADG} = \frac{\text{Finish weight} - \text{initial weight}}{\text{Age (days)}}$$

$$\textbf{FCR} = \frac{\text{Feed consumption (g)}}{\text{Body weight gain (g)}}$$

CHAPTER 1

INTRODUCTION

1.1 Background of study

Malaysia's poultry industry is becoming the most important business than other livestock industries. In Malaysia, the poultry sector is the biggest component of livestock industry by supplying about 81% of the total consumed meat and almost 110% in egg demand by domestic market. Here, we can say that Malaysia are self-sufficient in eggs production largely and almost reaching the same level in poultry meat production. The progress in this sector (poultry meat) is expanding slowly along with the local demand. Through a survey that was done by World Poultry and USDA (United States Department of Agriculture), in 2015 alone, it was verified that the production for poultry (broiler) meat was 1520 tons, with 1.6% increase in production compared with the production in 2014. In global poultry meat production, China is the leading nation that supplies most of the poultry meat, followed by Thailand, Denmark, and the Netherlands into Malaysia.

Mostly, the majority of feedstuffs used in rations for poultry industry are imported. Soybean and maize are the main imported ingredients to be used as poultry feed. In Malaysia, raw ingredients that are available locally contribute about 30 percent of the total feed ingredients. In an article that was r by World Poultry in 2014, it was stated that the poultry sector in this country uses about 4 million tons of compound feed annually, with forecast increase in demand for feed in line with expectations for output growth (2-3% per year). While the other 65% of the total production cost accounted from the imported corn.

Modern feeds for poultry consists largely of grain, protein supplements such as soybean oil meal, mineral supplements, and vitamin supplements. The quantity of feed, the nutritional requirements of the feed, depend on the weight and age of the poultry, their rate of growth, their rate of egg production, the weather (cold or wet weather causes higher formulations. The substitution of less expensive local ingredients introduces additional variations (Heuser, 1955).

In poultry production, mainly in broiler production, corn (*Zea mays*) is the main ingredient used in feed as energy source which make up for 60% of the total feed amount and 40% from the total feed cost. For rapid growth and fattening the chicken, energy expenditure, and the amount of nutrition the poultry obtain from foraging. This results in a wide variety of feed corn silage, with its relatively high energy content, is well adapted for use in low-cost rations. It can extend the harvest period for the entire corn acreage and provide an opportunity for salvage of stressed or damaged cornfields. Also, corn silage can efficiently recycle plant nutrients, especially large amounts of N and K (Roth and Heinrichs, 2001).

1.2 Problem Statement

The most common problem for poultry producers, especially broiler is the feed. The price for feed and additional supplements contributes the most to the production cost. The goal in feed industry includes converting feed into meat or eggs in highest efficiency. As the feed efficiency increases, the cost of production become lower. This will ultimately bring the highest profit in returns. Currently, the cost for commercial feed and corn upsurges compared with 10 years ago. The U.S also export about 60,000 tons of corn gluten meal and 50,000 tons of corn distiller by-product to Malaysia annually (Wahab, 2014). The main problem that is facing Malaysia's livestock industry right now is buying feed. Malaysia is importing raw materials such as soybean and corn as feedstuff in large quantities.

Malaysia imported 3.45 million tons of corn in 2015/16 from 3.22 million tons in 2014/15 (Wahab, 2014). The climate in Malaysia is acceptable to make corn silage although there may be some problems in storing. However, that problem can be solved by taking some precautions and details during storing the corn as silage and building the storage room.

1.3 Justification

Through the success from this research, a new type of feed can be commercialized as poultry feed. The cost of feed can be reduced thus ensuring the maximum profit and production. The positive result from this research will replace the dry corn and the common commercialized feed for grower with fermented corn grain as replacement for broiler. This is because the cost for buying dry corn is quite expensive, preventing farmers to buy them in large quantities. A new solution must be made to produce and improve our own feed using locally available resources with sufficient nutrients and energy. This feed can replace the current commercial feed with lower price. Hopefully the fermented corn silage will be able to fulfill the criteria needed and full scale production can be done as poultry feed.

1.4 Objective

The objective of this study is to investigate the performance of broiler chickens fed with fermented corn kernel silage.

1.5 Hypothesis

H_0: There is no significant effect on the growth and performance of broiler fed with fermented corn kernel silage compared with dry corn grain.

H_a: There is significant effect on the growth and performance of broiler fed with fermented corn kernel silage compared with dry corn grain.

CHAPTER 2

LITERATURE REVIEW

2.1 Broiler

Broiler chickens (*Gallus gallus domesticus*), or broilers, are a gallinaceous domesticated fowl, bred and raised specifically for meat production (Kruchten and Tom, 2002). A typical broiler have white feathers and yellowish skin. Most commercial broilers reach slaughter-weight at between five to seven weeks of age, although slower growing breeds reach slaughter-weight at approximately 14 weeks of age. This is because the meat broilers are still young during slaughter, their behaviour and physiology are that of an immature bird. Due to artificial selection for rapid early growth and the husbandry used to sustain this, broilers are susceptible to several welfare concerns, particularly skeletal malformation and dysfunction, skin and eye lesions, and congestive heart conditions. The breeding stock (broiler-breeders) grow to maturity and beyond but also have welfare issues related to frustration of a high feeding motivation and beak trimming. Broilers are usually grown as mixed-sex flocks in large sheds under intensive conditions, but some breeds can be grown as free-range flocks. Chickens are one of the most common and widespread domestic animals.

2.1.1 Nutritional Components of Feedstuff for Broiler

i. Carbohydrate

Carbohydrates represent a major part of poultry diets with contents ranging from 40% to 70%. The function of their digestible part is to supply energy to the host. The undigestible fractions of carbohydrate affect essentially the digestive tract, with effect which can be observed on its anatomy and histology, on the transit time, water losses, bacterial development, digestion efficiency, etc. These functions and effects of carbohydrate vary according to their chemical and physical properties (Carre, 2002).

ii. Protein

Proteins are polymers that are composed of α-amino acids, which are linked together by peptide bonds. Proteins are broken down and hydrolyzed in the digestive system into amino acids. Then, after absorption, the amino acids will be assembled and metabolized to form proteins that are used in the building of different body tissues (Aviagen, 2009). They also serve vital metabolic roles as blood plasma proteins, enzymes, hormones, and antibodies, each of which has a specific role in the body (Pond *et al.*, 1995). However, protein is also one of the most expensive ingredients in poultry diets. Therefore, nutritionally and economically, proper protein usage is essential in all feeding systems, and wasteful usage increases the cost of production.

iii. Fats

The use of supplemental dietary fat in commercial poultry diets has been wide-spread since research in the 1960s which demonstrated improved growth, feed efficiency and hatchability in poultry. In addition to their recognized value as a dense source of energy, supplemental fats are excellent sources of essential fatty acids, enhance the absorption of fat-soluble vitamins, increase the palatability of the diet, reduce dustiness of the feed, and act as a lubricant to reduce wear of pellet mills. (Palmquist, 2002).

iv. Macro Minerals

The most important macro minerals required in broiler consisted of calcium and phosphorus. For broilers, calcium influence growth, feed efficiency, leg health, bone development, immune system and nerve function. Calcium need to be supplied at a consistent basis and in adequate quantities to achieve optimum performance. Phosphorus is required for optimizing skeletal structure and growth in correct quantity. Other types of minerals like magnesium, iron, potassium and sodium are also important for broiler optimum body function and growth.

v. Vitamins

Vitamins in poultry feeds have two origins; they are natural components of the ingredients used to make the diet, and they can be added in concentrated form as a supplement. Both sources are important in practical nutrition. The natural feed vitamins can make an important contribution towards meeting birds' needs and it is useful for the nutritionist to be aware of likely feed contents (Whitehead, 2002).

2.1.2 Broiler water intake and requirement

Broiler and many other species of animal can survive 2 or 3 days without food, but not a single day without water. Knowing the water requirement for broiler per day is important to monitor the bird progress and performance. Water intake is also related with feed intake. Water intake depend on the age of the broiler on daily basis. Chicks drink less water compared to adult broiler and older one consume more water compared with younger broilers. Temperature also affect the rate of water intake. On hot day, birds will drink more to cool their body and to regulate their internal functions. In their lifetime, broiler will drink more than the feed they consume. Other factors that may affect the rate of water intake on daily basis include health of the broiler, length of the daylight and light intensity and changes of feed. There may be some other external factors that can affect the water intake like type of housing.

2.1.3 Form of broiler feed

In the book of "Commercial Chicken Production Manual", writer Mack and Donald, 1990 wrote that broiler feed comes in three forms. That three forms of broiler feeds are mash, crumbles and pellets. Mash is usually used for at least 2 weeks if crumbles are not available.

Broilers may be started on crumbles and continued on them during the entire growing period. When the chicks are 2 or 3 weeks of age they will eat starter pellets in preference to mash or crumbles, and most broiler feeding programs call for pellets at this age (Mack and Donald, 1990).

Later in that book, they also added that pelleting a high fiber feed will show more improvement in broiler growth rate than pelleting a low fiber feed. Pelleting also reduce the time the birds spend at the feeders. Up to 2 weeks of age, chicks eat more mash than crumbles or very small pellets, but after this age chicks pellets are more preferred (Mack and Donald, 1990).

2.2 Corn

Corn or also called maize (*Zea mays*) is a large grain plant first domesticated by indigenous peoples in Mexico about 10,000 years ago. Corn kernels are the largest cereal seed, weighing about 250-300 mg each. They are flat seed due to pressure during growth from adjacent kernels on the cob. Corn kernels are botanically classified as caryopsis (dry, indehescent, single-seeded fruit) and are attached to the cob by pedicle (ASBP *et al.*, 2006).

There are six major types of corn kernels: dent, flint, flour, sweet, pop and pod corn. Major differences are largely based on the quality, quantity and pattern of endosperm composition. Corn is often harvested as soon as the moisture content drops below 28%. Unless quickly dried, high-moisture corn is subject to rapid deterioration, especially be mold infestation. The critical moisture content for "safe" storage of corn is generally regarded as 15%, but lower moisture content are required for corn to be stored for long periods at warm temperature as occur in the tropics (ASBP *et al.*, 2006).

2.2.1 Corn as livestock feed

Corn and corn products are generally the most cost effective feeds or feed supplements available. The high yield, low cost and high digestibility make corn as the preferred feed. In addition, corn is highly palatable to livestock and poultry. It is easy to ground and processed, does not contain any antinutritional factors and rarely contains toxigenic compounds. Corn stover silage is important to dairy farmers as feed. Whole green plants are harvested and chopped. The chopped corn is placed in a silo and allowed to undergo natural lactic acid fermentation where sugars are converted to lactic acid, which act as preservative. Often corn kernel is processed to improve palatability, feed conversion and reduce wastage by animals. These processes include: dry rolling and pelleting, popping, roasting, micronizing, extruding and steam flaking (ASBP *et al.*, 2006)

2.3 Silage

Silage is the product formed when grass or other material of sufficiently high moisture content (e.g., forage legumes and forage corn) liable to spoilage by aerobic microorganisms is stored anaerobically. It is formed by the process referred to as ensilage which takes place in a vessel or structure called a silo. Normally during ensilage the fodder undergoes an acid fermentation in which bacteria produce lactic, acetic, and butyric acids from sugars present in the raw material. The net result is a reduction in pH which prevent the growth of spoilage microorganisms, the majority of which are intolerant of acid conditions (Woolford, 1984).

The efficiency of ensilage is judged according to the relative proportions of the fermentation acids produced: the greater the ratio of lactic acid to butyric acid the higher the efficiency. The preservation of animal feed by ensilage involves chemical changes which inevitably result in the loss of nutrient. Loss is sustained from one or more of the following source: respiration of the plant material in the field and in the silo, ingress of air into the silo causing spoilage at the surface of the silage, fermentation, the discharge of the effluent from the silo, and aerobic deterioration which occurs when the silo is opened for feeding (Woolford, 1984).

2.3.1 Factors affecting silage fermentation

There are a few factors that can affect the silage fermentation as mentioned in the book of "The Silage Fermentation" by Woolford, 1984. One of the factor involved is the chemical composition of the raw material. The other factor is moisture and pre-wilting. Moisture is essential for the proliferation of desirable microorganisms, however excess in moisture content will encourage the growth of undesirable type microorganisms. The benefit of pre-wilting to fermentation in silage is explained by the relatively greater tolerance of lactic acid bacteria to low moisture availability than the vegetative forms of clostridia.

The third factor is rate of acidification in which rapid acidification reduce the risk of early growth of clostridia. Besides, rapid acidification also prevent the growth of other undesirable microorganisms and post-harvest changes which are detrimental to silage quality. Air is also one of the factor affecting silage fermentation. The presence of air in silage encourages the growth aerobic microorganisms which is not good for silage fermentation. The presence of air not only delays the establishment of anaerobic condition but also can suppress the development of lactic acid bacteria. Temperature also has an impact in silage fermentation. The rate of microbial metabolism is increased by a rise in temperature. Any benefits to be gained from storing silage at a temperature above ambient or from permitting temperature to rise in silage will be influenced by the temperature optima for the microorganisms within each group represented in silage (Woolford, 1984).

2.4 Fermentation

Fermentation converts sugar to acids, gases or alcohol in a metabolic process. Fermentation happens in yeast and bacteria, and also in oxygen-starved muscle cells (lactic acid fermentation). According to Klein et al. (2006), fermentation takes place when the electron transport chain is unusable (often due to lack of a final electron receptor, such as oxygen), and becomes the cell's primary means of ATP (energy) production. It turns NADH and pyruvate produced in glycolysis into NAD^+ and an organic molecule (which varies depending on the type of fermentation; see examples below). In the presence of O_2, NADH and pyruvate are used to generate ATP in respiration. This is called oxidative phosphorylation, and it generates much more ATP than glycolysis alone. For that reason, cells generally benefit from avoiding fermentation when oxygen is available, the exception being obligate anaerobes which cannot tolerate oxygen.

aerobic phase	anaerobic phase				stable phase
day 1	day 2	day 3	days 4-7	days 8-21	after day 21
Cell respiration produces CO_2, heat and water.	Fermentation begins, producing acetic acid. Heating process slows.	Lactic acid production begins. Acetic acid production continues.	Lactic acid produced. Temperature drops.	Lactic acid produced. Silage pH drops and becomes stable.	Bacterial fermentation stops. Silage preserved until re-exposed to oxygen.
temp 70 F	95 F		80 to 85 F		Silage cools to ambient temperature.
pH 6.0	5.0	4.0			4.0

Source: Agriculture and Industrial Development Company (AIDCO), Lebanon, Syria

2.5 Purpose and benefits of food and feed fermentation

There are a few reason and benefits why there are many fermented foods and feeds which are in the market. According to Steinkraus (1995), food fermentation has been said to serve five main purposes, enrichment of the diet through development of a diversity of flavors, aromas, and textures in food substrates, preservation of substantial amounts of food through lactic acid, alcohol, acetic acid, and alkaline fermentations, biological enrichment of food substrates with protein, essential amino acids, and vitamins, elimination of antinutrients and a decrease in cooking time and fuel requirement.

Also according to the website from transformyourhealth.com, the process of fermentation renders food resistant to microbial spoilage and the development of toxins, inhibits the transfer of pathogenic organisms, improves digestion and nutrient absorption of food and preserves food between the time of harvest and consumption. In poultry industry, feed fermentation is a good approach because the nutrients are more readily absorbed in fermented foods, feed requirements lessen, and there is also less waste since the chickens love it. It's believed that chickens will eat 1/3 to 1/2 less fermented feed than regular dry feed. This increased nutritional absorption leads to reduced food intake since nutritional requirements are met faster with less feed. Additionally, fermentation increases enzymes in the feed and actually introduces vitamins, specifically the B vitamins (folic acid, riboflavin, niacin, and thiamin), not present before fermentation. This all leads to your chickens requiring less feed to achieve the same nutritional intake (Countryside Daily, 2016).

2.6 Influence of micro-organism and feed substrate on fermentation

Fermentation objectives that have influenced the use of lactic acid bacteria (LAB) have centred on; selection for rapid production of organic acids (mainly lactic acid) to ensure biosafety, selection for homolactic fermentation to improve feed palatability and breakdown of anti-nutrients and increased bioavailability of nutrients (Bertsch *et al.*, 2003).

From the research done by Niba et al. (2009), The advantages of fermenting feeds can be summarized into 4 things. First is reduction in the level of anti-nutrients within the feed. Fermenting feed also improved bioavailability of minerals (e.g. P, Ca, Mg and Cu) and increase in protein contents (lysine, histidine and methionine). The last one is the breakdown of indigestible carbohydrates.

2.7 Influence of fermentation length and condition

The quality of the fermentation product is influence by the length of steeping feed ingredients, the type of feed substrates and fermentation conditions (Niba *et al.,* 2009). According to Choct *et al.* (2004) the effects on growth and feed intake for weaner pigs resulting from steeping of feed for 15 h might be related to the release and activation of endogenous enzymes in the grain. The activation of these enzyme systems within the grain can act on cell wall structures in a similar way to exogenous feed enzymes (Choct *et al.*, 2004).

In reviewing the effect of steeping in liquid feeding systems, Brooks *et al.* (1996) indicated that phytases that were naturally present in the pericarp of some grains (like cereals) could be activated by soaking. They also stated that soaking feed for 8 - 16 h before feeding increased the bioavailability of phosphorus, calcium, magnesium and copper. In another study (Lyberg *et al.,* 2008).

2.8 Effect of fermented feed on poultry performance

Research on the use of fermented moist feeds on the performance of chickens is limited. However, some studies have shown that wet feeding increases the feed intake and growth rate of chickens (Yalda and Forbes, 1995; Yasar and Forbes, 1999). Pre-soaking of broiler feeds for 12 and 24 h significantly increased dry matter digestibility and body weight gain in male broilers (25 - 40 days of age) compared with dry feed (Yalda and Forbes, 1996).

Early access to semi-moist diets for day-old chicks stimulates gastrointestinal (GI) development and prevents dehydration during transport from the hatchery (Van den Brink and Van Rhee, 2007). Rapid GI tract development after hatch is essential for optimisation of digestive function and underpins efficient growth and development as well as a full expression of the genetic potential for production traits (Mitchell and Moreto, 2006; Mai, 2007). Furthermore, the moistening capacity of the crop of chicks during the first weeks of life is also believed to be a limiting factor for the optimal functioning of the gut when standard solid diets are fed (Mai, 2007). Yasar and Forbes (1999) attributed the beneficial effects of wet feeding to decreased viscosity of gut contents, greater development of the layer of villi in the digestive segments and reduced crypt cell proliferation in the crypts of the epithelium.

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