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Full Length Research paper

Enhancement of the feeding value of some agro-industrial by-products for laying hens after their solid state fermentation with *Trichoderma viride*

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This study with some agro-byproducts was carried out to provide information on the use of fermentation by-products; brewer's dried grains (BDG), rice bran (RB), palm kernel meal (PKM) and corn bran (CB). Changes in the nutrient compositions of some selected agro industrial by-products on biodegradation with *Trichoderma viride* and their feeding value as an energy source for layers were investigated. The protein in BDG, RB, PKM and CB increased by 87, 68, 32 and 61%, respectively, when they were fermented with the fungi for 14 days. At the same time, the fiber in the by-products decreased by 35.00, 40.00, 36.50 and 37.50%, respectively with a corresponding increase of 49.00, 37.00, 9.00 and 5.50% in the level of soluble sugars. The energy in the biodegraded by-products increased by 6.30, 5.00, 9.00 and 18.50%, respectively. In a feeding trial with layers, 50% of the maize in a standard commercial diet was replaced with biodegraded BDG, RB and PKM. Birds on the BDG and RB diets had significantly (P<0.05) higher hen day production than those on the other diets. Diets in which the biodegraded by-products replaced maize produced lower cost of egg production than the standard commercial diet. Of the test diets, BDG gave the lowest cost of US$0.38 per tray of eggs (30 eggs) compared with US$0.53 for the commercial diet. Results of the study showed that fungal biodegradation of the agro industrial by-products can enhance their nutritional status. Using such by-products to feed layers spared half of the maize in the diet and produced better laying performance.

Key words: Agro by-products, fungal fermentation, nutrient improvement, poultry feeding.

INTRODUCTION

The Nigerian livestock feed industry competes with other sectors for the consumption of conventional ingredients. This competition often pushes the prices of finished feed upwards. A redirection of efforts to the use of agro-byproducts has been advocated as a way of solving this problem.

Agro-industrial by -products are in abundance in Nigeria. Among the common ones are brewer's dried grains (BDG), rice bran (RB), palm kernel meal (PKM), corn bran (CB) and cassava peels (CP). Industries producing these by-products have in time past incurred expenses for their proper disposal. In recent years, the possibility of using these by-products for livestock feeding has been explored, but with limited success due to processing costs. The advent of biotechnology, specifically, fungal biotechnology, with its inexpensive mode of application, has been used as a tool for the effective conversion of these wastes into useful products. Fungi can increase the protein and soluble sugars and reduce the complex carbohydrates of these wastes. This paper reports on the improvement of the nutritive value of some agro-industrial by-products through fungal fermentation and their subsequent utilization for feeding layers.

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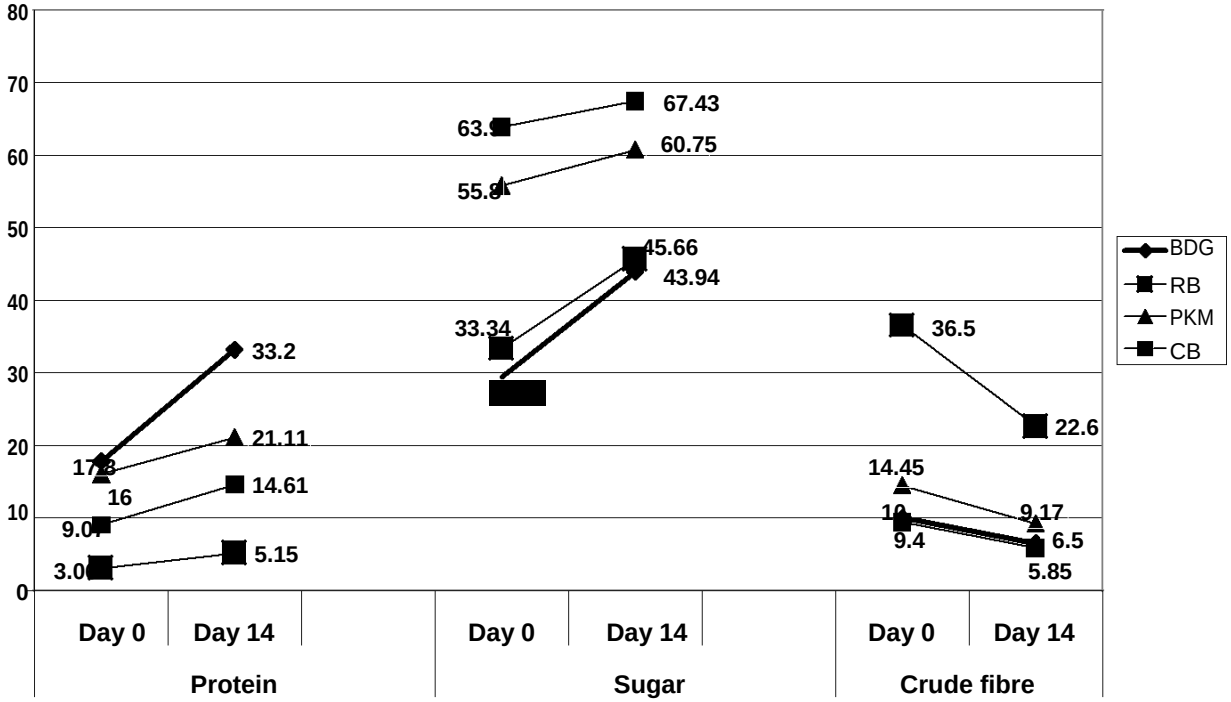

Figure 1. Changes in the levels of protein, sugar and crude fibre in BDG, RB, PKM and CB after biodegradation with *T. viride*.

MATERIALS AND METHODS

BDG, RB, PKM and CB were obtained from the respective industries where they are produced. They were dried to constant weight at 60^{o}C. 25 kg of each material was autoclaved and oven-dried. The autoclaved materials were then inoculated with *Trichoderma viride* under aseptic conditions after adjusting their moisture levels to 25%. After 14 days, the biodegradation reaction was stopped (Iyayi and Losel, 2001) and the materials dried. Samples were then withdrawn for analysis of protein, energy (AOAC, 1984), sugar (Deriaz, 1961) and cellulose (Bath, 1960).

The feeding value of BDG, RB, and PKM as energy sources in place of maize for laying hens was evaluated. In the feeding trial, 50% of the maize in a standard layer diet was replaced with biodegraded BDG, RB and PKM. The control diet (Diet 1) was a normal commercial layers diet. Diets 2, 3 and 4 contained 50% BDG, RB and PKM as energy source in the feeds. The diets were composed of other ingredients necessary to meet the nutrient requirements of laying hens. One hundred and eight Isa Brown birds, 24 weeks old and already at the point of egg-laying were assigned to the four experimental diets in a completely randomized designed on body weight basis. Each diet had 3 replicates and each replicate had 9 birds. Thus there were a total of 27 birds per treatment. Data were analyzed statistically using the Analysis of Variance (ANOVA) technique of Steele and Torrie (1980). Means, which were significantly different, were separated by the Duncan's multiple range test (1955).

RESULTS AND DISCUSSION

The results of changes in levels of protein, sugars and crude fiber in the biodegraded BDG, RB, PKM and CB are presented in Figure 1 while changes in their metabolizable energy contents are depicted in Figure 2. The protein of BDG, RB, PKM and CB increased by 68.00, 87.00, 32.00 and 61.00%, respectively while there was a moderate increase in the energy levels by 5.00, 6.30, 9.00 and 18.50%, respectively. The soluble sugars were increased by 37.00, 49.00, 9.00 and 5.50%, respectively for BDG, RB, PKM and CB, with a corresponding decrease in the crude fiber levels by 40.00, 35.00, 36.50 and 37.50%, respectively. *T. viride* was responsible for a significant change in the protein levels of the agro by-products with the effect most pronounced in BDG. Increase in the energy value of the wastes was, however, moderate. *T viride* was effective in reducing the level of fiber in the wastes by between 35.00 and 40.00 %. The ability of fungi to degrade fiber has been reported by several workers (Ofuya and Nwanjiuba, 1990; Iyayi and Losel, 2001). Earlier works by Ofuya and Nwanjiuba (1990) showed successful degradation of cassava peel (a fibrous by-products of cassava tuber processing) by *Rhizopus sp*. The authors reported that over 35.00% of the original cellulose content of the substrate were lost in solid state fermentation. *Aspergillus niger* grown on rye grass straw produced similar results as obtained in this study (Han, 1978). Working with *Trichoderma spp,* Balagopalan (1996) reported maximum reduction in starch in cassava wastes during the first 12

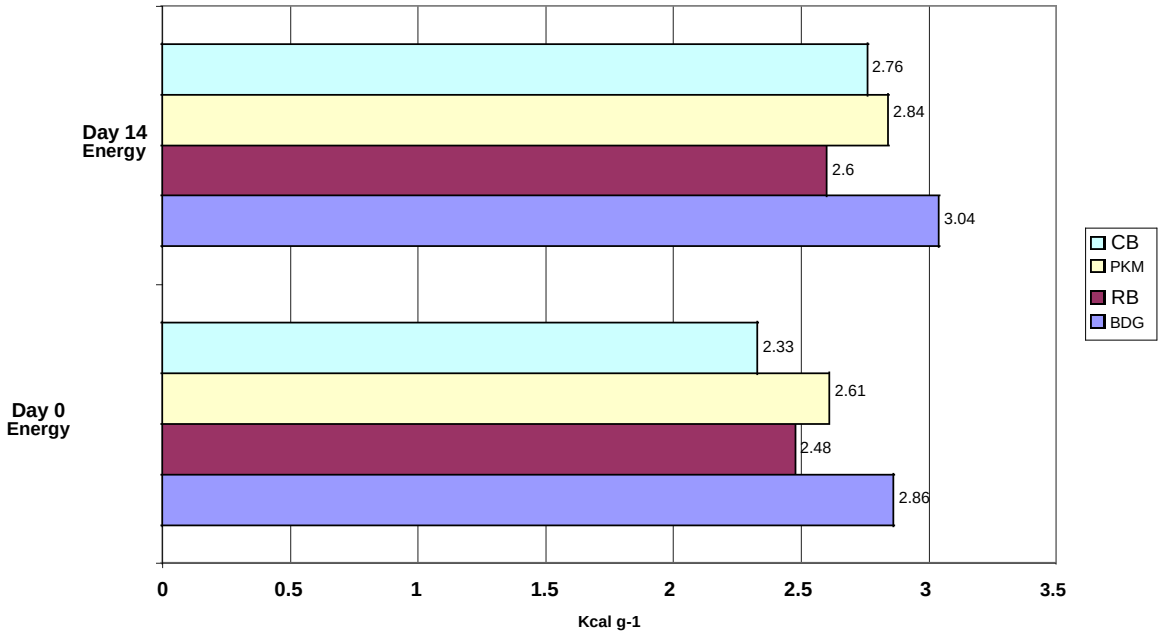

Figure 2. Changes in the energy levels in BDG, RB, PKM and CB after biodegradation with *T. viride*.

Table 1. Performance of layers on experimental diets.

Parameters	Commercial diet (Control)	50% BDG Diet	50% RB Diet	50% PKM Diet	SEx
Feed intake (g/bird/d)	141	120	138	111	±5.80
Efficiency of feed utilization	0.29	0.23	0.27	0.24	±0.01
Hen day production (%)	68.65**ab**	71.64**a**	70.64**a**	63.79**c**	±2.37
Number of eggs	41.17	44.25	44.50	39.75	

Note: Values on same row with different letters are significantly different (P<0.05)

days. This period also coincided with optimum sugar and protein levels. The increased protein and sugar and decreased fiber levels obtained in this study are an indication of the ability of *T. viride* to secrete cellulase enzyme (Balagopalan, 1996) which breaks the starch and non-starch polysaccharides to monomer sugars which are then easily metabolized. This also explains the increase in the energy value of the biodegraded by-products. Bioconversion of starch or sugars to proteins does occur, leading to the protein enrichment of the by-products. Similar trends in the decrease of starch and increase in proteins have been reported by many workers (Balagopalan and Gregory, 1985; Mikani et al., 1982; Manilal et al., 1985; Balagopalan and Padjama, 1988). The decrease in fiber content was synchronized with the increase in sugar concentration in all the treatments.

The results of the commercial and test diets on the performance of the laying hens are presented in Table 1. Birds on the BDG and RB diets performed significantly (P<0.05) better in terms of hen day production than those on the other diets. The enriched protein and energy levels in these diets were factors responsible for the performance of birds. BDG produced the best efficiency of feed utilization.

The effects of the respective diets on egg production are shown in Table 2. All the test diets caused reduction in the cost of egg production. Among the test diets, the BDG gave the lowest cost of US$0.38 per tray of eggs (i.e. 30 eggs is the unit in which eggs are sold in Nigeria). The conventional diet gave the highest cost of US$0.53 per tray. The significant reduction in cost of production was due to the inclusion of the biodegraded agro by-products in the diets. Each of them replaced 50% of the maize allowing for the reduction of the maize from 400 g kg^{-1} to 200 g kg^{-1} in the test diets. Biodegrading the agro by-products enhanced their feeding values by increasing their protein and energy levels and ensuring adequate egg production. It is clear from our results that using the

Table 2. Cost of egg production of birds on the commercial and test diets.

Parameters	Commercial Diet (Control)	50% BDG Diet	50% RB Diet	50% PKM Diet
Feed intake (g/bird/d)	141	120	138	111
Cost of kg feed (US$)	0.19	0.17	0.18	0.17
Cost of feed intake (US$)	0.03	0.02	0.08	0.02
Cost of feed intake of 27 birds (US$)	0.73	0.56	0.68	0.52
Cost of 1 tray of eggs (30 eggs) (US$)	0.53	0.38	0.47	0.40

Note: 1US$ = 126 Naira.

biodegraded agro by-products could also lead to more profitable production of eggs.

The results of the study have shown that fungal biotechnology is an effective tool for the enhancement of the nutritive value of agro industrial by-products. Utilization of these fermented by-products spares the use of up to half the quantity of maize in conventional layers diet. Moreover, birds on diets with biodegraded agro by-products resulted in lower cost of production of eggs. Among the by-products, brewer's dried grain (BDG) produced the lowest cost of egg production. It reduced cost of egg production by 28.30% compared with 11.32% for rice bran (RB) and 24.53% for palm kernel meal (PKM).

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