Comparative Study of Broiler Feeds Manufactured by Small Scale Manufacturers.

By

M. Frank Shelton Windser Fernando

Thesis submitted to the University of SriJayawardenapura for the award of the degree of Master of Science in Food Science and Technology.

2006
DECLARATION

The work described in this thesis was carried out by me under the supervision of Prof. Arthur Bamunuarachchi and Mrs. Indira Wickramasinghe and a report on this has not been submitted in whole or in part to any University or any other institution for another Degree / Diploma.

M. Frank Shelton Windser Fernando

Date: 24. n. 2006.
We certify that the above statement made by the candidate is true and that this thesis is suitable for submission to the University for the purpose of evaluation.

Prof. Arthur Bamunuarachchi
Head / Coordinator
Food Science and Technology Programme
Department of Food Science and Technology
University of SriJayewardenepura
Nugegoda, Sri Lanka.
Date:

Mrs. Indira Wickramasinghe
Senior Lecturer / Supervisor
Department of Food Science and Technology
University of SriJayewardenepura
Nugegoda, Sri Lanka.
Date:
AFFECTIONATELY DEDICATED

TO

MY LOVING WIFE AND DAUGHTERS
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table of Contents</td>
<td>V</td>
</tr>
<tr>
<td>List of Table</td>
<td>VII</td>
</tr>
<tr>
<td>Acknowledgement</td>
<td>VIII</td>
</tr>
<tr>
<td>Abstract</td>
<td>IX</td>
</tr>
<tr>
<td>1.0. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>2.0. Literature Survey</td>
<td>4</td>
</tr>
<tr>
<td>2.1. Raw Materials for Compound Feeds</td>
<td>4</td>
</tr>
<tr>
<td>2.1.1. Cereal Grain and Cereal Grain by-Products – Maize</td>
<td>6</td>
</tr>
<tr>
<td>2.1.2. Maize by-Products</td>
<td>8</td>
</tr>
<tr>
<td>2.1.3. Rice and Rice by-Products</td>
<td>9</td>
</tr>
<tr>
<td>2.1.4. Cassava Meal and Sweet Potatoes</td>
<td>10</td>
</tr>
<tr>
<td>2.2. Protein Sources and Their by-Products</td>
<td>12</td>
</tr>
<tr>
<td>2.2.1. Products of Vegetable Origin</td>
<td>12</td>
</tr>
<tr>
<td>2.2.2. Ground Nut Meal</td>
<td>14</td>
</tr>
<tr>
<td>2.2.3. Coconuts and by-Products</td>
<td>14</td>
</tr>
<tr>
<td>2.2.4. The average composition of oil meals and by-products</td>
<td>15</td>
</tr>
<tr>
<td>2.2.5. Products of Animal Origin</td>
<td>15</td>
</tr>
<tr>
<td>2.3. Synthetic Amino Acids</td>
<td>18</td>
</tr>
<tr>
<td>2.4. Vitamin- Mineral Premixes</td>
<td>18</td>
</tr>
<tr>
<td>2.5. Discovery of Aflatoxins</td>
<td>19</td>
</tr>
<tr>
<td>2.5.1. Occurrence of Aflatoxins</td>
<td>20</td>
</tr>
<tr>
<td>2.6. Storage</td>
<td>22</td>
</tr>
<tr>
<td>Section</td>
<td>Title</td>
</tr>
<tr>
<td>---------</td>
<td>-------</td>
</tr>
<tr>
<td>2.7</td>
<td>2.7. Standard Nutrient Level in Broiler Feed</td>
</tr>
<tr>
<td>2.8</td>
<td>2.8. Feed Ration for Commercial Broiler Chicken</td>
</tr>
<tr>
<td>3.0</td>
<td>3.0. Experimental Methods</td>
</tr>
<tr>
<td>3.1</td>
<td>3.1. Preparation of Samples</td>
</tr>
<tr>
<td>3.1.1</td>
<td>3.1.1. Method</td>
</tr>
<tr>
<td>3.2</td>
<td>3.2. Determination of Moisture</td>
</tr>
<tr>
<td>3.3</td>
<td>3.3. Determination of Crude Protein</td>
</tr>
<tr>
<td>3.4</td>
<td>3.4. Determination of Crude Fat</td>
</tr>
<tr>
<td>3.5</td>
<td>3.5. Determination of Crude Fibre</td>
</tr>
<tr>
<td>3.6</td>
<td>3.6. Determination of Total Ash</td>
</tr>
<tr>
<td>4.0</td>
<td>4.0. Result and Discussion</td>
</tr>
<tr>
<td>4.1</td>
<td>4.1. Local Raw Materials</td>
</tr>
<tr>
<td>4.2</td>
<td>4.2. Imported Raw Materials</td>
</tr>
<tr>
<td>4.3</td>
<td>4.3. Final Products- Formulated Feed</td>
</tr>
<tr>
<td>5.0</td>
<td>5.0. Conclusion</td>
</tr>
<tr>
<td>6.0</td>
<td>6.0. Suggestions</td>
</tr>
<tr>
<td>7.0</td>
<td>7.0 References</td>
</tr>
<tr>
<td>8.0</td>
<td>8.0. Appendix</td>
</tr>
</tbody>
</table>
List of Tables

Table of Contents

<table>
<thead>
<tr>
<th>Table Description</th>
<th>Page No</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1.5. The average composition of cereals and by-products</td>
<td>12</td>
</tr>
<tr>
<td>2.2.4. The average composition of oil meal and by-products</td>
<td>15</td>
</tr>
<tr>
<td>2.2.6. The average composition of Animal Protein</td>
<td>17</td>
</tr>
<tr>
<td>2.7.1. Optimum nutritive values of the common broiler feeds</td>
<td>24</td>
</tr>
<tr>
<td>2.8.1. Feed Ration</td>
<td>25</td>
</tr>
<tr>
<td>4.1.1.a. Proximate Analysis of Broken Rice</td>
<td>37</td>
</tr>
<tr>
<td>4.1.2.a. Proximate Analysis of Rice Polish</td>
<td>38</td>
</tr>
<tr>
<td>4.1.3.a. Proximate Analysis of Maize</td>
<td>39</td>
</tr>
<tr>
<td>4.1.4.a. Proximate Analysis of Sorghum</td>
<td>39</td>
</tr>
<tr>
<td>4.1.5.a. Proximate Analysis of Coconut Poonac</td>
<td>40</td>
</tr>
<tr>
<td>4.1.6.a. Proximate Analysis of Ground Nut Poonac</td>
<td>40</td>
</tr>
<tr>
<td>4.1.7.a. Proximate Analysis of Soya Bean Meal</td>
<td>41</td>
</tr>
<tr>
<td>4.2.1.a. Proximate Analysis of Fish Meal</td>
<td>41</td>
</tr>
<tr>
<td>4.2.2.a. Proximate Analysis of Meat and Bone Meal</td>
<td>42</td>
</tr>
<tr>
<td>4.3.1.a. Proximate Analysis of Broiler Starter</td>
<td>42</td>
</tr>
<tr>
<td>4.3.2.a. Proximate Analysis of Broiler Finisher</td>
<td>43</td>
</tr>
</tbody>
</table>
Acknowledgements

First, I wish to take this opportunity to express my sincere thanks to Professor Arthur Bammunuarachchi, Head / Coordinator Food Science and Technology Program, and Mrs. Indira Wickramasinghe, Senior Lecturer / Supervisor, Department of Food Science and Technology, University of SriJayawardenepera for invaluable guidance and continuous encouragement extended to me throughout my study.

Further, I wish to acknowledge my gratitude to Dr. (Mrs.) U.L.P. Mangalika, Head of Animal Nutrition Division, Veterinary Research Institute, Gannoruwa, Peradeniya, for the intellectual suggestions, constant supervision given to me during this study, and Providing me the opportunity to undertake this project at the Veterinary Research Institute.

I also wish to thank Dr. K.K.D.S. Raneweera, Head, Department of Food Science and Technology, University of SriJayawardenepera, for his interest and guidance given throughout the project.

I am also thankful to Mrs.G.D.J.Kumari Gunarathne and Mrs.D.M. Manel Sirisena Veterinary Research Assistants, Animal Nutrition Division, Veterinary Research Institute, Gannoruwa, Peradeniya, for all the support given.
COMPARATIVE STUDY OF BROILER FEEDS MANUFACTURED
BY SMALL SCALE MANUFACTURERS

ABSTRACT

In Sri Lanka, poultry is the main monogastric animal reared for human food. The poultry sector has developed rapidly during the last twenty years period, the commercial chicken [Broiler] population accounted for highly increased of the total chicken population. The growth of the commercial production of broiler has achieved impressive results over the most recent years. This resulted in a significant contribution to meat consumption from domestic production.

The expansion of poultry industry, the feed industry has also been growing very quickly. Generally, feed is considered the major input for poultry production and may account for 65 to 85 percent of the total production cost. Since poultry, feed is composed of several raw materials, the cost and supply of raw material either produced locally or imported affects the feed industry. The raw material quality is very important to produce concentrated nutrient for the diet and Animal performance.

Feed ingredients are categorized on different groups as cereals, pulses, Animal products and their by-products. Various feeding rations are used in different broiler rearing areas in Kurunagela District, Kuliypitiya area. It is important therefore to find ways and means to optimize the utilization of limited feed resources to reduce the cost of production of poultry meat.
Formulated feed quality depends on the type of raw materials and quality of raw materials. Complete knowledge about the nutritive value of raw materials is an important factor required for maximum utilization of any raw materials.

Proximate analysis was carried out for thirty-two broiler starter feed samples and twenty-eight broiler finisher feed samples and compared with the standard values to formulate the final best quality product.

This information will help in increasing of the use of locally available feed ingredients in feed formulation for monogastric animals, which will bring down cost of production, and increasing the quality of broiler meat. It will invariably help future growth of monogastric industry especially broiler chicken. Furthermore, scientists will be able to identify researchable areas to fill the gaps found present studies. Information will also help policy makers in important decision-making.
Chapter I

Introduction

Birds (poultry) eat food, which gives them the energy necessary for the function of their bodies and the materials indispensable for their products meat and eggs. To keep them in good health and allow them to attain maximum production, their needs must be supplied. It has been observed that results were optimal, both as regards hygiene and zoo technical performance, when feeding was balanced, that is when it satisfies all their needs without even one element of the diet being excessive in relation to the others.

Scientifically research has made it possible to determine the feeding requirements of specialized strains. (Meat producing)

At the practical level, development of balanced diets begins with calculation of a ration, which approaches the scientifically determined requirements by combining characteristics of the raw materials, as defined by many chemical analyses.

Calculation of rations leads to a feeding cost reduction by reducing poultry losses, by ensuring the best possible zootechnical performances and by economizing in feeds.

The raw materials used in poultry feeding are agricultural products (cereals), agro-industrial by-products (oil cakes, miller's and rice chandler's wastes, molasses and brewer's grains),
Animal by-products (blood meal, bone meal, meat meal, fish meal, feather meal) and chemical industries products (minerals, trace elements, synthetic vitamins and amino acids, additives)

The purpose of feeding broiler is to convert feedstuffs into broiler meat, rations are a major concern. Feed costs vary with the cost of ingredients but normally feed costs for broiler are 65-85% of the cost of production of the live broiler. The feed they consume is a complete ration. Broiler feeds are generally fed as crumbles for the starting feed and pellets for the remainder of the growing period. [Carmen and George, 1987]

Various types of feeding program are currently being considered by broiler producers and feed manufacturers, and these may be thought of as specialty feeds.

These programs may involve low nutrient dense diets as a means of simply reducing feed cost, or diets of higher protein / amino acid content used in an attempt to reduce carcass fat content.

Low nutrient density program by offering low protein, low energy diets, reduces feed cost and so make feeds more attractive to customers. However, the birds will necessarily consume more of these diets and that birds may take longer to reach market weight.

With low energy diets therefore, we can expect slightly reduced growth rate, because normal energy intake is rarely achieved, and this fact is the basis for program aimed at reducing early growth rate. Carcass weight and meat yield are often reduced, and which is associated with increased deposition of carcass fat, especially in the abdominal region. [Leeson, 1997]
Diets for improved meat yield program can be manipulated in order to advantageously influence the composition of the broiler and roaster carcass. This effect of reducing the energy level is due to reduced carcass fat content rather than any measurable increase in carcass protein content.

Poultry meat [Broiler] is ideally suited to meet the increased demands for animal product with improved efficiency of production. The success of the broiler chicken in Sri Lanka is now being mirrored around the world due to four major factors.

- Ease of establishing integrated operations
- Economically competitive price of poultry vs red meat
- Adaptability for further processing
- Meat composition in relation to Human Health
Chapter II

2.0 Literature Survey

Feed materials are broadly classified as roughage or forage and grains or concentrates. Roughages are high in cellulose or related compounds and are generally less digestible, particularly in the simple stomached animal. The grains are in general characterized by low cellulose content and high digestibility and energy values. [R. Ralph, 1987]

Feed materials include;

- Forage crops
- Seed, root grain and by-products

The utilization of various products from either plants or animal origin depends upon the digestibility and nutrient value of these materials.

2.1 Raw Materials for compound Feeds:

Raw materials for feed or feed ingredient are the building stones of a compound feed. Before attempting to formulate a balanced, compound feed for broiler, we need to pay attention to the ingredients.

- Identified and recognized the different ingredients
- Used our eyes, nose, and our touch- but do not taste
Know the origin (Animal/Plant) what product are they or from what process are they (by) products.

Look for their strong and week properties, the effect they have on the feed, the animal and it's performance.

To what extent can we use them in different feeds.

The amount of nutrients in cereal grains varies considerably from species to species. Soil, climate and added fertilizer also affect their composition. Processing can reduce the nutritive content of the grains.

Cereals play an essential role in the animal food supply. The efficiency of the use of the would food resources will improve a lot if animals are fed foodstuff which are unsuitable for human consumption (poor quality or waste product from food processing). Animal can convert otherwise useless raw materials into very valuable animal product, and thus contribute to the food supply.

The present project was conducted in Kurunagela district, Kuliapitiya divisional secretary area, selected twenty-two small-scale broiler feed manufactures. In this area, mostly available raw materials are, Maize, Maize bran, Sorghum, Paddy, Broken rice, Rice bran, Rice polish, Coconut poonac, Cassava and Sweet potato, Soybean and soybean by-products.

Feed manufactures are using in the above region, in these ingredients for their feed formulation.
Maize

Maize is the preferred cereal for feeding to poultry. Its dietary energy value is the highest amongst cereals. [Their energy values range from 1.00 to 1.63 MJ (240 to 390 kcal) per 100 gr.] In proper harvesting condition maize, have higher starch content and a lower concentration of oil. Compared with other cereals, has the highest digestibility in poultry (98%). The principal carbohydrate of all cereal seeds is starch, but there are small quantities of other present. Dextrins are present in very small quantities, more in flours since they are formed starch during milling. Cellulose is present in all parts of the seed in cell walls, and small amounts of lignin and pentosans mainly in the bran.

Cereals supply wide range of nutrients at low cost.

Animal nutrition maize is further classified as;

1. **Yellow maize**: contains much carotene (6-7 mg / kg) and xanthic pigments.

   Used as layer mash it gives an attractive yolk and skin colour.

2. **White maize**: this type of maize has lower carotene content, and is particularly useful for to produce broilers with white meat. For all other animals, this type of maize is too expensive.
**Protein:**  Maize is deficient in protein. The protein content is quite low (6.5-14%) and of a moderate quality. The lysine threonine and tryptophan content are particularly low, and supplementation with other raw materials is needed to meet the requirements for these amino acids. The amino acid profile is dependent upon the protein content of the cereal.

**Crude fibre:**  Maize grain does not have a husk so the crude fibre content is low and therefore the digestibility of maize if high for all types of animals.

**Fat:**  The fat content of cereals ranges 1-5% so that they contribute little to the total fat content of the diet. Maize mostly in the form of unsaturated fatty acids. This type of fat is not good for bacon quality. In poultry, these fatty acids support a rapid growth. The germ of a cereal contains 10 to 12% lipids.

**Minerals:**  There are wide variations in the amount of minerals in different verities of cereals. The mineral content is influenced by the soil on which it is grown on storage conditions and processing methods used. Maize contains little calcium, sodium and good sources of phosphorus.

**Vitamins:**  Cereals are important sources of thiamin, riboflavin and nicotinic acids. They contain negligible amounts of retinol and calciferol, and are practically devoid of ascorbic acid. Although cereals are important sources of pyridoxine, a great deal of this nutrient may be lost during processing.
Carotene: Most types of maize are rich in carotene, which is a vitamin A precursor. For the production of white meat, broiler should be fed carotene-poor maize.

2.1.2 Maize by-products:

Maize by-products is also important for poultry food supply. Wet maize and dry maize processing methods produce typical by-products are maize gluten feed, [Approx. 20 percentage crude protein], maize gluten meal [approx. 57% crude protein], maize germ meal [if not added to maize gluten feed]. In dry maize processing only maize bran is of importance as a by-product for animal feeding. The maize gluten feed quality can vary, depending on the production process. If the products contain too much moisture or ash, the crude protein percentage will be lower than 20% and protein and fat together will be lower than 23%. A low ash contain is an indication for additional supplementation with extracted maize germs. The colour and the smell of maize gluten feed are important for poultry. If the colour is dark or the product has a burnt flavors.

Maize bran consists of bran particles, maize germ, and other grain particles. Compared to maize meal it contains less starch, more crude fibre and more fat. Actually, the nutritive value can vary considerably, depending on place of origin and the grinding process. Occasionally the ash content can be high because chalk is added to improve the flowing property of the product. In poultry uses of maize bran, not more than 20% for older birds and 15% for young birds in general.
2.1.3 Rice and Rice by-products:

Rice is grown for Human consumption, although periodically in rice grown areas, samples unfit for human consumption or damaged samples are available for animal feeding.

Rice is a relatively poor quality ingredient for poultry, containing only 7-8% crude protein and providing just 2600-2700 kcal ME/kg. Rice does contain quite high levels of trypsin inhibitor that will be destroyed by normal pelleting temperatures.

By far the most important component of rice is the bran [outer layers of the grain with part of the germ] that is removed during processing, and this provides a very useful ingredient for the poultry feed industry.

Rice by-products may contain too much calcium. Calcium components are often used to polish the rice to a higher grade. Some by-products may contain up to 10% calcium and much of B vitamins. Rice husks have a low nutritive value (they consist mainly of crude fibre). Therefore rice by-products are split into three categories, mainly in rice bran contain crude fibre < 9 %, 9-15 % and > 15 %. Rice polish is the inner bran layers, with part of the germ and a small portion of the starchy endosperm. Rice polish is very rich in oil between 12%-18% and it becomes rancid somewhat easily. The condition of transport and storage are important. This by-product milling of rice used as animal feed.
2.1.4 Cassava meal and Sweet Potatoes:

Products are deriving from the cassava plant. The starch in its thick roots is used as animal feed. Usually these roots are harvested, peeled and sun-dried, all by hand. Pure cassava meal has good nutritional value but low-quality products occasionally occur. Potential problems are,

1. High moisture content; High moisture facilitates growth of fungi, and make the quality drop, moisture content should not be higher than 13%
2. High ash content; High ash is mainly from too much sand
3. High crude fibre; High crude fibre is possible from too much peeling and other vegetable material.

The fresh root has 50% to 75% water and less than 1% protein, about 3% of energy from manioc being from its proteins. The cyanogenic glucoside, linamarin is present in all part of the plant, especially in the skin and outer segments of the tuber. The enzyme, linamarase, which liberates free HCN from the glucoside, is also present in the plant.

Application for layers poultry feed, 20% is possible if more animal fat is added, and the feed is pelleted and crumbled. Moisture content in manure can be a problem if cassava meal is supplemented with soybean meal.

For broiler feed can contain 25% cassava meal, if it is good quality (minimum 66% starch), if methionine is added and if the manure is dry enough.
Sweet potato is also starchy root product, which can replace tapioca to some extent. The orange and yellow varieties have high carotene content and can be an important source of vitamin A precursors. The sweet potato contains up to 30 mg vitamin C / 100 gr. and more thiamin and riboflavin. Generally in poultry feed, used as no more than 15% of sweet potatoes.

Sorghum without husk is also used as animal feeds. The nutritive value is very much like that of maize. Protein contains very little lysine and methionine. Its tannin content is low.

The niacin in sorghum is freely available for absorption the high isoleucine to leucine ratio in sorghum proteins apparently interferes with formation of nicotinamide nucleotides. In poultry feeds, used up to 30% can be included in broiler feeds and if desired, sorghum can replace yellow maize.

The tannin content needs to be considered. Layer mash can also contain 30%, but then colorants need to be added for the yolk colour. If the percentage of tannin is not known, not more than 10% sorghum should be mixed in the feed.
2.1.5. The average composition of cereals and cereals by-products:

<table>
<thead>
<tr>
<th>Cereals &amp; cereals by-products</th>
<th>ME, poultry Kcal / kg</th>
<th>C.P. %</th>
<th>Fibre %</th>
<th>Fat %</th>
<th>Moisture %</th>
<th>Ca %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>3340</td>
<td>8.7</td>
<td>2.1</td>
<td>3.6</td>
<td>13.1</td>
<td>0.04</td>
</tr>
<tr>
<td>Maize Bran, 50% starch</td>
<td>2740</td>
<td>8.7</td>
<td>5.2</td>
<td>6.3</td>
<td>12.5</td>
<td>0.10</td>
</tr>
<tr>
<td>Maize gluten feed</td>
<td>1900</td>
<td>19.4</td>
<td>7.9</td>
<td>2.6</td>
<td>11.8</td>
<td>0.04</td>
</tr>
<tr>
<td>Rice Bran 9-15% fibre</td>
<td>2200</td>
<td>13.3</td>
<td>11.9</td>
<td>10.2</td>
<td>10.8</td>
<td>0.10</td>
</tr>
<tr>
<td>Sorghum</td>
<td>3260</td>
<td>10.0</td>
<td>2.1</td>
<td>3.1</td>
<td>12.6</td>
<td>0.03</td>
</tr>
<tr>
<td>Cassava 63% starch</td>
<td>2770</td>
<td>2.5</td>
<td>4.5</td>
<td>-</td>
<td>13.6</td>
<td>0.15</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>2960</td>
<td>3.8</td>
<td>2.7</td>
<td>0.7</td>
<td>12.5</td>
<td>0.12</td>
</tr>
<tr>
<td>Molasses –cane</td>
<td>1800</td>
<td>4.0</td>
<td>-</td>
<td>-</td>
<td>26.7</td>
<td>0.67</td>
</tr>
</tbody>
</table>

2.2. Protein sources and their by-products

Protein sources may be classified as to their origin of vegetable products, animal products and chemical products.

2.2.1. Products of Vegetable Origin:

These materials include protein concentrates such as soybean oil meal, which may be manufactured to protein contents ranging from approximately 40-50%.
Cottonseed oil meal, which may have protein level of 41-50%, sesame oil meal with a protein level of about 41% sunflower meal and peanut meal with protein level about 47%.

Vegetable products such as soybean meal the world wide standard against which other protein sources are compared. The protein level can be variable in processing conditions involved in fat extraction [65% of protein and 35% of oil]. The higher protein meals are produced from de-hulled beans and its amino acid profile is excellent for most types of poultry, and when combined with corn or sorghum, methionine is usually the only limited amino acid and very high lysine content.

Soybean contain a number of natural toxins for poultry, the most problematic being trypsin inhibitor. The tripsin inhibitor will disrupt protein digestion, and their presence is characterized by compensatory hypertrophy of the pancreas.

Apart from reduced growth rate and egg production, presence of inhibitors is diagnosed by a 50-100% increased in size of the pancreas. Heat treatment is also used as destroyed the tripsin inhibitors. In poultry, layers and broilers can take as is needed to meet the protein and lysine requirement maximum 20- 40 %, but preferably combine with some animal protein. Soybean meal contains much potassium and the linoleic acid is beneficial to the egg-weight and to the feed conversion.
2.2.2. Ground nut meal:

This oil seed has highest level of crude protein [protein 47%, fat 0.5-1%] with one of the best poultry feeds. The amino acid composition of the protein is moderate with a deficiency in lysine, sulphur amino acids and tryptophan.

The major problem with groundnut meal is linked to the possible presence of mycotoxins. These fungal metabolites arise from moulds [Aspergillus flavus], which develop during storage under inadequate conditions. Oil seed meals with low levels of toxin (below 1 ppm), promote excellent performance once supplemented with essential amino acids [lysine, methionine, and tryptophan]

2.2.3. Coconuts and by-products:

For animal feeding the kernel, [copra] and its by-products can be used. This copra contains 60% oil, and only copra is processed for animal feed. Coconut cake / expeller compared to other cakes and expeller the protein content is low.

In addition, lysine and methionine are moderate. The crude fibre content is high. Yet its digestibility is not so bad. Also in coconut products, aflatoxin can be found in too high quantities.
2.2.4. The average composition of oil meals and their by-products:

<table>
<thead>
<tr>
<th>Oil Meals</th>
<th>ME.poultry</th>
<th>C.P.</th>
<th>Fibre</th>
<th>Fat</th>
<th>Moisture</th>
<th>Ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean 49/3</td>
<td>2290</td>
<td>47.5</td>
<td>3.4</td>
<td>1.9</td>
<td>13.0</td>
<td>0.33</td>
</tr>
<tr>
<td>Sesame-expeller</td>
<td>2480</td>
<td>44.3</td>
<td>6.3</td>
<td>10.4</td>
<td>6.7</td>
<td>1.68</td>
</tr>
<tr>
<td>Groundnut-expeller</td>
<td>2580</td>
<td>39.1</td>
<td>10.0</td>
<td>7.5</td>
<td>8.1</td>
<td>0.18</td>
</tr>
<tr>
<td>Cottonseed-expeller</td>
<td>1840</td>
<td>37.1</td>
<td>16.8</td>
<td>6.9</td>
<td>8.0</td>
<td>0.24</td>
</tr>
<tr>
<td>Coconut-expeller</td>
<td>1850</td>
<td>20.0</td>
<td>13.4</td>
<td>12.2</td>
<td>7.2</td>
<td>0.11</td>
</tr>
<tr>
<td>Sunflower seed</td>
<td>1510</td>
<td>29.1</td>
<td>25.0</td>
<td>3.8</td>
<td>9.5</td>
<td>0.36</td>
</tr>
</tbody>
</table>

2.2.5. Products of Animal Origin:

Meals of animal origin include all those by-products from meat, fish and milk industries. The nutritional quality of animal proteins and their by-products are higher than that of vegetable protein. Most animal proteins are rich in mineral and vitamins. Animal proteins are usually added to poultry feed for high quality protein sources.

Most products need to be heated to decrease the moisture content and to eliminate the pathogens.
Meat and bone meal comes from heating and drying of waste products from beef and swine processing. The composition of meat and bone meal, very high protein content [Around 50%, tankage-60%] and mineral content [Ca, 14%, P, 6%] mainly from bone ingredients. Meat meals usually contain small residues of fat.

Generally, in poultry feed, meat and bone meal are used as maximum 6-7%. For layers tankage provides a good share of calcium supply to get a good quality eggshell.

Fishmeal comes from comes from or parts of fish that is processed in meal. The crude protein content in fishmeal is 67.5% to 75%, 5% lysine and variable fat content. It has a strong effect on energy value and gives a strong flavour on the animal product like egg and meat. High quality fishmeal is one of the best protein supplements available to the feed industry because of its well-balanced amino acid composition for simple stomached animal. In poultry, application of fishmeal maximum 5%, to avoid a fish flavour on the eggs, and broiler should have maximum 5% to avoid a fish flavour on the meat.

Blood meal is very high in crude protein [88%], including a lot of lysine [8.5%], rich in mineral like Fe, poor in Ca and P. In compound feed no, more than 2% should be mixed. Above 2%, problems may arise with taste and appetite and poultry may develop cannibalism.

Particular problem, which might be noted, are an isoleucine deficiency in blood meal and a sulfur amino acid deficiency in feather meal. Meat by-products are sources of vitamin B12 and a number of essential minerals.
Animal by-products should be sterilized during processing in order to destroy harmful organisms, of particular significance are *salmonella* and anthrax organisms in meat-by-products.

Feather meals must be processed to improve the digestibility and thus make the amino acids available; this is a steam-hydrolysis procedure, which cooks and aids in breaking down the keratin protein found in feathers. Feather meal cannot generally be used above 2% of the ration for simple stomached animal.

### 2.2.6. The average composition of Animal protein:

<table>
<thead>
<tr>
<th>Animal Protein</th>
<th>MEₜ.poultry Kcal/kg</th>
<th>C.P. %</th>
<th>Fibre %</th>
<th>Fat %</th>
<th>Moisture %</th>
<th>Ca %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonemeal</td>
<td>1500</td>
<td>40.7</td>
<td>-</td>
<td>5.4</td>
<td>9.5</td>
<td>16.04</td>
</tr>
<tr>
<td>Bloodmeal</td>
<td>3020</td>
<td>87.5</td>
<td>-</td>
<td>0.6</td>
<td>9.4</td>
<td>0.17</td>
</tr>
<tr>
<td>Meatmeal-58% C.P.</td>
<td>3090</td>
<td>58.2</td>
<td>-</td>
<td>13.0</td>
<td>5.2</td>
<td>6.0</td>
</tr>
<tr>
<td>Feathermeal</td>
<td>3170</td>
<td>82.5</td>
<td>-</td>
<td>7.5</td>
<td>8.3</td>
<td>0.44</td>
</tr>
<tr>
<td>Fishmeal-70% C.P.</td>
<td>3320</td>
<td>70.0</td>
<td>-</td>
<td>8.0</td>
<td>8.0</td>
<td>3.50</td>
</tr>
</tbody>
</table>
2.3. Synthetic Amino Acids

The protein quality of the rations is basic for poultry rearing. In particular, three amino acids are sought because amounts of them in the principal feeds are the lowest, lysine, methionine, and tryptophan. The raw materials containing important amounts of these three amino acids, but plant and animal proteins are relatively highly priced. To reduce incorporation of these raw materials, commercially produced synthetic amino acids are often incorporated in complete feeds.

2.4. Vitamin-Mineral Premixes

The average poultry feed contains relatively few synthetic ingredients and the smallest amount of any addition amounted to 0.5% or more. Especially the vitamin, trace mineral, pigments and various pharmacological compounds. Micro ingredients should be properly premixed before being added to a feed. These additives are not nutrients but categories as,

1. Drugs: such as antibiotics and coccidiostats which are introduced into feed in a preventive role

2. Growth factors: which may be antibiotics or which, like nitrovin, alter the digestive physiology to improve assimilation or use of nutrients
3. Preservatives: which have no function in the animal, but favour better keeping of the feed, these are chemical preservatives such as antioxidants used to delay rancidity of fats or else fungicides to prevent the development of moulds.

4. Detoxicants: such as ferrous sulphate used to limit the harmful effects of gossypol contained in cotton seed cake.

5. Correctives: such as carotenoid-base dyes used in feeds to compensate for the carotenoid deficiency of white maize, and to give good colour to yolks and meat.

2.5. Discovery of Aflatoxins

Aflatoxins were discovered because of massive losses of turkeys in Great Britain in 1960. Over 100,000 turkeys died in the outbreak, which was called "turkey x disease". Intensive investigation revealed the cause to be mycotoxins in mouldy groundnut (peanut) meal that was imported from Brazil for use as a protein supplement in animal diets. Within a short time, a similar disease was reported in duckling and chicken.

Through isolation, characterization and chemical properties, the aflatoxins were first isolated from samples of highly toxic peanut meals by conventional extraction and concentration procedures. The isolation procedures were greatly facilitated by the early discovery that the toxic substances were fluorescent in UV light.
2.5.1. Occurrence of Aflatoxins:

Aflatoxin producing by *Aspergillus flavus* mould, aflatoxine is one of the most potent carcinogens known. Usually present in cereals in ppb levels, acute toxicity will occur at 1.2 ppm.

Contamination is common with insect damaged corn grown in hot –humid areas, and there is little that can be done to rectify the horrendous consequences of high levels of this mycotoxin.

Aflatoxin is a potent hepatotoxin, and so varying degrees of liver breakdown occur. As toxicity develops, normal liver function declines, and reduced growth rate is quickly followed by death.

Toxicity is enhanced by the presence of other toxin such as ochratoxin and T2. The effects of aflatoxin are also much worse if birds are infected with aspergillosis. There also seems to be a nutrient interaction, because toxicity is more severe when diets are low in either crude protein or methionine or when the diet contains marginal levels of riboflavin, folic acid or vitamin D3. There is no treatment for acute aflatoxicosis, although because of the liver disruption, giving higher levels of antioxidant and/or selenium seems to slow the onset of symptoms and speed up recovery if aflatoxin is removed from the diet.
Mycotoxins are produced by Fusarium species molds such as *Fusarium graminearum* and *Fusarium roseum*. The tricothecenes affect protein metabolism and have the characteristic feature of causing mouth lesions in most animals.

A number of cereals and vegetable protein crops contain natural toxins that can affect bird performance.

Legume foods like soybeans, groundnuts, peanuts provide an excellent source of both energy and protein for poultry. Raw soybean meals have the trypsin inhibitor toxic compound and protein-phytic acid complex compounds. It will cause poor growth rate and reduced the meat production, egg size and bird's pancreas size can be expected to increase by 50-100%. Feeding raw soybean to animal has been shown to decrease the availability of trace elements zinc, manganese, copper, and iron.

In general, mold growth and aflatoxin formation require a moisture content of greater than 14% a temperature of at least 25°C, and some degree of aeration [O2].

When these requirements are met mold infestation followed by aflatoxin formation in target crops are likely occur.

Major feedstuffs with high potential for by *Aspergillus spp.* during growth, harvest, transportation or storage are cereals and legumes. Storage condition for legumes that promote aflatoxin formation aside from optimal moisture [greater than 14%] and temperature [29°C-35°C] condition are lack of aeration system or their improper use, kernel damage and spore dissemination caused by storage insects, presence of fine dust, weed seed and broken kernels and poor sanitary practices in feed areas.
2.6. Storage

Proper condition to storage cereals, legumes and feed ingredients are successfully conditions, which discourage or prevent the growth of microorganisms. Those conditions involve control or proper maintenance of,

1. Moisture content of the feed ingredients
2. Temperature of the grain
3. Oxygen supply of the storing environment
4. pH value of the moisture in the grain
5. Condition or soundness of the grain

The moisture content of the grain is most important factor affecting the growth of microorganisms. In general, grain low in the moisture content can be stored longer and safer.

The optimal moisture content varies with grain type. Common storage fungi grow most rapidly at temperatures between 80° and 100°F. at low temperature [30°- 40°F] the growth is slow. Thus, grain should be stored at as low a temperature as possible.

Microbial growth also is greatly affected by the oxygen concentration of the environment. It is generally difficult to control this factor. Fungi and bacteria prefer acidic solution for growth. Hence, a basic solution would prevent them to grow.
An increased amount of cracked or damaged kernels in stored grain can increase spoilage; therefore poor quality grain requires low moisture content for safe storage.

However, the quantitative relationship between the optimal moisture content and the condition of grain has not been established.

In general, prolonged storage of grain somewhat affects germination. Storage has no consistent effect on the protein content of grain, but some grain may show a slight apparent loss of protein during storage. The ash content of grain usually does not change, but the ash content of the grain product becomes consistently higher after a long period of storage. There is a definite and regular increase in fat acidity with storage.

The role of fungi in the deterioration of stored grain has been extensively investigated. (christense, 1974) it is well established that certain fungi which are a major cause of germ damage in wheat and corn and of rancidity which cause deterioration in storage don't enter the grain until after harvest, although the grain may be invaded at least to some extent before it reaches terminal storage (silo).

The major types of losses caused by fungi growing in stored grain are as follows;

1. Decrease in germinability
2. Discolouration of part or all of the seeds
3. Heating and mustiness

4. Various biochemical changes

5. Production of toxins that if consumed may be injurious to domestic animals

6. Losses in weight

2.7 Standard Nutrient Level in Broiler Feed.

2.7.1. Optimum nutritive values of the most common broiler feeds:

<table>
<thead>
<tr>
<th>Feed</th>
<th>ME/kg K cal.</th>
<th>CP</th>
<th>C.fat</th>
<th>C.fibre</th>
<th>Lys</th>
<th>Meth.</th>
<th>M+C</th>
<th>Ca</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broiler Starter</td>
<td>3000</td>
<td>21.0</td>
<td>09.0</td>
<td>5.00</td>
<td>1.20</td>
<td>0.50</td>
<td>0.90</td>
<td>1.00</td>
<td>0.80</td>
</tr>
<tr>
<td>Finisher-1</td>
<td>3200</td>
<td>20.0</td>
<td>10.0</td>
<td>5.00</td>
<td>1.00</td>
<td>0.45</td>
<td>0.80</td>
<td>1.00</td>
<td>0.70</td>
</tr>
<tr>
<td>Finisher-2</td>
<td>3100</td>
<td>19.0</td>
<td>10.0</td>
<td>5.00</td>
<td>0.95</td>
<td>0.44</td>
<td>0.76</td>
<td>0.90</td>
<td>0.70</td>
</tr>
</tbody>
</table>

Table 2.7 indicates the standard broiler-feeding program. There are several types of feeding programs used by broiler integrators. They include either the feeding of a Broiler Starter [0-28 days] and Broiler Finisher [29 days to market] or the feeding of a Broiler Starter [0-21 days], Finisher -1 [21 days to 35 days] and Finisher -2 [36 days to market].
### 2.8. Feed Ration for Commercial Broiler Chicken

#### 2.8.1. Feed Ration

Ingredients for the 100 kg of feed mixture,

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Broiler- Starter (kg)</th>
<th>Broiler- Finisher (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>33.22</td>
<td>31.70</td>
</tr>
<tr>
<td>Broken Rice</td>
<td>10.00</td>
<td>20.00</td>
</tr>
<tr>
<td>Rice Bran</td>
<td>18.65</td>
<td>24.00</td>
</tr>
<tr>
<td>Coconut Poonac</td>
<td>08.00</td>
<td>-</td>
</tr>
<tr>
<td>Soy seed Poonac</td>
<td>19.90</td>
<td>15.30</td>
</tr>
<tr>
<td>Fish Meal (72%)</td>
<td>05.00</td>
<td>03.30</td>
</tr>
<tr>
<td>Fish Meal (50%)</td>
<td>03.00</td>
<td>03.00</td>
</tr>
<tr>
<td>Salt</td>
<td>00.25</td>
<td>00.25</td>
</tr>
<tr>
<td>Shell Powder</td>
<td>00.74</td>
<td>00.53</td>
</tr>
<tr>
<td>DL- Methanine</td>
<td>00.16</td>
<td>00.16</td>
</tr>
<tr>
<td>L- Lysine</td>
<td>00.02</td>
<td>00.21</td>
</tr>
<tr>
<td>Vitamin - Premix</td>
<td>00.25</td>
<td>00.25</td>
</tr>
<tr>
<td>DCP</td>
<td>00.71</td>
<td>01.20</td>
</tr>
<tr>
<td>Antibiotic - Coccidia</td>
<td>+</td>
<td>+/-</td>
</tr>
<tr>
<td>Growth Promoters</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

*+ = Required Amounts*

Farmers can use the above-mentioned low cost standard feed ration as a feed, for their broiler chicken.
Chapter III

3.0 Experimental Methods

3.1 Preparation of Samples

Equal quantities of material were drawn from top, middle, bottom and sides of each of the bag using and sampling instruments. All the portions of materials were thoroughly mixed and reduced, using quartering got composite samples and carried out proximate analysis. Except rice polish, fishmeal, meat and bone meal other raw materials were ground before analysis.

3.1.1 Method

About 1.5 kg sample drawn from each batch, thoroughly mixed and reduced using a quartering method and ground with hammer mill, particle size 0.5-1.0 mm. before analysis.

Determination of Moisture (Dry matter)
Determination of Crude Protein
Determination of Crude Fat
Determination of Crude Fibre
Determination of Ash
3.2. Determination of Moisture - (Dry Matter)

Materials

Porcelain Crucibles
Electronic Balance
Vacuum Oven
Dessicator

Method

To find out the dry matter [moisture] content in poultry feed, a representative
Amount is weighted and put in an oven at a fixed temperature to evaporate its water
content. The difference between the first and last content weight is dried sample weight.

1. Dry the crucibles in the vacuum oven
2. Weight the empty crucible (W)
3. Weigh the accurately about 2.2 gram of the sample in the crucible (W1)
4. Shake the crucible until the contents are evenly distributed
5. Place the crucible in a vacuum oven. Maintained at 98' C and 1 atmosphere for 3
   hours, pressure or in a drying oven maintained at 103' + 2' for about 24 hours.
6. Cool in a desiccators and weight the crucible (W2)
Calculation

Dry Matter % = \( \frac{W_2 - W}{W_1 - W} \) \times 100

3.3. Determination of Crude Protein – Automated Kjeldhal Method

Apparatus

A Digestion System (Six Tubes)
B. Kjeldhal Distillation Unit
C. Titration Unit

Reagents

Sulphuric acid concentrated analytical grade N- free
Catalyst powder – K2 SO4 9.5 gram, Cu SO4 0.5 gram, Selenium 0.01 gram
Boric acid indicator

To make 02 liters;
Boric acid 20 gram
Alcohol 400 milliliters
Methyl Red 0.066 % in alcohol 10 milliliters
Bromocresol green 0.033 % in alcohol 10 milliliters
Adjust the colour with 0.1 N NaOH to light green purple colour and made up to vol.
with distilled water.

**Procedure**

Finely ground feed sample was weighed [1.2gr] into the digestion tube and added
12ml. – 13ml. Of concentrated H2SO4, in the presence of catalysts [5gr] in the
digestion tube. Digestion tubes [six tubes] were placed in the digestion unit and fitted
the exhaust manifold on top of it. Turn on the vacuum source [scrubber] to maximum
airflow. Digested for 420'C about 01 hour until the mixture was clear. Removed the
stand with the exhaust system and let cool. As soon as the sample solutions were cool
sufficiently, diluted the solution up to 250ml. with distilled water and mixed.

**Catalyst**

True protein + Nitrogenous compound +H2SO4  ---------------  (NH4)2SO4 +

Heat  NH4HSO4 +H2SO4 +CO2

The above digested solution [about 10ml] was distilled with steam. Known 5ml. amount
of 40% NaOH is also added. During the steam distillation (NH4)2SO4 break up to
liberate in ammonia gas, which is dissolved in Boric acid indicator flask. After about
150ml. was distilled over, automatically stopped.

**NaOH**

(NH4)2SO4,  ---------------  NH2OH + NH4SO4

NH4HSO4  Steam
**Titration**

The ammonia dissolved in the acid is estimated by titration with N/50 H2SO4 acid. The end point is reached when the colour changes from green to pink. A blank titration on the reagent is also made, this blank reading is subtracted from each determination.

**Calculation**

Total Nitrogen % \[= \frac{[V2-V1]*N*14}{W*1000} \times 100\]

Crude Protein % \[= \text{Total Nitrogen} \times 6.25\]

Where,

- $V_2$ is the volume (ml) of standard HCl used in blank titration
- $V_1$ is the volume (ml) of standard HCl used in sample titration
- $N$ is the normality of standard HCl
- $W$ is the weight (gr) of sample
- 14.0 is atomic weight of nitrogen
- 6.25 is protein – nitrogen conversion factor for feed stuff
- 1000 is the conversion of mg N/100gr to gr – N/100 sample
3.4. Determination of Crude Fat [Ether Extract]

The fat is determine by boiling a finely ground sample of the feed with petroleum ether (60'-80'C) boiling point continuously for 45 minutes by using Soxtex Instrument and evaporating the ether and weighing the fatty residue.

Reagent

Petroleum ether

Apparatus

A. Extraction thimble
B. Aluminum cups
C. Soxtex instrument
D. Oven
E. dessicator

Method

1. Weight the dry Aluminum cup (W)
2. Weight about 1.8 gr. samples to an extraction thimble
3. Put about 60 ml. petroleum ether (60'-80'C boiling point) into the Aluminum cup
4. Assemble the thimble to the instrument
5. Assemble the aluminum cup to the instrument

6. Set the boiling position in the instrument for 45 minutes

7. Set the rinsing position in the instrument for 1 hour

8. Close the valve and keep for 20 minutes

9. Turn to evaporation position and air switch on for 10 minutes

10. Take out the aluminum cups and dry in an oven (Temperature 100°C) for 1 hour

11. Placed the cups in a dessicator cool, dry and weight (W1)

**Calculation**

\[
\text{Crude Fat} \% = \frac{W1 - W}{W} \times 100
\]

Sample Wt.

Where,

\( W1 = \) the weight in gr. of the extraction cup with dried crude fat

\( W = \) the weight in gr. of the extraction cup
3.5. Determination of Crude Fibre

The fibre in a feed includes the cellulose, lignin and other polysaccharide, which are insoluble in hot diluted acid and diluted alkali. The percentage of fibre is found by boiling a sample of the feed successively in week acid and week alkali washing out of the dissolved material.

Reagent

1. Sulfuric acid solution 0.255N, 1.25 % H2 SO4
2. Sodium Hydroxide solution 0.313N, 1.25 % NaOH
3. Acetone
4. N-octanol Anti-foaming regent
5. Celite

Apparatus

A. Fibretec Extraction instrument
B. Hot plate
C. Filtration apparatus, Glass crucible with ceramic, fibre funnel, rubber ring, adaptors
   And flasks
D. Hot air oven
E. Muffle Furnace
Method

1. 1.6 gr. of ground material was weighted (W1) and extracted with petroleum ether. If fat is <1% extraction may be omitted

2. Added 1 gr. of celite into the dry crucible

3. Fat free residue placed into a dry crucible

4. Add 150 ml. of preheated 1.25% H2SO4 and heat to boiling

5. Boiled for 30 minutes

6. Filter

7. Washed residue three times with hot water

8. Added 150 ml. of preheated 1.25% NaOH and heat to boiling

9. Added some drops of antifoaming regent

10. Boiled slowly for 30 minutes and filtered

11. Washed three times with hot water

12. Washed three times with acetone [In cool extraction unit]

13. Dried at 130°C for 2 hours

14. Weight (W2)

15. Ash at 500°C for 3 hours

16. Weight the ash W3
Calculation

\[
\text{Crude Fibre} \% = \frac{W_2 - W_3}{W_1} \times 100
\]

Where,

- \( W_1 \) is the weight in gr. of the fresh sample
- \( W_2 \) is the weight in gr. of fibre before ashing
- \( W_3 \) is the weight in gr. of after ashing

3.6. Determination of Total Ash

Total Ash is determined in a feed by burning of the all-organic matter in the furnace.

Moreover, weighing the residue.

Materials

Porcelain Crucible
Muffle furnace
Dessicator
Method

1. Weigh an empty crucible $W$
2. Accurately weigh about 2.2 gr. of sample into the crucible $W_1$
3. After crucible placed in the muffle furnace, raise the temperature to about 550°C and incinerate until a white grayish ash is formed. (Usually 12 hours or 600°C - 8 hours should be sufficient)
4. Placed the ash in a dessicator, cool and weigh $W_2$

Calculation

$$\text{Ash} \% = \frac{W_2 - W}{W_1 - W} \times 100$$

Where,

$W$ is the weight in grams of the empty crucible
$W_1$ is the weight in grams crucible and dried test material
$W_2$ is the weight in grams of crucible and Ash
Chapter IV

4.0 Result and Discussion

4.1 Local Raw Materials

In the Kurunegala District, Kuliyapitiya area, small-scale feed manufactures are used in low cost, abundant local raw materials for their broiler feed formulation.

4.1.1. Material: Broken Rice

4.1.1. a. Proximate Analysis of Broken Rice

<table>
<thead>
<tr>
<th>Type</th>
<th>Computation</th>
<th>C. Protein</th>
<th>C. Fat</th>
<th>C. Fibre</th>
<th>Moisture</th>
<th>Ash</th>
<th>Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broken Rice</td>
<td>No. of Samples</td>
<td>38</td>
<td>12</td>
<td>12</td>
<td>38</td>
<td>38</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Mean Value</td>
<td>8.4384</td>
<td>1.4769</td>
<td>2.6429</td>
<td>10.4571</td>
<td>2.8421</td>
<td>1.0063</td>
</tr>
<tr>
<td></td>
<td>St. Deviation</td>
<td>0.5425</td>
<td>0.4026</td>
<td>0.8976</td>
<td>0.6563</td>
<td>1.1547</td>
<td>1.4462</td>
</tr>
</tbody>
</table>

Considered the mean value of Crude Protein content is 8.4%. The milling process affected the variation of crude protein content in broken rice. Different rice varieties show different protein content. Sand contamination and paddy husk mixing highly affect the quality of broken rice. Sand and paddy husk contamination are high and affect the crude protein content in final animal feed ration. However, these varieties do not show low crude protein content. Some rice varieties are not contaminated with sand, show slightly high ash content. [Found in 2.8%]
The broken rice crude fat and crude fibre content is comparatively low and moisture content is very low. It is important to prevent the contamination of bacterial and mould growth.

4.1.2. Material: Rice polish

4.1.2. a. Proximate Analysis of Rice polish

<table>
<thead>
<tr>
<th>Type</th>
<th>Computation</th>
<th>C.Protein %</th>
<th>C.Fat %</th>
<th>C.Fibre %</th>
<th>Moisture %</th>
<th>Ash %</th>
<th>Sand %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>No. of Samples</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>[Mixed]</td>
<td>St.Deviation</td>
<td>0.5427</td>
<td>1.9428</td>
<td>2.4571</td>
<td>0.6311</td>
<td>1.6391</td>
<td>1.5297</td>
</tr>
</tbody>
</table>

The preparing white rice, yield a product called rice bran which itself is composed of 30% of rice polish and 70% true bran. Compared mean values of mixed rice polish [red and white] with broken rice crude protein, crude fat, crude fibre and ash content were shown in high amounts. The milling process affecting the above variation. The rice polishing, found in very high in fat content and low in fibre, while the true bran is low in fat and high in fibre. The proportions of rice polish and true bran in a mixed product will therefore have a major effect on its nutritive value. Mixed rice polish shows increasing ash content because contamination with sand. The high oil content rice polish is very susceptible to oxidative rancidity.
4.1.3. Material: Maize

4.1.3. a. Proximate Analysis of Maize

<table>
<thead>
<tr>
<th>Type</th>
<th>Computation</th>
<th>C.Protein %</th>
<th>C.Fat %</th>
<th>C.Fibre %</th>
<th>Moisture %</th>
<th>Ash %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>No. of Samples</td>
<td>12</td>
<td>04</td>
<td>04</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>Mean Value</td>
<td>8.2427</td>
<td>3.2680</td>
<td>2.0431</td>
<td>11.9564</td>
<td>1.2541</td>
</tr>
<tr>
<td></td>
<td>St.Deviation</td>
<td>0.7684</td>
<td>0.4264</td>
<td>0.3259</td>
<td>0.5376</td>
<td>0.3163</td>
</tr>
<tr>
<td>Imported</td>
<td>No. of Samples</td>
<td>18</td>
<td>08</td>
<td>04</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Mean Value</td>
<td>9.1432</td>
<td>4.9081</td>
<td>2.3410</td>
<td>11.5642</td>
<td>1.9845</td>
</tr>
<tr>
<td></td>
<td>St.Deviation</td>
<td>0.7540</td>
<td>0.7192</td>
<td>0.3153</td>
<td>1.6207</td>
<td>0.6528</td>
</tr>
</tbody>
</table>

Compared with the mean values of the local and imported maize, imported maize are high content of crude protein, crude fat, crude fibre and ash. But imported maize contains low moisture content, and it is important to long term storage and prevent mould growth.

4.1.4. Material: Sorghum

4.1.4. a. Proximate Analysis of Sorghum

<table>
<thead>
<tr>
<th>Type</th>
<th>Computation</th>
<th>C.Protein%</th>
<th>C.Fat %</th>
<th>C.Fibre %</th>
<th>Moisture%</th>
<th>Ash %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>No. of Sample</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Mean Value</td>
<td>9.4370</td>
<td>3.3414</td>
<td>2.5254</td>
<td>12.4371</td>
<td>2.8123</td>
</tr>
<tr>
<td></td>
<td>St.Deviation</td>
<td>0.9245</td>
<td>0.6792</td>
<td>1.3163</td>
<td>1.2148</td>
<td>1.6057</td>
</tr>
</tbody>
</table>

From standard deviation values, variation of crude fibre, moisture and ash content is high. Variation of crude protein and crude fat content is low. Normally moisture content of grains is very high.
4.1.5. Material: Coconut Poonac

4.1.5. a. Proximate Analysis of Coconut Poonac

<table>
<thead>
<tr>
<th>Type</th>
<th>Computation</th>
<th>C.Protein</th>
<th>C.Fat</th>
<th>C.Fibre</th>
<th>Moisture</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.of Samples</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coconut</td>
<td>15</td>
<td>15</td>
<td>02</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Poonac</td>
<td>Mean Value</td>
<td>21.6943</td>
<td>11.6543</td>
<td>14.0543</td>
<td>8.2596</td>
<td>5.7580</td>
</tr>
<tr>
<td></td>
<td>St.Deviation</td>
<td>1.8790</td>
<td>2.4846</td>
<td>1.6653</td>
<td>1.6261</td>
<td>1.4749</td>
</tr>
</tbody>
</table>

Comparison of mean value variation crude protein, crude fibre and crude fat content is high amount. Variation is low in ash content. Oil extracted from coconut poonac crude protein content becomes high. During storage, coconut poonac becomes rancid due to high fat content and increasing free fatty acid level.

4.1.6. Material: Ground Nut Poonac

4.1.6. a. Proximate Analysis of Ground Nut Poonac

<table>
<thead>
<tr>
<th>Type</th>
<th>Computation</th>
<th>C.Protein</th>
<th>C.Fat</th>
<th>C.Fibre</th>
<th>Moisture</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Nut</td>
<td>Mean Value</td>
<td>46.8732</td>
<td>0.0487</td>
<td>9.3631</td>
<td>9.3761</td>
<td>6.4379</td>
</tr>
<tr>
<td>Poonac</td>
<td>St.Deviation</td>
<td>2.8971</td>
<td>0.8619</td>
<td>4.6210</td>
<td>2.6447</td>
<td>1.8374</td>
</tr>
</tbody>
</table>

Comparison of mean value the crude protein content is higher level in groundnut poonac. From standard deviation values, variation of crude fibre level is high and variation of crude fat level is low. Ash content is not so much varied.
4.1.7. Material: Soya Bean Meal

4.1.7. a. Proximate Analysis of Soya Bean Meal

<table>
<thead>
<tr>
<th>Type</th>
<th>Computation</th>
<th>C.Protein %</th>
<th>C.Fat %</th>
<th>C.Fibre %</th>
<th>Moisture %</th>
<th>Ash %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soya Sample</td>
<td>28</td>
<td>12</td>
<td>10</td>
<td>25</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Bean Mean Value</td>
<td>44.5482</td>
<td>0.8468</td>
<td>5.5873</td>
<td>11.7954</td>
<td>6.9735</td>
<td></td>
</tr>
<tr>
<td>Meal St.Deviation</td>
<td>1.5762</td>
<td>0.5873</td>
<td>1.1964</td>
<td>1.2653</td>
<td>0.5973</td>
<td></td>
</tr>
</tbody>
</table>

Comparison of mean and standard deviation values vary high in crude protein in Soya bean meal. Ash and crude fat content in soya bean meal is not so much varied. Variation of crude fibre content and moisture content is high. Urease activity is used to evaluate soya bean meal quality. The urease enzyme activity of soya bean meal is measured qualitatively by the conversion of urea to ammonia in the presence of phenol red indicator.

4.2 Imported Raw Materials

4.2.1. Material: Fish Meal

4.2.1. a. Proximate Analysis of Fish Meal

<table>
<thead>
<tr>
<th>Type</th>
<th>Computation</th>
<th>C.Protein %</th>
<th>C.Fat %</th>
<th>Moisture %</th>
<th>Ash %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish Meal</td>
<td>8</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>[Maldives]</td>
<td>63.2571</td>
<td>14.3247</td>
<td>6.1362</td>
<td>15.2371</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.4083</td>
<td>2.2315</td>
<td>3.1414</td>
<td>1.4476</td>
<td></td>
</tr>
</tbody>
</table>

Comparison of mean values of imported fishmeal with other protein sources, given the high crude protein content for animal feeds. Crude fat and ash content is also in higher amount.
4.2.2. Material: Meat and Bone Meal

4.2.2. a. Proximate Analysis of Meat and Bone Meal

<table>
<thead>
<tr>
<th>Type</th>
<th>Computation</th>
<th>C. Protein %</th>
<th>C. Fat %</th>
<th>Moisture %</th>
<th>Ash %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat and Bone Meal</td>
<td>No. of Samples</td>
<td>10</td>
<td>7</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Mean Value</td>
<td>60.2490</td>
<td>5.8467</td>
<td>4.3251</td>
<td>24.6749</td>
</tr>
<tr>
<td>[India]</td>
<td>St. Deviation</td>
<td>2.7624</td>
<td>2.4482</td>
<td>0.9732</td>
<td>3.0398</td>
</tr>
</tbody>
</table>

Consider the mean value of meat and bone meal shows high crude protein content. However, Indian meat and bone meal contain in highest ash content. It is important to animal feeds for their mineral requirement. Crude fat and moisture content is very low in imported meat and bone meal.

4.3 Final Products - Formulated Feed

4.3.1. Material: Broiler Starter

4.3.1. a. Proximate Analysis of Broiler Starter

<table>
<thead>
<tr>
<th>Feed Type</th>
<th>Computation</th>
<th>Crude Protein %</th>
<th>Crude Fat %</th>
<th>Crude Fibre %</th>
<th>Moisture %</th>
<th>Ash %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broiler Starter</td>
<td>No. of Sample</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Mean value</td>
<td>17.4563</td>
<td>6.5125</td>
<td>5.3031</td>
<td>10.2703</td>
<td>8.9215</td>
</tr>
<tr>
<td></td>
<td>St. Deviation</td>
<td>1.8577</td>
<td>1.6458</td>
<td>1.7306</td>
<td>0.9976</td>
<td>2.4299</td>
</tr>
</tbody>
</table>

Standard Values: 21% 09% 05% 12% 06%
Broiler Starter:

- In the final product [Broiler Starter], mean value of crude protein, compared with the standard value of crude protein content, show in considerably lower.
- Considered the mean value of crude fat content; the final product crude fat content is lower than the standard value.
- Compared with the standard value of crude fibre content, the final product had higher amount of crude fibre.
- Moisture content is very low amount in final product, compared with the standard moisture content.
- The ash content of final product, considerably higher than the standard value.
- From the Standard deviation values, moisture content value is very low [Less than 1.0] and ash content is very high amount. [More than 1.0]

4.3.2. Material: Broiler Finisher

4.3.2. a. Proximate Analysis of Broiler Finisher

<table>
<thead>
<tr>
<th>Feed Type</th>
<th>Computation</th>
<th>Crude Protein %</th>
<th>Crude Fat %</th>
<th>Crude Fibre %</th>
<th>Moisture %</th>
<th>Ash %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broiler Finisher</td>
<td>No. of Sample</td>
<td>28</td>
<td>28</td>
<td>28</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Mean Value</td>
<td>16.1893</td>
<td>6.7643</td>
<td>4.2500</td>
<td>10.0161</td>
<td>8.8982</td>
</tr>
<tr>
<td></td>
<td>St.Deviation</td>
<td>2.2153</td>
<td>1.8452</td>
<td>1.5298</td>
<td>1.0080</td>
<td>1.6483</td>
</tr>
</tbody>
</table>

**Standard Values:** 19 % 10 % 05 % 12 % 06 %
**Broiler Finisher:**

- In the Final product, [Broiler Finisher] mean value of crude protein compare with the standard value, cannot be comply with specification value. It is very low amount.
- The crude fat content considered with standard value, it is very low than the standard value.
- Considered the mean value of crude fibre content with standard value, it is slightly lower than specification value.
- Compare the mean value of moisture content with standard value, the final product moisture content is very low amount.
- The ash content was given the high amount compare with the standard value.

**5. Conclusion.**

In my research project area, found in the major and minor poultry rearing farmers. They are producing their feeds by using small-Scale feed manufacturing plants. Some small-scale manufactures, manufactured feeds only for poultry rearing farmers. They are using imported raw materials and abundant local raw materials in this area. The abundant raw materials are rice, broken rice, rice polish, maize, sorghum, coconut poonac, groundnut poonac, cassava, sweet potato and soya bean meal.

In order to minimize their cost, they used both high amount of abundant raw materials and low amount of standard raw materials for their feed formulation. [Mixed feed]
According to the proximate analysis results, some local raw materials contain low nutritional contents than the standard values, due to the presence of impurities such as seed husk, sand, and other plant materials. These are highly affected to the final quality, for feed ration formulation.

Some limited factors are also available in local feed ingredients, such as,

1. Nutritional aspects;  
   * Variability in nutrient quality  
   * Presence of anti-nutritional factors  
   * Need for supplementation

2. Socio-Economic aspects;  
   * Competition for Human Foods  
   * Ingredient cost per unit energy relative  
   * Cost of processing / supplementation / pelleting

3. Technical aspects;  
   * Seasonal and unreliable supply - storage  
   * Bulkiness and /or powdery texture - pelleting  
   * Processing requirement – drying, detoxification  
   * Lack of research and development efforts by the feed Industry

According to the proximate analysis results, the final mixed feed [Broiler Starter and Broiler Finisher] indicate the deep variation, compared with Standard nutritive values, due to low quality of raw materials and required amounts not in used.

Final mix feed moisture content quantitatively very low, because these local raw materials are found and stored in dry zone areas.
Ash content also shown in higher amount compared with standard value, because the farmers used local calcium and mineral sources to improve the animal health.

6. Suggestions

1. Concern the economic value of feed ingredients.
2. Consideration the quality and nutritional value of feed ingredients.
3. Evaluate the feed ingredients and feed additives.
4. Using the beneficial feeding program and special feeds for maximum production.
5. Motivate the farmer's technical knowledge, feed rations, and feed manufacturing.
6. Formulated feed samples and feed ingredients / additives should be tested before Feeding.
7. Carry out the standard slaughtering and processing procedures.
8. Overcome the nutritional, socio-economic and technical aspects.
7. References


Christensen, C.M. Storage of Cereal Grain and Their Products.


Feed Manufacturing Technology, American feed Manufactures Association Feed Production Council.


Gutcho, M.H. Feeds for Livestock, Poultry and Pets.

Gohl, B. Tropical Feeds, Food and Agriculture Organization of the United Nations, Rome. pp 320-322


Steven, Leeson and John, D. Summers, Commercial Poultry Nutrition, University Books P.O.Box 1326 Guelph, Ontario, Canada. 1991.


Appendix - I

ENERGY SOURCES

![Energy Sources Image]
PROTEIN SOURCES
PROTEIN SOURCES - ANIMAL ORIGIN

[Image of two containers with text in Sinhala]
VITAMIN - MINERAL PREMIXES
Appendix - V

Process Block flow chart for Manufacture of Broiler Feeds

Weighing Storage Raw Materials

[Maize, Broken rice, Rice bran, Coconut poonac, Soya bean, Fishmeal, Shell powder, Salt]

Purification

Blending Ingredients

Grinding

Mixing ← Adding; Vitamin, Antibiotic, Premixes

Sample testing

Filling / Packing [50 kg / Bag]

Storage / Delivery
Appendix – VIII

SMALL SCALE FEED MILL