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Studies on biochemical changes in maize wastes fermented with *Aspergillus niger*

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Abstract

In an attempt to transform the agricultural waste products of maize cobs and shafts into useful products such as animal feeds and reduce the pollution effects of these wastes during maize seasons, they were fermented using *Aspergillus niger* for 72 hours. The fermented residues were analyzed with regard to proximate composition, mineral composition and some antinutrients content. The results revealed that there were significant increases in the protein of the microbial fermentation (12.58g/100g) compare with the unfermented sample (5.51g/100g) and fat (7.83g/100g) and (6.04g/100g) respectively. Conversely, there was significant decrease in phytate (197.44mg/100g) for fermented and (282.10mg/100g) unfermented). The mineral contents in parts per million (Na ,Cu, Zn, Mg, Ca, Na, K, and Co) were slightly high, Na was found relatively low in fermented sample while Cu and Co were not detected in both cases. From the results of the work, it could be inferred that *Aspergillus niger,* a cheap and treated non-pathogenic fungus could be used to enhance the nutritional potential of agricultural wastes as animal feeds and reduce environmental pollution.

Keywords: Biochemical changes, wastes, fermentation and *Aspergillus niger*

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INTRODUCTION

The corn or maize (*Zea mays*) as we have it today is recognized to be a development of the America Indian, is believed to have developed somewhat later. The primary worldwide utilization of corn is in food products. Maize can be eaten raw after cooking or smoking and it can also be converted into animal feeds. Fermented maize products are also eaten in many parts of the world, particularly in developing countries, where they may be part of the basic diet. Some examples include: pozol in Mexico and Central America, ogi in Nigeria, uji in Kenya and koko in Ghana[1]

The wastes of maize, which are what is left after agricultural production, sometimes left behind on the land (straw) or after eating the maize the cobs form liters in the environment in the developing countries. According to van der Wal[2], these cellulose-rich substrates form a total of more than 1,800 million tons annually of renewable resources and the 95 per cent residue needs considerable processing be it physical, chemical, or via some form of bioconversion before it can be turned into suitable feed or food. These disposed corn wastes have some negative effects on the environment by causing a nuisance and health risk such as dust and odour, attraction of flies, offensive particulates, liquids or mists, alter soil health by changing the pH of the environment and by adding compounds that can be considered contaminants, and increase of nitrate levels in ground water, due to rapid mineralization and subsequent leaching of organic nitrogen[3].

Microorganisms have been closely associated with transforming organic matter in the nature for as long as such materials existed. But it was only 100 years ago that certain of these associations have become known or that advantage has been taken of helpful microbes in rural agricultural practices. Report has been made that fungi were one set of microorganisms used in converting such agricultural wastes into useful products such as animal feeds. Recently, fermentation of the agricultural wastes such as maize with fungi has gained considerable attention because it is necessary to increase the world food and feed supplies especially those high in protein and most of the nutritionally valuable metals with small amount of antinutrient content. This study thus aimed at useful microbial conversion of agricultural wastes to energy rich animal feeds and subsequent pollution control[4].

MATERIALS AND METHODS

The maize wastes used were collected from Ita-Awure village in Efon-Alaye Local Government Area of Ekiti State in Nigeria. The species of fungi was collected from Microbiology Department, Federal University of Technology, Akure, Nigeria. The chemicals used were analytical grade and the glass wares used were sterilized and deionized water was used.

Sample preparation

The maize wastes of cobs and shafts were dried, pulverized, boiled for 45mins.to pre-treat, sieved and dried in drying cabinet. The pure strain of *Aspergillus niger* was sub-cultured and inoculated into 200g of the treated sample in 300ml deionized water and 730ml nutrient solution [urea (80g), $MgSO_4$. $2H_2O$ (7g), KH_2PO_4 (13g) and citric acid (20g)] and then allowed to ferment for 3 days[5]. The product obtained after fermentation was subsequently boiled to eliminate any residual microorganism, sieved, washed and dried.

Sample analysis

The protein content of the sample was determined using micro-Kjeldahl method[6]. Briefly, 0.50g of the sample was digested in 10ml H_2SO_4 with half Kjeldahl catalyst tablet until the solution turned grey white. 10ml of the digest was steam distilled with 15ml 40% sodium hydroxide for 10minutes into 20ml 2% boric acid containing 3 drops of mixed indicator solution (0.018g of Bromo cresol green and 0.016g of methyl red dissolved 100ml water). 0.01M HCl was titrated against the distillate. The nitrogen (N) content was calculated from the titer value and the crude protein was obtained by multiplying the nitrogen content by a factor (N x 6.25). A blank determination was carried out simultaneously. The phytate content was determined by the method of Wheeler and Ferrel[7] based on the ability of standard ferric chloride to precipitate phytate in dilute HCl extracts of the vegetables. The tannin content fermented and the unfermented samples were determined using method of Makkar *et al* [8]. This is based on the ability of tannin-like compounds to reduce phosphotungstomolybdic acid in alkaline solution to produce a highly coloured blue solution, the intensity of which is proportion of the amount of tannins. The intensity is measured in Spectrophotometer 725nm. The mineral (Ca, Fe, Cu, Zn, Mg and Co) contents were determined on aliquots of the solutions of the ash by established flame atomic absorption spectrophotometer procedures using a Perkin-Elmer atomic absorption spectrophotometer (model 372), while Na and K were analyzed with flame photometer.

RESULTS AND DISCUSSION

The utilization of the wastes from agricultural farm products can be of immense importance. Therefore most attention today must be given to possible use of microorganisms to convert relatively high-energy wastes into more useful and highly nutritious end product. However, there are some important considerations necessary for microbial conversion i.e. which microorganism or microorganisms possess potentials for the bioconversion of the organic materials under consideration[9].

The results of the proximate analysis revealed that the protein contents (Table 1) of the *Aspergillus niger* fermented sample was higher than unfermented. This high protein contents could be attributed to the ability of the microorganism to secret some extra cellular enzymes (proteins), which degrade the cellulotic materials during fermentation. Contrary to expectation, the crude fiber of the fermented residue was higher than the unfermented sample. Perez-Hidalgo *et al*[10] proposed that the formation of resistant starch together with condensed tannin-protein complex could contribute to the increase. This may also be responsible for the high tannin content (Table3) of the fermented sample which is within the accepted save level, while the phytate (Table3) (which is capable of chelating divalent cationic minerals like Ca, Fe, Mg and Zn, thereby inducing dietary deficiency) content of the fermented sample was reduced as a result of fermentation as supported by Shakuntalamanay and Shadaksharaswamy[11].

Table 1: Proximate composition of the fermented maize wastes on dry matter basis (g/100g)

	Unfermented Sample	Fermented Sample
Protein	5.51 ± 0.2	12.58± 0.3
Fat	6.04 ±0.4	7.83± 0.4
Crude fiber	35.72 ±0.3	48.57± 1.2
Ash	1.82 ±0.2	2.07± 0.5
Carbohydrate	49.95 ±1.2	29.20± 0.9

Table 2: Tannin and phytate contents of fermented maize wastes

	Unfermented Sample	Fermented Sample
Tannin (µg/100g)	576.00±10.6	650.00± 8.5
Phytate (mg/100g)	282.10± 4.5	197.44± 3.5

Table 3: Mineral composition of the fermented maize wastes in parts per million (ppm)

	Unfermented Sample	Fermented Sample
Fe	73.58± 1.2	92.28± 2.3
Cu	ND	ND
Zn	278.00± 2.1	418.04±1.9
Mg	165.81± 1.4	272.88± 3.1
Ca	558.66± 2.0	830.62± 3.2
Na	725.04± 3.0	676.39± 4.2
K	408.75± 1.8	708.47± 5.2
Co	ND	ND

The result of the mineral content (Table2) clearly showed that the unfermented wastes have the lowest quantity of Mg, Zn, Fe, Ca, and K. The result also showed that Na is slightly high in the unfermented while Cu and Co were not detected in both samples. However, the mineral content of both samples are higher than fungi fermented cassava [5].

The fermented sample was very rich in some essential minerals which perform various functions in the body[12]. The low antinutrient content and the high nutritional status make the fermented maize wastes useful as poultry, aquatic and live-stock feeds.

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