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Effect of Different Processing Methods of Seed Meal of *Cassia Tora* on Nutritional Composition, Phytochemicals, Mineral Composition and Amino Acid Assay

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Abstract

The nutritional composition of available legumes indicates that they are rich in nutrients. The effects of different processing methods of seed meal of Cassia tora on nutritional and chemical composition were investigated. The pods of the Cassia tora seed were collected within the premises of Federal University Dutse, it was then threshed and winnowed to obtain the seeds. The raw samples of the Cassia tora seeds were then subjected to different processing methods amongst which are toasting, soaking, autoclaving, boiling, fermenting, boiling + fermenting and soaking + toasting. The raw and processed seeds were then subjected to proximate composition, chemical and amino acid analysis in triplicates. The nutritional composition of the raw and differently processed seed meal of Cassia tora revealed that the toasted seed meal had significantly better (P<0.05) crude protein (18.90%) and metabolisable energy (3393.76 kcal/kg). Likewise, the mineral composition of the raw and differently processed seed meal indicated that the toasted had significantly (P<0.05) higher mineral amongst most of the minerals determined. Furthermore, the phytochemical analysis showed the toasted seed meal had highest significantly (P<0.05) depleted concentrations compared to the values recorded for the other processed seeds. Tannins, Phytate and Alkaloids with concentration of 104.42, 508.00 and 240.60 mg/100g in the raw seed meal were significantly (P<0.05) degraded to 78.33, 200.04 and 119.11 mg/100g, respectively in the toasted seed meal of Cassia tora. In conclusion, the nutritional composition of the toasted seed meal of Cassia tora showed great potentials to be used as a fish feed ingredient.

Keywords: *Effect, Processing, Cassia tora, Nutritional composition, Phytochemical*

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INTRODUCTION

Legumes are flowering plants producing seeds in pods that are often cultured for food and feeds. They are the third largest family of flowering plants with more than 19 500 species and over 750 genera (Lewis *et al.*, 2016). *Cassia tora* seed are moderate source of protein with reasonable amino acid composition (Ingweye *et al.*, 2010; Ayssiwede *et al.*, 2012; Augustine, 2017; Augustine *et al.*, 2018a). However, the presence of phytochemicals limits their efficient utilization as feed ingredients, especially in fish diets (Adebowale *et al.*, 2005). Different processing techniques were used by different authors to inactivate or remove phytochemicals, thus enhancing the nutritional quality of legumes. Sometimes, a single processing treatment is not effective against phytochemicals, hence combination of two or more methods are used (Sathe *et al.*, 1984b). This study wishes to explore the effects of using different processing methods on the nutritional quality, mineral composition and anti-nutritional factors of *Cassia tora* seed meal.

MATERIALS AND METHODS

Collection and Processing of the *Cassia tora* Seeds

Ripped *Cassia tora* pods were removed from its shrubs. The samples were collected in the premises of Federal University Dutse, Jigawa state. The samples were threshed and winnowed to obtain the seeds. The seeds were removed by threshing and winnowing. The prepared seeds were then washed with distilled water in order to remove dirt, residual pulp and other debris to reduce the level of contamination.

Processing of the *Cassia tora* Seeds

The seeds of *Cassia tora* were subjected to various processing methods according to the methods by Hernandez *et al.*, (2010); Doss *et al*. (2011) and Antye, (2018).

i. Raw seeds were milled, stored in an air-tight polytene bag and labeled as raw seed meal (RSM)
ii. Raw seeds were soaked in water in the ratio of 1:3 for 72 hours, oven dried at 50^{0}C to constant weight. The seeds were then milled, labeled and stored in an air-tight polythene bag. It was labelled as soaked seed meal (SSM).
iii. Raw seeds were boiled for 30 minutes, oven dried at 50^{0}C to constant weight, then milled and stored in an air-tight polythene bag. It was labelled as boiled seed meal (BSM).
iv. Raw seeds were toasted at 70^{0}C using electric hot plate until the seeds turn brownish in colour, the seeds were then milled, stored in an air-tight polythene bag and labelled as toasted seed meal (TSM).
v. Raw seeds were autoclaved at 120^{0}C for 15 minutes, oven dried at 50^{0}C in an oven, milled, stored in an air-tight polythene bag and labeled as autoclaved seed meal (ASM).
vi. Raw seeds were moistened with water, kept in a container with a cover to ferment for 7 days under laboratory condition, the fermented seeds were subsequently oven dried at 50^{0}C in an oven, milled, stored in an air-tight polythene bag and labeled as fermented seed meal (FSM).
vii. Raw seeds were boiled for 30 minutes and thereafter, kept in a container with cover to ferment for 7 days under laboratory condition, oven dried at 50^{0}C in an oven, milled, stored in an air-tight polythene bag and labeled as boiled fermented (BFSM).

Determination of nutritional, chemical and amino acid composition of *Cassia tora*s seed meal

The raw and processed seeds meal of *Cassia tora* were subjected to nutritional composition, amino acid and chemical analysis using the method described by AOAC (2010).

RESULTS AND DISCUSSION

The nutritional composition of the raw and differently processed *Cassia tora* seed meal (CTSM) is as shown in Table 1. The crude protein and ether extract were significantly higher (P<0.05) in the toasted seed while the crude fibre and the ash content were significantly higher (P<0.05) in the raw seeds. The soaked and the toasted CTSM had significantly (P<0.05) better level of nitrogen free extract and metabolizable energy, respectively.

Table 1: Nutritional composition of raw and differently processed *Cassia tora* seed meal

Parameters	Raw and Differently Processed Seed Meal of *Cassia tora*								SEM	P-Value
	T1	T2	T3	T4	T5	T6	T7	T8		
Crude protein	12.48^{g}	18.90^{a}	13.51^{f}	14.03^{e}	14.29^{d}	14.03^{e}	16.40^{c}	18.51^{b}	0.46	0.001
Ether extract	3.49^{g}	16.10^{a}	3.42^{g}	7.47^{c}	5.82^{f}	6.82^{e}	7.06^{d}	10.18^{b}	0.79	0.001
Moisture	7.32^{g}	8.07^{d}	9.82^{b}	7.53^{f}	9.89^{a}	8.48^{c}	6.53^{h}	8.02^{e}	0.22	0.001
Crude fibre	11.62a	9.70c	10.64b	10.00d	9.55e	8.55f	7.91g	10.21c	0.22	0.001
Ash	9.52a	7.69c	5.52g	5.89f	7.93b	6.06e	7.06d	5.22h	0.28	0.001
NFE	55.55c	39.38g	57.08a	55.67d	52.50e	56.03b	55.03d	47.81f	1.16	0.001
ME	2692.26^{h}	3393.76^{a}	2777.42^{g}	3058.01^{d}	2842.71^{f}	3038.55^{e}	3110.53^{c}	3192.53^{b}	45.26	0.001

The mineral composition of the raw and differently processed seed of *Cassia tora* is as shown in Table 2. The recorded level calcium, copper, magnesium, iron and phosphorus were significantly higher (P<0.05) in the toasted CTSM. However, the potassium concentration was significantly better (P<0.05) in the soaked + toasted seed while the autoclaved seed significantly (P<0.05) higher concentration of zinc.

Table 2: Mineral composition of raw and differently processed *Cassia tora* seed meal

Para.	Composition of minerals (mg/100g) of raw and processed *Cassia tora* seed meal								SEM	P-Val
	T1	T2	T3	T4	T5	T6	T7	T8		
Ca	851.10^{e}	983.42^{a}	913.56^{c}	859.76^{d}	823.53^{f}	721.12^{h}	724.80^{g}	980.67^{b}	19.72	0.001
Cu	900.01^{g}	933.42^{a}	904.60^{e}	911.20^{c}	908.57^{d}	902.91^{f}	911.12^{c}	928.43^{b}	2.35	0.001
Fe	215.39^{g}	327.74^{a}	250.55^{c}	234.44^{d}	221.39^{e}	218.32^{f}	215.06^{h}	325.80^{b}	9.44	0.001
Mg	610.70^{h}	683.39^{a}	673.49^{c}	623.29^{f}	657.78^{d}	634.25^{e}	613.22^{g}	682.87^{b}	5.99	0.001
P	1101.25^{g}	1650.43^{a}	1130.68^{e}	1151.33^{d}	1113.69^{f}	1264.59^{c}	1097.72^{h}	1635.88^{h}	46.30	0.001
K	950.8^{1}e	960.57^{b}	924.50^{h}	957.40^{c}	953.53^{d}	929.41^{g}	945.32^{f}	961.30^{a}	2.72	0.001
Na	573.29^{g}	614.71^{a}	581.74^{d}	581.87^{c}	577.75^{f}	579.19^{e}	570.21^{h}	610.34^{b}	3.27	0.001
Zn	51.52^{h}	55.27^{b}	54.50^{d}	56.19^{a}	52.37^{f}	52.97^{e}	52.12^{g}	54.98^{c}	0.33	0.001

Means within the same row with different superscript differ significantly (P<0.05)
Key: SEM = Standard error of means, T1= Raw, T2 = Toasted, T3 = Soaked, T4 = Autoclaved, T5 = Boiled, T6 = Fermented, T7 = Boiled + fermented, T8 = Soaked + Toasted,

The amino acid composition of the raw seed and processed seeds of *Cassia tora* is shown in Table 3. The level of alanine and arginine concentrations were significantly higher (P<0.05) in the boiled seeds, while the aspartic acid concentration was significantly higher (P<0.05) in the toasted seed with recorded value of 10.98 mg/100g. Cysteine concentration of 1.18 mg/100g was recorded in the raw seed, which was significantly better (P<0.05) compared to the recorded values of the differently processed seeds. However, there was no significant difference (P>0.05) in the glutamic acid concentration of the autoclaved and boiled + fermented seed meal. Furthermore, histidine level of 2.37 mg/100g was recorded in the boiled + fermented seed, while isoleucine concentration level in the raw, fermented, boiled + fermented and soaked + toasted have no significant (P>0.05) difference. The leucine concentration was significantly higher (P<0.05) in the boiled seed. The toasted seed meal had significantly higher (P<0.05) level of lysine, while the methionine and phenylalanine concentrations were significantly higher (P<0.05) in the fermented seed with values of 2.13 and 4.71 mg/100g, respectively. There was no significant difference (P>0.05) in the concentration of tryptophan in the fermented and the soaked + toasted seed, but the valine concentration was significantly higher (P<0.05) in the boiled + fermented seed meal.

Table 3: Amino acid assay (mg/100g) of raw and differently processed *Cassia tora* seed meal

Parameters	Raw and Differently processed seeds of *Cassia tora*									
	T1	T2	T3	T4	T5	T6	T7	T8	SEM	P-Value
Alanine	3.31^{e}	4.01^{c}	3.36^{e}	3.65^{d}	4.84^{a}	3.24^{f}	4.35^{b}	3.10^{g}	0.12	0.001
Arginine	5.51^{b}	5.41^{bc}	5.17^{d}	5.23^{cd}	6.16^{a}	5.40^{bc}	6.07^{a}	5.34^{cd}	0.07	0.001
Aspartic acid	9.55^{d}	10.98^{a}	10.03^{c}	9.30^{e}	8.76^{f}	10.40^{b}	9.07^{e}	8.40^{g}	0.17	0.001
Cystine	1.18^{a}	0.65^{d}	0.93^{b}	0.43^{e}	0.91^{b}	0.90^{b}	0.81^{c}	0.72^{cd}	0.05	0.001
Glutamic acid	13.70^{e}	14.81^{b}	14.10^{d}	15.02^{a}	14.43^{c}	14.51^{c}	15.13^{a}	12.83^{f}	0.15	0.001
Glycine	4.00^{cd}	4.07^{c}	3.81^{e}	3.95^{d}	4.39^{a}	3.93^{d}	4.24^{b}	3.60^{f}	0.05	0.001
Histidine	2.17^{c}	1.94^{e}	1.95^{de}	1.28^{f}	2.13^{c}	2.27^{b}	2.37^{a}	2.01^{d}	0.07	0.001
Isoleucine	3.98^{a}	2.59^{d}	2.87^{bc}	2.70^{d}	2.83^{c}	3.00^{a}	2.99^{ab}	3.07^{a}	0.04	0.001
Leucine	6.17^{d}	6.42^{c}	5.03^{f}	6.03^{e}	7.03^{a}	6.16^{d}	6.91^{b}	4.79^{g}	0.16	0.001
Lysine	4.79^{b}	4.94^{a}	4.46^{c}	4.75^{b}	3.95^{f}	4.27^{e}	4.40^{d}	3.56^{g}	0.09	0.001
Methionine	1.93^{b}	1.49^{e}	1.90^{b}	1.29^{f}	2.13^{a}	1.84^{c}	1.58^{e}	1.72^{d}	0.05	0.001
Phenylalanine	4.47^{c}	3.40^{e}	4.02^{d}	3.17^{g}	4.71^{a}	3.23^{f}	4.63^{b}	4.01^{d}	0.12	0.001
Proline	2.82^{b}	2.04^{e}	3.00^{a}	2.40^{c}	2.05^{e}	3.05^{a}	2.21^{d}	3.01^{a}	0.09	0.001
Serine	3.18^{a}	2.53^{f}	3.00^{bc}	3.02^{e}	2.70^{e}	2.96^{cd}	2.93^{d}	3.04^{b}	0.04	0.001
Threonine	3.15^{d}	3.44^{b}	2.94^{e}	3.02^{e}	3.02^{e}	3.55^{a}	2.96^{e}	3.35^{c}	0.05	0.001
Tryptophan	3.02^{c}	3.07^{bc}	3.01^{c}	3.03^{bc}	3.23^{a}	3.08^{bc}	3.18^{ab}	2.32^{d}	0.06	0.001
Valine	4.44^{c}	4.03^{f}	4.42^{c}	4.18^{e}	4.54^{b}	4.34^{d}	4.83^{a}	3.49^{g}	0.08	0.001

The phytochemical composition of the raw and differently processed seeds of *Cassia tora* seed meal is as shown in Table 4.

The concentration of tannins, phytate, oxalate, flavonoid, alkaloids, phenolics and saponins were significantly higher (P<0.05) in the raw seed meal. However, the significantly (P<0.05) lower concentrations of tannins, phytate, flavonoid and alkaloids recorded as a result of processing were in the soaked + toasted seed meal. Furthermore, the concentration of oxalate was significantly (P<0.05) lower in the toasted seed meal. As for phenolics and saponins, the concentration level were significantly (P<0.05) low in the boiled and boiled + fermented seed meal, respectively.

Table 4: Phytochemical composition (mg/100g) of raw and differently processed seed meal of *Cassia tora*

Parameters	Raw and Differently Processed Seed Meal of *Cassia tora*								SEM	P-Value
	T1	T2	T3	T4	T5	T6	T7	T8		
Tannin	104.42[a]	78.33[g]	95.47[c]	83.85[e]	86.12[d]	98.28[b]	79.63[f]	69.52[h]	2.27	0.001
Phytate	508.00[a]	200.04[g]	435.47[d]	440.10[c]	260.80[f]	462.28[b]	399.37[e]	174.01[h]	25.11	0.001
0xalate	70.05[a]	17.80[h]	55.14[c]	60.11[b]	36.05[g]	49.33[d]	42.93[e]	38.07[f]	3.16	0.001
Flavanoid	98.80[a]	57.29[e]	60.00[d]	69.47[c]	48.67[f]	75.36[b]	40.17[g]	31.70[h]	4.14	0.001
Alkaloid	240.60[a]	119.11[g]	222.39[b]	150.92[c]	138.12[f]	149.37[d]	140.21[e]	102.29[h]	9.45	0.001
Phenolics	126.02[a]	74.50[f]	90.09[d]	93.93[c]	65.50[h]	108.76[b]	78.86[e]	70.45[g]	4.03	0.001
Saponin	166.77[a]	150.38[b]	121.03[f]	137.92[d]	109.32[g]	141.57[c]	103.75[h]	131.03[e]	4.11	0.001

T1 = Raw, T2 = Toasted, T3= Soaked, T4 = Autoclaved, T5 = Boiled, T6 = Fermented, T7 = Boiled and Fermented and T8 = Soaked and Toasted

DISCUSSION

The recorded crude protein content of the raw *Cassia tora* seed meal in this study is 12.49%. The findings slightly correspond with what was obtained by Adamu *et al*. (2013) who obtained 13.79% crude protein for the raw seed of *Cassia tora.* Furthermore, Adoke *et al*. (2018) reported 18.20% crude protein while Augustine *et al*. (2017) recorded 23.40% crude protein for the raw seed of *Cassia tora.* In addition, Gohl (1981) reported crude of protein of 18.20% while Augustine et al. (2014) and Augustine *et al*. (2016) reported crude protein of 21.89 and 19.60%, respectively.

Meanwhile, the toasted *Cassia tora* seed meal recorded significant increase of the crude protein from 12.49% in the raw to 18.90% in the toasted seed. The finding in respect of nutritional composition of this study is corroborated by the work of other researchers such as Augustine *et al*. 2016 and Onimisi *et al*. 2017. They recorded increase in the crude protein of the test ingredients upon subjecting them to different processing methods, which includes toasting.

Abbas and Ahmad (2018) supports the assertion that heat treatment improves the nutritional value and quality of legume grains so that the heat treatment are used to enhance the protein quality of legume grains by inactivating the anti-nutrients, such as tannins, phytate, phenols to mention but few.

The ether extract of the raw seed of this study (3.50%) is slightly above the value reported by Ingweye *et al*. (2010) of 2.31% and little below the ether extract value recorded by Gohl (1981) and Augustine *et al*. (2016) of4.60% and 4.00%, respectively. However, Adamu *et al*. (2018) reported much higher ether extract value of 13.79% for the raw seed of *Cassia tora*.

The crude fibre of 11.62% recorded in the raw *Cassia tora* seed meal of this study was above the acceptable level of fish nutrition. However, the processed seed (toasted) had lower crude fibre. The crude fibre findings of this study corroborates the ones reported by Adoke *et al.* (2018), Augustine *et al.* (2014), Augustine *et al. (*2016) and Ingweye *et al.* (2010) of 13.35, 12.45, 13.80 and 10.18%, respectively. However, much lower crude fibre content was observed by Adamu *et al.* (2018) and Gohl (1981) of 7.78 and 7.40%.

The difference in some of the proximate composition parameters for the seed of *Cassia tora* might be attributed to the variation in geographical location of the experimental site.

The amino acid content of the raw *Cassia tora* seed meal shows slight similarity with the values recorded by Augustine *et al*. (2017). The methionine and lysine content reported in this study were 1.93 and 4.79 mg/100g as against the 1.30 and 3.90 mg/100g recorded by Augustine *et* *al*. (2017). Likewise, Ingweye *et al*. (2010) who worked on the nutritional evaluation of *Cassia tora* seed meal from Obanliku reported the lysine and methionine of the seed as 4.02 and 1.02 mg/100g. The values is a little below the recommended range for fish, which is 5.1 and 2.3 mg/100g. Khattab *et al*. (2009) corroborates the findings of this study that different processing treatments such as soaking, toasting, boiling, autoclaving increases the total essential amino acids.

The reported calcium, cupper, iron, magnesium, phosphorus, potassium, sodium and zinc in the raw seed of this study were 851.10, 900.01, 215.39, 610.70, 1101.25, 950.89, 573.29 and 51.52 mg/100g as against the values reported by Ingweye *et al*. (2010) of 960, 10.48, 234.60, 640, 810, 1200, 600 and 53.12 mg/100g. Some of the minerals such as sodium, magnesium, zinc and copper have similar concentration. Some processing methods reported by El-Adawy (2002) suggests retention of mineral contents in legume seeds as against the report by Lee and Karumanithy (1990) that some processing methods leached down mineral contents in different legumes.

The oxalate concentration revealed in this study for raw, toasted, soaked, autoclaved, boiled, fermented, boiled + fermented and soaked + toasted were 70.05, 17.80, 55.22, 60.06, 36.01, 49.31, 43.00 and 38.10 mg/100g. The percentage reduction in the concentration of oxalate in the processed *Cassia tora* seed as against the raw seeds were 74.59, 21.17, 14.26, 48.59, 29.61, 38.62 and 45.61 for the toasted, soaked, autoclaved, boiled, fermented, boiled + fermented and soaked + toasted, respectively. This suggests decrease or degradation of oxalate upon subjecting the seed meal to processing as corroborated by Adoke *et al*. (2018) who reported oxalate concentration of 1.14, 0.88, 0.65,0.67 and 0.64% for the raw, soaked, boiled, soaked + toasted and toasted seed meal. The percentage decline of oxalate content in differently processed as against the value recorded for the raw seed were 22.81, 42.98, 41.23 and 43.86%, respectively.

In addition, this study recorded saponin concentration in the raw seed of 166.90 mg/100g. However, processing through toasting, soaking, autoclaving, boiling, fermenting, boiling + fermenting and soaking + toasting resulted to decrease in the concentration by 9.88, 27.50, 17.35, 34.49, 15.18, 37.77 and 21.51%. Furthermore, Abdullateef *et al*. (2016) who worked on the growth response and feed utilization of *Clarias gariepinus* juveniles fed graded levels of boiled *Cassia tora* seed meal as a replacement for soya bean meal observed significant reduction of the anti-nutritional factor, saponin by 54.17%, which is from 0.96 to 0.44 mg/100g. The reduction is saponin concentration as reported by Augustine (2017) agrees with the findings of agrees with the findings of this study. Augustine (2017) reported decline in the concentration of saponin from 2.44 to 1.17, 1.18 and 1.31 mg/100g for the seed soaked for 6 hours, 12 hours and 24 hours, respectively.

The content of tannin recorded in this study was 104.43 mg/100g, which reduced by 25.00, 8.46, 19.66, 17.60, 5.87, 23.87 and 33.40% upon subjecting the seeds of *Cassia tora* seed to different processing method. However, Juji *et al*. (2023) reported higher tannin concentration (196.56 mg/100g) in the raw seed of *Cassia tora* seed meal than the value recorded in this study. Thereafter, upon subjecting the seeds to processing via toasting, sprouting, boiling and fermentation, the tannin concentration reduced by 12.90, 43.86, 49.01 and 55.73%.

Irrespective of the processing method adopted, there is an apparent decline in the concentration of anti-nutritional factors, which corroborates the findings of Augustine (2017), Adoke *et al*. (2018), Adamu *et al*. (2018) and Juji *et al*. (2023).

CONCLUSION

The nutritional composition of the toasted seed meal of *Cassia tora* showed great potentials as a fish feed ingredient, with crude protein of 18.90%, despite the strong limitations which can be attributed to the strong presence of anti-nutritional factors that hinders fish ability to absorb and assimilate nutrients from diets administered to them. The concentration of phytochemicals was significantly reduced through the application of different processing methods especially, toasting which had higher percentage reduction of the phytochemicals. The toasted seed meal of *Cassia tora* had relatively good amino acid and is rich in minerals.

Processing of legumes (*Cassia tora*) should be encouraged to deactivate anti-nutrients and boost the nutritional composition of the seeds in preparation for its usage as a fish feed ingredient.

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