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Rice Mill Feed: an Agro-industrial By-product with Potential for Rural Development

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Introduction

Africa is the only continent where both species of rice - *Oryzae sativa* (Asian rice) and *Oryzae glaberrima* (African rice) are cultivated. Rice is generally grown under subsistence conditions by smallholder farmers, many of whom are women. These small scale producers lack the means to irrigate and apply chemical ferlizers or pesticides, thereby limiting their level of production as well as income. To these smallholder rice farmers, cultivation and milling of rice culminates in consumption and sale of milled rice, the by-product obtained after the single-step milling of rice - rice mill feed (RMF) has no particular economic value. Often referred to as rice husk, local rice bran or rice offal, RMF is made up of ground hulls, bran and broken rice (FAO, 2007). The increasing demand for rice in West and Central Africa (Sub-Saharan-Africa rice belt) at the rate of about 6% annually (WARDA, 2008) would mean increased production of rice in this region with a corresponding increase in RMF output. Rice Mill Feed is often used to fatten or feed cattle while on transit for large scale sales by cattle traders. This provides a ready market for rice millers while the rice farmers only get the milled rice since they are too poor to own cattle. Small amounts of rice mill feed otherwise referred to as rice husk, rice bran or rice offal by rice and feed millers is included in diets of monogastric animals. The high fibre concentration results in poor nutrient utilization with a consequent poor growth performance when fed to broiler birds without any form of treatment thereby limiting its utilization in broiler feeding.

The poor nutrient utilization and performance of broilers fed untreated RMF may be due to the presence of non-starch-polysaccharides (NSP) and phytate. Reports have indicated the presence of NSP and water-soluble proteoglycan in rice bran (Shibuya and Iwasaki, 1985; ENV/JM/MONO, 2004). A series of experiments was designed to determine the nutrient, amino acid and NSP concentration of rice mill feed and hence it’s feeding value in broiler birds when supplemented with NSP degrading enzyme.

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Materials and methods

Rice mill feed was purchased from a rice milling plant in Ilorin, Kwara state Nigeria. The mill was a one-step mill, meaning that the product contained the bran, ground hulls and some broken rice. The RMF samples were fine crushed (0.75 mm sieve) in a Retsch (Type: ZMI) mill, stored in air-tight plastic containers and taken to the laboratory for analysis. Proximate, gross energy, minerals and fibre (NDF, ADF and ADL) analyses were analysed according to“Verband Deutscher Landwirtschaftlicher Untersuchungs- und Forschungsanstalten”

(VDLUFA; Bassler, 1988, 1993). Amino acid concentrations were determined using standard procedures at the Evonik Degussa GmbH, Hanau, Germany. The water-soluble and water-insoluble NSP of rice mill feed were determined using standard procedures.

Results and Discussion

The nutrient and NSP concentration of RMF and its amino acid concentration are presented in Table 1. The hull of rice is comprised of small amounts of starch and mostly non-starch polysaccharides such as cellulose and hemicellulose. This was reflected in the cellulose and water insoluble NSP content of RMF. The bran and gem of rice are also comprised mainly of non-starch-polysaccharides and partly of free sugars as well as small amount of starch. The presence of arabinoxylans, uronic acids and water soluble proteoglycans has been reported in rice bran (Shibuya and Iwasaki, 1985). This further highlights the possibility of using NSP degrading enzymes to breakdown the NSPs present in RMF thereby enhancing bird performance via the hydrolysis of carbohydrate protein complexes (glycoproteins and proteoglycans) thereby improving crude protein and ether extract digestibility as presented in Table2. The protein content of rice fluctuates according to the variety grown and can also be affected by growing conditions such as early or late maturing, soil fertility and water stress. Protein and amino acid composition varies in different fractions of rice kernel. These appear to be likely reasons for the crude protein concentration of RMF recorded in the present study (51.3 g/kg DM) which was low compared to that reported for rice bran (106 - 169 g/kg) in literature (FAO, 2003). There appears to be similarities in the amino acid concentration of RMF and rice bran as indicated in Table 1. Lysine and methionine concentrations (% of crude protein) were 5.18 and 1.87, respectively. These values reflected those reported earlier (Houston *et al*. 1969; Kennedy and Schelstraete, 1974; Juliano and Bechtel, 1985), which ranged from 5.0 to 5.7, and 1.8 to 2.4%, respectively. As mentioned above, RMF comprises bran, ground hulls and some broken rice, which appears to account for this observed similarity. Glutamic acid concentration (13% of crude protein) was high compared to the other amino acids, a similar result has been recorded for rice bran as indicated in Table 1.

The nutrient composition of RMF recorded in the present study showed close relationship between RMF and rice bran in exception of ether extract concentration which was low compared to rice bran (18.3%). Although, the lipid composition of RMF was not determined in the current study, however, the presence of starch-lipid complexes have been reported (Choudhury and Juliano, 1980). The major components are phospholipids, neutral lipids and glycolipids of which glycolipids and phospholipids, respectively, are higher in the hull (25 and 11% of total lipids) than bran (4 and 7%). This further reiterates the possibility of phytase breaking down such starch lipid complexes present in RMF thereby enhancing bird performance by improving crude protein, starch and fatty acid digestibility as shown in Table 3.

The high phosphorous concentration (5.35 g/kg DM) recorded in the present study compared to maize (0.9 g/kg DM) could be due to the presence of phytate phosphorous in the bran which is a component of RMF. Others have shown the absence of phytate phosphorous in rice hull (Kennedy and Schelstrade, 1975; Dikeman *et al.*, 1981; Juliano and Bechtel, 1985) and a concentration of 11 – 26 g/kg DM in the bran. Available phosphorous concentration in rice hull has been reported to range from 0.4 to 0.8 g/kg DM and 13 to 29 g/kg DM in the bran (ENV/JM/MONO, 2004).

Table 1: Nutrients, non-starch polysaccharide (NSP) and amino acid (AA) concentrations of rice mill feed

Nutrient (g/kg DM unless stated)	Rice Mill Feed	Amino acid	AA (%)	AA (% of CP)	Bran [1]
Dry matter (g/kg)	904	Methionine	0.09	1.87	1.8-2.4
Crude protein	51.3	Cystine	0.09	1.89	2.4-2.7
Ether extract	59.5	Methionine+ Cystine	0.18	3.76	
Ash	216	Lysine	0.24	5.18	5.0-5.7
Organic matter	688	Threonine	0.20	4.15	4.0-4.4
Neutral Detergent Fibre	712	Arginine	0.34	7.19	8.2-8.7
Acid Detergent Fibre	501	Isoleucine	0.18	3.72	2.8-4.3
Acid Detergent Lignin	8	Leucine	0.36	7.58	7.2-8.0
Cellulose	493	Valine	0.28	6.02	5.1-6.3
Hemicelluloses	211	Histidine	0.13	2.67	2.8-3.5
Gross energy (MJ/kg DM)	16.59	Phenyl alanine	0.22	4.74	4.7-5.0
Phosphorous	5.35	Glycine	0.27	5.77	5.5-5.9
Magnesium	3	Serine	0.22	4.56	4.9-5.7
Sodium	0.14	Proline	0.30	6.33	4.4-5.8
Potassium	3.53	Alanine	0.32	6.68	6.2-6.7
Calcium	0.96	Aspartic acid	0.42	8.89	9.5-10.5
Water-soluble NSP	13	Glutamic acid	0.62	13.00	13.9-14.3
Water-insoluble NSP	576	NH_3	0.08	1.75	1.8-7.2

[1] Mean amino acid composition (% crude protein) of rice bran (Houston *et al*. 1969; Kennedy and Schelstraete, 1974; Juliano and Bechtel, 1985)

Table 2: Performance and total tract nutrient digestibility in broilers fed graded levels of Roxazyme G2G supplemented rice mill feed (RMF)

Roxazyme G2 G (ppm)	M/SBM diet 0	75 g RMF/kg 200	150 g RMF/kg 200	225 g RMF/kg 200	SEM	*P* value
Weight gain (kg/bird)	2.19	2.10	2.17	2.02	0.06	0.23
FCR	2.09	2.18	2.03	2.11	0.70	0.52
Crude protein (%)	69.6	69.6	71.2	68.7	1.84	0.82
Ether extract (%)	90.6	91.3	91.9	91.1	0.08	0.69

M/SBM: maize - soybean meal

Table 3: Performance and total tract nutrient digestibility in broilers fed graded levels of Ronozyme p5000 (ct) – phytase-supplemented rice mill feed (RMF)

Ronozyme p5000 (ct) (FYT)	M/SBM diet 0	75 g RMF/kg 750	150 g RMF/kg 750	225 g RMF/kg 750	SEM	*P* value
Weight gain (kg/bird)	2.19	2.13	2.09	2.14	0.08	0.84
FCR	2.09	2.12	2.15	2.09	0.97	0.96
Crude protein (%)	69.6	69.2	70.9	71.0	1.38	0.71
Ether extract (%)	90.6[b]	91.75[ab]	93.2[a]	93.1[a]	0.05	0.05

[ab] means along the same row with different superscripts are significantly different (P<0.05)
FYT: Phytase units
M/SBM: maize - soybean meal

Conclusion

Supplementation of RMF with a amino acids and NSP-degrading enzymes or phytase appears to enhance its feeding value when included in the diets of broilers as indicated in Tables 2 and 3. The results showed similarities in performance of broilers fed graded levels of enzyme supplemented RMF-based diets to broilers fed a standard maize-soybean meal diet.

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