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Full Length Research Paper

Solid state fermentation of *Jatropha curcas* kernel cake: Proximate composition and antinutritional components

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Five fungi (*Aspergillus niger, Penicillium chrysogenum, Rhizopus oligosporus, Rhizopus nigricans and Trichoderma longibrachitum)* were used in the fermentation of *Jatropha curcas* kernel cake for a 7 days period in a completely randomized design model. The results revealed significant increase in the crude protein content of all the fungi treated samples with *Aspergillus niger and T. longbrachitum* treated cake recorded higher value compared to other treated samples. There was no significant difference in the crude fiber content among all the samples. With the exception of ether extract content of sample treated with *Rhizopus nigricans* which was similar to that of the control (untreated sample) other samples showed lower significant values than the untreated (control) sample. Contrarily, the ash content was significantly lower in the control sample compared to other fungi treated samples. The content of the trypsin inhibitor was highest (18.6 mg/kg) in the control but reduced significantly in the fungi treated samples (6.50 - 8.23). The lectin, saponins, phytate and phorbolester contents followed similar trend. It could be concluded from this study that solid state fermentation of *Jatropha* kernel cake detoxified and inactivate almost 100% of the antinutrient contents expect phorbolester to a tolerable level in the *A. niger* treated sample.

Key words: *Jatropha curcas* kernel cake, proximate composition, trypsin inhibitor, lectin, phytic acid, saponins, phorbolester.

INTRODUCTION

Jatropha curcas L. Linnaeus 1753 is a small shrub plant which grows wildly in the tropics and sub-tropics but it is used as fencing in Nigeria. Apart from the University of Ilorin that has the plantation of *Jatropha*, its economic importance is still at the infancy stage in Nigeria (www.unilorin.edu.ng). The plant could adapt to marginal areas with poor soils and low rainfall (480 mm per annum and 28.5°C) where growth is not in competition with annual food crops. The cake which is obtained after the extraction of the oil contains a crude protein content of between 58 and 64 percent. Hence, it has high potential to complement and substitute soybean meal as a protein source in livestock diets (Makkar and Becher, 1997b). The percentage of essential amino acids and mineral contents can be compared to those of other seed and press cakes used as a fodder (Trabi et al., 1997). Additionally, *J. curcas* contains various antinutrients like trypsin inhibitor, lectin, tannins, saponins, phytate and phorbolester. The above named toxins can be removed either by chemical or physical methods while phorbolester is the most difficult toxin to be detoxified by these methods. Phorbolester is a natural plant derived from organic compound which is a member of the tigliance family of diterpene.

Symptoms of phorbolester toxicity include dehydration, sunken eyes, skin irritation, loss of appetite, loss of condition and finally death (Belewu, 2008). Makkar and Becker (1997a) reported on the chemical treatment of *Jatropha* seed cake with no encouraging result .Hence, the thrust of this study was to evaluate the efficacy of fungal fermentation of *J. curcas* kernel cake on proximate composition and antinutrient content of spent substrates.

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Table 1. Proximate composition of the fungi treated and untreated *J. curcas cake.*

Parameters (%)	Untreated sample (control)	*Penicillium* treated sample	*R. oligosporus* treated sample	*R. nigricans* treated sample	*A. niger* treated sample	*T. longibrachitum* treated sample
Dry matter	80.70	77.40	76.35	75.65	90.20	88.05
Crude Protein	37.82^{c}	48.18^{b}	$49..22^{b}$	52.49^{b}	65.75^{a}	63.06^{a}
Crude fibre	6.50^{b}	6.70^{b}	5.96^{b}	6.87^{b}	5.70^{b}	11.70^{a}
Ether extract	13.18^{b}	12.00^{b}	12.55^{b}	16.20^{a}	10.70^{b}	11.75^{b}
Ash	4.68^{b}	5.80^{b}	6.00^{a}	5.17^{b}	5.26^{b}	5.17^{b}

Means along the same row with similar superscripts are not significantly different ($p > 0.05$).

MATERIALS AND METHODS

Collection and processing of *Jatropha curcas* seed

Mature seeds of *J. curcas* were collected around the University of Ilorin as well as Ilorin metropolis, Nigeria. The seeds were hand picked to get rid of stones and other debris. The cleaned seeds were weighed and later cracked individually to remove the kernel which was equally weighed and expressed as the percentage of the seed. The kernel was later milled using grinder and then defatted using mechanical hydraulic press. The defatted kernel cake was kept in a polythene bags for autoclaving at 121°C for 30 min, so as to get rid of any microbes that could be present in the cake (Belewu, 2008).

Fungi used

The fungi used which was collected from International Institute of Tropical Agriculture Ibadan (IITTA), Nigeria include *Rhizopus oligosporus, Rhizopus nigericans, Aspergillus niger, Trichoderma longibrachiatum and Penicillium chrysogenum.* The fungi were maintained on potato dextrose agar (PDA) and later used in inoculating the cooled autoclaved dried substrate.

Inoculation and Incubation of the substrate

The cooled autoclaved *J. curcas* kernel cake containing in Petri dishes were inoculated each with the fungi (*R. oligosporus, R. nigericans, A. niger, T. longibrachiatum, and P. chrysogenum*), while the control experiment was not inoculated with any fungus. Each of the fungi was replicated five times throughout the experimental period. The spores of each fungus was harvested with Tween 80 solution and adjusted to 10^{7} - 10^{8} spores per ml with sterile water (serial dilution and haemocytometer methods). After inoculation the samples were incubated for each inoculum to colonize the substrate in about 7 days. The fermented substrates were ovendried at 70°C to terminate the fungi growth.

Chemical analysis

Samples of the fungi treated and untreated were collected for proximate analysis and antinutrient determinations (AOAC, 2000).

Statistical analysis

All data collected were subjected to analysis of variance of a completely randomized design model while the means were separated using Duncan (1955) multiple range test.

RESULTS AND DISCUSSION

The average weight of the Jatropha seed found in Nigeria was 0.60g while the weight of the kernel expressed as the weight of the seed was 0.63%. These values agreed with the reported values of Makkar et al. (1998). The dry matter (Table 1) content of the *Aspergillus niger* treated *Jatropha curcas* kernel cake was significantly higher than that of the control and other samples. The higher content was consistent with the report of Belewu (2008) for similar substrate. The improvement in the crude protein content (Table 1) of the fungi treated samples was in agreement with the work of Jacqueline and Visser (1996), Belewu (2008) and Belewu et al. (2009) who used similar fungi in the treatment of Jatropha seed cake and discarded cell phone recharged cards. The increment in the protein content could be due probably to the addition of microbial protein during the process of fermentation.

With the exception of highly significant ether extract content of *R. oligosporus* treated sample (Table 1) other samples had similar values of ether extract ($p>0.05$). The higher content of the ether extract in the *R. oligosporus* treated sample could be due to ability of the fungus in producing lipase. The ash content and the crude fibre content showed no significant difference in all the samples.

The reduction of trypsin inhibitor activity in the fungi treated samples (Table 2) showed the potential of the various fungi in reducing the toxins. There are few reports on the reduction of such compounds. Other toxins decreased appreciably in all the samples as compared to the untreated sample (control). The decreased in the various toxins levels could be due to the production of various enzymes during the vegetative and reproductive phases of the fungi (Jacqueline and Visser (1996).The various enzymes secreted during incubation period include cellulose, xylanase, xylosidases, hemicellulase, amylases beta glycosidase, proteinases, pectinases, alpha-galactosidae etc and these could have contributed to the detoxification of the kernel cake.

Table 2. Antinutritional factors of fungi treated and untreated *J. curcas* kernel cake.

Parameters (%)	Untreated sample (control)	*Penicillium* treated sample	*R. oligosporus* treated sample	*R. nigricans* treated sample	*A. niger* treated sample	*T. longibrachitum* treated sample
Trypsin inhibitor	20.51[a]	8.23[b]	8.15[b]	8.01[b]	6.50[c]	7.98[b]
Lectin	34.36[a]	15.25[b]	14.75[b]	13.98[b]	7.58[c]	14.10[b]
Saponin	2.47[a]	0.53[b]	0.33[b]	0.22c	0.13d	0.43b
Phytate	9.10[a]	4.32[b]	4.18[b]	3.88[b]	2.70[c]	4.12[b]
Phorbolester	0.013[a]	0.011[a]	0.012[a]	0.010[a]	0.003[b]	0.011[a]

Means with different super scribes along the same row are significantly different from each other ($p < 0.05$).

It is noteworthy that, the content of phorbolester in most of the samples was still high (Table 2). These findings are in conformity with the work of Belewu (2008) who reported the death of albino rats fed fungus treated *Jatropha* seed meal. However, it was noted that *Aspergillus t*reated sample showed the least content of phorbolester and this provides a better biotechnology for detoxifying *J. curcas* kernel cake. The variation in this result and that of Belewu (2008) could be due to the processing method of *J. curcas* seed. In this study the kernel was defatted compared to the undefatted seed cake used in previous study and this could have enhanced the activities of the fungi in this study.

CONCLUSION AND IMPLICATIONS

1 It could be concluded from this study that *J. curcas* kernel cake could be detoxified using A. *niger*.

2 The technique is simple and could easily be adopted.

3 The use of chemical could have a residual effect on the animal and humans consuming the feed.

4 Finally, it should be noted that the seed should be defatted before inoculation for best result.

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