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Chemical and Functional Properties of Full Fat and Defatted *Cassia fistula* Seed Flours

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Abstract: A relatively unknown leguminous (*Cassia fistula*) seeds were processed to full fat and defatted seed flours and the chemical and functional properties of seed flour were investigated using standard methods. Results showed the following respective values for FCF and DCF: Fat 6.68 and 0.39%, ash 4.52 and 4.71%, protein 26.25 and 28.09%, fibre 7.47 and 7.68%, carbohydrate 49.80 and 53.44%, moisture content 5.28 and 5.69%. The respective mineral contents (mg/kg) were P 1.52 and 1.76, Zn 270.67 and 241.82, Fe 179.529 and 242.50, Mn 37.21 and 41.73, Mg 947.38 and 896.00, Na 118.42 and 145.31, Ca 924.99 and 1001.20, K 837.61 and 899.18. The respective phytic acid and tannin contents were 0.26 and 0.21%; 7.70 and 8.18%. The water absorption capacity, oil absorption capacity, emulsion capacity, least gelation capacity, foaming capacity and foaming stability (after 4 hours) of FCF and DCF were: 512 and 558%, 216.20 and 218.08%, 40 and 20%, 10 and 8% (m/v), 33.33 and 37.25%, 27.45 and 29.49% respectively. The protein solubility of FCF and DCF was least between pH 4 and highest between pH 7-10. Defatting significantly influenced the chemical composition and functional properties of CF.

Key words: *Cassia fistula* seed, emulsion stability, water absorption capacity

INTRODUCTION

Cassia fistula is a legume, of the Fabaceae family. It is also called purging cassia, Indian laburnum and Golden shower. *Cassia fistula* is widely planted as a handsome ornamental tree. The Drug "*Cassia fistula*" is obtained from the Sweetish pulp around the seed. *Cassia fistula* is reported to be aperient, astringent, laxative, purgative and vermifuge, Indian laburnum is a folk remedy for burns, cancer, constipation, convulsions, delirium, diarrhea, dysuria, epilepsy, gravel, hematuria, pimples and glandular tumors Duke and Wain (1981). Ayurvedic medicine recognizes the seeds as antibilious aperitif, carminative and laxative. According to Roskoski *et al.* (1980), studying Mexican material, the seeds contain 5.3% humidity. 4.55% ash, 24.00% crude protein, 4.33% crude fat, 6.68% crude fiber and 50.36% carbohydrates with a 81.17% in vitro digestibility. The utilization and exploitation of a seed or legume or plant generally depends on the available information and data on such plant. It is the aim and objective of this study to investigate proximate composition, metallic composition, antinutritional factors and functional properties of both full fat and defatted seed flours.

MATERIALS AND METHODS

The major raw materials used in this work are mature healthy, freshly harvested *Cassia fistula* (CF) seeds obtained at Obanla area of the Federal University of Technology, Akure, Ondo State, Nigeria. The seeds were taken to the Crop, Soil and Pest Management laboratory of the Federal University of technology, Akure, for identification. The seeds were washed with distilled water, air-dried and collected into sterile plastic containers.

Preparation of samples: The fruits of CF were split into two, the hard husks were removed and the seed pulverized. The flour was divided into two; one part was defatted using n-hexane while the other was not. The operations involved are as shown in the flowchart (Fig. 1).

Chemical analysis: The mixtures were analyzed for proximate composition according to the standard methods (Coffman and Garcia, 1977). The crude protein was determined by multiplying the total nitrogen content by a factor of 6.25. The carbohydrate was obtained by difference. The mineral contents, namely: Na, K, Ca, Mg, Fe, Cu, Zn and Mn were determined using atomic absorption spectrophotometer (AAS) model 703, 23.
The total phosphorus in each sample was determined spectrophotometrically by the phosphovanadomolybdate method (Coffman and Garcia, 1977). A regression equation was used to calculate the amount of phosphorus in each sample (using their absorbance and dilutions). The regression equation obtained was: $y = 36.5756x + 0.2315$ ($R^2 = 0.995$); where y = concentration of phosphorus (mg) and x = absorbance.
The tannin content of the flours was determined as described by Makkar (Makker, 1994) with modification. From the absorbance and the standard tannic acid solution, the regression equation $y = 0.021x - 0.01$;

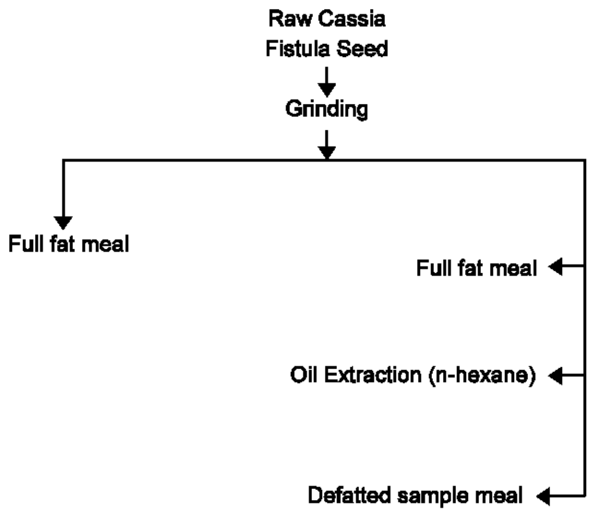

Fig 1: Flowchart for the preparation of raw full fat and defatted *Cassia fistula* seed flours.

(where x = absorbance; y = tannic acid in µg) was obtained and the tannic acid content of each sample solution was calculated from the equation. The results were expressed on percentage dry weight basis. The phytic acid was determined by extracting and precipitating it as described by Wheeler and Ferrell (1971).

Determination of functional properties

Water absorption capacity (WAC): WAC was determined by a combination of the AACC (1985) methods. 2g of each sample was dispersed in 20 ml of distilled water, stirred using a magnetic stirrer at 1,000 rpm and centrifuged at 4000 rpm for 30 min. The supernatant was carefully decanted, allowed to drain at a 45° angle for 10 minutes using measuring cylinder. The WAC of the protein was expressed as percentage of water bound. Assuming the density of water to be 1 gallon/litre.

Foaming properties: 5 g of meal was dispersed in 20 ml of distilled water, homogenized using a metabolic shaker for 30 minutes and centrifuged at 3000 rpm for 15 minutes at 30°C. The supernatant obtained was stirred for 5 minutes using a magnetic stirrer at 1200 rpm, poured into a 100 ml measuring cylinder and its volume was immediately noted. Foaming capacity (FC) was then expressed using the following equation as described by Lawhon *et al.* (1972).

$$FC = \frac{\text{(Vol. after whipping - Vol. before whipping)}}{\text{Volume before whipping}} \times 100$$

The foam volume was recorded at different time intervals after whipping to determine foam stability (FS) as described by Ahmed and Schmidt (1979).

$$FS = \frac{\text{(Foam volume after time t x 100)}}{\text{Initial foam volume}}$$

Oil absorption capacity (OAC): The method of Sathe and Salunkhe (1981) was used. 10 cm^3 vegetable oil (0.9 g/cm^3) was added to 1.0g of each sample in a beaker and stirred using magnetic stirrer at 1,000 rpm. The mixture was then centrifuged at 3,500 rpm for 30 minutes. The absorbed oil was expressed as the percentage of oil bound by 100 g sample on g/g basis. Weight (%) = (vol. of absorbed oil x 100)/wt of sample.

Emulsion capacity (EC): The procedure of Abbey and Ibeh (1988) was followed with slight modifications. EC was determined by dispersing 1.0g of each flour sample in a beaker containing 5 ml distilled water and 5 ml of vegetable oil was added. The mixture was emulsified by centrifuging at 1,600 for 5 min.

Emulsion capacity, EC (%) can be calculated as:

$$\frac{\text{(Initial vol. of oil – Final vol. of oil)}}{\text{(Wt of sample x density of oil)}} \times 100$$

Emulsion stability (ES): ES was determined by a slight modification of the method of Sathe and Salunkhe (1981). 0.5g of the sample was blended in a Kenwood blender with 25 ml of distilled water for 30 seconds at high speed. Oil was added continuously from a burette at the rate of 5ml per minute while blending continued. The emulsion so prepared was allowed to stand in a graduated cylinder and volume of water separated at time intervals of 0.5, 1, 2… 12 hours was noted in each case as the ES.

Emulsion stability, ES (%) can be calculated as:

$$\frac{\text{Height of the emulsified layer}}{\text{Height of total content in the tube}} \times 100$$

Least gelation concentration (LGC): The method of Coffman and Garcia (1977) was followed with slight modifications. Appropriate sample suspensions of 2, 4, 6, 8, 10, 12, 14, 16 and 18% (m/v) were prepared in 5 cm3 distilled water. The test tube containing these suspensions were heated for 1 hour in boiling water followed by rapid cooling using chilled water at 4°C for 1 hour. The LGC was taken as the concentration when the sample from the inverted test-tube did not fall down or slip.

Protein solubility (PS): The PS of the seed flours was determined as described by Ige *et al.* (1984). The effect of pH on protein solubility of the seed flours was

Table 1: Proximate composition of full fat and defatted Cassia fistula seed flours

Parameters	% Composition	
	Full fat flour	Defatted flour
Moisture	5.28	5.69
Fat	6.68	0.39
Ash	4.52	4.71
Protein	26.25	28.09
Fibre	7.47	7.68
Carbohydrate	49.80	53.44

Means of three determinations.

Table 2: Mineral contents (mg/kg) and some computed mineral ratios of full fat and defatted Cassia fistula seed flour

Metals	% Composition	
	Full fat flour	Defatted flour
P	1.52	1.76
Zn	270.67	241.80
Fe	179.52	242.50
Mn	37.21	41.73
Mg	947.39	896.45
Na	118.42	145.31
Ca	924.99	1001.51
K	837.61	899.18

Means of three determinations.

determined by adjusting the pH of the mixture from 2-12 using either 0.1 M HCl or 0.1 M NaOH, determining the corresponding PS and plotting it against pH values.

RESULTS AND DISCUSSION

Proximate composition: The proximate composition of the full fat and defatted CF seed flours are shown in Table 1. Results show significant variation in the fat (6.68 and 0.39%), ash (4.52 and 4.70%) and protein (26.25 and 28.09%) of the full fat and defatted *Cassia fitsula* (FCF and DCF) seed flours respectively. The protein content of FCF and DCF was high to warrant their consideration for use in food and feed formulations. The protein content obtained for FCF and DCF was comparable with the reports of Roskoski, *et al.* (1973) on CF. Meeting the recommended 23–56% human daily protein consumption (National Research Council, 1989) may not be difficult if FCF and DCF flours are consumed. The high protein content of the flours suggests that it may find use in food and feed formulation. However, the digestibility, availability and quality of amino acids present in the seed flours have to be determined before a conclusion on its suitability or otherwise.

Mineral contents: The nutritionally important mineral content of raw full fat and defatted CF seed flour are shown in Table 2. Potassium, calcium and magnesium are comparatively higher than manganese, phosphorus and sodium. For normal retention of protein during growth and for balancing metabolic fluid, a K/Na ratio of 1 is recommended (Helsper *et al.,* 1993). The high K: Na ratio obtained for raw CF seed flour thus suggests its suitability for normal protein retention. The daily amounts of macro minerals (mg) recommended for adult are K 2500, Ca 800, Mg 300-350, P 800 and Na 2500 respectively. The daily Ca and Mg requirements can be met easily while the diet may need to be supplemented with food materials high in K, P and Na. Iron, magnesium and calcium deficiencies in foods can lead to abnormal bone development and anemia; their presence in CF seed flour is therefore advantageous.

Table 3: Anti nutritional factors of full fat and defatted Cassia fistula seed flour

Sample	Cassia fistula seed flour	
	Full fat	Defatted
Phytic acid (%)	0.26	0.21
Tanin (%)	7.70	8.18

Values are means of three replicates. Values in the same row having different superscript are significantly different (P< 0.05)

Table 4: Functional properties of full fat and defatted Cassia fistula seed flour

Functional properties	Cassia fistula seed flour	
	Full fat	Defatted
Water absorption (WAC) %	512.00	558.00
Oil absorption capacity (OAC) %	216.20	218.08
Emulsion capacity (EC) %	40.00	20.00
Least gelation capacity, LGC (m/v)	10.00	8.00
Foaming capacity, FC (%)	33.33	37.25
Foaming stability (after 4 hours)%	27.45	29.49

Means of three determinations.

Antinutritional factors: The amount of phytic acid and tannin in full fat and defatted CF seed flours are shown in Table 3. Defatting decreased the phytic acid (PA) content (41.2%) but had no significant effect on the tannin content. Forbes and Erdman (1983) reported that the antinutritional nature of PA lies in its ability to chelate Ca, Mg, Fe and Zn thereby rendering them metabolically unavoidable and leading to the development of osteomalacia in some growing animals. Tannins have been reported to interfere with digestion by displaying anti-trypsin, anti-proline and anti-amylase activity in higher animals (Helsper *et al.,* 1993). The poor palatability generally associated with high-tannin diets can be ascribed to its astringent property which is a consequence of its ability to bind with the proteins of saliva and the mucosal membrane of the mouth during the mastication of food. The high tannin content of CF may thus limit its utility in weaning formulations.

Functional properties: Table 4 shows some functional properties of full fat and defatted CF seed flour. Results show that defatting significantly increased the WAC, OAC, FC and FS of CF seed flour. While EC decreased significantly with defatting, LGC was slightly influenced.

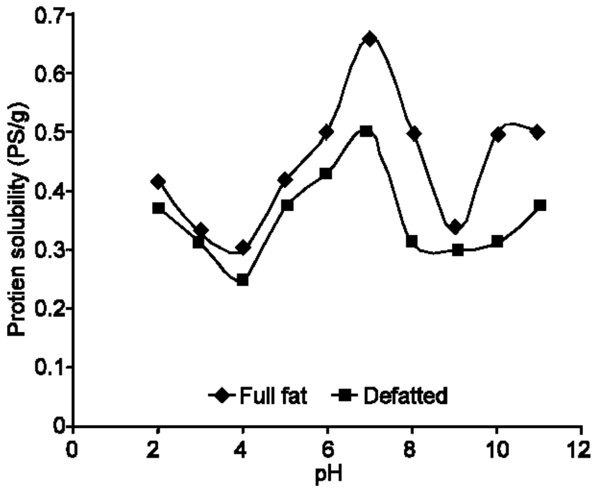

Fig. 2: Effect of defatting and pH on protein solubility of Cassia fitsula.

The WAC values obtained for full fat and defatted CF (512 and 558% respectively) are comparatively higher than 130% reported for soy flour 25. The OAC of FCF and DCF (216.20 and 218.08%) are also higher than 193, for soya bean flours (Lin *et al.,* 1974). The high WAC associated with defatted CF seed flour may be due to the exposure of water binding sites present on side chain groups of proteins by defatting previously blocked in a lipophilic environment. WAC ranging from 149.1 to 471.5% is considered critical in viscous foods such as soups and gravies (AOAC, 1990), thus the flours may find use as functional ingredients in soups, gravies and baked products. The water/fat binding capacity of proteins is an index of its ability to absorb and retain water/oil, which in turn influences the texture and mouthfeel of food products like ground meat formulations, doughnuts, pancakes, baked goods and soups. The seed flours may thus be used to replace some legumes and oil seeds as thickeners used in some liquid and semi liquid foods. The EC of the full fat and defatted CF seed flours (40 and 20%) are higher than 8.1 and reported for soya flours. EC is an important consideration in the production of pastries, coffee whiteners and frozen desserts. FCF and DCF may thus find use in such food formulations. The LGC of the CF seed flours (10.00 and 8.00% m/v) compares favourably with 10, great northern bean (Sathe and Salunkhe, 1981). The ability of seed flours to form gel is desirable in the preparation of extended meat products.

Fig. 2 shows the pH dependency of the protein solubility (PS) of fullfat and defatted CF. The seed flours show their least solubility between pH 4 and their maximum solubility between pH 7-10. This result agrees with findings of Fan and Sosulski (Fan and Sosulski, 1974) which showed a narrow pH range of 4-5 at the isoelectric point for mungbean and field pea. Seed protein concentrates which are soluble at pH 4-7 could be used in such beverages as “vegetable milk”. The flours of the samples may be used in such beverages as “vegetable milk”. PS is an index of functionality and finds potential application in food products such as soups, beverages and food cakes, in which gelation, emulsification and foaming properties are required.

Conclusion: This work has shown that *Cassia fistula* seed flour is a potential source of dietary proteins and minerals for use in food and feed formulation. Its functional properties suggest that it has potential for use as functional ingredients in food formulations. The presence of antinutrients may limit its utilization.

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