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Physicochemical and Functional Properties of Defatted Cakes from Two Euphorbiaceae from Cameroon: Riconodendron Heudelotii (Bail) and *Tetracarpidium conophorum* (Müll. Arg.)

[1]Clergé Tchiegang, [1]Laurette Blandine and [1]Mezajoug Kenfack,
[2]Dzudie Tenin and [1]Robert Ndjouenkeu
[1]Department of Food Science and Nutrition,[2]Department of Process Engineering,
National Advanced School of Agro Industrial Sciences,
University of Ngaoundere, P.O. Box 455 Ngaoundere, Cameroon

Abstract: Proximate composition, amino acid profiles and some functional properties of seeds and defatted cakes from two Euphorbiaceae *Ricinodendron heudelotii* and *Tetracarpidium conophorum* were determined. Both kernels are rich in fats (more than 55%) and have the same total protein content (more than 20.0%). The crude fibre content varied between 5.6 and 6.2% indicating that these kernels could be as a good source of this component. The total ash were higher in the *R. heudelotii* kernel (7.6%) compared to the 2.6% found in the *T. conophorum* kernels. The amino acid profiles of the defatted cake showed that essential amino acid represented 33% of the total amino acid in the two oilseeds. The *T. conophorum* and the *R. heudelotii* proteins present two points of minimum solubility at pH 4.0 and 8.0. NaCl 0.5N increased the solubility of the two defatted cake tested. The oil absorption value was lower for the *T. conophorum* defatted cake and higher for the *R. heudelotii* defatted cake. The emulsion capacity followed an inverse trend. Both defatted cakes had similar emulsion stability. The highest foaming capacity was recorded with the *T. conophorum* defatted cake. The lowest gelation concentration for the *T. conophorum* defatted cake was 8% compared to 18% for the *R. heudelotii* defatted cake. The *T. conophorum* and *R. heudelotii* defatted cakes, with their high total protein content, their sufficient amount of amino acid (isoleucine, leucine, tyrosine, phenylalanine, threonine, valine) and their functionality suggests their potential use in the food industry.

Key words: *Ricinodendron heudelotii, Tetracarpidium conophorum,* defatted cake, physicochemical characteristics, amino acid profiles, functional properties

INTRODUCTION

Efficient exploitation of available food resources is needed to feed the growing population and to develop agriculture, especially in developing countries. Conventional food resources do not always meet the nutritional needs of humans. This justifies increasing research in the development of non conventional food resources, especially high protein content food from plants.

It is generally recognized that many non-timber forest products that have been traditionally used by local people in Cameroon are nutritionally important as sources of vitamins, minerals, proteins, oils and carbohydrates. *Ricinodendron heudelotii* and *Tetracarpidium conophorum* are two under exploited oil seeds plants that belong to the Euphorbiaceae family. *R. heudelotii* is a high tree of 30 m length with 3 m circumference[1]. In Cameroon, it grows in south, littoral, west and central regions[2]. It has pale yellow seeds and the kernels of these seeds are important ingredients in culinary usage. They are generally ground and used with other spices to set off the taste of sauces. In Cameroon, the kernels are readily obtained from local markets where they are known as *Djansang* (Douala and Bassa dialects), *Nzonel* (Ngoumba), or *Ezezang* (Yaounde). *T. conophorum* is a sarmentous plant of about 30 m length, which in Cameroon grows in the west, south and littoral regions[3]. Its fruits are striped capsules green then yellow. Nuts are pale white and are usually eaten after they have been cooked. In Cameroon, nuts are readily obtained from local markets (mainly Nkongsamba, Melong, Bafoussam, Bangangté) where they are known as *ngak* (*bangangte* dialect) or *kaso* (*bush English*).

Scientific reports on their chemical properties have revealed that both kernels of *R. heudelotii*

Corresponding Author: Clergé Tchiegang ,Department of Food Science and Nutrition,National Advanced School of Agro Industrial Sciences,University of Ngaoundere, P.O. Box 455 Ngaoundere, Cameroon

and *T. conophorum* contains more than 50% of total lipids and more than 20% of crude proteins[4-6]. Those results describing them as being a potential source of nutritious fats and proteins. Because of its protein content, the resulting flours obtained after oil extraction are of nutritional interest. They represented invisible sources of proteins.

Surprisingly, the characteristics of they proteins have not been extensively investigated.

In the present study, some physicochemical and functional properties of defatted cakes from *R. heudelotii* and *T. conophorum* from Cameroon were investigated.

MATERIALS AND METHODS

T. conophorum seeds and *R. heudelotii* kernels were purchased from a local market (Nkongsamba, Cameroon). *T. conophorum* seeds were cracked and dehulled while *R. heudelotii* kernels were purchased ready for use. *T. conophorum* and *R. heudelotii* kernels were coarsely ground in a hammer mill. Oil was extracted with petroleum ether at 40-60°C in a soxhlet apparatus and the resultant flakes air-dried. The dehulled flours (defatted cakes) were oven-dried at 40°C for one day and subsequently milled into fine grain (400 μm) of powder.

Chemical composition: The proximate composition of the flours was determined according to the[7] procedures. Each analysis were done in triplicate. Amino acid profiles (excepted cystein) were determined in a Pico-Tag Station (Waters, Milford, MA, USA) equiped with an automatic analyser model 420A Perkin Elmer PE Biosystems (Foster City, CA. USA). Results were recorded and calculated using the Model 600 Data Analysis System (ABI, Perkin Elmer). Amino acid concentrations were calculated as g of amino acid per 100 g of defatted flour.

Functional properties: The method described by[8] was used to determine nitrogen solubility. 0.16 g of defatted cake were dispersed in NaCl 0.0 or NaCl 0.5N solution and the desired pH obtained by adding 0.1M of HCl or NaOH. Soluble nitrogen were extracted within 30 min at room temperature and the pH was readjusted as necessary after each 10 min. Protein solubility (%) was calculated as water soluble protein x 100 / total protein in the sample.

Wettability, emulsion capacity, oil and water absorption and foam stability determinations were carried out following the methods described by[9]. Emulsion capacity is expressed as the amount of oil emulsified. Water and oil absorption were expressed as grams of water or oil per 100 g of flour. Volumetric changes in the foam, oil and aqueous layer were recorded after 1, 10 and 120 min, respectively. Foam volume changes in the cylinder were recorded at the same intervals. The gelation was analysed by the method of[10]. Suspensions of the samples in the range of 2-20% were prepared in a distilled water and warmed during 1 hour in a water bath at 80°C. Observation of gel formation were made at 5 min. intervals. The lowest gel concentration is that of the tube in which gelification is observed with the lowest defatted cake concentration. In this case, the preparation of the tube could not link when the tube is returned.

Statistical analysis: The experiment were performed in triplicate and the means ± standard deviation of three values were reported. The T-test was used to compare the results.

RESULTS AND DISCUSSION

Chemical composition: The proximate composition of flours (Table 1) prepared from the two kernels showed significant differences ($p<0.05$) among some constituents of the two fruits. The two fruits had comparable amount of lipids (55.5 -56.0%) and total protein contents (22.3 -23.2%), indicating that the *T. conophorum* and *R. heudelotii* kernels could be used as lipid and protein sources in food products. The total carbohydrate content varied between 4.4 and 6.5% for the *R. heudelotii* and the *T. conophorum* kernels, respectively. The crude fibre content varied between 5.61 and 6.22% indicating that these kernels could be as a good source of this component. The total ash were higher in the *R. heudelotii* defatted cake (16.3%) compared to 6.0% found in the *T. conophorum* defatted cake. For the *R. heudelotii* defatted cake, higher values (16.0) of ash were reported by[5,11] found that *T. conophorum* defatted flour contained 8% of nitrogen and 8.4% of total ash. A value of 3.1% ash was determined in nigerian *T. conophorum* flour[4]. The observed results demonstrated that proximate composition of the *T. conophorum* and *R. heudelotii* flours is climatic zone dependent. *Irvingia gabonensis* nuts which is other oil bearing non timber forest product currently used as soup thickener contain 88.1% of dry

Table 1: Proximate composition of kernels and defatted cakes of *R. heudelotii* and *T. conophorum* (g/100 g dw)

Kernels	Total lipids	R. heudelotii	T. conophorum
		55.5±2.1^{a}*	56.0±0.3^{a}
	Residual moisture	3.1±0.8^{a}	2.4±0.0^{b}
Defatted cake	Total protein	50.3±1.46^{a}	52,6±0.58^{a}
	Ash	16.3±0.7^{a}	6.0±0.6^{b}
	Total carbohydrate	4.4±0.3^{a}	6.5±0.2^{b}
	Crude fibre	13.9±0.2^{a}	12.7±0.2^{b}

* Means of the same line with different superscript are significantly different at $p<0.05$

Table 2: Water and oil absorption capacities, gel formation, foam and emulsion capacities and stabilities of defatted cake from *R. heudelotii* and *T. conophorum*

Functional properties	*R. heudelotii*	*T. conophorum*
Water absorption capacity (%)	287.2 ± 0.4^{a}*	280.9 ± 1.8^{b}
Oil absorption capacity (%)	54.1 ± 2.5^{a}	45.4 ± 1.2^{b}
Gel formation: lowest conc. (W/V)	18%	8%
Emulsion capacity (%)	33.0 ± 0.3^{a}	51.4 ± 1.0^{b}
Emulsion stability	92.2 ± 0.3^{a}	96.4 ± 0.4^{b}
Foam capacity (%)	5.1 ± 0.1^{a}	40.1 ± 0.3^{b}
Foam stability (%) after:		
-1 min	100.0 ± 0.0^{a}	100.0 ± 0.0^{b}
-10 min	100.0 ± 0.1^{a}	99.2 ± 0.8^{b}
-120 min	37.0 ± 0.0^{a}	85.0 ± 0.0^{b}

* Means of the same line with different superscript are significantly different at $p<0.05$

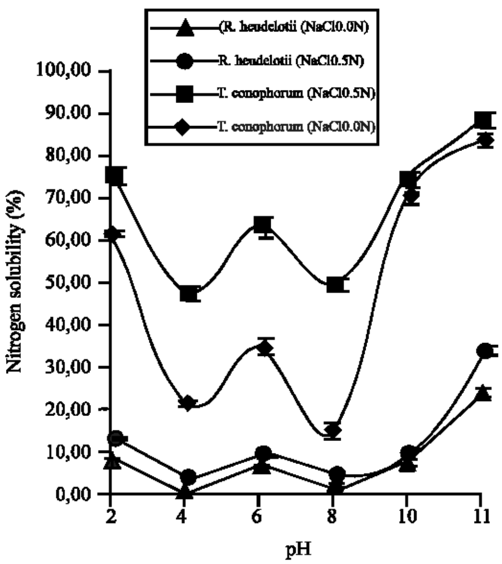

Fig. 1: Nitrogen solubility of *R. heudelotii* and *T. conophorum* in the NaCl at 0.0N and 0.5N

matter, 51.3% fat, 26% total carbohydrate, 2.5% ash, 7.4% crude protein, 0.9% crude fibre[12].

Functional properties: The nitrogen solubility patterns from both defatted cakes are pH and ionic dependent in 0.0 and 0.5N NaCl (Fig.1), with the *T. conophorum* proteins showing high solubility in all conditions. The high ash content of the *R. heudelotii* defatted cake may explain the low solubility of its proteins, owing to the hypothesis that these minerals could have partially formed insoluble complexes with proteins. The *T. conophorum* and the *R. heudelotii* proteins present two points of minimum solubility, at pH 4.0 and 8.0. These two minimum are more evident with *T. conophorum* defatted cake[4] found that defatted cake obtained from *T. conophorum* and seeds had two minimum solubilities at pH 5.5 and 8.0 and at pH 5.0 and 9.0, respectively. The high solubility of the *T. conophorum* and the *R. heudelotii* defatted cakes at acidic pH suggested that the protein of these nuts may be used in acidic foods, like beverages. These proteins could be also used in basic foods due to their high solubility at pH 9 and 10. Melon seeds protein also presented minimum solubility at about pH 3.0 and 5.5[4] The results suggested that there may be more than one protein in these oilseeds.

The water absorption capacity (Table 2) of the two defatted cakes are high and different, suggesting that the hydrophilic character of their proteins can be due to a high number of carboxyl and amino acid groups or to the presence of polysaccharides. Wolff[13] showed that the high water absorption of flours enabled bakers to add more water to doughs so as to improve handling characteristics and maintain freshness in the bread. Meanwhile, the *R. heudelotii* defatted cake thickened the solution at a very high concentration, as shown by its highest gel concentration (18%), twice higher than the value obtained with *T. conophorum* defatted cake (8%). This difference in the gelation behaviour indicated that, though the apparent hydrophilic properties of the two flours were similar, the conformational behaviour of their constituent molecules (proteins, carbohydrates, lipids) and certainly the relative ratios of these molecules should be different[14]. The interactions between such components affect functional properties. Their mineral content may also play a role by influencing the gelation as the *R. heudelotii* defatted cake had more total ash content than the *T. conophorum* defatted cake.

The *R. heudelotii* defatted cake absorbed more oil than *T. conophorum* defatted cake, but presented a lower emulsion capacity. The emulsion stability of the *R. heudelotii* and the *T. conophorum* defatted cakes after 30 min were 92.2 and 96.4%, respectively. Sathe[14] suggested that, in the case of winged bean isolate and soy isolate, the high emulsion stability of both flours defatted cakes were due to the globular nature of the major protein. The nature of these proteins of the two seeds is to be investigated. The behaviour of the *T. conophorum* defatted cake in oil corroborated the results obtained by[4] on Nigerian cultivar, despite the fact that the later presented a high fat absorption (98.5%). These results suggested that the defatted cakes prepared from the two nuts may be used as extenders in communited products such as sausages, as suggested for flour extenders or as analogs and baked doughs[9,15,16].

The foaming capacity and stability of the flours defatted cakes are also shown in Table 2. The *T. conophorum* defatted cake had a higher foam capacity and stability than the *R. heudelotii* defatted cake. After 120 min the *T. conophorum* defatted cake showed a higher foam stability of 85% compared to that of 37% recorded for the *R. heudelotii* sample.

Table 3: Amino acids profiles of defatted cakes from *R. heudelotii* and *T. conophorum* (g of amino acid/ 100 g of flour)

Amino acids	*R. heudelotii*	Chemical scores	*T. conophorum*	Chemical scores	FAO/WHO (1990) pattern
Essentials					
isoleucine	3.29	117.6	4.05	144.60	2.8
leucine	7.34	111.2	7.06	106.90	6.6
lysine	2.64	45.5	4.22	72.70	5.8
methionine	1.68	112	0.8	47.61	1.5
cysteic acid	nd*	/	nd	/	/
phenylalanine	4.16	138.8**	2.37	109.40**	4.14**
tyrosine	1.59	-	2.16	-	-
threonine	4.26	125.3	5.27	155,00	3.4
valine	7.77	222	6.00	171.40	3.5
tryptophane	0.37	33.63	1.09	99.10	1.1
Non essentials					
alanine	7.26		6.13		
arginine	8.19		6.3		
aspartic acid	11.19		14.4		
glutamic acid	17.9		12.23		
glycine	8.77		13.85		
histidine	1.76		1.44		
proline	6.45		6.43		
serine	5.39		6.20		

*nd: non determined, ** Phe + Tyr

The amino acid profiles of the two defatted cakes are given in Table 3, in comparison with amino acid scoring pattern of the Food and Agricultural Organisation of the United Nations[17]. The amino acid profiles of the two Euphorbiaceae defatted cakes indicated considerable amount of isoleucine, leucine, tyrosine, threonine, phenylalanine and valine. Essential amino acids represented up to 33% of total amino acids in both defatted cakes; which, according to[18], indicated a good equilibrium between the amino acids. The chemical scores of the two defatted cakes were 33.6 and 47.6 for *R. heudelotii* and *T. conophorum,* respectively. These values represented tryptophane and methionine, which appeared as limiting amino acids in *R. heudelotii* and *T. conophorum* defatted cake, respectively. Lysine is the second limiting amino acid in the two defatted cakes, generating chemical scores of 45.5 and 72.7 for *R. heudelotii* and *T. conophorum*, respectively. It should be observed that the limiting character of lysine in the *T. conophorum* defatted cake was less drastic than in the majority of cereal grains[19]. Common cereal grains that have lysine as the first limiting amino acid and their respective chemical scores are barley (64), cornmeal (49), millet (63), polish rice (66), sorghum (37), wheat flour (38)[19]. The results indicated that the *T. conophorum* and the *R. heudelotii* used as "mouth fruit" and soup thickener, respectively have comparable nutritional quality. The chemical scores of the two flours are comparable to those of soy defatted flour (limited in methionine) which is 80[20] and cottonseed flour (limited in sulfur amino acids and lysine) with 74[21].

The results of his study show that *R. heudelotii* and *T. conophorum* could be used as lipid, protein, mineral and crude fibre sources. Nitrogen solubility from the two defatted cakes present two points of minimum solubility, suggested the presence of more than one proteins. Functional properties of the *R. heudelotii* defatted cake could be influenced by it higher ash content. Nevertheless, results obtained suggesting that seeds from *T. conophorum* and *R. heudelotii* could have potentials of being used in a number of food formulation. Preparation of concentrates and isolates from their defatted cakes needs to be investigated.

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