IMPROVING NUTRITIONAL QUALITY OF SOME FIBROUS AGRICULTURAL WASTES USING WHITE ROT FUNGI (*PLEUROTUS PLUMONARIUS)*

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ABSTRACT
A 30-day study was carried out to convert separately milled cocoa pod (CP), cowpea husk (CH) and corn cobs (CC) to a value added ruminant feed employing white rot fungus, (Pleurotus plumonarius) through a solid state fermentation procedure. Chemical composition of resulting substrates were determined. Results revealed significant ($p<0.05$) differences in the values of the proximate composition and fibre fractions. The dry matter and crude protein ranged from 91.33 to 92.40% in CC and CP, and 4.83 to 6.69% in CC and CH respectively for undegraded samples, while it ranged from 46.17 to 65.51 in CC and CH, and 9.31 to 10.27% in CP and CH respectively for the biodegraded agricultural wastes. It was observed that fermentation with Pleurotus plumonarius increased the crude protein content significantly ($p<0.05$). Same trend was observed for ether extract and ash content. The fibre fractions of CP, CH and CC were reduced by biological treatment with Pleurotus plumonarius. The neutral detergent fibre (NDF) reduced from 60.39 to 50.23%, 53.47 to 50. 43% and 52.85 to 50.26% in CP, CH and CC respectively. Same trend was observed for ADF and ADL. It can be concluded that the white rot fungal treatment of CP, CH and CC improved chemical composition, therefore CP, CH and CC has potential in livestock nutrition. Also the problem associated with disposal of agricultural wastes can be conveniently reduced by incorporating these wastes into ruminant feed,

Key words: agricultural wastes, chemical composition, nutritional quality, Solid State Fermentation, white-rot fungus

INTRODUCTION

Feeding in animal husbandry accounts for 60 -70% cost of production (Thirumalaisamy *et al.*, 2016). Grasses are the bulk of feed for ruminants, which are available in abundance with high nutrients during the lush season, animals are fattened during this period with less cost. These grasses soon become scarce, lignified and low in nutrients during the dry season. Feed shortage during the dry season has been identified as a critical factor, especially in the humid and sub-humid regions (Konlan *et al.*, 2012). The animals are left with crop residues and agricultural wastes which could not meet their nutrient requirements nor sustain them (Ogunbosoye and Babayemi, 2008).

Agro-industrial wastes are mostly untreated and underutilized such as rice bran, maize bran, cassava peels, brewer grain, palm kernel wastes, cocoa pods and shells and cowpea husk or shell. Agricultural wastes have become a significant source of pollution to the environment (Abiola-Olagunju, 2020). The random burning of wastes such as straw and livestock dung in the Agrarian countries has led to series of environmental problems (Wang *et al.*, 2016) such as water, air and soil pollution. The increasing quantity of wastes and its inadequate removal especially in developing countries have always been a major threat to human health and has serious effect on the safety of environment, this has also contributed greatly to the global greenhouse emissions in developing countries (Dedinec *et al*., 2015).

Biodegradation is the process by which organic substances are broken down into smaller compounds by living microbial organisms (Bennet *et al*., 2002). There are a number of agricultural wastes that are yet to be exploited as ruminant feed. The wastes are important because they are cheap and cannot be consumed by man, hence it will reduce the cost of feeding especially during the off season when grasses are almost not available.

Therefore this research presents a study on value addition to the nutritive benefits of cowpea husk, cocoa pod and corn cob by white rot fungi i.e. *Pleurotus pulmonarius* in a 30-day Solid State Fermentation, as feed supplements for ruminants in Nigeria.

MATERIALS AND METHODS

Sample collection

Dry samples of cowpea husk, corn cobs and cocoa pods were obtained from Oke-Aje market Ijebu-Ode. Samples were milled and treated in the oven at 65^0 C to constant weight for dry matter determination.

Substrate preparation

Pleurotus plumonarius was obtained from the Federal Institute of Industrial Research Oshodi (FIIRO), Lagos State, Nigeria. Using the procedure of Jonathan and Fasidi, cited by Akinfemi *et al*. (2009); these were tissue cultured to obtain fungal mycelia. The pure culture obtained were then maintained on plates of potatoe dextrose agar medium at 25^0Cuntil used. Jam bottles were used for biodegradation. They were washed, dried for 10 min at 100^0C. Twenty five grammes (25 g) of the dried substrate was weighed into a bottle and 70 mL distilled water added. The bottles were immediately covered with aluminium foil and sterilized in the autoclave at 121^0C for 15 minutes (Akinfemi *et al*., 2009). Each treatment was replicated thrice.

Inoculation

Each bottle was inoculated at the centre and surface of the substrate with two 15 mm mycelia disc and covered immediately. Bottles were kept in a dark cupboard in the laboratory at 30^0 C and 100 % relative humidity. On the 30th day of inoculation, the experimental bottles were autoclaved again to terminate mycelia growth. Biodegraded samples were then oven dried to constant weight and withdrawn for chemical analysis

Chemical composition

Dry matter (DM), crude protein(CP), crude fibre (CF), ether extract (EE) and ash were determined by the standard procedure of AOAC (2012). Also, another set of samples were analyzed for fibre, [neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) by the procedure of Van Soest *et al.* (1991). All analysis was replicated thrice.

Statistical analysis

Data obtained were analyzed by ANOVA procedure of SAS (2012) and significant different means separated by Duncan's multiple range tests of the same software.

RESULTS AND DISCUSSION

Presented in Table 1 is the chemical composition of undegraded cocoa pods (CP), cowpea husk (CH) and corn cobs (CC), while the chemical composition of *Pleurotus plumonarius* degraded CP, CH and CC is shown on Table 2.

Table 1: Chemical composition (%) of undegraded cocoa pods, cowpea husk and corn cobs

Substrates	DM	CP	CF	EE	ASH	NDF	ADF	ADL
Cocoa pods	92.40^a	6.16^b	24.58^a	1.88^a	8.39^a	60.39^a	47.09^a	23.18^a
Cowpea husk	91.92^b	6.69^a	23.10^b	1.18^c	8.21^b	53.47^b	45.01^b	21.92^b
Corn cobs	91.33^c	4.83^c	20.37^c	1.62^b	6.24^c	52.85^c	31.92^c	13.53^c
SEM	0.05	0.02	0.02	0.01	0.03	0.20	0.10	0.10

Table 2: Chemical composition (%) of *Pleurotus pulmonarius* degraded cocoa pods, cowpea husk and corn cobs

Substrates	DM	CP	CF	EE	ASH	NDF	ADF	ADL
Cocoa pods	50.41^b	9.31^b	21.00^b	3.50^b	9.70^b	50.23^b	32.04^b	12.53^b
Cowpea husk	65.51^a	10.27^a	21.21^a	2.61^c	10.20^a	50.43^a	33.48^a	14.69^a
Corn cobs	46.17^c	9.45^b	20.01^c	4.00^a	6.80^c	50.26^b	30.16^c	11.34^c
SEM	1.05	0.05	0.50	0.05	0.10	1.05	0.50	0.35

It was observed that all parameters investigated differed significantly ($p<0.05$) among the treatment means. The dry matter (DM) of undegraded samples ranged from 91.33 to 92.40% in CC and CH respectively. This result is in agreement with the findings of Ettu and Mako (2020), who reported a

value range of 85.5 -92.18% DM for some crop residues. The CP ranged from 4.83 to 6.69% in CC and CH respectively. This result is comparable to findings elsewhere (Ettu and Mako, 2020).

The DM and CP of *Pleurotus plumonarius* degraded CP, CH and CC ranged from 46.17 - 65.51% and 9.45 – 10.27% in CC and CH respectively. It was observed that *Pleurotus plumonarius* enhanced the nutrient content of the agricultural waste samples. The CP value of cocoa pods obtained in this study increased from 6.69 to 10.27 %, this result is comparable to the findings of Laconi and Jayanegara (2015) who reported a value increase of 8.4 to 10.0% for cocoa pods using chemical and biological treatments. The CF (24.58%) obtained here for undegraded cocoa pods is lower than the value (55.7%) reported by

Laconi and Jayanegara (2015), but *Pleurotus plumonarius* (Pp) still reduced the CF here to 23.10%. Same trend was observed for ether extract and ash, Pp increased their values significantly ($p<0.05$).

The DM, CP, EE, CF and ash obtained in this study for undegraded and degraded cowpea husk was lower and at variance with the findings of Abiola-Olagunju *et al*., (2020), however degrading CH with Pp increased the CP content here from 6.69 to 9.31%. This was probably due to the mycelia growth of the fungus, which increased the concentration of protein (Ghorai *et al*., 2009).

Same significant pattern of increase in nutrient content was observed for undegraded and degraded corn cobs. Values obtained for degraded were similar to the findings of Khonkhaeng and Cherdthong (2020).

Fermenting CP, CH and CC with *Pleurotus plumonarius* reduced the values of NDF, ADF and ADL significantly ($p<0.05$). This could be an indication of cell wall breakdown by *Pleurotus plumonarius.* The values of NDF, ADF and ADL reduced from 60.39 to 50.23% , 53.47 to 50.43% and 52.85 to 50.26% ; 47.09 to 32.04% , 47.09 to 33.48% and 31.92 to 30.16%; 23.18 to 12.53%, 21.92 to 14.46% and 13.53 to 11.34% in cocoa pods, cowpea husk and corn cobs for NDF, ADF and ADL respectively. This fungus was able to increase the nutrient of agricultural waste samples by lowering its cell wall consistency (Khonkhaeng and Cherdthong, 2020).

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