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BIODELIGNIFICATION OF RICE HUSK AND SORGHUM STOVER BY EDIBLE MUSHROOM (*Pleurotus sajor caju*)

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Target Audience: Local farmers, livestock researchers

ABSTRACT

Edible mushroom, *Pleurotus sajor caju* was grown at 37°C in solid state culture on rice husk and sorghum stover. The rice husk and stover had 5.66% and 8.45% permanganate lignin and holocellulose fraction of 50.54 and 72.68% respectively. After three weeks, the fungi produced a solid residue from the two agricultural wastes with higher crude protein and ash contents ($P < 0.05$) and low hemicellulose, lignin and cellulose contents. The fungi decreased lignin content by 31.86% of the original value of rice husk and 39.05% for sorghum stover. There was a higher in-vitro dry-matter enzymatic digesti-bility (IVDMED) than the original samples but the best value was recorded for rice husk (23-28%) compared to sorghum stover (15-20%). The increased IVDMED was positively correlated with lignin, hemicellulose and lignin losses. The fungus showed a preference for hemicellulose over cellulose.

The results revealed that treatment of rice husk and sorghum stover with edible mushroom (*Pleurotus sajor caju*) degraded the cellwall and enhanced the availability of energy and fungal protein.

Key words: Rice husk, sorghum stover, delignification, edible mushroom.

DESCRIPTION OF PROBLEM

Ruminants make great contributions to the nutritional well-being of Nigerians. The animals are usually fed on poor quality forages, crop residues and pastures produced on infertile land and thus do not compete with man for staple food.

Rice husk and sorghum stover are agricultural wastes which are available in Nigeria in large quantities (1). After the removal of the grains from the plant, the husk, bran and the stover constitute a nuisance to the environment. There is limitation to their consumption by livestock due to their high fibre content. But these wastes could be used as a source of lignocellulosic biomass for animals if treated with fungus (*Pleurotus sajor caju*).

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Belewu (2) and Belewu and Okhawere (1) have reported on the delignification and nutritive values of rice husk and sorghum stover treated with *Trichoderma harzanium*. These workers found that the crude protein contents of the treated plant residues increased while the fibre fractions were significantly reduced. The fungal-treated diet fed to sheep resulted in higher weight gain and improved feed efficiency. In view of the paucity of information on this vital subject, it was necessary to design an experiment to examine the possible influence of edible mushroom (*Pleurotus sajor caju*) on the structural and nutritive values of rice husk and sorghum stover.

MATERIALS AND METHODS

The rice husk and sorghum stover used in this study were obtained from a rice milling plant and the University of Ilorin research farm, respectively. They were collected and sun-dried to a moisture content of about 6 to 7% and packed in plastic ventilated bags.

Incubation procedure: The fungus *Pleurotus sajor caju*, was kept on potato dextrose agar plus 3% yeast extract in a culture macarthy bottle for about 5 to 6 days at ambient temperature (37°C). It was transferred to a petri dish of 4.4cm diameter with the same medium. Usually, it took 10 days at ambient temperature to cover the whole surface. One sixth (0.02kg) of the pure fungus was used to inoculate about 50gm of the wet substrate which had previously been sterilized for 30 minutes at 121°C. Duplicate samples of each inoculated substrate were left for 6 weeks at ambient temperature until fungal growth had completely covered the substrate surface. The inoculated substrates were watered regularly so as to provide a humid environment for the growing mycelia. The entire treated samples were dried at 70°C in a forced-air laboratory oven to terminate the growth.

Chemical Analysis

After drying, all the samples were milled in a Norris Wiley mill with 0.84mm sieve and the following analysis were carried out: Crude protein, crude fibre and ether extract, using A.O.A.C(3) method while acid detergent fibre, neutral detergent fibre, cellulose and lignin were determined following Van soest and Roberson (4) techniques. The in-vitro dry matter enzymatic digestibility (IVDMED) which represents percentage loss due to enzymatic action was determined according to the method of Dowman and Collins(5).

Statistical analysis

Analysis of variance was determined using the F-test. Treatment effects and the deviation of the treatment means from the general means were evaluated using the F statistics.

RESULTS AND DISCUSSION

The analytical data of the lignocellulosic waste are presented in Table 1. The holocellulose fraction amenable to enzymatic hydrolysis, represented 21.90% (dry weight) for rice husk and 72.68% (dry weight) for sorghum stover. The crude protein content for sorghum stover was lower than value representatives of maize, rice grain, sorghum grain and *stylosanthes*, which usually are in the range of 6-2%% (NRC) (6). The fibre fractions (ADF NDF, cellulose and lignin) for both rice husk and sorghum stover are similar to that of straw.

Table 1: Lignocellulose fractions of original rice husk and sorghum stover before inoculation

Component	% (dry matter)	
	Rice husk	Sorghum stover
Neutral detergent fibre (NDF)	80.50	72.30
Acid detergent fibre (ADF)	71.80	51.50
Permanganate lignin	5.65	8.45
Cellulose	15.00	31.85
Hemicellulose	6.90	20.80
Holocellulose	21.90	72.68
Crude protein (N x 6. 25)	6.10	5.10

With the analysis of the solid samples from each treatment and the corresponding solid yields, a mass balance of the fibrous fraction was made. The resulting data are shown in Table 2 for rice husk and sorghum stover expressed in percent changes relative to the original sample values. The effect of fungal treatment gave average losses of 31.86 and 25.05% for lignin in rice husk and sorghum stover respectively. These losses fall within expected values. Using eight white rot fungi strains, Zadrazil and Brunnert (9) reported up to 54% degradation by *pleurotus florida* in wheat straw, *P. florida* biodegraded 60.3 and 21.6% in sunflower hulls and rice husks respectively and *P cornucopiae* degraded 68.1 and 59.6% respectively.

Table 2: Changes in the Proximate composition and lignocellulose fractions of samples after inoculation at 37°C for 42 days

Component	Rice husk (%)	Sorghum stover (%)
Crude protein	7.95	10.80
Crude fibre	10.90	26.30
Ether extract	0.28	1.58
Ash	34.68	20.40
Gross Energy (M.Cal/kg)*	2.89	3.60
Lignin loss	31.86	25.05
Hemicellulose loss	76.81	63.74
Cellulose loss	31.33	20.80

**Calculated from the proximate composition.*

Practically, the fungus showed a preference to degrade hemicellulose over cellulose and sorghum stover over rice husk. The ratios of lignin to hemicellulose losses and lignin to cellulose losses were on the average: for rice husk 0.41 and 1.0; for sorghum stover 0.39 and 1.2. Kirk and Moore (10) first reported that lignin removal by White rot fungus from Aspen and Birch woods was always accompanied by the removal of polysaccharides, although not necessarily correlated with removal of any particular fraction. The results of this study agree with the observations by these authors. The report of Reid (11) however contradicts the observations here in which cellulose was removed in preference to hemicellulose, but our results corroborate the report of Sanni (12).

Lignin is not only a bind-component of the lignocellulose matrix, it also forms part of the lignin carbohydrate complex stabilized by phenolic acid (ferulic, 4 - coumaric acid) and acetyl constituents of the cell wall (7). Hence, it was not unexpected to have the fungus degrading about the same amount of cellulose and lignin. The lignin - carbohydrate complexes are usually chemically modified during microbial attack and are not recovered in the acid detergent residue (7).

The Invitro dry matter enzymatic digestibility (IVDMED) values for rice husk and sorghum stover are shown in Table 3. The fungus produced values that were significantly ($P < 0.05$) different from the control. There was a positive correlation between increase in IVDMED and weight loss ($r_2 = 0.81$) and this could be due to structural polymer modification and defiberization (2). The IVDMED values reported here followed a similar pattern with those reported elsewhere (8) while the increased IVDMED could be due to higher lignin loss of between 25-32%.

Table 3: In vitro dry matter enzymatic digestibility (IVDMED) for the rice husk and Sorghum stover

SUBSTRATES	RICE HUSK		SORGHUM STOVER	
	Untreated	Treated	Untreated	Treated
IVDMED	12.59[a]	55.82[b]	10.50[a]	43.23[c]
Weight loss (g)	0	25.50	0	32.25

Means followed by different superscripts are significantly different from each other ($P < 0.05$).

The range of experimental weight losses observed for rice husk and sorghum stover were in general slightly higher than expected. Other reports (2) have shown, for instance that in 40 days at 32°C *Trichoderma harzanium rifai* degraded 57% dry matter in rice husk. Somewhat higher weight losses have been reported for cereal straws with some specific White rot fungi. For example, with wheat straw in 17 weeks at 30°C *Pleurotus cornucopiae* degraded

60 to 65% dry matter and *P. florida* degraded 45% while in 7 weeks at 22°C, *P. florida* degraded 26.3% dry and *P. eryngl.* degraded 10.6% (8).

CONCLUSION AND APPLICATION

1. The study revealed that treatment of rice husk and sorghum stovers with *Pleurotus sajor caju* enhanced ($P < 0.05$) their crude protein contents while the fibre fractions were reduced.
2. The higher crude protein and energy contents of the treated agricultural wastes (rice husk and sorghum stover) due to the predigestion ability of the fungus, made the wastes to be beneficial thereby increasing their nutritive value, minimizing the amount of waste produced and solving the problem of environmental pollution.
3. The application of this technique helps in the conversion of crop residues into animal feeds thereby improving their preservation and utilisation by livestock.
4. Finally, it must be realised that the types of bonds hydrolysed, and new compounds synthesised by the fungus, and physical characteristics of the residues play vital roles in determining the extent and rate of further enzymatic hydrolysis either in rumen or otherwise.

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