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Chemical composition and nutritional characteristics of rice distillers dried grains with solubles

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Abstract

Rice distillers dried grains with solubles (rDDGS) are nutrient-rich co-products of bioethanol production and have potential as an alternative protein source in livestock and poultry feed. The present study evaluated the gross energy, proximate composition, fibre fractions, major minerals and mycotoxin profile of six rDDGS samples collected from different ethanol production industries and analysed by using standard analytical methods. The gross energy was 4331 kcal/kg, while dry matter, crude protein, crude fibre, ether extract, nitrogen-free extract and total ash were 88.73, 47.83, 1.65, 2.32, 44.35 and 3.83 per cent, respectively. Neutral detergent fibre, acid detergent fibre, cellulose and lignin were 35.15, 15.89, 19.94 and 3.26 per cent, respectively. Calcium and total phosphorus were 0.20 and 0.61 per cent. Aflatoxin B₁ and B₂ were detected, whereas other screened mycotoxins were not detected. Overall, rDDGS showed considerable nutritional value and potential for use in animal feed formulations, with appropriate monitoring of mycotoxin contamination.

Keywords: Rice distillers dried grains with solubles (rDDGS), Nutritional value, Mycotoxins

Introduction

Feeding is one of the most important factors influencing the performance and profitability of livestock and poultry farming. Feed accounts for a major portion of production cost maximum 60% of total expenditure of the farm and plays a crucial role in supporting maintenance, growth, milk production and reproduction. Due to increased demand for animal products and rising feed costs, the use of alternative feed ingredients and nutritional interventions has gained significant importance.

Bioethanol production is increasing worldwide because of growing demand of the renewable energy, because it reduces the dependence of the fossil fuels. Ethanol is primarily produced during the fermentation of starch rich cereal grains such as corn, wheat, sorghum, barley and rice. Cereals yield one third ethanol, one third carbon di-oxide and one third Distillers Dried Grains with Soluble (DDGS) which is co-product during the ethanol production. DDGS are nutrient rich dried residues obtained after the fermentation of grains by enzymes and yeast. DDGS contain all the nutrients from grain in a concentrated form except for the majority of the starch, which has been utilized in the fermentation process during the ethanol production (Babcock *et al.*, 2008) ^[1]. Thus, DDGS is very low in starch but higher in non-starch polysaccharides (NSP) compared to the parent grains used in ethanol production. Rice DDGS and corn DDGS can partially replace the costly feed ingredients like soyabean meal due to its high energy, protein and phosphorus content. DDGS can be used as an unconventional protein source for both livestock and poultry feeding.

The nutrients level of DDGS may differ based on grain sources and manufacturing technique and it also vary from one production plant to another or even from batch to batch. Thus, the objective of the research study was to assess the gross energy, nutrient composition, fiber fraction, macro mineral status and mycotoxins of the rice DDGS which is predominantly available in India and can be used as a protein source in livestock and poultry feed formulation.

Materials and Methods

The six samples of rice DDGS were procured from different ethanol production industry. The finely ground rice DDGS were analyzed for gross energy, proximate composition, fiber fractions, calcium, phosphorus and mycotoxins. Gross energy of rice DDGS were estimated using isothermal Bomb calorimeter Model RSBT-6 (Rico Scientific Industries, Delhi). The proximate composition of rice DDGS were analyzed according to AOAC (2023) [2]. The fiber fractions were estimated for neutral detergent fiber, acid detergent fiber, cellulose, hemicellulose and lignin according to the Van Soest *et al.* (1991) [3]. Minerals such as calcium and phosphorus were estimated calorimetrically as per AOAC (2023) [2]. Mycotoxins such as aflatoxin (B₁, B₂, G₁, G₂), ochratoxin A, citrinin, T₂ toxin and zearalenone were screened by two- dimensional Thin Layer Chromatographic method (Tapia, 1985) [4]. Aflatoxins were quantified with High Performance Liquid Chromatography (HPLC) using fluorescence detector.

Results and Discussion

Gross energy

The gross energy of rDDGS was estimated to be 4331 Kcal/Kg (Table 1), which is higher than the GE value of rice grain (Zhang *et al.*, 2021) [5]. Our present findings corroborated with research findings (Dinani *et al.*, 2018) [6] of 4232 Kcal/Kg gross energy of rDDGS. In contrast, a slightly higher gross energy value (Ranjan *et al.*, 2017, Xue *et al.* 2012) [7, 8] of 4739.73 Kcal/Kg and 4513 Kcal/Kg of rice DDGS respectively has also been reported. The GE value of maize DDGS ranged from 4895-5540 Kcal/Kg in different studies (Stein *et al.*, 2007, olukosi *et al.*, 2010, Rochell *et al.*, 2011) [9, 10, 11] which were higher than our findings of GE value, which might be due to less crude fat content in rice than corn.

Proximate composition

The proximate composition (%) in terms of Dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), Nitrogen free extract (NFE) and total ash (TA) was 88.73, 47.83, 1.65, 2.32, 44.35 and 3.83% respectively (Table 1). The moisture content of the present study was little bit higher (10.5%). In contrast, a slightly lower moisture content of (7-8%) has also been reported in (Gupta *et al.*, 2015, Ranjan *et al.*, 2017, Dinani *et al.*, 2018) [12, 7, 6], whereas one author reported the moisture content of rDDGS varying between 14-19% (Kaninde, 2022) [13]. The crude protein content of the rDDGS found in this study were in line with the previous workers who reported 42.60 to 48.43% in rDDGS (Dinani *et al.*, 2018, Yogi *et al.*, 2017, Talsani *et al.*, 2021) [6, 14, 15]. Whereas rDDGS with a higher crude protein level of 61.41% has also been reported by (Ranjan *et al.*, 2017) [7]. According to previous researchers, the crude protein level of corn DDGS was between 29 and 30% (Liu K. S, 2008 and Spiehs *et al.*, 2002) [16, 17], which is lesser than our present findings. The crude fibre content of rDDGS found in this study was slightly lower when compared with the findings of previous study (Gupta *et al.*, 2015, Ranjan *et al.*, 2017, Dinani *et al.*, 2018) [12, 7, 6]. The Ether extract content of rDDGS found in this study were similar with the previous study who reported 2.24% in rDDGS (Ranjan *et al.*, 2017) [7], whereas rDDGS with higher ether extract level of 4-6% has also been reported (Gupta *et al.*, 2015, Dinani *et al.*, 2018) [12, 7]. The variation in the crude fiber and ether extract level in rDDGS may be due to differences in the ethanol processing and drying process of

DDGS (Pedersen *et al.*, 2014) [18].

Table 1: Gross energy and chemical composition of rice DDGS

S. No	Nutrient	Mean	SE
1	Gross energy (Kcal/Kg)	4331	0.66
2	Moisture (%)	11.26	0.91
3	Crude protein (%)	47.83	1.55
4	Crude fibre (%)	1.65	0.70
5	Ether extract (%)	2.32	1.30
6	Nitrogen free extract (%)	44.35	3.26
7	Total ash (%)	3.83	0.54

Fiber Fractions

Fibre fraction refers to the structural carbohydrate components of feed, mainly neutral detergent fibre (NDF) and Acid detergent fibre (ADF) which represents the different portions of the plant cell wall. The neutral detergent fibre (NDF) and Acid detergent fibre (ADF) of fibre fraction constitute 35.15% and 15.89% respectively. These findings are similar as reported that the NDF and ADF OF rice DDGS were 37.84% and 14.33% respectively (Kurechiya *et al.*, 2024) [19]. In contrast, slightly higher neutral detergent fibre (40-44%) and acid detergent fibre (16-17.4%) have also been reported (Patil *et al.*, 2015, Chatterjee *et al.*, 2017) [20, 21]. The cellulose and lignin content in the rDDGS in the present study were 19.94% and 3.26% respectively.

Mineral composition

Major minerals mainly calcium (Ca) and total phosphorus were 0.20% and 0.61% respectively. The calcium and phosphorus content in the present study was lower than the previous study as they have reports that calcium content was 0.6-0.7% (Gupta *et al.*, 2015, Dinani *et al.*, 2018) [12, 6] and phosphorus content was 1.20% (Kurechiya *et al.*, 2024) [19].

Mycotoxins composition

Among the analysed mycotoxins, only Aflatoxin B₁ was detected in five of the six samples at a concentration of 16 ppb each and Aflatoxin B₂ was detected in two samples at a concentration of 8 ppb each. In contrast, slightly lower Aflatoxin B₁ and Aflatoxin B₂ (14ppb and 6 ppb) have also been reported in the DDGS samples (Alaeldein M. Abudabos *et al.*, 2017) [22]. The remaining mycotoxins like Aflatoxin G₁, Aflatoxin G₂, ochratoxin, T-2 toxin, citrinin and zearalenone were not detected (ND) in any of the rice DDGS samples.

Conclusion

Based upon the result of the present study, it can be concluded that rice DDGS is a nutrient rich unconventional feed ingredient with high crude protein and gross energy and can serve as a potential protein and energy source in both livestock and poultry feed formulation. The fibre fractions and major mineral composition indicate that the rice DDGS can contribute appreciably to the nutrient supply. Overall, rice DDGS has good potential as an alternative feed ingredient, provided its nutrient variability and mycotoxin contamination are carefully monitored.

Conflict of Interest

Not available.

Financial Support

Not available.

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