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Effect of Processing on Nutrients and Anti-nutrients of Castor Oil Bean (*Ricinus communis*) Seeds and By-products

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Abstract: Studies were conducted on the proximate, mineral and anti-nutrients composition of raw and processed castor oil seeds and by-product. Processing methods adopted include fermentation, dry and moist heat (toasting and boiling) treatments respectively. The results revealed that, the processing methods have tremendous effect on the chemical and anti-nutrient components of the seed and by product. Nevertheless, the traditional methods of processing employed eventually reduced the concentration of anti-nutrients and encouraged its utilization in animal nutrition generally.

Key words: Antinutrient, nutrients, castor oil bean seed

INTRODUCTION

The value of edible legumes as a source of cheap quality protein for both human and livestock have long been recognized. In developing nations such as Nigeria, where there is acute shortage in supply of animal protein in diets occasioned by outrageous prices of products such as eggs, meat and milk, efforts should be geared towards harnessing the nutritive potentials of some under-exploited oil seeds including castor oil bean seeds.

Castor oil seed is presently planted, harvested and fermented for usage as condiments in soup in south-eastern Nigeria. However, of a possible that paucity of information on the chemical and anti-nutrients contents might have limited its usage as sources of edible oil and perhaps suitability as animal feedstuff. This study is aimed at investigating the efficacy of heat treatment (boiling and toasting) and fermentation on the nutrients and endogenous anti-nutrients of castor oil seed and by-products which may expose their potentials for commercial exploitation.

MATERIALS AND METHODS

The castor oil seed for this study was purchased from open market at Ogbete market, Enugu, South-Eastern Nigeria. The Castor seeds were divided into six (6) batches as below:

A = Raw seed without hull
B = Two-stage cooked seed and crushed
C = Toasted and crushed
D = Raw seed crushed with hull
E = Raw dehulled seed fermented
F = Crushed castor hull without cotyledon.

Each of the batches above was duplicated and analyzed for proximate and anti-nutritional compositions; the two-stages-cooking was as outlined by Udedible and Carlini (1998). The fermentation was achieved by soaking the seed in water (3 times volume of the seed) for 72 h and sundried while toasting of dehulled seed in fine sand and stirred on Gallenkamp hot plate until brownish colour obtained, thereafter, seeds were cleaned and cooled in a desiccator. All samples so prepared were crushed and sundried to crispy prior to analyses except those toasted.

Chemical analysis

Proximate analysis: Determination of proximate chemical composition of processed samples was according to standard procedures of the Association of Official Analytical Chemists (AOAC, 1990). Crude protein was subsequently calculated by multiplying the nitrogen content by a factor of 6.25. The Nitrogen Free Extract (NFE) referred to as soluble carbohydrate is not determined directly but obtained by difference. NFE = (100 - (% Ash + % Crude fibre + crude Fat + crude protein).

Mineral determination: Sodium and Potassium were determined by flame photometric method (Jeumeay) while phosphorous was determined by vanado-molybdate method (AOAC, 1990). Calcium, magnesium, iron, zinc, copper and manganese were determined after wet digestion with a mixture of Nitric, Sulphuric and Hydrochloric acids using Atomic absorption Spectrometer (Buck 210 AAS). Each sample was analyzed twice.

Determination of anti-nutrients in castor bean

Tannins: Finely milled raw and processed sample (200 mg in 10 ml of 70% aqueous acetone) were extracted for 2 h at 30°C in water bath using Gallenkamp or bital shaker (Surrey, Uk) at 120 revolutions per minute.

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Pigments and fat were first removed from the samples by extracting with diethyl ether containing 1% acetic acid. Thereafter, the total polyphenols (as tannic equivalent) was determined in 0.05 ml aliquot in test tubes by the addition of distilled water to make it to 1.0 ml, followed by the addition of 0.5 ml of the folin ciocalteau reagent (sigma) and then 2.5 ml of the sodium carbonate solution. The tubes were vortexed and the absorbance recorded at 735 nm after 40 min as described by Makkar and Goodchild (1996). The amount of total polyphenols (as tannic equivalent) was calculated from the standard curve. Duplicate samples of each seed were analyzed.

Phytin and phytin-phosphate: For the quantification of phytin, 8 g of each finely ground raw and processed samples was soaked in 200 ml of 2% hydrochloric acid and allowed to stand for three hours. The extract was thereafter filtered through two layers of hardened filter paper. Fifty millimeter of filtrate was pipetted in duplicate into 400 ml capacity beakers before the addition of 10 ml 0.3% ammonium thiocyanate solution as an indicator and 107 ml of distilled water to obtain the proper acidity (PH 4.5). The solution was then titrated with a standard iron chloride ($FeCl_3$) solution containing 0.00195 gm Fe/ml until a brownish yellow colour persists for 5 min. Phytin-phosphorous was determined and phytin content was calculated by multiplying the value of phytin-phosphorus by 3.55 (Young and Greaves, 1940). Each milligram of iron is equivalent to 1.19 mg of phytin-phosphorus. Duplicate samples of each seed type were analyzed.

Determination of oxalate: One gram of the samples was ground in mortar with pestle and 75 ml of 5 N H_2SO_4 was added. The solution was carefully stirred intermittently with a magnetic stirrer for 1 h and the filtrate (extract) was collected and titrated hot (80-90°C) against 0.1 N $KMnO_4$ solution, unit the point when a faint pink colour appeared, that persisted for at least 30 sec, according to Day and Underwood (1986).

RESULTS AND DISCUSSION

A very vital but not surprising observation from these analytical results is the high concentration of nutrients and anti-nutrients in the castor oil seeds and by-products.

The crude protein content of the processed castor oil seed is comparatively higher than that of some conventional protein feed stuff such as PKC (18.87% CP) and spent grain (18.10% CP) in term of crude protein which range from 20.15-29.13% depending on the processing method (Table 1). The results confirm the high oil content of the raw seeds and reveal the potential for their utilization in commercial vegetable oil production having about 44.75%. This result agrees with 44.96% oil content of this seed earlier reported by Enujiugha and Olubunmi (2003).

Nevertheless, the relative low moisture content of the raw seed (5.32%) is a good advantage for its shelf life. The ash content is relatively low, about 3.65% but can be compared with other oil seed such as *Dioclea reflexa*. It is a good source of phosphorous, sodium, potassium and magnesium but low in iron, copper and manganese, hence, it is a good source of macro elements necessary in both human and livestock diets (Table 3).

Castor oil seed has also been found to contain some anti-nutrients such as phytic acid, oxalate, phytate-P and Tannin which is typical of most legumes and oil seeds (Balogun and Fetuga, 1986) as shown in Table 2.

Apart from oxalate and tannins which are in low concentration, the phytic acid and phytin-phosphate in raw and processed seed are fairly high and agree with the observation of Balogun and Fetuga (1986). However, the values of 3.48-4.64 mg/g and 12.36-16.48 mg/g for phytin-phosphate and phytate respectively are higher than 0.89 mg/g and 0.25 mg/g observed by Enujiugha and Olubunmi (2003) in raw castor oil seed, probably due to method of processing.

Table 1: Proximate composition of variously processed castor oil seed and by-products

	Processing techniques	Ash (%)	MC (%)	CP (%)	Fat (%)	Fibre (%)	CHO (%)
A	Raw intact seed without hull	3.65	5.32	16.91	36.91	2.22	34.99
B	2 Step cooked seed	3.39	2.40	20.15	44.75	3.50	25.81
C	Toasted and crushed	3.74	3.84	29.13	39.13	3.01	21.15
D	Raw crushed seed with hull	3.43	3.45	24.77	34.77	5.81	27.77
E	Raw dehulled seed fermented	2.91	3.19	20.44	42.44	3.20	27.82
F	Crushed castor hull	8.88	5.23	17.69	11.69	8.70	52.19

Table 2: Anti-nutrients in castor oil beans

Processing techniques	Tannin (%)	Oxalate (mg/g)	Phytin-p (mg/g)	Phytic acid (mg/g)
Raw intact seed without hulls	1.11	1.89	3.48	12.36
2 Stage cooked seed	0.83	0.99	4.18	14.83
Toasted and crushed	1.24	2.79	4.64	16.48
Raw crushed seed with hulls	1.67	3.06	3.02	10.71
Raw dehulled/fermented	0.70	2.88	6.73	23.89
Crushed castor hulls	1.28	1.94	3.13	11.12

Table 3: Mineral content of castor oil bean

Processing methods	Na	K	Ca	Mg	Zn	Fe	Cu	Pb	Mn	P
Raw intact seed without hull	10.11	12.20	08.25	12.18	15.43	0.36	0.01	0.001	0.02	14.25
2 Stage cooked seed	18.41	23.76	11.98	28.19	39.76	0.25	ND	ND	ND	28.08
Toasted and crushed seed	21.33	29.35	20.31	31.24	35.63	0.85	ND	ND	ND	39.37
Raw crushed seed with hulls	16.52	13.28	16.22	25.00	28.31	0.48	0.01	ND	0.05	23.92
Raw dehulled seed/fermented	19.32	25.33	15.38	31.25	42.14	0.32	ND	ND	ND	30.33
Crushed castor hulls	15.21	18.24	10.12	12.21	24.35	0.73	0.02	ND	0.03	20.73

ND = Not Determined

A previous report (Enujiugha and Oladunjoye, 2001) had revealed noticeable reductions in phytin and phytin-phosphate after processing of African oil bean seed, a reduction attributed to soaking (fermentation) which is known to be effective against the antinutritional factors especially polyphenols including tannins.

It is also possible that the low value of 16.91% crude protein content of the raw seed may be due to high concentration of tannins which has been implicated to form insoluble complexes with protein, thereby, interfering with their bioavailability (Enujiugha and Agbede, 2000).

Conclusion: Data from this study reveals that Castor oil seed has a potential as animal feedstuff with crude-protein value of about 29% and relatively high macro elements. Nevertheless, processing the seeds via fermentation and/or 2-stage cooking prior to drying has proved a positive way of reducing the anti-nutrients in the raw seed.

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