Evaluation of Physico-chemical Characteristics of Locally Available Broken Rice as Feed Ingredients for Poultry

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Abstract- *The increased price for maize forced domestic farmers to search for a novel type of ingredient as an energy source and the utilization of locally available broken rice is observed as a replacement to maize. Most importantly, feed cost accounts for up to 70% of the total cost. Any mistake in the formulation can negatively affect poultry production and profit. The performance of compounded feed is a contribution from different raw materials. An understanding of the Physico-chemical properties of feed ingredients is important since these influence the performance of chicken. Hence, this study investigated bulk density, ash content, foreign matter content, grades of broken rice, crude protein and gross energy content of broken rice types sudu kekulu, red peacock and parboiled rice with laboratory analysis. The study found that bulk density, ash content, crude protein and gross energy content were not significantly different (P<0.05) between broken rice types indicating that three broken rice types are similar in these characteristics. Gross energy and crude protein content are the two most important parameters investigated when considering the replacement to maize grain. Mean crude protein and gross energy values of broken rice types were 9.36% and 15.91 MJ/Kg respectively. Based on the findings of the study, it is concluded that maize grain can be replaced with the domestically available broken rice types when considering their crude protein and gross content. However, it is suggested to conduct a feeding trial with a feed formulated with locally available broken rice types to investigate the production performance of poultry.*

Keywords: poultry production; energy; crude protein: broken rice grades

I. INTRODUCTION

Poultry farming is a promising income generation operation and a quick way for return on investment. In the commercial poultry operation, feeding of a balanced ration and correctly formulated feed increases animal productivity, quality of product, and animal welfare. On the other hand, according to Waller (2007), feed cost is the primary component of the variable cost, accounting for up to 70% of the total cost. Therefore, any mistake in the feed formulation can negatively affect farm profits as well as animal production. These together indicate the research needs in general on feeds and feeding with the prime goal of cutting down the costs expended on feeding the animals, without compromising the quality of feed.

A large number of raw materials are utilized for the production of livestock feed based on their chemical composition and current price structure. The quality of compounded animal feeds is based on the quality of its constituents used to formulate the ration. Hence, the assessment of the quality of incoming ingredients is crucial for predicting the quality of a finished feed. The physical properties of the feed are a very important factor in feed processing. The efficiency of handling, processing, and storage of feed in feed mills not only requires information about the chemical nature and nutritive value; but the physical properties of the feed should also be known (Jaelani and Firahmi, 2007). Further, the physical properties are much related to the processing or handling of feed material mechanically (Syarif and Irawati, 1988). Apart from these, according to De Lange (2000), there should be an understanding of the physico-chemical properties of feed ingredients because these properties may influence nutrient digestibility, the gut microflora, and associated microbial fermentation and gut health.

Rezaei et al. (2006) concluded that the use of broken rice up to 500 kg/T in the broiler diets has no adverse effect on performance. Chen et al. (2020) investigated the effect of replacing dietary corn with broken rice on goose growth performance, body size, and bare skin color. With regard to the performance of goose, they concluded that replacing corn with broken rice in diets has no adverse effect on the body weight of geese and further they recommended that 75% of broken rice can be used instead of corn in goose diets. Apart from the studies on the poultry performance on the inclusion of broken rice in the diet, there are studies on Phsysico-chemical characteristics of broken rice in different parts of the world (Mukhopadhyay and Siebenmorgen, 2017; Bruce et al. 2020). However, Omede (2008) indicated that the influence of physical characteristics of feeds and feedstuffs on animal production in the tropics received limited attention because this is not considered a major factor of influence on livestock productivity. Hence, investigating the quality of feed raw materials not only in terms of their nutritional potential but also of their physical characteristics is important in the formulation of commercial feeds and the evaluation provides different types of information, as required by nutritionists and farmers.

A large quantity of broken rice 5% – 25% is produced as a byproduct of the rice milling process (IRRI, 2021). According to the Department of Census and Statistics (2020), the paddy harvest was 5.12 million metric tons in Sri Lanka in the year 2020. Hence, it is estimated that 0.25 – 1.28 million MT of broken rice might have been produced as a byproduct from the rice milling process as per the paddy production in the year 2020. Whereas, our preliminary observation indicated that local farmers in recent days move towards the broken rice as an energy source in poultry feed production by replacing maize because of the increased price of maize due to the short supply. However, to our knowledge, the data about the characteristics of the locally used broken rice as a feed ingredient in poultry feed so far is quite low. Therefore, it is necessary to evaluate the Physico-chemical properties of broken rice used in local poultry farms, which is crucial for predicting the quality of the finished feed. Hence, this study was an attempt to determine the Physico-chemical characteristics of the locally used broken rice as a feed ingredient. Further, this study compared crude protein and gross energy content of broken rice types with that of maize having the data available in the previous study. It is expected that the findings of this study will be helpful for farmers in formulating balanced poultry feeds at a domestic level.

II. RESEARCH METHODS

A. Preparation of Samples

Three broken rice types namely Sudu Kekulu, red peacock, and parboiled rice that are locally available and used in poultry feed production as an energy source were selected for the study. Primary samples were collected using a grain sampler directly from three bags separately for each broken rice type. For this purpose, 500g of broken rice from the top, bottom and sides of each bag was collected thus nine primary samples were obtained. The primary samples of each broken rice type were mixed and prepared a composite sample of 2 Kg. The composite sample was piled to create a cone shape heap. A minimum of 300g of sample was taken from the composite sample for each laboratory analysis.

B. Estimation of Bulk Density

Each broken rice type was filled in a measuring cylinder with a volume of 100cm^3. Then each type of broken rice was taken out from the measuring cylinder and the weight was taken. Having the volume and the weight bulk density for each rice type was obtained (Zainuddin *et al*, 2014).

C. Estimation of Foreign Matter

Broken rice sample of 100g was obtained for each rice type from the composite sample. Then the sample was sieved. The sieve was shaken horizontally 20 times and powder was removed. Then the sample that remained on the sieve was taken and were divided into five groups and spread on the white sheet. Then the foreign matter was separated manually using the forceps and the weight was taken.

D. Grading the Broken Rice Type

A 100g sample of broken rice from each type was taken and sieved. The sample remained on the sieve was removed and were divided into five groups. Each group was spread on the white sheet and the broken rice was manually separated into three grades as given below.

Grade 1: large broken kernel containing 50% - 75% of the whole kernel

Grade 2: medium broken kernel containing 50% - 25% of whole kernel

Grade 3: small broken kernel containing less than 25% of the whole kernel

(EAS, 2011)

E. Estimation of Crude Protein

The Kjeldahl method was performed according to AOAC International (Latimer, 2016). Approximately 1g of powdered broken rice samples from Sudu Kekulu, parboiled and red peacock were hydrolyzed with 20 ml concentrated sulfuric acid (H_2SO_4) containing two catalyst tablets (potassium sulphate , copper sulphate) in a heating block for 40 min at 300℃ and 90 min at 420℃. After cooling distilled water was added to hydrolysates in sufficient quantity to double the final volume of the solution and manually stirred and the content was steam distilled in the Kjeldhal distillation apparatus. Then the nitrogen content was estimated by titration.

F. Estimation of Gross Energy

The IKA C 6000 global standards oxygen bomb calorimeter was used to estimate the gross energy of broken rice. For each broken rice type, 1g of powder was taken after grinding and placed in the bomb. The vessel was then filled with oxygen, the sample was combusted, and the heat produced was recorded. The gross energy was obtained in Joule/g then converted into MJ/kg.

III. RESULTS

A. Descriptive Statistics

The descriptive statistics for bulk density, true density, ash, foreign matter, grades (grade 01, grade 02, and grade 03) crude protein, and gross energy of three broken rice types i.e. Sudu Kekulu, red peacock, and parboiled rice were given in Table 01.

Results in Table 01 indicated that bulk density, true density, ash and foreign matter of the three broken rice types vary from 0.727 g/cm^3 to 0.838 g/cm^3, 0.8096 g/cm^3 to 0.8867 g/cm^3, 0.9650g to 3. 4920g and 0.2100g to 0.5000g with the mean of 0.806, 0.8509, 2.0319 and 0.3492. Similarly, the grades of the broken rice vary from 14.319g to 63.599g, 28.820g to 65.984g and 6.562g to 19.966g with the mean of 37.2144, 49.2111 and 12.6654 respectively. The value of crude protein and gross energy vary from 9.1065g to 9.6318g and 15.4949MJ/Kg to 16.4290MJ/Kg with the mean of 9.369 and 15.915 respectively.

B. Comparison of Different Broken Rice Types

Table 02 provides outcomes of the analysis of variance of the Physico-chamical parameters of the broken rice types of Sudu Kekulu, red peacock and parboiled rice.

Table 02: ANOVA for comparisons of Physico – chemical parameters of three different types of broken rice analyzed.

Physico-chemical parameters	**df**	**F- value**	**P- value**
Bulk density (g/cm3)	2	1.116	0.369
Ash (g)	2	3.974	0.058
Foreign matter (g)	2	8.678	0.008
Grade 01 (g)	2	27.353	0.000
Grade 02 (g)	2	16.389	0.001
Grade 03 (g)	2	44.630	0.000
Crude protein (g)	2	4.000	0.142
Gross energy (MJ/Kg)	2	1.762	0.226

$P<0.05$ is statistically significant at 95% confidence interval.

According to the results in Table 02, foreign matter content and grades of the broken rice types were significantly different ($P<0.05$). Whereas the difference in the bulk density, crude protein and gross energy between three broken rice types was not significant at $P<0.05$.

Table 01: Descriptive statistics for Physico-chemical parameters of broken rice types (common minimum, maximum, mean, and standard deviation values for all three broken rice types).

Parameters	**Number of samples**	**Minimum**	**Maximum**	**Mean**	**Std. deviation**
Bulk density (g/cm^3)	12	0.7270	0.8380	0.8060	0.036
True density (g/cm^3)	12	0.8096	0.8867	0.8509	0.025
Ash (g)	12	0.9650	3.4920	2.0319	0.897
Foreign matter (g)	12	0.2100	0.5000	0.3492	0.095
Grade 01 (g)	12	14.319	63.599	37.214	15.74
Grade 02 (g)	12	28.820	65.984	49.211	11.38
Grade 03 (g)	12	6.5620	19.966	12.665	4.731
Crude protein (g)	6	9.1065	9.6318	9.3691	0.183
Gross energy (MJ/Kg)	12	15.494	16.429	15.915	0.328

C. Pairwise Comparisons of Broken Rice Types

Post hoc tests were performed with Tukey HSD to find out the significant difference between Sudu Kekulu, red peacock and parboiled broken rice types for all the parameters investigated and the outcomes are given in Table 03 for the parameters found with statistically significance at P<0.05.

D. Mean Crude Protein Content

Though the difference in mean weight between Sudu Kekulu, red peacock and parboiled broken rice types were not significant (P<0.05) for crude protein, a column chart is presented to show the mean weight difference in Figure 01.

Table 03: Weight of foreign matter content and weight of different grades of Sudu Kekulu, red peacock, and par boiled broken rice types in grams.

Broken rice type	Foreign matter content	Grade 01	Grade 02	Grade 03
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Sudu kekulu (g)	0.450± 0.043[a]	53.662± 4.625[a]	38.410± 4.129[a]	38.410± 4.129[a]
Red peacock (g)	0.275± 0.043[b]	38.464± 4.625[b]	47.385± 4.129[a]	47.385± 4.129[b]
Par boiled (g)	0.322± 0.043[b]	19.516± 4.625[c]	61.838± 4.129[b]	61.838± 4.129[c]

The mean foreign matter content (Table 03) was significantly different (P<0.05) between Sudu Kekulu and red peacock as well as between Sudu Kekulu and parboiled broken rice types. However, it was not significantly different (P<0.05) between the red peacock and parboiled types. The quantity of grade 01 broken rice (Table 03) was significantly different (P<0.05) between Sudu Kekulu and red peacock, between Sudu Kekulu and parboiled and between red peacock and parboiled as well. According to the results obtained (Table 03), a significant difference (P<0.05) was found for grade 02 between Sudu Kekulu and parboiled broken rice types as well as red peacock and parboiled broken rice types. However, no significant difference was found between the red peacock and parboiled broken rice types. The differences between broken rice type i.e. Sudu Kekulu and red peacock, Sudu Kekulu and parboiled as well as red peacock and parboiled were significant at P<0.05 (Table 03).

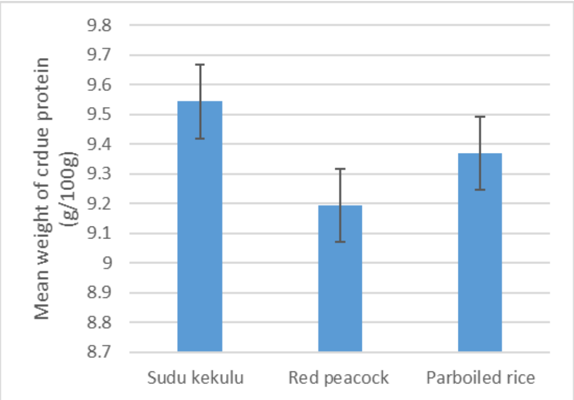

Figure 01: Mean weight of crude protein in different broken rice types

As per the results obtained in Figure 01, Sudu Kekulu was found with the highest crude content of 9.54g/100g of broken rice followed by parboiled and red peacock types.

IV. DISCUSSION

Considering the demand and price increase for conventional type energy ingredients such as maize grain for poultry feed, domestic level poultry farmers search for a novel type of feed ingredients. They utilize the broken rice domestically available as a replacement for maize.

The study found that parameters such as bulk density, ash content, crude protein and gross energy for Sudu Kekulu, red peacock and parboiled rice types are not significantly different at P<0.05 and the results obtained indicate that three broken rice types investigated are almost similar in these characteristics. The gross energy and crude protein content of broken rice are the two most important parameters investigated as a replacement to maize. Mean crude protein and gross energy values of three broken rice types (Table 01) are 9.36g/100 (9.36%) and 15.91 MJ/Kg respectively. According to Zhang et al. (2021), crude protein and gross energy content of broken rice are 10.24% and 15.57MJ/Kg respectively, which are almost in agreement with our findings. Though the difference between crude protein and gross energy content was not significant (P<0.05), Figure 01 indicates that Sudu Kekulu broken rice type contains the highest crude protein compared to red peacock and parboiled types. With regard to gross energy content, parboiled and red peacock types contain equal gross energy that is higher than Sudu Kekulu.

The reason for the difference between the values of crude protein and gross energy in this study and the previous studies (Zhang *et al.*, 2021) and also the differences between the broken rice types in this study may be attributed to the milling process and the resultant grades (Table 01). The grades of broken rice depend on the size of the pieces including or excluding rice germ. Further, results indicate the significant difference in grades (grade 01, grade 02, and grade 03) may affect crude protein and gross energy content in broken rice types. The study found that the foreign matter is very low (0.45g/100g) in the locally available broken rice types indicating that the broken rice types are of an acceptable quality. It is noteworthy to indicate that authors could not find literature on the acceptable level of foreign matter content for broken rice.

Crude protein content in maize grain is 9.1% and gross energy content is 19MJ/Kg (Dei, 2015). The gross energy content in maize is significantly higher compared to broken rice (15.91MJ/Kg). However, the broken rice seems to be acceptable as an energy replacement for maize grain based on gross energy content. However, a feeding trial needs to be conducted on broken rice as an energy source to investigate the production performance of poultry chicken.

V. CONCLUSION

Based on the findings of the study, it is concluded that maize grain can be replaced by the domestically available broken rice types by considering their crude protein and gross energy content. However, it is suggested to conduct a feeding trial to investigate the production performance of poultry with broken rice as an energy source.

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