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Proximate and Toxicological Analyses of Detoxified Jatropha Curcas Seeds

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Abstract: *The need for detoxification of less utilized crops with similar nutritional composition with soybeans as potential substitute or supplement for soybeans in conventional feeds production is obvious as price of soybean continue to rise. Jatropha curcas is one of such crops which can serve as a potential source of dietary energy and protein. However, the presence of anti-nutritional factors restricts the utilization of the Jatropha curcas seed in animal feed. Several researchers however have shown that this obstacle can be overcome by detoxifying the seeds, but many of them failed to established the effects of these detoxification methods on the nutritional content of Jatropha curcas .The main objective of this study therefore was to determine the effect of three simple inexpensive physical methods of detoxification (soaking, roasting and fermentation) on the proximate and toxicological compositions of Jatropha curcas seed meal. To achieve this, Jatropha curcas seeds sample used were divided into four parts. The first three parts were subjected to the three different physical treatments after which they were dried to constant weight and while the fourth part was dried to constant weight and milled. These four samples were then analysed for their proximate and toxicological composition .The results showed that fermentation deactivated the antinutrients most in the seeds and did not adversely affect the nutritional composition of the seeds.*

Keywords: *Anti-nutrients, Detoxified, Jatropha carcus, Fermentation, Roasting, Soaking.*

I. Introduction

Increase in the prices of conventional livestock feeds has resulted in increase in the price of livestock and livestock products, this makes it necessary to look for alternatives to the conventional feedstuffs that is locally available and affordable in order to widen sources of raw material and prevents a transition to the use of artificial feedstuffs and its dangerous effects on both the livestock and the consumers[1].As a result of this, many less utilized crops are being examined for their potential to serve as a substitute or supplement to the raw materials that are used for conventional feeds especially soybeans[2].

Jatropha curcas, a drought resistant shrub in the Euphorbiaceae family has been proposed as one of the alternative [3]. The plant is well adapted to climatic zones with low rainfall or drought affected areas and even survives in dry, stony and very shallow soil [4-6]. It is resistant to diseases and can grow on wasteland where no irrigation facility is available [7]. Jatropha curcas seeds are rich in oil, protein, energy and low in fibre with significant quantities of macrominerals like sodium, potassium, magnesium, calcium, phosphorus and microminerals like manganess, iron and zinc[8,9].The kernel of Jatropha curcas seed contains 57 – 63% oil[10] and arou33.6 – 34.5% crude protein[8,11].The protein quality of the J. curcas seed cake is high and the quantity of essential amino acids (except lysine) are higher in Jatropha seed cake than in the FAO reference protein for a growing child[12].

According to Aderibigbe et al.[13] Jatropha meal or the seed cake (fully defatted Jatropha seed) contain almost the same amount of protein as raw Jatropha seeds of which 90% exist as true protein. The nutritional value of Jatropha meal compares favourably with those from conventional seed meals, such as soybean, making it a potential source of dietary energy and protein [14-16]. However, the presence of anti-nutritional factors such as phorbol esters, saponins, tannins, phytate, lectins, hydrocyanide, oxalate restricts the utilization of the Jatropha curcas meal in animal feed [17, 18].

This obstacle however can be overcome by detoxifying the seed through solvent extraction of the kernels which is the most exploited but expensive methods of detoxification [19]. Other researchers have therefore propose other simple inexpensive physical methods like soaking, roasting, germination, autoclaving ,cooking and fermentation for its detoxification[8,20]. The main objective of this study is to determine the effect of three of these physical methods (soaking, roasting and fermentation) on the proximate and toxicological compositions of Jatropha curcas seed meal.

II. Materials And Methods

2.1Collection and Preparation of the Jatropha Curcas Seeds

Mature seeds of Jatropha curcas were obtained from Agwada area of Nasarawa state Nigeria. The sample was cleaned manually to remove all foreign materials and immature seeds. The sample was thereafter divided into four parts and processed as shown below:

Raw: Jatropha curcas seeds in this group were dried in the oven at 40^{o}C to constant weight after which the seeds were removed from their shells and milled.

Roasted: Jatropha curcas seeds in this group were placed in a pan containing dry sand and roasted for 30minutes at 160^{o}C with continuous stirring after which they were allowed to cooled, de- shelled and milled[20].

Soaked: Jatropha curcas seeds in this group were soaked in a basin of tap water at ratio of 1:10 (w/v) at room temperature for 5days after which they were dried in an oven at 40^{o}C to constant weight, de- shelled and milled [20].

Fermented: Jatropha curcas seeds in this group were lined on a tray that had already been cushioned with wet cotton wool and further covered with wet cotton wool. They were then allowed to ferment for 5 days with consistent watering after which they were dried in an oven at 40^{o}C to constant weight, removed from their shells and milled. After all the samples have being milled they were passed through a 0.5 mm sieve and stored in air tight containers until they were required for further analysis.

2.2 Proximate Analysis

All the milled samples were analysed for their proximate composition according to the methods of A.O.A.C[21].

2.3 Antinutritional Contents Analysis

The AOAC [21] Analytical Method was used to determine the oxalate content of the samples. Phytate was determined using the method descibed by Mohamed et al.[22].The cyanide in the samples were determined by the method used for flour samples by Ojo et al.[23] and tannis as described by Aderibigbe et al[13].

III. Result And Discussion

Table1: Nutritional contents of processed Jatropha curcas

SAMPLES	Crude Protein (%)	Crude Fat (%)	Carbohydrate (%)	Crude Fibre (%)	Ash Content (%)	Moisture Content (%)
FERMENTED	26.50^{a}±0.04	33.91^{a}±0.05	29.34^{b}±0.26	3.61^{a}±0.03	4.02^{a}±0.03	6.23±0.30
ROASTED	29.04^{b}±0.05	42.47^{a}±0.03	19.36^{b}±1.70	7.06^{b}±0.07	4.08^{a}±0.08	4.03^{a}±0.03
SOAKED	28.07±0.03	35.25^{a}±0.05	22.60^{b}±0.41	4.95^{a}±0.05	4.03^{a}±0.06	10.00^{b}±0.43
RAW	27.76±0.05	45.91±0.18	14.25±0.28	6.12±0.02	5.00±0.20	7.08±0.08

The results are expressed as ± standard deviation of four observations.
a= significant decrease at $p<0.05$ compare with raw sample. b = significant increase at $p<0.05$ compare with raw sample.

Table 1 shows the percentage crude protein in the four samples. It was observed that roasted Jatropha curcas has the highest amount of crude protein (29.04%) while the raw unprocessed Jatropha curcas has the lowest value of crude protein (27.76%). The increase in protein contents of roasted sample might be attributed to an increase in the free nitrogen content after roasting [24]. The fermented sample had the lowest crude protein value (26.50%) which might be as a result of degradation of the protein by micro organisms. This was also observed in fermented B. Eurycoma "Achi" where a decrease in protein content was recorded during fermentation [25]. The slight decrease of protein in soaked sample (28.07%) when compared to roasted sample may be as a result of leaching out of some nutrients in water which agree with the work of Obasi and Wogu[26] who recorded decrease in protein content of soaked yellow maize.

From the result, it is evident that the raw Jatropha curcas has the highest crude fat (45.91%) closely followed by roasted sample (42.47%). Soaked and fermented samples have the lowest crude fat composition (35.25% and 33.91% respectively). This may be as a result of utilization of lipids by fermentation microbes to obtain energy for their activity when sugars were in short supply. This result is comparable to that obtained durng the fermentation of locust bean [27]. For the crude fibre, roasted sample has the highest percentage of crude fibre (7.06%) with the lowest value recorded for the fermented sample (3.61%) which is similar to results of Makinde et al. [28] on fermented sesame seeds.

Table1 also shows the result for percentage moisture content in all the four samples. The raw unprocessed Jatropha curcas meal had moisture content of (7.08%). The soaked sample had the highest value for moisture content (10.00%) which is as a result of soaking in water. The fermented sample had the second highest value for moisture content which is as a result of the fermentation process which involved soaking in water. The roasted sample had the lowest value for moisture (4.02%) which is obviously due to drying effect of roasting. The raw unprocessed Jatropha curcas has the highest percentage of ash content (5.00%). The slight reduction in the ash content of fermented and soaked samples (4.02% and 4.03% respectively) might be as a result of diffusion of minerals into the water[29,30]. The reduction of ash content in roasted sample (4.08%) might be as a result of loss of organic residue due to heat when it was roasted.

Table2: Antinutritional contents of processed Jatropha curcas

SAMPLES	Phytate (%)	Cyanide(mg/kg)	Tannin(mg/100g)	Oxalate(mg/100g)
Fermented	3.89^{a}±0.04	4.63^{a}±0.12	0.12^{a}±0.02	11.07^{a} ± 0.12
Roast	7.03^{a}±0.03	6.93^{a}±0.06	0.16^{a}±0.02	13.72^{a} ± 0.03
Soaked	6.42^{a}±0.02	4.90^{a}±0.10	0.20±0.03	22.17^{a} ± 0.29
Raw	8.77±0.04	12.80±0.36	0.22±0.04	24.73 ± 0.02

The results are expressed as ± standard deviation of four observations.
a= significant decrease at $p<0.05$ compare with raw sample. b = significant increase at $p<0.05$ compare with raw sample.

The effect of different processing methods on the Antinutritional contents of processed Jatropha curcas is shown in Table 2. The raw Jatropha curcas has the highest as expected followed by the roasted sample which asserts the finding of previous researchers that phytate is the major heat-resistant antinutritive component in Jatropha curcas. These results coincide with those obtained by Makkar et al. [15].The phytate content also decreased with soaking (6.42%). This reduction may be attributed to leaching out of phytate ions into soaking water which is due to change in permeability of seed coat[8,31,32]. The significant reduction in phytate content observed in the fermented sample (3.89%) might be due to the activity of enzymes such as phytase and oxidase produced by fermenting microbes[33] and leaching out of phytate . The antinutritional activity of phytate lies in its ability to form complexes with metals like Cacium, Zinc, Magnessium and Iron[28]. Phytates have also been implicated in decreasing protein digestibility by forming complexes and also by interacting with enzymes such as trypsin and pepsin[8] .Therefore the high level of phytate in the unprocessed seeds might decrease bio-availability of minerals especially calcium and iron, impaired protein digestibility through the formation of phytic-protein complexes [34].

The raw Jatropha curcas had cyanide content of (12.8mg/kg), in contrast to the significant decrease in cyanide content observed in soaked sample (4.90mg/kg) and fermented sample (4.63mg/kg). This reduction may have occurred due to leaching out of cyanide when it was soaked in water as it forms Hydrocyanic acid in water which is a very volatile compound from which free cyanide is released by the enzyme limarase from the cells to dissolve in water[35] and due to microbial activity during fermentation.

The raw Jatropha curcas had a tannin value of (0.22mg/100g). The reduction observed in soaked sample of Jatropha curcas (0.20mg/100g) and fermented sample of Jatropha curcas (0.12mg/100g) might as a result of leaching of tannins into water[36].

Fermentation had a significant effect on oxalate contents compare to raw Jatropha curcas (Table 2). This reduction in oxalate as a result of fermentation may be as a result of activity of enzymes such as oxidase produced by fermenting microbes[33]. The not too significant reduction of oxalate in soaked sample may be as a result of reabsorption of leached out oxalate ion back into the seeds. Roasting also caused a significant reduction in oxalate content (13.72mg/100g) as Oxalates are heat liable and can be partially or completely denatured when exposed to elevated temperature[28] .

IV. Conclusion

In conclusion, different physical treatments (fermentation, roasting and soaking) examined reduced the antinutritional contents of Jatropha curcas meal and did not adversely affect its high nutritional content but Fermentation was the most effective method of reducing the antinutrients examined and also did not adversely affect the nutritional contents. However before the utilisation of Jatropha curcas as feed further research should be carried out to determine the effect of the methods examined on phorbol esters other possible antinutritional factors that were not examined in this study.

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