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Effects of extraction methods on the proximate, mineral and anti-nutrient composition of Huracrepitans seed cake

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ABSTRACT

As it is widely known that the methods of extraction affect the qualities of oil, it is necessary to find out if these extraction methods affect the qualities of the seed cakes as well. The aim of this article is to investigate the effect of extraction methods on the proximate, minerals and anti-nutrient composition of Hura crepitans seed cake. Three extraction methods (mechanical, Soxhlet and cold maceration) were employed using the methods of (Womeni et al., 2018) and (Nehdi et al., 2010). The proximate composition of the seed cakes was determined using (AOAC, 2010) methods while their elemental mineral component was analysed using Atomic Absorption Spectrophotometer (AAS) following (AOAC, 2016) methods, Sodium and Potassium were determined using Flame photometer. Their anti-nutrient content was determined following the method of (Akaninwor and Okechukwu, 2004). The proximate composition showed that apart from the dry matter for the mechanically extracted seed cake which is 94% DM basis, the remaining parameters (crude fibre, crude protein, ether extract, energy content and ash content) values were higher compared to the Soxhlet and cold maceration extracted seed cake. The mineral composition goes in the following order: (MEM>SEM>CEM) while the anti-nutrient content took the following trend: (CEM>SEM>MEM). This study has shown that methods of extraction also affect the qualities of seed cake as it does to the oil.

Keywords— *Seed cakes, Mechanical, Soxhlet, Cold maceration, Huracrepitans*

1. INTRODUCTION

Oilseed cakes are residues obtained after extraction of oil from seeds and are rich sources of energy and nutrition. The oils and fats present in them are useful as food fats and industrial raw materials. Proteins present in some oilseeds and their cakes are edible to humans while some are useful as animal feeds. It also contains carbohydrates, vitamins and minerals. Oilseeds and oilseed meals have an important role in relieving the malnutrition and calorie nutrition of human and animal population. The oil obtained from oilseeds is by either mechanical expression or solvent extraction method. In the mechanical expression, hydraulic and screw presses are usually employed while the solvent is used to extract all the oil from the seed in the solvent extraction method. It has been reported by various authors that extraction methods affect the quality of oil, however, not much information is available if these methods of extraction affect the qualities of the residual cakes. The aim of this study is to investigate the effect of extraction methods on the proximate, minerals and anti-nutrient composition of *Hura crepitans* seed cake.

Hura crepitans falls into the group of underutilized species of plants. **H**. *crepitans* Linn is a tropical plant belonging to the family Euphorbiacea. **H**. *crepitans* is usually planted in towns and villages as a cover tree and as a self-regenerating ornamental plant in the tropics. It is commonly known as a sand box tree with spiny trunk and branches and it is commonly planted as a shade with about 25 m tall (Arkroyed *et al*., 1982). This seed represents a very important oil source as well as a conventional energy feed source. **H**. *crepitans* seeds contain amino acids at levels that compared favourably with the other conventional seeds and even better in terms of some other additional amino acid such as lysine, methionine, cystine, threonine and Histidine (Esono *et al*., 2014). Lots of work have been done on the chemical and nutritional evaluation of the seed flour but less information is available on the effect of extraction methods on the seed cake.

2. MATERIALS AND METHODS

2.1 Sample collection and pre-treatment

The *Hura crepitans* seeds were collected from Olorunda village, Akobo, Ibadan, Oyo State. The shells of **H**. *crepitans* seeds were cracked mechanically to obtain the seeds. The oilseeds collected were dried, sorted to remove foreign materials, pulverized and prepared for extraction.

2.1.1 Cold maceration method: This was done according to the method described by (Womeni *et al*., 2017) pulverized samples (500 g) was soaked with 3000 ml of hexane each in different amber bottles for 48 hours. The mixture was later filtered using filter paper (Whatman, No 2), the residue was collected and kept in an air tight container for further analysis.

2.1.2 Soxhlet extraction method: The method of (Nehdi *et al*., 2010).The pulverized seed (30g) was weighed and placed in a thimble, the oil in the seed was extracted using a Soxhlet apparatus.

2.1.3 Mechanical extraction method: The milled seed (500g) was pressed for the extraction of the oil and the resulting cake was stored in an air tight container for further analysis.

2.2 Proximate composition of the seed cakes

The proximate composition of the seed cakes, such as dry matter, crude protein, crude fibre, ash contents, ether extracts and energy content were all determined using (AOAC, 2010) methods as follows:

2.2.1 Crude Protein: The crude protein content was determined using a micro kjeldahl method. 0.20 g of sample was weighed into a long necked Kjeldahl flask, 1 tablet of Kjeldahl catalyst (Kjeltabs) was added along with 25cm³ concentrated H_2SO_4. The flask was swirled to mix the contents. It was gently clamped in an inclined position and heated electrically in a fume cupboard until a clear solution was obtained. The solution was then allowed to cool, transferred to a 100cm³ volumetric flask and diluted up to the mark with distilled water. 10ml of the diluted solution was placed in a distillation flask and made alkaline with 0.1 M NaOH. The flask was connected to the distillation apparatus and 40% NaOH was added to the flask through a tap funnel and swirled to mix its content. Steam generated by heating water in a steam generator connected to the flask was passed in to liberate ammonia gas. Liberated ammonia gas was trapped in a conical flask containing the boric acid solution. The conical flask was positioned such that the steam of the condenser dipped into the boric acid solution. After collecting about 50cm³of the distillate, the receiver was lowered and the tip of the condenser was washed with distilled water, the ammonia solution in the distillate was titrated against 0.1M HCl. A blank determination was carried out using the same amount of the reagents in the absence of the sample.

$$\% \text{ Nitrogen Content} = \frac{(Titre\ value\ X\ M\ X\ 0.0014\ X\ Df\ X\ Cf)}{(Weight\ of\ sample)}$$

Where,
M = Molarity of HCl = 0.01M
Df = Dilution factor = 50
Cf = Correction factor = 10

$$\% \text{ Crude protein} = \% \text{ Nitrogen x } 6.25$$

% Nitrogen was converted to percent crude protein by multiplying with 6.25, the conversion factor. Most proteins contain 16% Nitrogen, hence, the conversion factor is 6.25 (100/16 = 6.25).

2.2.2 Dry matter: The seed flour was dried to constant weight at 105°C. Clean, dry, weighed evaporating dishes were used for this purpose. About 2g of the powdered sample was taken in the dish and placed in an oven to dry at 105°C for 24hrs.

$$\% \text{ Dry matter } = \frac{(Weight\ loss\ due\ to\ drying)\ X\ 100}{(Weight\ of\ sample)}$$

2.2.3 Determination of crude fibre: Freshly prepared 200 ml of 1.25% H_2SO_4 (0.1275M) was added to 2g of seed flour, which had been defatted by extraction with ether, and brought to boil quickly. Boiling was continued for 30 minutes after which the mixture was filtered. The residue was washed free of acid with plenty of warm water. The residue was then transferred quantitatively into a digestion flask; 200ml of 1.25% NaOH (0.313M) was added and boiled for 30minutes. The mixture was then filtered and the residue washed free of alkali with warm water. The residue was them washed thrice with methylated spirit and petroleum ether and then allowed to properly drain. The residue was then transferred to a dried, weighed silica dish and dried to a constant weight at 105°C. The organic matter of the residue was burnt off by igniting for 30 minutes in a muffle furnace at 600°C. The ash left behind was cooled and weighed. The loss in weight on ignition was reported as crude fibre.

2.2.4 Determination of total ash: The sample (5g) was weighed into a previously dried, cooled and weighed silica crucible. The crucible and content were ignited, first gently over a low flame until charred, and then in a muffle furnace at 55, 0°C until white ash was obtained. The ash was moistened with distilled water, dried on a steam bath and then on a hot–plate and re ashed at 550°C to constant weight. The weight of ash formed was obtained by difference and expressed as a percentage of the sample used.

2.3 Mineral composition of defatted D. *regia* seed cake

The seed cakes were analysed for their mineral content using Atomic Absorption Spectrophotometer, (Model 215 VGP BUCK Scientific) according to (AOAC, 2016) methods for metals such as Magnesium, Iron, Zinc, Calcium, Manganese, Copper and Cobalt while Sodium and Potassium were determined by flame photometry.

2.4 Determination of anti-nutrient content of the seed cakes

The tannin and phytate contents were determined according to the method of (Akaninwor and Okechukwu, 2004) with some modifications. Oxalate content was determined according to the method described by (Aina *et al*., 2012).

3. RESULT AND DISCUSSION

The dry matter value for *Hura crepitans* for mechanical extracted, Soxhlet extracted and cold macerated cakes are 94%, 97% and 96% DM respectively. The values compare well with those of groundnut seed cake and soybean seed cake (97g/100g and 95g/100g) reported by (Aletor and Ojelabi, 2007), although, the method of extraction of these seed cakes were not stated. There is no significant difference in the protein content for the three extraction methods employed. This shows that the method of extraction does not have a significant effect on the protein content of **H**. *crepitans* seed cake. The protein content of the seed cake within 23.00% is lower than those of groundnut, soybean and palm kernel cake which are commonly utilized. This value is within the range of those reported for some leguminous seed flours ranging between 23.1-33.0% (Olaofe *et al*., 1994), the values for the ether extract, 10.05%, 4.35% and 4.15% for mechanical extracted, cold macerated and Soxhlet extracted cake respectively shows that there are still some residual fat left in the mechanically extracted cake as this method of extraction may not be able to squeeze out all the fat from the seed. The ash content of **H.** *crepitans* seed cakes using the three extraction methods is low. It has been reported by (Pomeranz and Clifton, 1981) that for nuts, seed and tubers to be suitable for animal feed, the ash content should fall in the range 1.5-2.5%. The ash content of **H**. *crepitans* seed cake falls within this range, hence, it may be suitable for animal feeds. The crude fibre values for **H**. crepitans seed cakes (6.79%, 6.75% and 6.80%) for the three extraction methods employed compares favourably when compared with legumes, mean values ranging between 5-6% (Anonymous, 1972; Aremu *et al*., 2006). The energy content for the seed cakes are high, this compares favourably with the high energy values for groundnut seed cake and soybean seed cake reported by (Aletor and Ojelabi, 2007). The mineral composition of the seed cakes showed a high concentration of magnesium, potassium, sodium and calcium in all the methods of extraction employed. The mineral values for the screw pressed cake is slightly higher than those of the Soxhlet and cold macerated cake. The values are in the range of those reported by (Oladitoye *et al*., 2010) for the seed flour. Minerals are needed in the diet because of the function they perform in the body human and animals, they are required for various physiological and metabolic functions. The animal body can use calcium and phosphorus independently of each other to only a limited extent. The utilization of both calcium and phosphorus is connected closely with Vitamin D. A significant supply of Vitamin D (or its equivalent in sunshine) is necessary for the proper utilization of the calcium and phosphorus contained in the ration (Hang, 1951). The tannin, oxalate and phytate content of the seed cakes are (0.28mg/100g, 0.96mg/100g and 1.35mg/100g) for mechanical extracted, (0.36mg/100g, 1.02mg/100g and 1.40mg/100g) for Soxhlet extracted, (0.40mg/100g, 1.12mg/100g and 1.43mg/100g) cold macerated respectively. These values have no significant difference. Tannins are known to be responsible for decreased feed intake, growth rate, feed efficiency and protein digestibility in human and animals. If tannin concentration in the diet becomes too high, microbial enzyme activities including cellulose and intestinal digestion may be depressed (Aletor *et al*., 2005). Tannins also form insoluble complexes with proteins and the tannin-protein complexes may be responsible for the anti-nutritional effects of tannin-containing foods (Panhwar, 2005; Kyriazakis and Whittenmore, 2006). Phytate is usually present in plant, seeds and grains, comprising 0.5 to 5 percent (w/w) (Loewus, 2002).

Table 1: Proximate composition of the seed cakes (DM basis)

Parameters	MEM	SEM	CEM
Dry matter	94.0±0.13	97.0±0.15	96.0±0.10
Ash content	1.63±0.05	1.75±0.26	1.69±0.37
Crude protein	23.51±0.13	22.95±0.25	23.00±0.14
Crude fibre	6.80±0.10	6.75±0.18	6.79±0.05
Energy content (kcal/100g)	278.15±0.04	267.26±0.15	271.19±0.02
Ether extract	10.05±0.06	4.35±0.14	4.15±0.08

MEM- Mechanical extraction method, **SEM**- Soxhlet extraction method, **CEM**- Cold maceration extraction method. Values are mean ± standard deviation of triplicate determinations.

Table 2: Mineral constituents of the seed cakes (ppm)

Extraction	Mg	Fe	Zn	K	Na	Mn	Ca	Co	Cu
MEM	212.794	115.251	8.779	52.539	60.220	1.852	97.172	10.011	1.921
SEM	198.215	113.143	6.128	46.289	57.352	1.412	94.350	8.025	1.712
CEM	195.145	97.256	6.025	44.246	56.5430	1.405	93.487	7.949	1.702

MEM- Mechanical extraction method, **SEM**- Soxhlet extraction method, **CEM**- Cold maceration extraction method. Values are mean ± standard deviation of triplicate determinations

Table 3: Anti nutrient composition of the seed cakes (g/100g)

Extraction methods	Tanin	Oxalate	Phytate
MEM	0.28	0.96	1.35
SEM	0.36	1.02	1.40
CEM	0.40	1.12	1.43

MEM- Mechanical extraction method, **SEM**- Soxhlet extraction method, **CEM**- Cold maceration extraction method. Values are mean ± standard deviation of triplicate determinations

4. CONCLUSION

From this study, it shows that methods of extraction does not have a significant effect on the anti-nutrient composition of *Hura crepitans* seed cake but has a significant effect on the proximate and mineral composition.

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