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RESEARCH ARTICLE

INFLUENCE OF WHITE ROT FUNGI DEGRADATION ON THE NUTRITIONAL VALUE OF CASSAVA PEELS

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ABSTRACT

The study was carried out to assess the influence biodegradation on the nutritive value of cassava peels. Cassava peels were obtained from a 'gari' processing mill in Makurdi and sun-dried for a period of seven days to reduce the moisture content to less than 10 %. The dried cassava peels were milled using a hammer mill. Five hundred kilograms (500kg) of milled cassava peels were moistened with water on a concrete floor and covered with cellophane sheet and allowed to ferment for two weeks. Dried *Pleurotus tuber-regium* (mushroom) was soaked in water for 24 hours in a basin, transferred into a clean basin and allowed to grow mycelia. After the completion of the composting process, the fermented substrate was transferred to inoculation trays (60 cm x 180 cm) and allowed to cool for one hour; the trays were subsequently inoculated with the active mycelia of the mushroom. At the end of the degradation period (30 days), the biodegraded cassava peels were sundried until the substrate attained less than 10 % moisture content. The result shows that P. *tuber-regium* degraded cassava peels was significantly ($P < 0.05$) higher in dry matter, crude protein, crude fibre, ash and ether extract compared to un-degraded cassava peels: CP content was 5.41 % for UDCP and 6.04 % for BDCP, CF content was 15.40 % and 17.40 %, Ash content was 15.60 % and 19.20 % while DM was 93.70 % and 94.70 % for UDCP and BDCP, respectively. The NDF fraction was 65.82 % and 62.39 % for UDCP and BDCP, respectively while ADF was 28.18 % and 29.40 %, ADL was 11.12 % and 10.15 %, Hemicellulose was 37.64 % and 32.99 % and cellulose was 17.06 % and 19.25 % for UDCP and BDCP, respectively. The result shows a significantly ($P < 0.05$) decrease in the level of NDF, ADL and Hemcellulose after degradation whereas ADF and Cellulose component increase significantly ($P < 0.05$). it was concluded that biodegradation of cassava peels with *Pleurotus tuber-regium* enhanced its nutritive value.

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INTRODUCTION

Agricultural by-products are carbohydrate-rich residues which represent a potential source of dietary energy for ruminants. Cassava peels has become an important by-product in Nigeria and is available from the local processing of cassava root for gari as well as from the newly introduced large scale plants producing gari and starch (Iyayi and Tewe, 1994). Cassava peels have been found as a source of energy in ruminant feeding system, serving either as the main basal diet or as supplement (Asaolu and Odeyinka, 2006) However, their feed value is limited by the low polysaccharide degradation achieved during rumen digestion (Sundstol and Owen, 1984). The digestibility of these materials is limited by the presence of lignin which prevents access of hydrolytic enzymes to cellulose and hemicellulose. Various works on pretreatment mechanism ranging from delignification, saccharrification, irradiation with high electron, subdivision into micro size particles and steeping in alkali which provide enhanced utilization of food carbohydrate by bacterial enzymes have been reviewed (Millet *et al.,* 1970, Benvink and Mulder, 1989). Biological treatments include the use of microbial proteins, antibiotics, probiotics, enzymes, and ensiling etcetera. These constitute the most recent methods of enrichment of non digestible feedstuffs or those imbued with the well known anti-nutrients. Dierick (1989) emphasized that polyphenols such as tannins are not removed by physical or chemical treatments but by fermentation or germination. Even, the nutritive value of maize in form of lysine and tryptophan contents leading to improvement in biological value and utilizable protein was achieved through germination, (Ram *et al.,* 1979). Besides ensiling, the most recent additive for improving silage quality

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is the biological aid. Microorganisms both aerobic and anaerobic are able to produce extracellular enzymes to degrade macromolecules like starch, cellulose, hemicellulose, lignin and pectin of the plant cell (Priest, 1984) as well as proteins and other membrane constituents. Lignin-degrading microorganisms have potential for selective delignification of lignocellulose agricultural by-products. Various white rot fungi have been studied for the purpose of selective delignification of straw as an alternative to chemical and physical pre-treatments (Zadrazil and Brunnert, 1981).

It has been reported that several strains of white-rot fungi remove lignin with limited degradation of cellulose and hemicellulose (Agosin and Odier, 1985). White-rot fungi, such as edible mushrooms, can degrade fibrous crop residues and by-products, whereby, not only the digestibility of lignocellulose but the nutritional value also increases. Edible mushrooms are able to bioconvert a wide variety of lignocellulosic material due to the secretion of extra cellular enzymes (Chang and Buswell, 1996). Evidence (Belewu and Belewu, 2005) showed that the bioconverted materials have higher content of protein and a decrease in fiber and can be used as ruminant feed supplement (Mahrous, 2005). The natural microbial delignification of wood dust (Zadrazil *et al.,* 1990) testifies to the great potential of white-rot fungi (edible mushroom) in degrading lignocelluloses, leading to enhance utilization of animal feed. The incorporation of fungal treated wastes along with other feeds in the diet of small ruminants can offset the dry season shortages of pastures. Lignocellulose consists of lignin, hemicellulose and cellulose. Because of the difficulty in dissolving lignin without destroying it and some of its sub units, its exact chemical structure is difficult to ascertain (Howard *et al.,* 2003). In general, lignin contains three aromatic alcohols (Coniferyl alcohol, Sinapyl and P-Coumaryl). Lignin is further linked to both hemicellulose and cellulose. Forming a physical seal around the latter two components is an impenetrable barrier preventing penetration of solution and enzymes. Lignin is the most recalcitrant to degradation whereas cellulose, because of its highly ordered crystalline structure, is more resistant to hydrolysis than hemicellulose. Alkaline (Chahal, 1992) and acid (Nguyen 1993) hydrolysis methods have been used to degrade lignocellulose. Weak acids tend to remove lignin but result in poor hydrolysis of cellulose whereas strong acid treatment occurs under relatively extreme corrosive conditions of high temperature and pH which necessitate the use of expensive equipment. Also, unspecific side reactions occurs which yield non-specific, by-products other than glucose, promote glucose degradation and therefore reduce its yield.

In a recent review, Malherbe and Cloete (2003) reiterated that the lignocellulose potential of cellulose is encrusted by lignin within the lignocelulose matrix. They expressed the opinion that a combination of solid state fermentation (SSF) technology with the ability of an appropriate fungus to selectively degrade lignin will make possible industrial scale implementation of lignocellulose-based biotechnologies. This study was conducted to assess the effect *Pleurotus tuber-regium* degradation on the nutritive value of cassava peels meal.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Livestock Teaching and Research Farm of University of Agriculture, Makurdi. Makurdi is the capital of Benue State and is located on longitude 8^{o} 37^{1} East and latitude 7^{o} 41^{1} North, with annual rainfall ranges from 609.9 mm – 1219.8 mm, temperature ranges from 25.6 ^{o}C -39.6^{0}C and relative humidity of about 21 % - 85 % (TAC, 2011).

Fungal Treatment of Cassava Peel (on-farm condition)

Cassava peels were obtained from a 'gari' processing mill in Makurdi and sun-dried for a period of seven days to reduce the moisture content to less than 10 %. The dried cassava peel was milled using a hammer mill. Five hundred kilograms (500kg) of milled cassava peels were moistened with water on a concrete floor and covered with cellophane sheet and allowed to ferment for two weeks as described by Akinfemi *et al*. (2011). *Pleurotus tuber-regium* (mushroom) was purchased from Makurdi Modern Market and soaked in water for 24 hours in a basin. The wet mushroom was then transferred into a clean basin and allowed to grow mycelia. After the completion of the composting process, the fermented substrate was transferred to inoculation trays (60 cm x 180 cm) and allowed to cool for about one hour; the trays were subsequently inoculated with the active mycelia of the mushroom as described by Akinfemi *et al*. (2011). At the end of the fermentation period (30 days) the treated cassava peels were sundried until the substrate attained less than 10 % moisture content.

Chemical Analysis

The untreated cassava peels and treated cassava peels were analyzed for organic matter and nitrogen by AOAC (1995) procedure, while Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) were determined according to the method of Van Soest and Robertson (1980).

Statistical Analysis

Data obtained from this study were subjected to one - way analysis of variance (ANOVA) using Minitab Statistical Software (Min-Tab, 1991)

RESULTS

Proximate composition and fibre fraction of undegraded (UDCP) and bio-degraded cassava peels are presented in Table 1. Bio- degraded cassava peels (BDCP) was significantly ($P < 0.05$) higher in dry matter, crude protein, crude fibre, ash and ether extract, but significantly ($P < 0.05$) lower in NFE than un-degraded cassava peel. The CP content was 5.41 % for UDCP and 6.04 % for BDCP. The CF content was 15.40 % and 17.40 %, Ash content was 15.60 % and 19.20 % while DM was 93.70 % and 94.70 % for UDCP and BDCP respectively.

Table 1. Proximate Composition and Fibre Fraction of Undegraded and Bio-degraded Cassava Peels (%) (DM)

	UDCP	BDCP	SEM
Dry Matter	93.70[b]	94.70[a]	0.091
Crude Protein	5.41[b]	6.04[a]	0.006
Crude Fibre	15.40[b]	17.40[a]	0.091
Ether Extract	0.65[b]	1.10[a]	0.028
Ash	15.60[b]	19.20[a]	0.091
Nitrogen Free Extract	56.64[a]	50.96[b]	0.055
NDF	65.82[a]	62.39[b]	0.190
ADF	28.18[a]	29.40[a]	0.083
ADL	11.12[a]	10.15[b]	0.022
Hemicellulose	37.64[a]	32.99[b]	0.023
Cellulose	17.64[a]	19.25[a]	0.012
Calcium	0.62[b]	0.75[a]	0.012
Potassium	0.05[a]	0.004[b]	0.004

[ab] Means on same row with different superscripts differ significantly (P<0.05)
UDCP=Undegraded cassava Peel
BDCP= Biodegraded cassava peel (*Pleurotus tuber regium)*
NDF=Neutral Detergent Fibre
ADF=Acid Detergent Fibre
ADL=Acid Detergent Lignin

The NDF was 65.82 % and 62.39 %, ADF was 28.18 % and 29.40 %, ADL was 11.12 % and 10.15 %, Hemicellulose was 37.64 % and 32.99 % while cellulose was 17.06 % and 19.25 % for UDCP and BDCP respectively. The result shows a significantly (P < 0.05) decrease in the level of NDF, ADL and Hemcellulose after degradation and increase in ADF and Cellulose component of BDCP.

DISCUSSION

It was observed that *P. tuber-regium* degraded cassava peels was significantly (P < 0.05) higher in dry matter, crude protein, crude fibre, ash, ether extract, ADF and cellulose, and significantly (P < 0.05) lower in NFE, NDF, ADL and hemicelluloses compared to un-degraded cassava peel. The nutritional improvement observed in BDCP may be explained on the basis that the cassava peel served as the medium for metabolism and subsequent growth of the inoculated organism. Besides, the organism (*P. tuber-regium)* could have depolymerised the NDF, ADL and hemicellulose therein and then converted the products to other useful components such as protein, cellulose and other useful nutrients as reported by Liu and Baidoo, 2005 and Lawal *et al.,* 2011. The increase in the crude protein value could be partly due to ability of the fungi to increase the bioavailability of the protein hitherto encapsulated by the cell walls. Liu and Baidoo, (2005) reported that Fungal enzymes have the potential of improving not only the non-starch polysaccharides (NSP) but also the crude proteins as well as other dietary components such as ash and fatty acids. The increase in ash content of the degraded cassava peels is in agreement with Akinfemi *et al*. (2011) who reported improved value for ash when maize husk was degraded using different species of white rot fungi. This means more minerals and vitamins were made available. The fibre fraction shows decrease in the level of NDF, ADL and Hemcellulose after degradation and increase in ADF and Cellulose component. Similar reports of reduction in some proximate components and increase in others have been reported (Akinfemi *et al*., 2011; Sabry, 2007). The decreased values NDF, ADL and Hemcellulose might be due to delignification of lignocelluloses complex and its utilization by microbes during fermentation (Van Soest *et al*., 1991). According to Sarklong *et al.* (2010), some white rot fungi preferably attack lignin without degrading cellulose and hemicelluloses. In this study it appears that the fungi (*P. tuber-regium)* did not degrade cellulose leading to more cellulose content in the degraded cassava peels than un-degraded cassava peels.

Conclusion

The bio-degradation of cassava peels by *Pleurotus tuber-regium* increased its nutritional value. It is therefore recommended that this technology be adopted to improve the nutritional values of crop residues and agricultural by-products for ruminant feeding.

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