THE CRUDE PROTEIN DIGESTIBILITY OF FERMENTED CORN KERNEL SILAGE FED TO BROILERS

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ABSTRACT

The objective of this study was to study the crude protein digestibility of fermented corn kernel silage fed to broilers. Ileal crude protein digestibility of dry corn and fermented corn kernel silage were compared using 21 days old Cobb-500 male chickens. The test ingredients were used as sole sources of protein sources in the test assay. Test comprises of feeding the animals using tube feeder and fed with 10g sample feeds in dry matter basis. Collection of ileal digesta was carried out 4 hour post-feeding. All birds were slaughtered and dissection was carried out to remove the ileum and ileal digesta content were collected. True Ileal digestibility were calculated by using blank ileum content as correction for endogenous Nitrogen. Fermented corn kernel silage was found to have higher crude protein value of 16.06% compared to 13.79% in dry corn with both has digestibility of 67.61% for fermented corn kernel silage and 68.38% for dry corn. Ileal crude protein digestibility values were similar for both treatments, having almost the same digestibility values. It was concluded that fermented corn kernel silage can become an alternative for dry corn.

Key words: Crude protein, digestibility, dry corn, fermented corn kernel silage, ileal digesta, true ileal digestibility, endogenous N.

ABSTRAK

Objektif kajian ini adalah untuk mengkaji penghadaman orotin kasar kernel jagung silaj yang ditapai yang diberikan kepada broiler. Penghadaman ileal protin kasar jagung kering dan kernel jagung silaj yang ditapai telah dibandingkan menggunakan ayam jantan Cobb-500 yang berumur 21 hari. Bahan-bahan ujian digunakan sebagai satu-satunya sumber protin di dalam perlaksanaan ujian. Ujian terdiri daripada member makan kepada haiwan menggunakan tiub makanan dan diberi makan 10g sampel makanan dalam asas bahan kering. Pengumpulan digesta ileal dilaksanakan 4 jam selepas diberi makan. Kesemua burung disembelih dan pembedahan telah dilakukan untuk mengeluarkan ileum dan digesta ileum telah dikumpul. Penghadaman ileal benar telah dikira dengan menggunakan kandungan ileum kosong sebagai pembetulan untuk Nitrogen dalaman. Kernel jagung silaj yang ditapal didapati mengandungi nilal protin kasar yang lebih tinggl iaitu 16.06% berbanding 13.79% di dalam jagung kering dengan kedua-duanya mempunyai penghadaman sebanyak 67.61% untuk kernel jagung silaj yang ditapai dan 68.38% untuk jagung kering. Nilai penghadaman protin kasar ileal adalah hampir sama bagi kedua-dua rawatan. Ianya telah disimpulkan bahawa kernel jagung silaj yang ditapai boleh menjadi alternatif kepada jagung kering.

Kata kunci: Protein kasar, penghadaman, jagung kering, kernel jagung silaj yang ditapai, digesta ileal , penghadaman ileal benar, N dalaman.

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LIST OF SYMBOLS, UNITS AND ABBREVIATIONS

% - Percentage

µ - micro

^{O}C - Degree Celcius

ANOVA – Analysis of Variance

AOAC – Association of Analytical Communities

ARC - Agricultural Research Council

CE-HPLC - Cation exchange High Performance Liquid Chromatography

CO_2 – Carbon Dioxide

Cm - Centimeter

CP - Crude Protein

DM - Dry Matter

Dm^3 – Decimeter cube

FAO – Food and Agriculture Organization

FCKS - Fermented corn kernel silage

H_2O - Water

HCl - Hydrochloric acid

HPLC - High Performance Liquid Chromatography

IP-HPLC - ion-pairing High Performance Liquid Chromatography

L - Liter

Mg - Miligram

Ml - Mililiter

MS - Mass spectrometry

N - Nitrogen

Na_2HPO_4 - Sodium Phosphate Dibasic

NDF – Neutral Detergent Fiber

Nm – nanometer

NRC - National Research Council

OPA - Ortho-Phthalaldehyde

RP-HPLC – reverse-phase High Performance Liquid Chromatography

SAS – Statistical Analysis Software

Vis - Visible

UV - Ultraviolet

LIST OF FORMULAE

CHAPTER 1
INTRODUCTION

1.1 Introduction

Flourishing of livestock and poultry industry causes increasing production of livestock and poultry which are essential with increasing demand. However, feed contributes to the large proportion of production cost for any livestock and poultry industry .The increasing demand for livestock feed is also an undeniable scenario as human's protein need is increasing as human population increase. The significant increase in demand for livestock products has triggered the need to expand the use of existing raw materials for new protein feed sources, with high nutritional value, economically feasible and locally available as raw ingredients for animal feeds are not usually produced in Malaysia. Due to this current scenario, only sustainable production of suitable feed crop is available as a solution to overcome high feed price of animal feed.

The calculation of crude protein in animal feed formulation was a little bit controversial as it determine solely on the amount of total nitrogen in the ingredient, which may or not be essential. Chickens supplied with low protein diet, although having sufficient amount of essential amino acids for excellent growth, are found failed to thrive and excessively fat. It was further realized that chickens also require the combinations of all essential and some non essential amino acids at optimum amount which are essential for growth (Pesti *et. al*, 2009).

Silage is the product of fermentation of stored field crops or fodder under as little oxygen amount as possible in an airtight container (Brian and Wood, 1997). Preparation of fermented silage does not usually use any chemicals and is easy to prepare at farm and industrial level.

Therefore, it is important to evaluate digestibility differences between fermented corn kernel silage and dry corn to establish our own style of producing corn silage in our current situation thus providing sustainable sources of animal feed.

1.2 Problem Statement

Rising cost of broiler feed increase the need of producing our own animal feed as we are facing weak currency and slow economic growth that is unavoidable in the near future. Major problems faced by commercial broiler industries are high cost of feeding which were passed through consumer by higher broiler meat price per kilogram. Production own feed crop such as corn grain is one of the solutions taken to lower feed cost.

Main problem faced by broiler farmers were lack of feed thus increase the need for us to import. Weak currency also increase our import value but lower amount and this trend was seen in corn import where 3.22 million tons were imported in 2014/15 compared to 3.4 million tons in 2013/14, a decrease of 7.6 percent (Abdul Ghani Wahab, 2016).

With the production of fermented corn kernel silage, we can reduce our dependency on imported dry corn grain as we are facing high production cost to produce dry corn grain.

1.3 Significance of Study

There have been a lot of concern on hiking price of poultry feed among consumer and producer. There are also concern regarding expensive pricing of imported dry corn and commercial feed for broilers which result in higher price of broilers meat.

Corn kernel silage is a good alternative as it provide farmers alternative feed source to broilers in case of heavy rain along with high air humidity which restrict the production of dry corn. Fermented corn kernel silage is also easy and practical to be done by farmers in the farm (in-situ) because it involve very little the use of machineries which is during decobbing compared to drying.

Therefore, study on crude protein and amino acids digestibility of fermented corn kernel silage will help farmer to develop our current existing source as well as reducing dependency on imported feed. Broilers were chosen as the experimental unit as majority of Malaysian consumes broiler meat as major protein source and the cost of feeding broiler using commercial feed is quite high. By introducing corn grain silage, we can reduce our dependency on imported animal feed and to overcome challenges in near future such as currency downfall and price hike of commodities.

1.4 Objective

The objectives of this research is to study the crude protein and amino acids digestibility of fermented corn kernel silage fed to broilers.

1.5 Hypothesis

H_0: There are no significance differences in the content and digestibility of crude protein and essential amino acids between dry corn and fermented corn kernel silage.
H_a: There are significance differences in the content and digestibility of crude protein and essential amino acids between dry corn and fermented corn kernel silage.

CHAPTER 2
LITERATURE REVIEW

2.1 Protein

2.1.1 Crude Protein

Protein are macro minerals that are consumed in large amount. They consist of large macromolecules comprising of one or more chains of amino acids sequences. Crude protein is generally referred to as total protein content in a sample, where it is determined by the total nitrogen content. However, crude protein only determine the protein content, not its source or quality. Protein quality is not only dependant on amino acids composition but also on the availability of the amino acid (Hector and Feldman, 1960). Proteins are essential in animals because they are involved in almost every body metabolic processes. Many enzymes are made up of protein molecules which are why they are vital to the body, as well as important in body immune response (Sleator, 2012).

2.1.2 Amino Acids

2.1.2.1 Essential Amino Acids

Amino acids is a group of molecules that contain nitrogen in the form of amine group, carboxylic acid and side chain of differing group or length that differentiates between each amino acids. It is the basic building blocks that build up protein. Currently, there are 20 amino acids recognized which form various protein molecules. These amino acids are either synthesized by animals body or plant and are used to synthesize protein and other biomolecules or broken down into urea and carbon dioxide through hydrolysis.

According to Ravindran *et al.*, (1999), dietary requirement for proteins are also referred to as amino acids requirements, since proteins are made up of amino acids. Further hydrolysis of protein also yield amino acids, which reflect the amino acids content in the samples. All animals also require amino acids in continuous supply to maintain body metabolism.

Animals require at least nine amino acids, which are crucial for body maintenance and productive performance. These amino acids are also called as indispensable because animals are unable to synthesize the corresponding carbon skeleton amino acids or keto acid, which make it compulsory for the amino acids to be supplied in the diet. However, some amino acids may be conditionally essential depending on age and growth, especially during early rapid growth.

Table 2.1 Nutritional classification of amino acids

Common core	**Additional Species-related requirements**	**Conditionally non-essential**	**Non-essential**
Lysine Histidine Leucine Isoleucine Valine Methionine Threonine Tryptohan Phenylalanine	Arginine (cats, poultry, fish) Taurine (cats)	Cysteine Tyrosine Arginine Proline	Glutamate Glutamine Glycine Serine Alanine Aspartate Asparagine

Source: D' Mello, 2003

As with other vertebrates, poultry, especially broilers require 11 essential amino acids for maximum growth performance. These portion must be supplied in the diet in balanced proportion to make sure broilers show good growth performance. D'Mello (2003) proposed that response of growing poultry to amino acids are affected by wide range of factors. These include environmental temperature, immunological stress, sex, age, species and several dietary factors.

2.1.2.2 Application of Amino Acid Analysis in Feedstuff

Nowadays, poultry and pig diets are formulated in order to supply the animals with right amino acids requirements to ensure optimal growth, feed conversion and performance. To achieve this, animal nutritionist depends heavily on data obtained on amino acids composition in their raw materials in order to formulate their feed formulation.

2.1.2.3 Ideal Amino Acid Profile in Broiler Chicken Feed

The concept of determining ideal amino acids profile was first proposed in pig diet by Agricultural Research Council, ARC in 1981 when Cole (1980) proposed in his experiment that ideal amino acids can be practiced in formulating pig feed. From this experiment, there had been increasing research assay on ideal amino acid ratio using lysine as the reference amino acid. This method had gain worldwide recognition in formulating pig diet (ARC, 1981; Chung and Baker, 1992; Fuller, 1994; Baker *et al.,* 2002) and had increasing interest for application in poultry industry.

Empirical data proposed by Baker (1997) is also based on assumption that ideal ratio for maintenance of specific amino acids may exceed those of ideal ratio of same amino acid for protein accretion.

Table 2.2 Ideal amino acid profile for broiler feed

Amino acid	**Ideal ratio (%)**
Lysine	100
Methionine	36
Cysteine	36
Sulphur amino acid	72
Threonine	67

Valine	77
Isoleucine	67
Leucine	109
Tryptophan	16
Arginine	105
Histidine	35
Phenylalanine+Tyrosine	105

Source: Baker, 1997

2.2 Corn

2.2.1 Background of Corn

Maize (*zea mays*) or corn are botanically classified as caryopsis (dry, indehiscent, single seeded fruit). They are classified as large grain and first official record that it was domesticated by indigenous people in what are now called Mexico 10,000 years ago (Beadle, 1980).

Corn kernel are the largest cereal seeds, weighing about 250-300mg each. The seeds are flat due to pressure during growth from adjacent kernels on the cob. There are six different types of corn kernel classified according to quality, quantity and pattern of endosperm composition which are: dent, flint, flour, sweet, pop and pod corns (Beadle, 1980).

Corn has become world's second most important crop by production after sugarcane (FAO, 2013) and is a major feedstuff for livestock. Corn is often harvested when the moisture content reach below 28%. High moisture corn is usually subjected to rapid deterioration, especially mold infestation. In some hot and dry country, corns were left to dry at the tree to ease drying and save cost.

Corn are globally used as animal feed as these materials help to supply adequate nutrient content when mixed with soybean. Corn and corn products are generally the most cost-effective feeds or feed supplements available. The high yield, abundant and predictable supply make corn a preferred animal feed.

Table 2.3 Proximate Composition of Corn Kernel (as it is)

Chemical composition	g/kg
Dry Matter	90.4
Protein	10.7
Crude Fibre	1.8
Ether extract	2.2
Ash	2.9
Energy Mcal/lb.	1.02

Source: Cortez and Wild-Altamirano, 1972.

Protein component in corn is the second largest after carbohydrate (energy), where most of the proteins are found in the endosperm. The proteins are made up of five different types, mainly albumins, globulins and non-protein nitrogen (Landry and Moureaux, 1982). Protein quality of a feed is also determined by the amino acid that make up the protein substance. In maize, low lysine and tryptophan content are common as well as high in leucine content.

In term of amino acid profile, corn grain such as SUWAN-1 corn contains low amount of methionine and lycine, which is why addition of soybean is needed to complement the amino acids requirement in animal feed (Imamul Huq, 1983).

Table 2.4 Contents of amino acids (g amino acid 16 g N-1) in the protein of SUWAN-1 corn (DM basis).

Amino acids	
Cysteine	2
Asparagine	6.4
Methionine	2.3
Threonine	3.5
Serine	5.1

Glutamine	20
Glycine	3.7
Alanine	7.7
Valine	5.2
Isoleucine	2.6
Leucine	13
Tyrosine	4.4
Phenyalanine	4.8
Lysine	2.7
Histidine	2.9

Source: Imamul Huq, 1983

Crude fibre in the corn usually come from the pericarp and the tip of the cap, and from the endosperm cell walls. Corn also contain quite high crude fiber content. Fibre in corn grain are largely made up of NDF and hemicelluloses.

Table 2.5 Van soest fibre determination in corn grain

Fibre	% (dry matter basis)
Neutral detergent fibre	10.79
Acid detergent fibre	2.79
Hemicelluloses	8.00
Lignin	0.13
Cellular walls	11.8

Source: Bressani *et al.*, 1989

Crude fat, or ether extract in corn mainly comes from the germ, and varies with variety. Corn oil has low level of saturated fatty acids, with only 11% palmitic and 2% stearic acid on average (FAO, 2010).

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