CHEMICAL AND PHYTOCHEMICAL CONSTITUENTS OF WHITE ROT FUNGI (*Pleurotus ostreatus*) BIODEGRADED SUGARCANE SCRAPINGS

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Abstract
An experiment was conducted to study the effect of the white rot fungi (*Pleurotus ostreatus*) degradation or solid state fermentation of sugarcane scrapings on the chemical composition and anti-nutritional constituents. Sterilised sugarcane scrapings were inoculated with *Pleurotus ostreatus* and allowed to ferment for 21 days. Biodegradation of sugarcane scrapings increased the crude protein, ether extract, ash, nitrogen free extract, metabolisable energy concentrations, and decreased dry matter, crude fibre, neutral detergent fibre and the secondary metabolites (saponins, oxalate, phytate, tannins and flavonoids) concentrations relative to the non-biodegraded sugarcane scrapings. Due to the increment in the crude protein and metabolisable energy concentrations, and reduction in the fibre and secondary metabolites concentrations, it is concluded that biodegradation of sugarcane scrapings with *Pleurotus ostreatus* can be used to enhance the nutritive potential of sugarcane scrapings.

Keywords: biodegradation, *Pleurotus ostreatus*, sugarcane scrapings, secondary metabolites, nutritive potential

Introduction
Agro-industrial by-products (AIBs) and crop residues are abundantly available in Nigeria due to increased crop cultivation to feed the ever rising human population. One of such AIBs is sugarcane scrapings (SS). Sugarcane scrapings are readily available waste produced from scraping the rind of the sugarcane stem with a sharp knife in order to provide easier access to the underlying, soft parenchyma tissue, when the cane is being processed for chewing to extract the cane juice. These scrapings are mostly heaped and sometimes burnt or left thereby constituting an environmental hazard. High energy and crude fibre (CF) but low crude protein (CP) contents have been reported for SC (Ayoade *et al*., 2007; Alu *et al*., 2012). The high CF and low CP of SC necessitates some form of treatments or processing to enhance the nutritive value. Biodegradation technique improves the nutritive quality of many poor quality farm wastes by reducing the fibre proportion and increasing the protein content, making the fibrous materials rich in soluble carbohydrates which are functional livestock nutrient (Dairo and Ogunmodede, 2001; Fasuyi *et al*., 2010; Oboh *et al*., 2012). Although biodegradation techniques such as enzymatic supplementation, solid state fermentation with fungi or microbial fermentation, etc. have been used to enhance the feed value of poor quality non-conventional ingredients used in livestock feed formulation, there is no report of the effect of solid state fermentation on the nutritive potential of SC. This study was, therefore, designed to evaluate the effects of solid state fermentation of SS on its chemical composition and anti-nutritional constituents.

Materials and Methods
Sugarcane scrapings were collected and sun dried on a clean floor to reduce the moisture content. 100 kg of the sugarcane scrapings were chopped to smaller pieces using a sharp cutlass to reduce the size to 2-3 cm. As described by Belewu *et al*. (2006) and Akinfemi *et al*. (2009), jam bottles were thoroughly washed and dried for 10 minutes at 100 ℃. 25.0 g of SS was weighed and put into each jam bottle, which was covered with foil and autoclaved at 121 ℃ for 15 minutes. Each bottle was then allowed to cool for about 18 hours in a sterile environment and inoculated at the centre of the substrate with two 10.00 mm mycelia disc and covered immediately. They were kept in the dark cupboard in the laboratory at 30 ℃ and 100% relative humidity. After 21 days of fermentation, the contents of the bottles were harvested and autoclaved again to terminate and prevent further biodegradation.

Phytochemical constituents (saponins, phytate, oxalate, condensed tannins and flavonoids) analyses were carried out according to procedures outlined by Harbone (1973); Boham and Kocipai- Abyazan (1974). Samples of treated and untreated SS were ground to pass a 1 mm sieve in a Wiley mill and stored for further analysis. Proximate analyses of samples were carried in accordance with the procedures of AOAC (2000). Neutral detergent fibre (NDF) was determined by the methods of Van Soest *et al.* (1991).

Results and Discussion

The crude protein (CP), ether extract (EE), ash, nitrogen free extract (NFE) and metabolisable energy of BSS were higher, while the DM, crude fibre (CF) and NDF were lower relative to USS (Table 1).

Table 1 Chemical composition of untreated and biodegraded sugarcane scrapings

Components	Sugarcane scrapings	
	USS	BSS
Dry matter	92.85	91.13
Crude protein (% DM)	8.33	11.67
Crude fibre (% DM)	30.43	21.06
Ether extract (% DM)	2.66	3.21
Ash (% DM)	7.20	8.92
Nitrogen free extract (% DM)	51.38	55.14
Neutral detergent fibre (% DM)	51.37	42.18
Metabolisable energy (MJ/kg DM)*	11.40	11.45

USS, untreated sugarcane scrapings; BSS, biodegraded sugarcane scrapings

*Calculated based on Alderman (1985): ME (MJ/kg DM) = 11.78 + 0.00654CP + (0.000665EE) 2 - CF (0.00414EE) – 0.0118Ash

The decrease in values of DM, CF, NDF and increase in values of crude protein, ether extract, ash, nitrogen free extract and metabolisable energy with biodegradation of SS are line with the previous results (Akinfemi, 2010) on biodegradation of peanut husk with two different strains of Pleurotus. Yilka (2015) also reported increased CP, EE and ash contents, and reduced fibre contents for white rot fungi biodegraded straw compared with untreated straw. It is noteworthy that biodegradation of SS increased the CP, EE, ash and NFE by about 40.1, 20.7, 23.9 and 7.34% respectively, and increased the CF and NDF by 30.1 and 17.9% respectively relative to the USS. The increased CP is perhaps the consequence of bioconversion of organic materials broken down into one of the fungi body components or the addition of microbial protein during fermentation process, in consonance with earlier reports (Belewu, 2008). The reduction in the fibre content of BSS is obviously the result of degradation of the cell wall component of the SS by the extracellular enzymes of the fungus. The reduced ash content of BSS may be due to the utilisation of fibre and other carbon sources (organic matter) for growth and delignification by the fungus. The increase in ash content of BSS could as well be explained by the correlated increase in fungal growth and fruiting bodies causing decreased concentrations of CF by 30.1% and NDF by 17.8% in BSS, in concurrence with the earlier observations of Bento *et al*. (2014).

Phytochemical analysis of the untreated and biodegraded sugarcane scrapings is shown below in Table 2. The following secondary metabolites: saponins, phytate, oxalate, condensed tannins and flavonoids were present in both untreated and BSS. Saponins (7.93 to 8.77 g/100 g DM), phytate (1.86 to 2.06 g/100 g DM), oxalate (0.11 to 0.21 g/100 g DM), condensed tannins (1.67 to 2.22 g/100 g DM) and flavonoids (4.49 to 6.50 g/100 g DM) were higher for the untreated sugarcane scrapings relative to the Pluerotus biodegraded sugarcane scrapings.

Table 2 Phytochemical constituents (g/100 g DM) of untreated and biodegraded sugarcane scrapings

Parameters	Sugarcane scrapings	
	USS	BSS
Saponins	8.77	7.93

Phytate	2.06	1.82
Oxalate	0.21	0.11
Condensed tannins	2.22	1.67
Flavonoids	6.50	4.49

USS, untreated sugarcane scrapings; BSS, biodegraded sugarcane scrapings

Generally, secondary metabolites give plants their therapeutic properties and are often referred to as bioactive constituents (Farnsworth, 1966). The decreases in the phytochemical constituents of the BSS are in tandem with previous reports of Gado *et al*. (2011) who observed decreases in the total phenolics, saponin and other phytochemicals after biological treatment of orange pulp with fungi. Yilkal (2015) also reported the ability of white-rot fungi to decompose free anti-nutritional factors in several crop residues and AIBs. Reduction in concentrations of phytochemical components due to biological treatment could be caused by metabolic processes of inherent microorganism's ability to secrete extracellular enzymes that degrade phytogenics (plant secondary metabolites) or anti-nutritional factors (Adeleke *et al*., 2017). Secretions of certain endogenous enzymes by certain microorganisms have been reported to enhance the degradation of certain recalcitrant substances such as plant secondary metabolites or anti-nutritional factors, in nature Adeleke *et al*. (2017).

Conclusion

It was concluded that biodegradation of sugarcane scrapings improved its nutritional value and adjusted its antinutrients within acceptable ranges.

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