

Changes in Nutritional Value of Rice Husk during *Trichoderma viride* Degradation

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Abstract

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Possible improvement in nutritional status of rice husk using *Trichoderma viride* a fungus was investigated over a period of 40 days. Proximate composition was significantly ($P < 0.05$) improved with microbial treatment except the ether extract, which fell on day 40. With the mineral content of the biodegraded samples, both the calcium and sodium contents rose, the only exception being the potassium content, which fell below that of the undegraded sample. Biodegradation also resulted in improvement in the energy content of the treated samples when compared to the untreated but no regular pattern was observed over the period studied. Significant reduction in the cell wall content of the rice husk was observed as the period of degradation increases. The least value for NDF and ADF was obtained on Day 40 while the least value for hemicelluloses was obtained by the 30th day.

Key words: *Trichoderma viride*, rice husk, nutritional value, biodegradation

Introduction

Rice husk is a by product of rice milling. During milling of paddy about 78% of weight is received as rice, broken rice and bran, the rest 22% of the paddy is received as husk. Presently, it is used as fuel for boilers, the ash from the husk can be used as fertilizer and the high silica content could be of use in steel industry.

Traditionally, rice husk has been used as ingredient in ruminant and poultry feeds but the problem of low nutrients digestibility, high silica/ash content and abrasive characteristics are limiting factors in its utilization.

According to Oyenuga (1968), rice husk is composed of crude protein 2.9-3.6%, oil, 8-12%, crude fibre 39-42% and ash 15-22%.

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Methods suggested at reducing limiting factors in rice husk utilization includes soaking in hot water, irradiation, acid and alkaline hydrolyses, ensiling, fermentation and use of enzymes and antibiotics (Longe, 1988 and Dierick et al., 1989). Biological improvement of rice husk which include the use of microbial inoculants, cellulolytic enzymes antibiotics and probiotics are easy and safer to handle. It is neither volatile nor corrosive, aimed at breaking down cell wall components to provide wealth of readily available nutrients. According to Edward (1972) enzymes from microbes have more advantages than the commercially prepared enzymes.

Microorganisms of both aerobic and anaerobic sources are able to produce extra cellular enzymes to degrade macromolecules like starch, cellulose, hemicellulose, lignin and pectin of the plant cell wall (Priest, 1984) as well as improve the protein content of rice husk and reduction in fibre composition of the substrates. The necessity for resource recovery as well as reduction in the overhead cost of conventional feed materials which skyrocketed in Nigeria has taken us into improving the nutritional value of rice husk through biological approach which is the essence of the current study.

Materials and Methods

Purchase and treatment of feed-stuffs

Rice husk was obtained from a commercial feed store in Agbowo area of Ibadan, Nigeria. Enough quantity was purchased at the commencement of the experiment to safeguard fluctuations in quality of this ingredient with different batches because of the inconsistency in processing techniques as noted by Omole and Tewe (1989). 100g of the rice husk was

poured into a 250 ml conical flask, autoclaved at 121°C for 15 minutes.

Source of inoculum's and culture methods

The *Trichoderma viride* utilized in this study was obtained from the culture collection of the Department of Botany & Microbiology, University of Ibadan, Nigeria. It was maintained on Potato Dextrose Agar (PDA) and sub cultured fortnightly.

Inoculation and Fermentation of Sample

The study involves the use of a completely randomized block design as was previously used by Iyayi and Losel (2001). There were 5 periods of study (0, 10, 20, 30 and 40 days) with a replicate per period. The samples were moistened with distilled water at the rate of 30 ml/100g of sample (Onilude 1994). A 6mm cork borer was used to prepare mycelia discs from a 5-day old *Trichoderma viride* culture. The autoclaved rice husk samples (100g) as above were inoculated each with 5 discs of the inoculum's (19). Each inoculated sample was well mixed, labeled and incubated within an environment of 28°C + 5°C. A control experiment was equally set up without inoculums. Samples were stirred every 3 days and microaerophily provided through a loose tightening of the mouth of the conical flask. At the end of each experimental period, the samples were oven-dried at 80°C for 24 hours to stop the degradation process.

Chemical Analysis of the Samples

Proximate analysis

The samples were analyzed for their proximate composition according to the standard methods of A.O.A.C. (1990).

Cell wall components

These were determined by the method of Van Soest et al. (1991). By definition, NDF fraction includes lignin, cellulose and hemicellulose while ADF consists of cellulose and lignin. Hemicellulose content was estimated as the difference between NDF and ADF.

Mineral Analysis

The wet oxidation procedure of A.O.A.C. (1990) was applied in the preparation of the digest for mineral determination. Suitable preparations of the digest were read on the flame photometer and to determine the calcium, sodium and potassium content of the feed.

Calorific value

The use of the Gallenkamp oxygen Ballistic Colorimeter with thermo-chemi-

cal grade benzoic acid as standard was used in the energy determination.

Statistical Analysis

Treatment means were separated using Duncan's Multiple Range test at 5% level of probability.

Results

Figure 1 shows the proximate composition of treated and untreated Rice husk over the fermentation period. The crude protein rose significantly ($P < 0.05$) as the period of degradation increases. The ether extract value was lower than the uninoculated sample; the only exception is on the 40th day. The ash content increases as the fermentation progresses but the difference was not significant ($P < 0.05$). The crude fibre was significantly

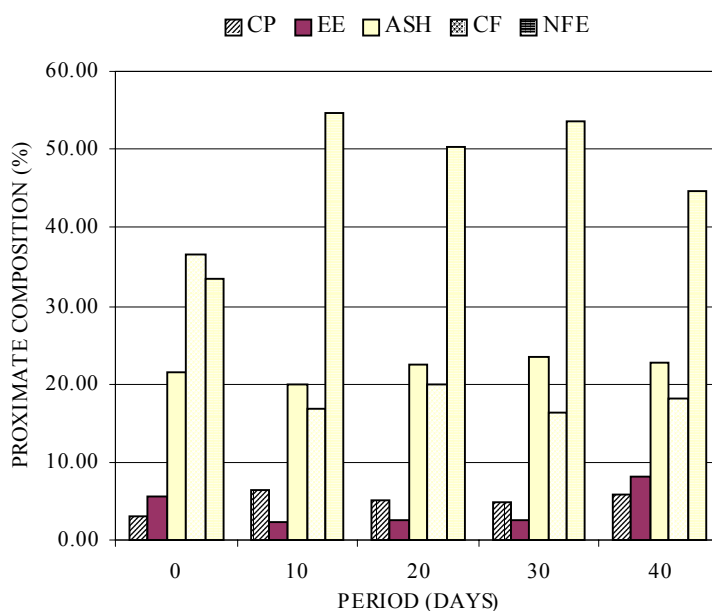


Fig. 1. Effect of period on proximate composition of rice husk

Table 1
Effect of variation in fermentation period on the mineral and energy content of rice husk

Parameters	Fermentation period, days				
	0.00	10.00	20.00	30.00	40.00
Calcium, mg/g	0.086 ^{d*}	0.127 ^a	0.105 ^c	0.105 ^c	0.117 ^b
Potassium, mg/g	0.060 ^a	0.0051 ^e	0.010 ^d	0.0209 ^c	0.022 ^b
Sodium, mg/g	0.00025 ^e	0.00036 ^d	0.00075 ^a	0.00041 ^b	0.00039 ^c
Energy, kcal/kg	2.48 ^e	2.59 ^c	2.60 ^b	2.83 ^a	2.57 ^d

*a-e Values with different superscripts are significantly different ($P < 0.005$) as separated by Duncan's Multiple Range Test.

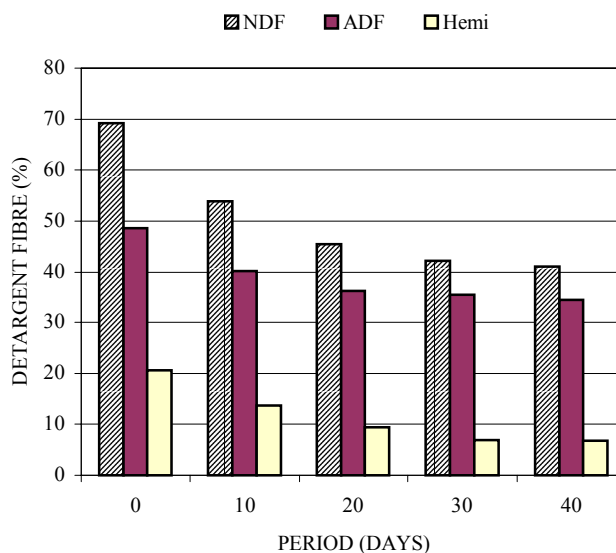


Fig. 2. Effect of periodic variations on the NDF, ADF and Hemicelulose of rice husk

reduced by 45.70-55.12% when compared to the untreated sample. Similar trend was observed for this nitrogen extract.

The energy content of the substrate increased significantly through the period of inoculation (2.48 kcal/kg through 2.83 kcal/kg) with a fall in value on day 40 but not below the value obtained for the non inoculated sample (Table 1). The effect of biodegradation resulted in reduction in

the Potassium content of the samples when compared to that of the control. There is, however, an increase in sodium content of all treated samples with a peak value obtained on the 20th day of fermentation.

The effect of microbial treatment on the different cell wall component of the Rice husk is shown in Figure 2. A significant reduction ($P < 0.05$) in the NDF, ADF and Hemicellulose was observed through-

out the study period when compared to the control experiment. Day 40 recorded the least value in all cell wall components measured.

Discussion

The increase in crude protein especially during the first 10 days might have resulted from the fermentation by other substrates by the microbe used in this study. The growth of the organism lead to lost of nutrient, the enabling environment becomes depleted gradually. This then accounts for the initial rate of increase in the crude protein observed in our result. Increase in crude protein content as a result of microbial treatment has been reported previously (Belewu and Okhwere, 1997; Yang et al., 1993 and Smith et al., 1996).

Reduction in the ether extract value obtained was similar to the value obtained by Abu (1) in the improvement of sweet potato using *Aspergillus niger*. This reduction might be as a result of conversion of ether extract to energy to provide the necessary nutrients needed for the solid-state fermentation process (Nishimura and Beevers, 1979).

Other reports on reduction in crude fibre value were probably due to the activities of fungal enzymes which degraded the non-cellulosic wall polysaccharides of the rice husk. Similar result was obtained by Smith et al. (1996) when wheat bran was degraded with *Trichoderma reesei*. According to Coey and Robinson (1955) the difference between Nitrogen free extract and crude fibre as source of useful energy to animal is primarily of comparative digestibility. Increase in Nitrogen free extract as observed in our work is in agreement with the findings of Onilude (1994).

The rise in value of energy content of

the substrate during the period of study was in line with the findings of Graham et al. (1990) and Ogunlayi (1995). Inconsistency in the value of the energy obtained during biodegradation of the rice husk followed similar pattern observed by Eruvbetine and Adegboyega (1996) during the biodegradation of cassava. Sijtsma and Tan (1993) opined that the product of the biodegradation (simple sugars) might limit the activities of the microbe used.

With the cell wall component, the rate of Neutral detergent, Acid detergent and hemicellulose loss was even throughout the fermentation period. The rate of loss of these fibre components was highest on the 20th day. This might probably be associated with the period of active growth of the organism, which might have to do with the sufficiency of conditions for the best performance of *Trichoderma viridii*.

Dietary phytate is known to reduce the availability of Calcium, Zinc, Magnesium, Iron, Manganese and Copper among others (Davies and Nightingale, 1975). Since the degradation of phytic acid decreases over days with the introduction of dietary enzymes, then the mineral content might necessarily increase. While potassium content of the degraded samples was on the increase, the sodium content was on the rise. This could be supported with the results of Macedo and Makata (1997) that observed a similar trend while working on cheese ripening.

Conclusion

This study has shown that nutritional improvement of rice husk is possible and the inclusion of it's subsequently biodegraded product in animal feed can be pursued with expected better utilization.

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