CHARACTERIZATION OF PROTEIN PROFILE AND MINERAL COMPOSITION OF ANIMAL FEED

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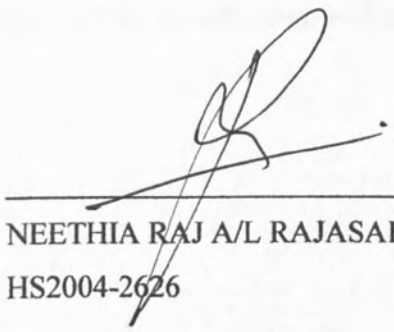

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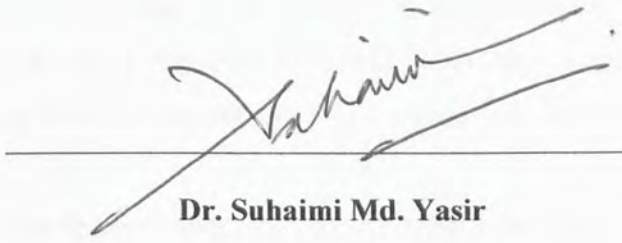

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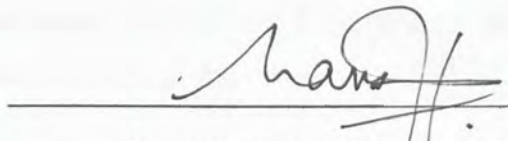

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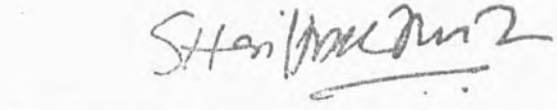

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ABSTRACT

Samples of chicken feed and rabbit feed were analysed for its protein profile, protein content, moisture content, fat content and mineral composition such as potassium and calcium. The results showed that chicken feed have 8.41% of fat content, 12.84% of moisture content, 21.52% protein content, 15.6 mg/100g calcium and 17.35 mg/100g potassium. While rabbit feed have 6.63% of fat content, 10.76% of moisture content, 17.62% of protein content and 11.8 mg/100g calcium and 30.51 mg/100g potassium. The protein profiles of chicken and rabbit feed showed that there were more hydrophobic amino acids present because of the greater amount of absorption at the earlier retention time. Comparison of lysine amino acids in chicken feed and rabbit feed indicated lysine was present in chicken feed but absent in rabbit feed. The moisture content of rabbit feed and chicken feed based on dry weight are naturally low due the main ingredient.

ABSTRAK

PERINCIAN PROFIL PROTEIN DAN KANDUNGAN MINERAL DI DALM MAKANAN HAIWAN

Sampel makanan ayam dan arnab dikaji untuk menentukan profil protein, kandungan protein, kandungan air, kandungan lemak dan kandungan mineral kalsium dan kalium. Kajian menunjukkan bahawa makanan ayam mempunyai 8.41% lemak, 12.84% kandungan air, 21.52% kandungan protein, 15.6 mg/100g kalsium, 17.35 mg/100g kalium manakala makanan arnab mempunyai 6.63% lemak, 10.76% kandungan air, 17.62% kandungan protein, 11.8mg/100g kalsium dan 30.51 mg/100g kalium. Profil protein bagi makanan ayam dan arnab menunjukkan bahawa terdapat lebih amino acid yang bersifat hidrofobik kerana kadar penyerapan sampel pada masa terawalnya. Perbandingan acid amino lysine di dalam makanan ayam dan arnab menunjukkan wujudnya lysine didalam makanan ayam dan tiada dalam makanan arnab. Kandungan air adalah rendah di dalam makanan haiwan berdasarkan berat kering disebabkan oleh kandungan primernya.

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%	Percentage
°C	Celcius
mg	Miligram
g	Gram
mL	Mililiter
µL	Microliter
mgL^{-1}	Miligram per liter
(v/v)	Volume per volume
(w/v)	Weight per volume
ppm	Parts per million
nm	Nanometer
Na	Sodium
Ca	Calcium
Mg	Magnesium
K	Potassium
AAS	Atomic Absorption Spectrophotometry
ARC	Agriculture Research Council
NRC	National Reasearch Council
PKC	Palm kernel cake
HCL	Hydrochloric acid
HNO_3	Nitric acid
La_2O_3	Lanthanum oxide
M	Molarity
$lb/inch^2$	Pound per inch square
m	Minute

CHAPTER 1

INTRODUCTION

1.1 Animal Feed

Feed is edible materials that are consumed by animals and contribute energy or nutrients to the animal. While feed ingredient or feed stuffs are component parts of any combination or mixture making up a commercial feed. Various forms of livestock have anatomical and physiological differences that only allows them to consume a spesific type of feed. Therefore, feeds are natural materials and elaborative products that is able to provide adequate animal nutrition (Martin *et al*., 2006).

Currently, a wide range of feeding standards can be found throughout the world, largely reflecting the feeding systems of the country or region. In British Commonwealth countries, recommendation of the Technical Committee of the Agricultural Research Council (ARC) are used because of the rapidly expanding information on livestock and poultry nutrition thus nutritional standards are under continual review and modification. In the United States and Latin America, the reccomendations of the National research Council (NRC) of the National Academy of

Science provide the basis for nutritional research and livestock feeding (Elvers *et al.*, 1988).

Feed formulation is used to provide 'least-cost' diets in order to remain competitive in the market place. Ten countries produce more than 60 percent of the world's total industrial feed, while 50 countries produce more than 90 percent of the total. Manufactured feeds for poultry are the greatest proportion of tonnage. Next is pig followed by cattle feeds, which are mainly concentrates for dairy cows (Gilbert, 2002).

1.2 Animal Distribution

There are approximately 4.3 billion large farm animals and 15.8 trillion poultry distributed throughout the world. The number of large farm animals has been increasing at a very modest rate for the past two or more decades. Table 1.2 states the agricultural animal numbers in Asia, North and Central America and world wide (Damron, 2003).

More than two-thirds of the large farm animals are found in developing countries that produce only about one-third of the meat, milk and wool produced in the world. There several reasons for this low productivity are unfavorable climate environments, the prevalence of diseases and parasites, genetically inferior livestocks, poor management practices and sociological factors.

Table 1.1 Agricultural Animal Numbers in Asia, North and Central America and world wide

Animal	World Total	North and Central America	Asia
Large farm animals (×1,000)			
Cattle	1,350,130	160,454	472,852
Sheep	1,057,908	15,179	413,465
Pigs	908,104	93,157	535,553
Goats	720,008	14,111	455,247
Buffaloes	164,968	5	160,383
Horses, donkeys and mules	115,777	21,707	41,866
Camels	18,229	-	4,595
Other camelids	6,200	-	-
Total	4,341,324	304,613	2,083,961
Poultry numbers in the world (× 1,000,000)			
Chicken	14,447	2,554	7,166
Geese	235	0.3	209
Turkeys	240	94	14
Ducks	885	16	779
Total	15,807	2,664	8,168

Source : Damron, (2003)

1.3 Research Objectives

The objective of this research are :

a. To evaluate the protein profile of animal feeds.

b. To evaluate the mineral composition of animal feeds.

1.4 Research Scope

The research scope of this study is determined the protein content, moisture content, fat content, lysine comparison in animal feed and the major mineral element which are Potassium and Calcium of animal feed that are produced by local manufacturers.

CHAPTER 2

LITERATURE REVIEW

2.1 Animal Nutrition

Animal nutrition are divided into ruminants and nonruminants. Nonruminant nutritions focus on one-stomached animals such as poultry and ruminant nutritions specify in animals like cattle. Nutrition is the study of how the body uses the nutrients in feed to sustain life and for productive purposes. Nutrient is any chemical element or compound in the diet that supports normal reproduction, growth or maintenance of life processes. Nutrient are classified into water, carbohydrates, vitamins, minerals, proteins and fat(lipids) (Damron, 2003).

2.2 Feed Classification

Feeds of many origins, qualities and availability are used in animal diets in the United States and around the world. The National Research Council(NRC) publishes a series of report that uses eight categories to group feedstuffs with others that have common

characteristics. Feedstuff within a group generally have similar nutritive values as other common characteristics. The feed categories are (1) dry forages and roughages; (2) pasture, range plant and green forages; (3) silages; (4) energy feeds; (5) protein supplements; (6) mineral supplements; (7) vitamin supplements; and (8) nonnutritive additives (Damron, 2003). In Table 2.1, feed classification for animals are made from the mixtures of proteins, roughages, cereals, minerals, specialty product and vitamins. A complete feed-ruminants and nonruminant are commercially prepared product that provides all nutrients required. A supplement or concentrate is a commercially prepared feed that is formulated to be mixed with primary grain or roughages to provide all the nutrients required. A base mix or superconcentrate is a low inclusion commercially prepared feed designed in such a way as to require the adition of a primary source of energy (grains), a primary source of protein(such as saybean meal), or roughage. Premixes are commercially prepared feeds designed to provide microingredients or specialty products to a mixture of feed ingridients to make a nutritional complete feed as shown Table 2.1.

Table 2.1 Feed classification

	Complete feed ruminant	Complete feed nonruminant	Supplement or concentrate	Base mix or superconcentrate	Premix
Roughages : Silage, hay, byproducts					
Cereals : Corn, wheat, rye, barley, oats					
Vegetable plant protein,soybean meal, cottonseed meal, linseed meal, sunflower meal, ryeseed meal					
Cereal byproduct : Bran, middings other byproduct					
Animal protein : Fishmeal, meat meal, meat and Bone meal					
Macromineral sources : NaCl, Mg, P, Ca, K					
Specialty product : Antibiotics, medication, mold Inhibitors, etc.					
Vitamins : Trace metals					

Source : Elvers *et al.*, (1988)

2.3 Feed Ingredient

Feed ingredient contain a wide array of protein and nonprotein nitrogen (NPN) compounds. Protein are large molecules that differ in shape, solubility and amino acid composition. Nonprotein nitrogen compounds are smaller molecules that include peptides, free amino acids, nucleic acids, amides, nitrates and ammonia. Proteins are present in cell walls and cell content of all plant and animal tissues where they provide a variety of function like storage, structural, catalytic, transport and contractile. The feeds also contain macromineral sources and vitamins (Schwab *et al.*, 2003)

A feed is usually produced from agricultural products or byproducts. Micro-ingridients are added to improve levels of amino acids, vitamins and minerals. New additives such as metabolic modifiers, anti anti-microbial agents, probiotics and special minerals are also incorporated in order to supply essential nutrients and also to enhance growth and to avoid diseases. Table 2.2 presents the raw materials that are commonly used in feed production.

Table 2.2 Raw materials used to prepare feeds

Macro ingredients	
Grains	Maize, sorghum, wheat, barley and oats
Processing waste	Orange, apple, brewer's grains, sugarcane and cassava
Brans	Soya, cotton, coffee, peanut, sunflower, colza, babassu, rice, Wheat and maize
Meals	Meat, bone, blood, feather, oyster and fish
Minerals	Salt, limestone and bicalcium phosphate
Micro ingredients	
Minerals	Cobalt, zinc, iron, manganese, magnesium, copper and iodine
Further additives	Amino acids, vitamins, antioxidants, antibiotics, medicinal and enzymes

Source : Vilas-Boas *et al*., (2002)

2.4 Feed Nutrients

Feeds are of little value to the animals unless they can be digested to essential nutrients. Therefore, feeds and feed ingredients are routinely evaluated for their nutrient profile. In basic feed formulation, energy and protein parameters are the primary references followed by vitamins, minerals and feed additives. Ruminants can effectively synthesize protein from nonprotein nitrogen, where poultry and nonruminants cannot. Ruminants can also synthesize adequate amounts of water soluble vitamins to fulfill nutrients requirements. Table 2.3 shows the analytical and nutritional parameters commonly used for feeding livestock and poultry.

Table 2.3 Nutrient partitioning of feed

energy	Gross	digestibility	metabolizable	net
Protein	Nonprotein nitrogen	Protein		
		Nonessential amino acids	Essential amino acids	
	Purines Urea Ammonia	Alanine Asparagines Aspartic acid Cysteine Cystine Glutamic acid Glutamine Glycine Praline Serine Tyrosine	arginine histidine isoleucine leucine lysine methionine phenylalanine threonine tryptophan valine	
Vitamins	Fat soluble		Water soluble	
	A D E K		B-12 biotin choline folic acid Niacin Pantothenic acid Pyridoxine Riboflavin Thiamine Vitamin C	
Minerals	Macro		Micro	
	Calcium Phosphorus Potassium Magnesium Sulfur		cobalt copper iron iodine manganese Molybdenum Selenium	

Source : Elvers *et al.*, (1988)

2.4.1 Nonruminant amino acid and minerals requirements

Amino acid requirement of any individual vary during its life according to a number of genetic and environmental factors. The requirements also vary according to the function of the animal. For example whether it is growing, lactating, pregnant or laying eggs (Wallace *et al.*, 1995). Table 2.4 shows the indicative amino acid requirements of chickens.

Table 2.4 Indicative amino acid requirements (g kg^{-1} diet) of chickens

	Broilers (weeks)			Laying hens
	0-3	3-6	6-8	
Threonine	8.0	7.4	6.8	4.3
Glycine + serine	12.5	11.4	9.7	-
Valine	9.0	8.2	7.0	6.4
Methionine + cysteine	9.0	7.2	6.0	5.3
Methionine	5.0	3.8	3.2	2.7
Isoleucine	8.0	7.3	6.2	5.9
Leucine	12.0	10.9	9.3	7.5
Phenylalanine + tyrosine	13.4	12.2	10.4	7.5
Phenylalanine	7.2	6.5	5.6	4.3
Lysine	11.0	10.0	8.5	6.3
Histidine	3.5	3.2	2.7	1.5
Arginine	12.5	11.0	10.0	6.4
Tryptophan	2.0	1.8	1.6	1.5

Source : NRC, (1994)

A large number of inorganic elements or minerals are essential for the growth and health of young poultry. Macro or trace minerals play vital roles as structural components of the skeleton and a wide range of functions related to body metabolism. The availabilty of minerals is a major concern in mineral nutrition and is influenced by a number of factors. Excessive dietary levels of minerals such as calcium can cause malabsorption of trace elements. Besides that, dietary fibre can also bind minerals and

reduce absorption. Fats reduce the mineral absorption with formation of insoluble soaps when cations come in contact with free fatty acids released during digestion (Hunton, 1995). Therefore the requirements of minerals for growing chickens are shown in Table 2.5.

Table 2.5 Mineral requirements of growing chicken (dietary content per kg)

Minerals	Chicken starter	Chicken grower
Sodium (g)	2.0	1.5
Chloride (g)	2.0	1.5
Potassium (g)	3.0	3.0
Copper (mg)	8.0	8.0
Iodine (mg)	0.35	0.35
Iron (mg)	80	80
Magnesium (mg)	600	600
Manganese (mg)	60	60
Selenium (mg)	0.15	0.15
Zinc (mg)	40	40

Source : Hunton, (1995)

2.4.2 Ruminant mineral requirements

The functions of minerals can be divided into four major areas which are (a) Skeletal Development and Maintenance; including bone and tooth formation. (b) Energy; including minerals that are components of enzymes or other compounds in the body essential for energy production and utilization or other activities necessary for normal growth and reproduction. (c) Milk Production and (d) Basis Body Function; minerals essential for the normal function of basic systems in the body such as the nervous system.

Macro mineral is required in larger amounts than trace minerals in cattle dietary. Calcium and phosphorus are the major mineral constituents of bone. Calcium

also plays an important role in muscle function, whereas phosphorus is key to major metabolic functions throughout the body (carbohydrate, protein and fat metabolism, and nerve and muscle function). Magnesium is a key component in the initiation of many metabolic enzymes and pathways, and also is important in neuromuscular function. Cattle need potassium in large amounts to maintain normal body and organ function. Potassium works in conjunction with natrium in the body to transport nutrients in and out of cells. It also helps maintain health by maintaining the cellular water balance or known as osmotic pressure. Inadequate amount of mineral disrupts the cattle metabolic functions (McDonald *et al.*, 2002). Table 2.6 shows the mineral requirements and maximum tolerable concentration based on stage production in beef cattle.

Table 2.6 Mineral requirements and maximum tolerable concentration

Minerals	**Unit**	**Requirement cows**		**Maximum tolerable concentration**
		Gestating	**Early lactating**	
Calcium	%	0.21	0.30	-
Cobalt	mg/kg	0.10	0.10	10.00
Copper	mg/kg	10.0	10.00	100.00
Iodine	mg/kg	0.50	0.50	50.00
Iron	mg/kg	50.00	50.00	1000.00
Magnesium	%	0.12	0.20	0.40
Manganese	mg/kg	40.00	40.00	1000.00
Phosphorus	%	0.15	0.19	-
Potassium	%	0.60	0.70	3.00
Selenium	mg/kg	0.10	0.10	2.00
Sodium	%	0.06-0.08	0.10	-
Sulfur	%	0.15	0.15	0.40
Zinc	mg/kg	30.00	30.00	500.00

Source : National Research Council , (2000)

2.5 Feedstuff in Malaysia

The raw materials for animal feed are obtained locally and also imported from various countries. The imported ingredients range from cereal grains, vegetable and animal proteins such as soybean meal, corn gluten meal, fish meal and meat and bone meal, mineral sources and various micro-ingredients - vitamins, minerals and other additives used to improve feed efficiency and growth. Table 2.7 shows the raw materials used by the local feed industry whereas, Table 2.8 shows the sources of imported feed ingredients for the livestock in Malaysia.

Table 2.7 Raw materials used by the local feed industry

Materials	
Local	**Imported**
Rice bran	Maize
Wheat pollard	Soybean meal
Wheat bran	Skimmed milk powder
Limestone	Whey powder
Palm kernel cake	Fish meal
Palm oil sludge	DCP/MCP
Palm oil	Salt
Molasses	Meat and bone meal
Rock salt	Rice bran
OPF	Groundnut cake
Broken rice	Sesame cake
Fish meal	Chinese leaf pellet
Tapioca	Wheat
Sago	Vitamins/minerals
Copra cake	DL-methionine
Brewer grains	L-lysine
Rice husk	Blood meal
Cocoa meal	Feather meal
Rubber seed meal	Rapeseed meal
Oyster shells	Corn gluten meal

Source : Raghavan, (2000)

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