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BIOTRANSFORMATION OF CASSAVA WASTE BY FUNGAL FERMENTATION

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Abstract
The biological treatment of cassava peels was done using Aspergillus flavus, Aspergillus funmigatus, Rhizopus stolonifer, Mucor mucedo and Penicillium notatum bringing about a decrease in the cyanide and an increase in the protein contents with peels fermented with the fungi Rhizopus stolonifer having best fermentative ability. The cyanide content decreased from 43.94 mg/kg to 10.85 mg/kg while protein content increased from 7.96% to 22.28%. There was also an increase in the percentage dry matter and ash contents of the fermented cassava peels when compared with the unfermented while a significant decrease in the carbohydrate, fat and fibre contents was observed. These findings showed that the nutritional composition of cassava peels characterized by high cyanide content, high carbohydrate content coupled with low protein and ash contents, improved when treated biologically with fungal isolates resulting in decrease in cyanide, carbohydrate and fat contents and increase in protein, dry matter and ash contents. The biological treatment of cassava peels with fungal isolates could be a good source of protein in livestock feeds and subsequent improvement in its nutritional quality.

Key words: Biological treatment, Cassava peels, Fungal isolates, Livestock feeds

Introduction

Agricultural wastes and their disposal has become an environmental concern worldwide when these wastes can be biodegraded to useful products (Shide *et al.*, 2004).These wastes are left unutilized, causing environmental pollution and health hazards and even those that are utilized do not have their full potentials harnessed (Iyayi and Aderolu, 2003). Increase in population and development, diversification of individual consumption, urban concentration, increase in the number of industrial units and the lack of treatment of garbage by satisfactory techniques can result into human health hazards (Ennouli, *et al.*, 2006). Larger percentage of agro-industrial products are generated from farm produce wastes, the bulk of which is dumped in sites where it serves as breeding ground for small mammals, reptiles and arthropods (Williams, 2001).

Fermentation is one of the oldest biotechnologies, having been used in food processing and preservation as well as beverages production for over 6,000 years (Motarjemi, 2002). The fermentation process of staples serves as a means of providing a major source of nourishment for large rural populations, and contributes significantly to food security by increasing the range of raw materials which can be used in the production of edible products (Adewusi *et al.*, 2003). Fermentation enhances the nutrient content of foods through the biosynthesis of vitamins, essential amino acids and proteins, by improving protein quality and fibre digestibility. It also enhances micronutrient bioavailability and aids in degrading anti nutritional factors (Achinewhu *et al.*, 2002).

Two important biological wastes, which are detrimental to the environment, are generated during the traditional processing of cassava starchy storage roots for garri production, namely, the cassava peels and the liquid squeezed out of the fermented parenchyma mash. Cassava peels derived from garri processing are normally discarded as wastes and allowed to rot in the open, resulting in environmental pollution and health hazards. Since these peels make up to 10% of the wet weight of the roots, they constitute an important potential resource for animal feeds if processed by fermentation since the peels contain toxic levels of cyanogenic glucoside (Tweyongyere and Katongole, 2002).

Nutritional enhancement of cassava peels using a mixed culture of *Saccharomyces cerevisiae* and *Lactobacillus spp*. has been studied by Oboh (2006).He reported a decrease in the cyanide and carbohydrate contents but increase in protein content of the peels after fermentation of garri. The biotransformation of algal waste by biological fermentation has been reported by Ennouali *et al.* (2006) The end product from the process can be integrated into animal feeds or used as fertilizer. The production of the enzyme, amylase from the bio- deterioration of selected agro-industrial wastes such as cassava peels, yam peels, cocoyam peels, banana

peels, plantain peels, rice bran using some fungi isolates such as *Geotrichum candidum, Mucor mucedo, Rhizopus stolonifer, Saccharomyces cerevisiae* and *Aspergillus spp.*, has also been reported by Akinyosoye *et al*.(2003) and Oboh (2005). Their study revealed that the isolates except G*eotrichum candidum,* demonstrated high amylolytic activity on the above listed agro- industrial wastes. Agro-industrial residues are generally considered the best substrates for fermentation process. A number of these substrates have been employed for the cultivation of microorganisms to produce host of enzymes (Baig *et al.*, 2004). This study aimed to utilize common fungal isolates in the biological treatment of cassava peels as well as evaluate the possible use of the end product as animal feed.

Materials and Methods

Cultivation of Fungal Isolates

The fungal isolates used were *Aspergillus flavus, Aspergillus funmigatus, Rhizopus stolonifer, Penicillium notatum* and *Mucor mucedo* obtained from the Microbiology Department, Federal University of Technology, Akure and maintained on Potato Dextrose Agar.

Preparation and Inoculation of Substrate

Fresh cassava peels were collected from Ibule Village in Akure, Ondo State washed, cut into small sizes and sun dried. After drying, the peels were grinded into powder using a Grinding Forty grams (40g) each of the substrate was weighed into 250mls conical flasks and 100mls of sterile water was added to moisten it. Then the substrates in the conical flasks were sterilized in the Autoclave at 121^{0}C for 15 minutes. After sterilization, fungal isolates mycelia were inoculated aseptically and the substrates fermented at 25^{0}C for 12 days.

Analysis

On days zero, 4, 8 and 12 of fermentation, samples were collected aseptically into sterile Petri dishes for analysis. The cyanide content of the fermented cassava peels was determined by Silver nitrate titration (Oboh *et al.*, 2002) and the nutritional composition by Cordenunsi *et al. (*2004**).** All readings were in triplicate and the results obtained subjected to analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT).

Results and Discussion

The high concentration of cyanogenic glucoside in cassava peels makes the peel unsuitable as animal feed. A significant decrease in the cyanide content was observed when fermented with *Rhizopus stolonifer* from 43.96mg/ kg on day zero to 10.85mg/kg on day 12 (Fig 1**).** The fungal isolates used were efficient in reducing the cyanide content of the cassava peels. Oboh (2006) reported that fermentation of cassava pulp with pure strains of

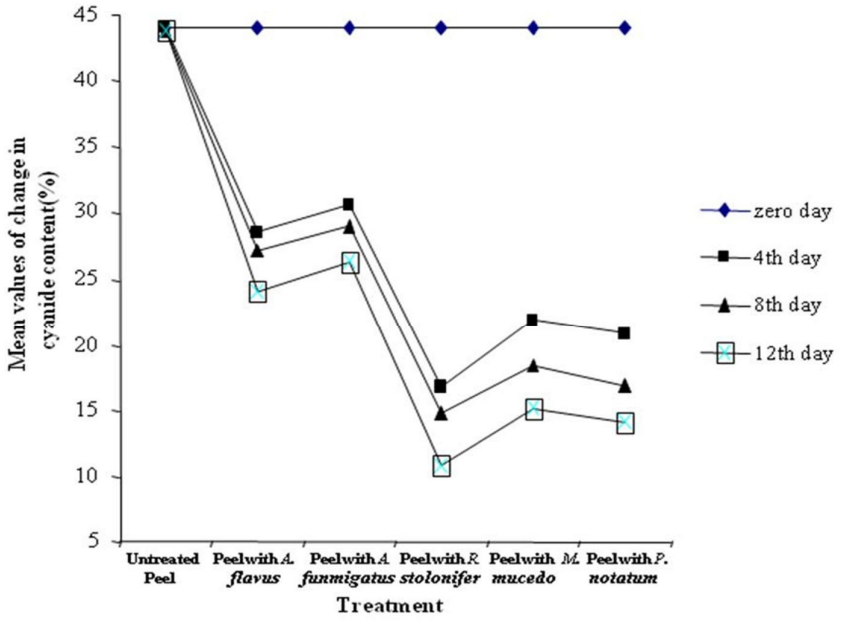

Figure 1. Changes in cyanide content of cassava peels during fermentation

Saccharomyces cerevisiae, Lactobacillus delbruckii and *Lactobacillus coryneformis* resulted in decrease in cyanide content from 44.6mg/kg to 6.2mg/kg while a mixture of these organisms gave enhancement in the nutrient composition of the peels making the fermented cassava peels safe in terms of cyanide poisoning which was below the deleterious level of 30 mg/kg (Tweyongyere and Katongole, 2002).

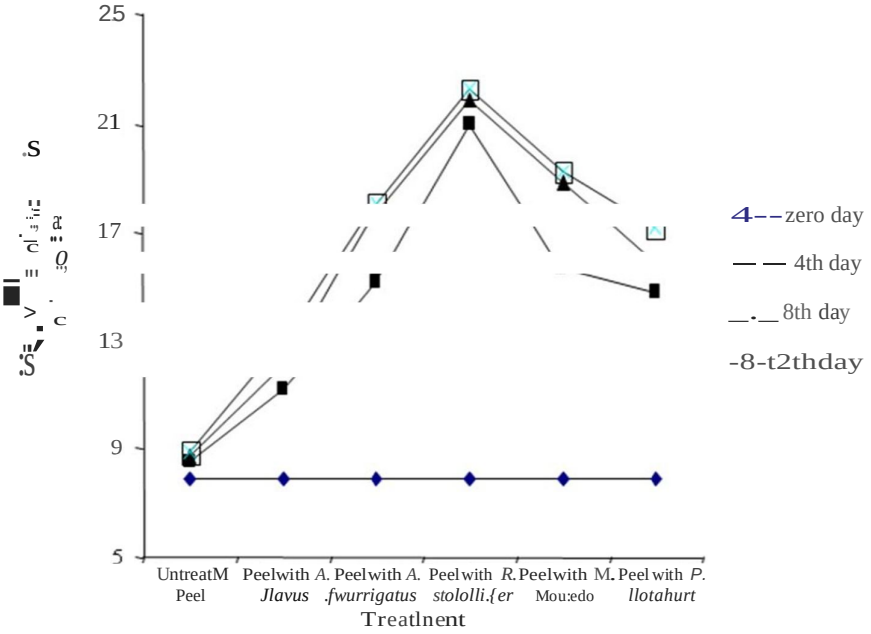

Figure 2. Changes in crude protein content of cassava peels during fermentation

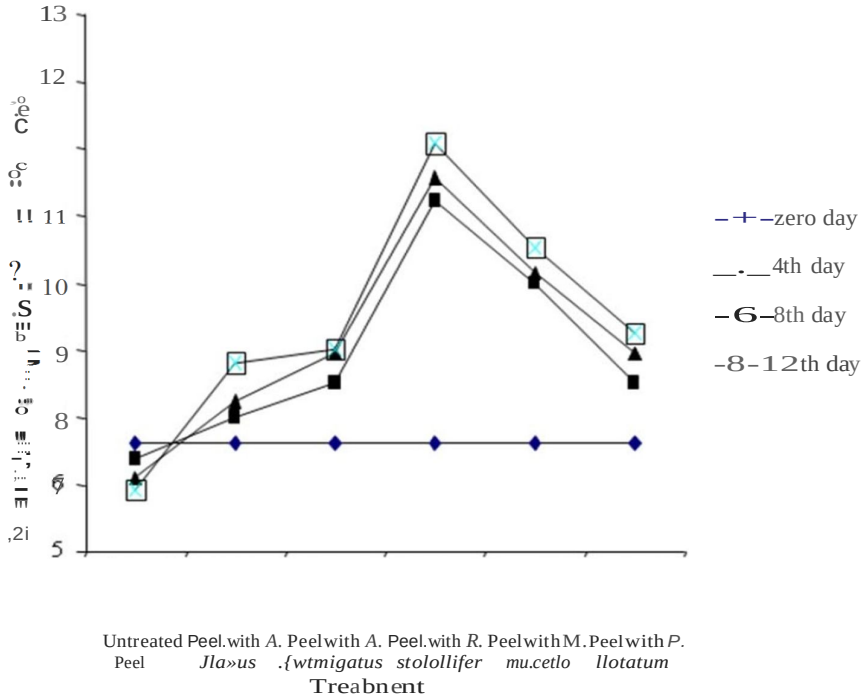

Figure 3. Changes in ash content of cassava peels during fermentation

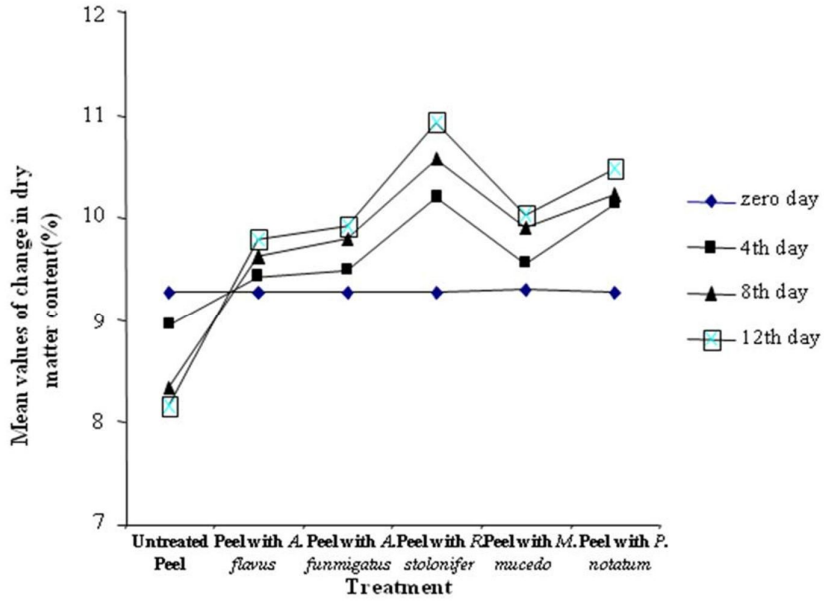

Figure 4. Changes in dry matter content of cassava peels during fermentation

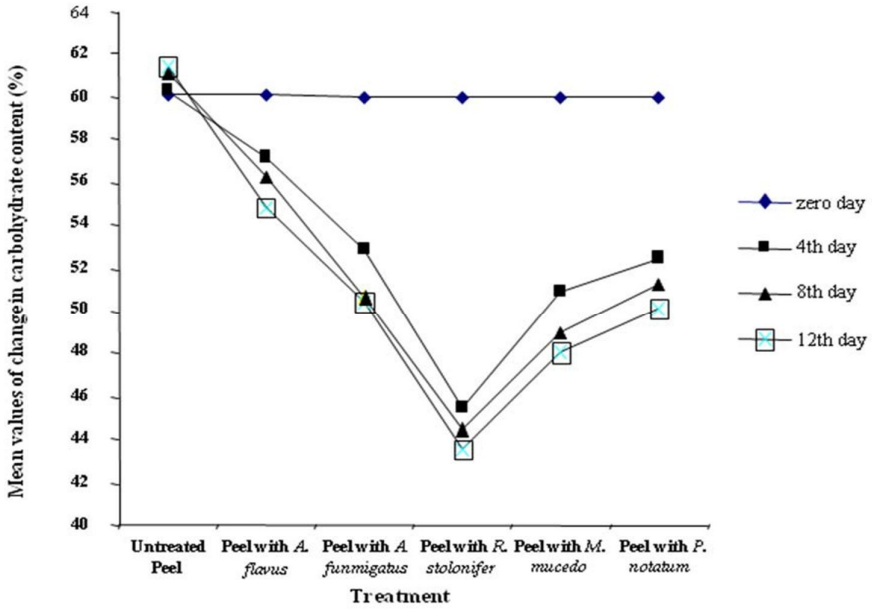

Figure 5. Changes in carbohydrate content of cassava peels during fermentation

The protein content of the fermented cassava peels treated with fungal isolates increased during fermentation. Protein content of Cassava peels fermented with *Rhizopus stolonifer* increased from 7.96% on day zero to 22.28% on day 12, while the unfermented peel had 7.96% and 8.89%, respectively (Fig.2). A similar trend was also observed for the other fungi used. This may be as result secretion of extra cellular enzymes by the fermenting organisms as well as increase in the growth and proliferation of the fungi in the form of single cell protein (Oboh, 2006; Oboh *et al.*, 2002; Oboh and Akindahunsi, 2003). There was also an increase in ash and dry matter contents of the cassava peels during fermentation (Figs. 3 and 4). A decrease in the carbohydrate content of fermented peels with *Rhizopus stolonifer* from 60.03% on day zero to 43.53% on day 12 while the untreated had 60.04% on Zero day and 61.40% on day 12 (Fig. 5) but decrease in fat, fibre and moisture contents (Figs 6,7and 8). A similar trend of decrease was also observed by the other fungi used for

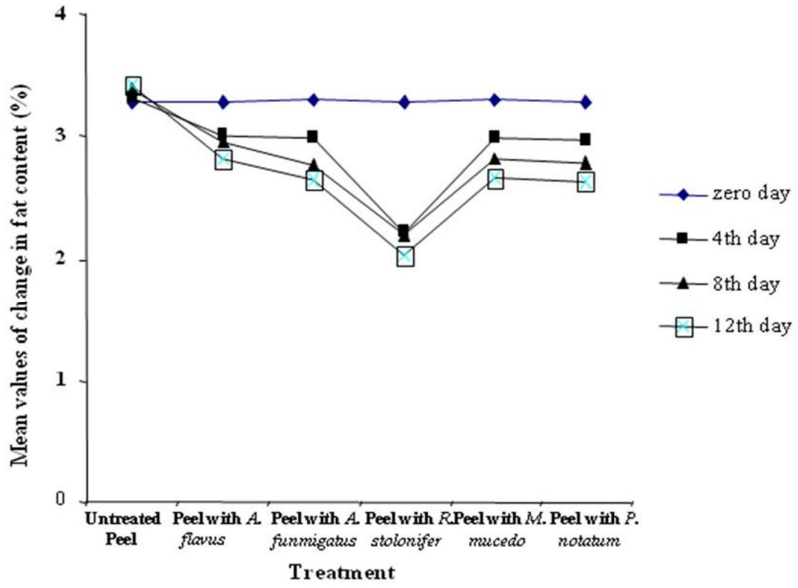

Figure 6. Changes in fat content of cassava peels during fermentation

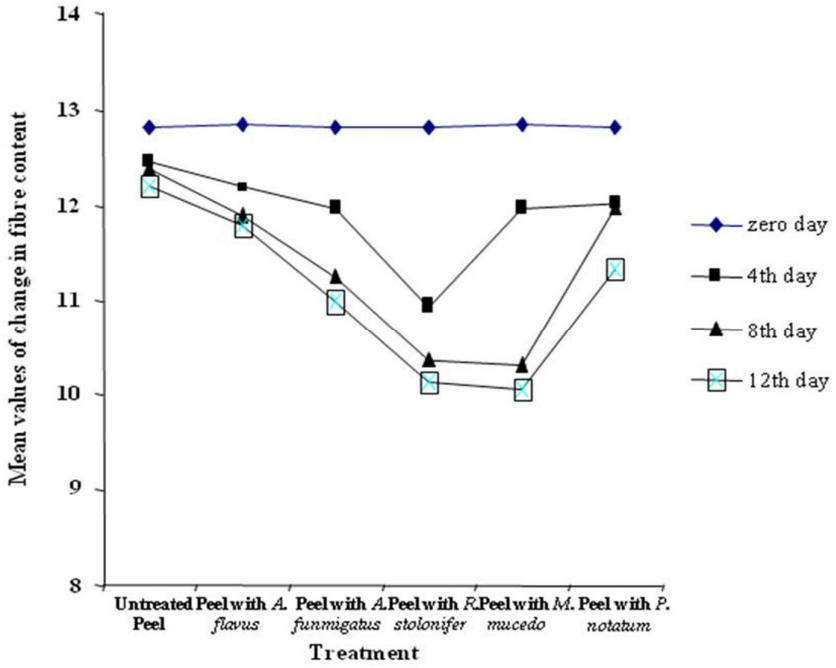

Figure 7. Changes in crude fibre content of cassava peels during fermentation

fermentation. These changes are likely due to the ability of fungi to hydrolyze starch into sugars, especially glucose that may be used by the isolates as a carbon source to synthesize biomass rich in protein (Oboh, 2006; Oboh *et al.*, 2002).

Agro-industrial by-products in Nigeria vary from primary processing of farm produce wastes some of which are left unutilized, causing environmental pollution and hazard. Fermentation is an effective and efficient means of transforming and stabilizing cassava peels to a nutritious livestock feed. Enhancement of the feeding value of some agro industrial by-products for laying hens after their solid state fermentation with *Trichoderma viride* revealed that birds on the diet of the fermented agro products has significant higher egg production than those on other diets. Incorporation of fermented agricultural wastes increases the nutritional quality of animal

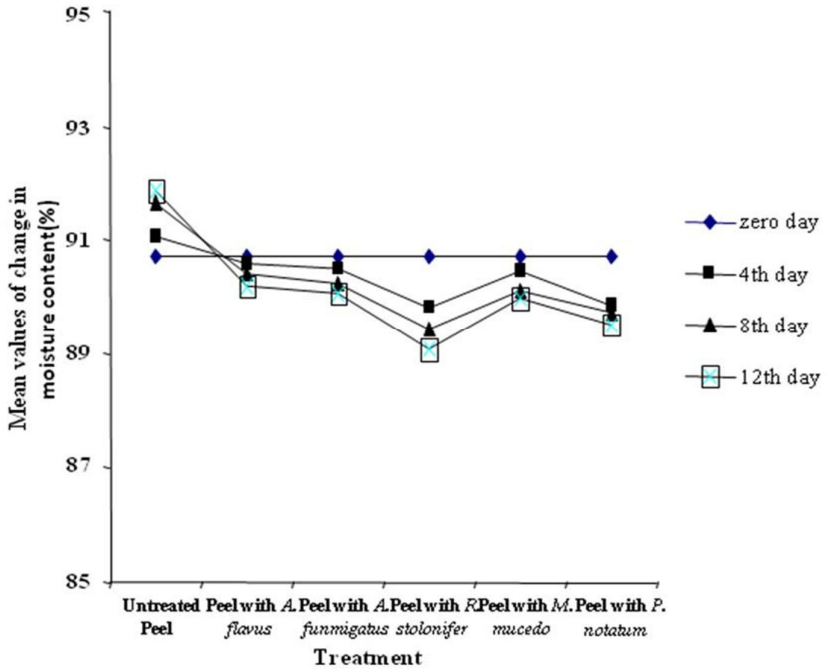

Figure 8. Changes in moisture content of cassava peels during fermentation

feed and also reduces the cost of feed of animals thereby helping to alleviate financial problems faced by many farmers in feeding their livestock in developing countries.

The use of biological means in the degradation of agricultural wastes has greater advantages over the use of chemical because biotechnological synthesized products are less toxic and environmental friendly. Further research on identification of strains of *Rhizopus stolonifer* that can be used in the biotransformation of wastes with special emphasis on the use of those with high fermentative ability and non toxin producers should also be encouraged. This will result in the improvement of the nutritive values of wastes from agricultural by- products and also ensure good environmental sanitation.

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