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Method of extraction and demucilagination of *Treculia africana:* effect on composition

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ABSTRACT

Treculia africana (African breadfruit) seeds extracted from fresh fruit heads were treated with graded concentrations (1% - 5%) of trona (sodium sesquicarbonate) and wood ash for 5 – 25 min to evaluate their demucilaginating effectiveness. Seeds from naturally fermented and unfermented fruit heads served as controls. The effect of the demucilaginating aid on nutrient composition, colour and water absorption capacity were determined. Trona at 5% (w/w) concentration removed 27% of the total seed mucilage (30%) in 25 min while wood ash at the same concentration and treatment time removed 6% of the total mucilage. There were no significant ($p > 0.05$) variations among treatments in colour, water absorption and proximate composition. Seeds from the naturally fermented and unfermented fruit heads (controls) contained 13.8% and 15.2% crude protein respectively. The control sample (seeds from the unfermented fruit head) had 28% to 38% more calcium than seeds from the other treatments. Free fatty acid and peroxide values were very high ($P < 0.05$) in the ether extract of seeds from the fermented fruit head (control). Using trona as a demucilaginating aid was found to be more effective than using wood ash.

Keyword: Extraction, composition demucilagation, T. africana

INTRODUCTION

Treculia africana Decne (African breadfruit) is a member of the Moracea family. It is widely grown in southern Nigeria for its seeds. It is a common forest tree known by various tribal names in Nigeria. Such names include “afon” (Yoruba), “barafuta” (Hausa), “Ize” (Bini) “eyo” (Igala) “edikang” (Efik) and “Ukwa”’ (Igbo) (Irvine, 1961). Treculia africana is commonly called African breadfruit because of its large compound fruit (Ejiofor, 1988). The fruit is hard and spongy in texture when ripe and contains numerous seeds like orange pips embedded at various depths in the fleshy pulp (Ejiofor, 1988; Enibe, 2001). A mature seed consists of an outer covering or seed coat and an inner edible endosperm. The husk is coated with a thin viscous highly hydrated layer or mesocarp similar to the coffee bean mucilage. African breadfruit seed husk is brown in colour but the colour changes to black due to oxidation after a fermentation period that varies between 6 to 12 days. The fermentation is done to degrade the fruit pulp and seed mucilage in order to facilitate the extraction of the seeds. The traditional fermentation process as a method of seed extraction and demucilagination imparts a characteristic offensive odour to the seeds. Besides, subsequent cleaning of the seeds after fermentation is slow, dirty and tedious requiring very large volumes of water. African breadfruit is an important food item that contributes immensely to the diet of Nigerians. Iwe and Ngoddy (2001) reported the development of a mechanical dehulling process for African breadfruit however the seeds need to be extracted from the fruit heads and demucilaginated before it can be dehulled.

In view of the long period required for the fermentation of the fruit head to facilitate extraction of the seeds, the characteristic odour imparted to the seeds by fermentation and the fact that the pulp can be better utilized as fodder (Ejiofor 1988; Enibe 2001), this project was designed to assess the possibility of using trona and wood ash (which are common household traditional processing aids) as demucilaginating aids. Effects of the demucilaginating treatments on the nutrient composition of the seed flours were also determined.

MATERIALS AND METHODS

Mature fresh fruit heads of Treculia africana were procured and divided into four treatment groups using randomized complete block design (RCBD). The first group was allowed to ferment naturally for 8 days before the seeds were extracted and washed (fermented control). The second group was quartered, after which the seeds were extracted fresh from the pulp, demucilaginated by brushing with fine sea sand and subsequently rinsed with water (unfermented control). Groups 3 and 4 were also quartered and the seeds were extracted fresh as in group 2 but the seeds were divided into 10 portions and treated with graded concentrations (1% - 5%) of trona and wood ash for times varying from 5 to 25 min. Following the alkaline treatments the seeds were washed with water and the effectiveness of the treatments in removing the seed mucilage was determined by weight differences.

Preparation of seed flours:

The demucilaginated seeds were dried in a hot air oven at 85^{0}C for 48h, dehulled and milled into flour to pass through 40mm mesh (British Standard Sieves) in an attrition mill. The flours were packed in polyethylene bags, heat sealed and stored at between 0^{o}C – 4^{o}C until used for analysis.

Proximate analyses for percentage moisture, crude fat, protein (N x 6.25), crude fibre and ash were done according to the standard method of the AOAC (1990). The nitrogen free extract (total carbohydrate) was calculated by difference.The ether extract was analysed for peroxide value and free fatty acid content using the standard method of Pearson (1991).

Trace elements were estimated after wet oxidation of samples (2g) using concentrated Nitric acid and Perchloric acid as described by Osborne and Voogt (1978). The concentration of the minerals, Calcium, Magnesium, Copper and Zinc in the digested sample were determined with the Pye Unicam Atomic Absorption Spectrophotometer. Potassium and Sodium were determined with the Flame Photometer.

Colour:

Flour (1g) from each sample treatment was extracted with 10ml n-Hexane as described by Camire et al. (1990). Absorbance of the n–Hexane extract was determined at 450nm using spectronic 21 spectrophotometer against a reagent blank.

Bulk density

The apparent bulk density of each sample flour was determined as outlined by Okaka and Potter (1979). The bulk densities (gcm^{-3}) were calculated as weight of flour (g) divided by flour volume (cm^3).

Water Absorption

Water absorption was determined according to the method described by Beuchat (1977). Water absorption capacity was expressed as the amount (g) of water retained by 1g of the flour.

Data Analysis

Data obtained were subjected to statistical analysis using Genstat 5 release 3.2 (Windows 95), Package of Lawes Agricultural Trust (Rothamsted Experimental Station).

RESULTS AND DISCUSSION

Figure 1 shows the effectiveness of the different concentrations of trona (1% - 5%) and wood ash (1% - 5%) in demucilaginating freshly extracted Treculia africana seeds. Mucilage constitutes about 30 + 2% of the whole T. africana seeds used in the study on wet basis. There is no report in literature on the mucilage of T. africana seeds however the results obtained in this study differ considerably from a mucilage value of 9.4% reported for cocoa mucilage by Avellone et al. (2000) but compares closely with 20% to 30% average mucilage content reported by Menchú and Rolz (1973) for cocoa. Average mucilage content can vary with the demucilaginating conditions and methods. Avellone *et al.* (2000) noted that demucilaginating condition and method that allow a variable proportion of mucilage to adhere to the seed will show low average mucilage content. At the highest concentration (5%) and longest treatment time (25min) trona removed 26.87% of T. africana seed mucilage while wood ash removed about 6% mucilage. Wood ash at this concentration (5%) and treatment time (25 min) exhibited a demucilaginating effectiveness that is comparable to the effectiveness of the lowest concentration (1%) of trona at 5min treatment time. Expectedly, the demucilaginating effectiveness of trona and wood ash increased with increase in concentration and treatment time. However 4% concentration was considered to be an optimal level of application since a 1% higher demucilaginating effect may not be a logical justification for a 1% increase in the concentration of trona used, its cheapness or low cost not withstanding.

Following the drying of the seeds after demucilagination, all trona treated samples dehulled very easily on slight application of pressure. Trona may possibly have loosened the gum and non starchy polysaccharide layer that attach the hull to the cotyledon thus facilitating the dehulling. Gums and non-starchy polysaccharides have been implicated in the tight adherance of seed hulls to cotyledons of legumes and pulses (Singh, 1995). Traditionally, dehulling of Treculia africana seeds extracted from naturally fermented fruit heads follow a rigorous process of 45 to 60min parboiling at 80^{o}C to 100^{o}C, threshing, drying and winnowing (Iwe and Ngoddy, 2001). The use of trona will evidently avert such rigorous process.

Table 1 shows the effect of the demucilaginating treatments on the colour, bulk density and water absorption capacity of the dehulled T. africana seed flour. Hexane extract from the unfermented and fermented samples (controls) showed absorbance (A450) values of 0.28 and 0.22 respectively. Trona and wood ash treated samples showed marginal variations in hexane extractable colour with increase in the concentration of trona and wood ash as well as increase in treatment time. However, differences between colour of the trona and wood ash treated samples and the control samples were not significant statistically ($p > 0.05$).

Flours from the fermented and unfermented seeds (controls) showed water absorption capacity (WAC) of 1.68 g/g and 2.07 g/g respectively while the trona and wood ash treated samples exhibited WAC range of 1.64 g/g to 2.77 g/g. The WAC of flour from the control samples compare with the WAC value (1.70 g/g) reported by Akubor (1997) for African bread fruit flour. Flours from the trona treated seeds showed marginal ($p< 0.05$) increase in WAC with increase in trona concentration and treatment time. The highest WAC was shown by samples treated with 5% trona for 25 min. The relatively higher WAC exhibited by trona treated flours was attributed to a possible effect of the trona on the water binding sites of the sample protein. Treculia africana seed flours from all the treatments in this study showed low WAC when compared with the WAC of soybean flour which has been extensively used as a functional ingredient in many products. (Onweluzo *et al*. 1995).

The implication of this low water absorption capacity is that T. africana seed flour may not be a good functional ingredient in food systems where water absorption is of prime importance. Evidently the use of trona or wood ash as a demucilaginating aid did not influence the water absorption capacity of T. africana seed flour adversely.

Samples from both trona and wood ash demucilaginating treatment showed an average bulk density value of 0.35g/cm^3 which is lower than the values reported for soybean meal (0.45g/ cm3) and cowpea flour (0.62g/cm^3) by Marfor et al. (1986) and Okaka and Iseih (1990) respectively. Flours from the fermented and unfermented seeds (controls) showed bulk density of 0.38 g/cm3 and 0.39 g/cm^3 respectively. Treatment did not affect bulk density since samples from all the treatments showed comparable bulk density values that ranged from 0.34 to 0.39. With the exhibition of such low bulk density value, T. africana flour may be a good functional ingredient for weaning formular production.

Samples from all the treatments showed marginal variations in proximate composition (Table 2). Flour from the fermented seeds (control) showed a crude protein content (13.83%) that differed significantly ($p < 0.05$) from the crude protein content (15.20%) of flour from the unfermented seed (control) and flour from the seeds treated with 5% trona for 25 min. However, the crude protein values obtained in this study did not differ significantly from the values reported by other workers. Olalawal (1986), Iwe and Ngoddy (2001) and Ugwu *et al.* (2001) reported crude protein content of 14.4%; 14.89% and 18.70% respectively for dehulled African breadfruit. The observed marginal increases in the protein content of trona treated samples with increases in trona concentration and treatment time was attributed to possible formation of amino acyl cross links and lysinoalanine (Nashef *et al*., 1977). Friedman *et al*. (1984) reported that alkaline processing can cause protein–alkali interactions which can lead to the formation of unusual peptides and amino acids such as lysinoalanine and D-amino acids.

Similar variations were also observed in the crude ether extract of the samples. The 5% trona demucilaginated samples showed an average ether extract value of 10% which compares with the ether extract content of the control (unfermented) but differed ($p < 0.05$) from the ether extract content of other treatment samples. The crude ether extract content of the flours from the control treatment and the 5% trona treated samples agree closely with the values reported by Ola Lawal (1986) but differed appreciably from the values reported by Iwe and Ngoddy (2001) and Ugwu *et al*. (2002).

Figure 2 shows the effect of treatment on the peroxide value (PV) and free fatty acid (FFA) content of the T. africana seed ether extract. Ether extract from the fermented seed (control) showed a PV of 5.28% and FFA of 20. 20mg KOH while the ether extract from the unfermented seed flour (control) showed a PV of 1.20% and FFA of 1.35 mg KOH. Peroxide value and free fatty acid which are indices of fat deteriorative changes were observed to be significantly ($p < 0.05$) lower in the ether extract from the unfermented seed flour than in the ether extract from the other treatment. The FFA and PV of ether extract from the trona and wood ash treated samples showed marginal ($p > 0.05$) variations and increases with increases in the demucilaginating aid concentration and treatment time. The FFA and PV of ether extract from the flours of all the treatments used were significantly ($p < 0.05$) lower than the FFA and PV of ether extract from the fermented seed flour (control). At 4% and 5% concentrations and 25 min treatment time, the trona and wood ash treated samples showed significantly ($p < 0.05$) higher PV than the unfermented (control) sample. The FFA value of the trona and wood ash treated samples also differed significantly ($p < 0.05$) from that of the unfermented (control) sample at all the concentration levels and treatment time. Evidently trona and wood ash treatments had some effects on the quality of *T. africana* seed ether extract but the effects were marginal when compared to the effects of fermentation. *Treculia africana* has been shown to be rich in polyunsaturated fatty acids. Umoh (1991) reported a total unsaturated fatty acid content of 60.37% which is about twice the total content of saturated fatty acid (39.25%). Apparently the ether extract of *T. africana* being high in polyunsaturated fatty acid is highly susceptible to oxidative and hydrolytic changes and the fermentation treatment may have provided an additional optimal condition that enhanced the reaction. The offensive odour characteristic of *T. africana* kernels demucilaginated by the traditional fermentation method may be attributed to the presence of FFA and the breakdown products from the peroxides and hydroperoxides.

Table 3 shows the effect of demucilaginating treatment on the mineral content of *T. africana* seed flour. Marginal variations were observed in the mineral content of the samples except in calcium and potassium which were appreciably higher in the unfermented samples (control) than in the other treatment samples. The level of calcium, potassium and copper in the fermented sample (control) agrees closely with the values reported by Ezeokonkwo (2003) for parboiled *T. africana* seeds

In both trona and wood ash treated samples, potassium was observed to decrease with increase in the concentration of the demucilaginating aid and treatment time due possibly to leaching. Sodium in contrast increased with increase in concentration of the aid and treatment time. No definite variation was observed in the level of calcium and magnesium with increase in demucilaginating aid and treatment time.

CONCLUSION

It is evident from the study that treatment of Treculia africana seeds with 4% trona for 25mins provides more effective demucilagination and the treatment does not affect the composition and functional properties of the seed kernel adversely. However a mechanically adaptable method of extracting the seeds from the fruit head need to be evolved before the benefit of trona demucilagination can be profitably utilized.

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Table 1: Effect of demucilaginating treatment on the colour, bulk density (g/cm^3) and water absorption capacity (g/g) of *Treculia africana* seed flour

Conc. (%)	Time (min)	Colour	Bulk Density (A450nm)(g/cm^3)	Water absorption capacity (g/g)
		Trona		
3	15	0.15±0.02	0.34±0.06	1.53^{a}±0.62
	20	0.16±0.02	0.36±0.10	2.49^{ab}±0.08
	25	0.22±0.01	0.35±0.06	2.72^{ab}±0.07
4	15	0.15±0.01	0.35±0.10	1.67^{a}±0.61
	20	0.17±0.03	0.35±0.20	2.54^{ab}±0.06
	25	0.23±0.01	0.37±0.10	2.71^{ab}±0.11
5	15	0.21±0.02	0.35±0.06	1.72^{a}±0.55
	20	0.25±0.01	0.35±0.20	2.75^{ab}±0.02
	25	0.25±0.01	0.35±0.10	2.77^{ab}±0.02
LSD		0.15	0.05	1.12
		Wood ash		
3	15	0.15±0.02	0.35±0.03	2.51±0.21
	20	0.15±0.01	0.36±0.02	2.62±0.03
	25	0.16±0.01	0.35±0.02	2.44±0.27
4	15	0.16±0.01	0.35±0.20	2.47±0.20
	20	0.16±0.02	0.36±0.20	2.63±0.09
	25	0.16±0.02	0.35±0.10	2.69±0.07
5	15	0.16±0.01	0.36±0.10	2.51±0.25
	20	0.25±0.01	0.35±0.10	2.56±0.28
	25	0.25±0.01	0.35±0.20	2.56±0.28
LSD		0.12	0.03	0.46
		Control		
Control (fermented)		0.22±0.01	0.38±0.04	1.67^{a}±0.12
Control (unfermented)		0.28±0.02	0.39±0.02	2.87^{b}±0.15
LSD		0.09	0.02	1.02

Mean ± SD, n =3
Means on the same column and treatment block bearing different super-script differ significantly (P<0.05)

Table 2: Effect of demucilaginating treatment on the proximate composition of *Treculia africana* seed flour.

Conc.(%)	Time	Moisture (min.)	Protein (%)	Crude (Nx6.25)	Crude Fat (%)	Total fibre(%)	Nitrogen Free
Ash(%)	extract(%)						
				Trona			
	15	1.70±0.09	14.61±0.12	8.00±04	4.73±0.02	5.80±0.02	65.16±0.12
3	20	1.60±0.11	14.63±0.09	8.10±0.08	4.75±0.05	5.70±0.04	65.22±0.15
	25	1.50±0.06	14.65±0.08	8.30±0.06	4.76±0.04	5.60±0.07	65.19±0.13
4	15	1.30±0.11	14.62±0.11	9.00±0.07	4.81±0.05	5.60±0.09	64.67±0.11
	20	1.20±0.02	14.64±0.12	9.20±0.10	4.84±0.07	5.50±0.01	64.62±0.12
	25	1.10±0.01	14.68±0.07	9.50±0.11	4.87±0.09	5.40±0.12	64.45±0.13
5	15	1.10±0.01	15.01±0.09	10.10±0.09	4.15±0.10	5.40±0.08	64.24±0.11
	20	1.10±0.01	15.04±0.11	10.20±0.07	4.15±0.11	5.30±0.09	64.21±0.14
	25	1.10±0.01	15.56±0.12	10.40±0.10	4.81±0.12	5.60±0.08	62.53±0.12
LSD		0.32	1.43	2.54	0.98	0.65	3.04
				Wood ash			
3	15	1.40±0.07	14.0±0.02	8.80±0.13	4.70±0.03	5.50±0.09	65.60±0.14
	20	1.60±0.02	14.01±0.04	8.90±0.09	4.72±0.02	5.50±0.01	65.27±0.11
	25	1.80±0.05	14.03±0.07	8.90±0.07	4.74±0.03	5.60±0.09	64.93±0.12
4	15	1.50±0.03	14.02±0.10	9.30±0.08	4.75±0.04	5.60±0.12	64.83±0.15
	20	1.80±0.09	14.04±0.11	9.30±0.06	4.77±0.03	5.70±0.11	64.38±0.13
	25	1.80±0.07	14.01±0.09	9.40±0.01	4.74±0.02	5.80±0.00	64.25±0.11
5	15	1.60±0.04	14.03±0.07	9.40±0.08	4.79±0.03	5.80±0.08	64.68±0.16
	20	1.90±0.10	14.05±0.09	9.40±0.10	4.76±0.03	5.90±0.06	63.99±0.14
	25	1.90±0.09	14.01±0.09	9.60±0.11	4.87±0.05	5.90±0.09	63.68±0.12
LSD		0.62	0.25	0.96	0.34	0.56	2.23
				Control			
Control (fermented)		1.96±0.21	13.83a±0.13	9.46±0.05	4.21±0.02	5.24±0.04	65.30^{b}±0.14
Control (unfermented)		1.28±0.41	15.20^{b}±0.12	10.61±0.13	4.64±0.03	6.30±0.11	61.97^{a}±0.11
LSD		0.96	1.2	1.24	0.52	1.10	2.53

Mean + SD, n= 3

Means on the same column and treatment block bearing different super-script differ significantly (P £ 0.05)

Table 3: Effect of demucilaginating treatment on the mineral content of *Treculia africana* seed flour.

		Mineral (mg/100g)					
Conc. (%)	**Time (min.)**	**Ca**	**Mg**	**K**	**Na**	**Cu**	**Zn**
				Trona			
3	20	15.6±0.02	7.97±0.01	14.42±0.01	28.5±0.01	0.01±0.00	0.16±0.01
	25	15.1±0.02	80.6±0.01	142.4±0.01	28.6±0.01	0.01±0.00	0.22±0.02
4	20	16.0±0.01	81.7±0.03	132.4±0.02	34.8±0.02	0.08±0.00	0.37±0.01
	25	15.0±0.01	81.9±0.02	133.6±0.03	39.1±0.02	0.08±0.01	0.37±0.01
5	20	15.1±0.01	81.2±0.01	134.1±0.02	45.2±0.03	0.01±0.00	0.43±0.01
	25	15.8±0.02	81.3±0.01	130.4±0.02	49.1±0.01	0.02±0.00	0.38±0.02
				Wood ash			
3	20	15.0±0.02	80.4±0.02	141.51±0.01	28.4±0.02	0.01±0.00	0.24±0.02
	25	15.7±0.01	81.7±0.02	141.0±0.01	28.3±0.02	0.01±0.00	0.22±0.02
4	20	14.6±0.03	81.5±0.01	132.6±0.03	38.1±0.02	0.08±0.01	0.32±0.02
	25	16.0±0.02	81.3±0.02	1.34.6±0.02	39.8±0.03	0.08±0.01	0.33±0.02
5	20	15.1±0.02	81.6±0.02	131.0±0.02	47.0±0.02	0.01±0.00	0.35±0.02
	25	16.1±0.03	81.4±0.02	1.34.0±0.03	48.1±0.02	0.01±0.00	0.36±0.01
				Control			
Control (fermented)		16.8±0.01	81.36±0.04	131.6±0.04	43.64±0.03	0.02±0.00	0.45±0.01
Control (unfermented)		23.6±0.02	82.2±0.05	146.4±0.03	46.3±0.03	0.16±0.00	0.13±0.02

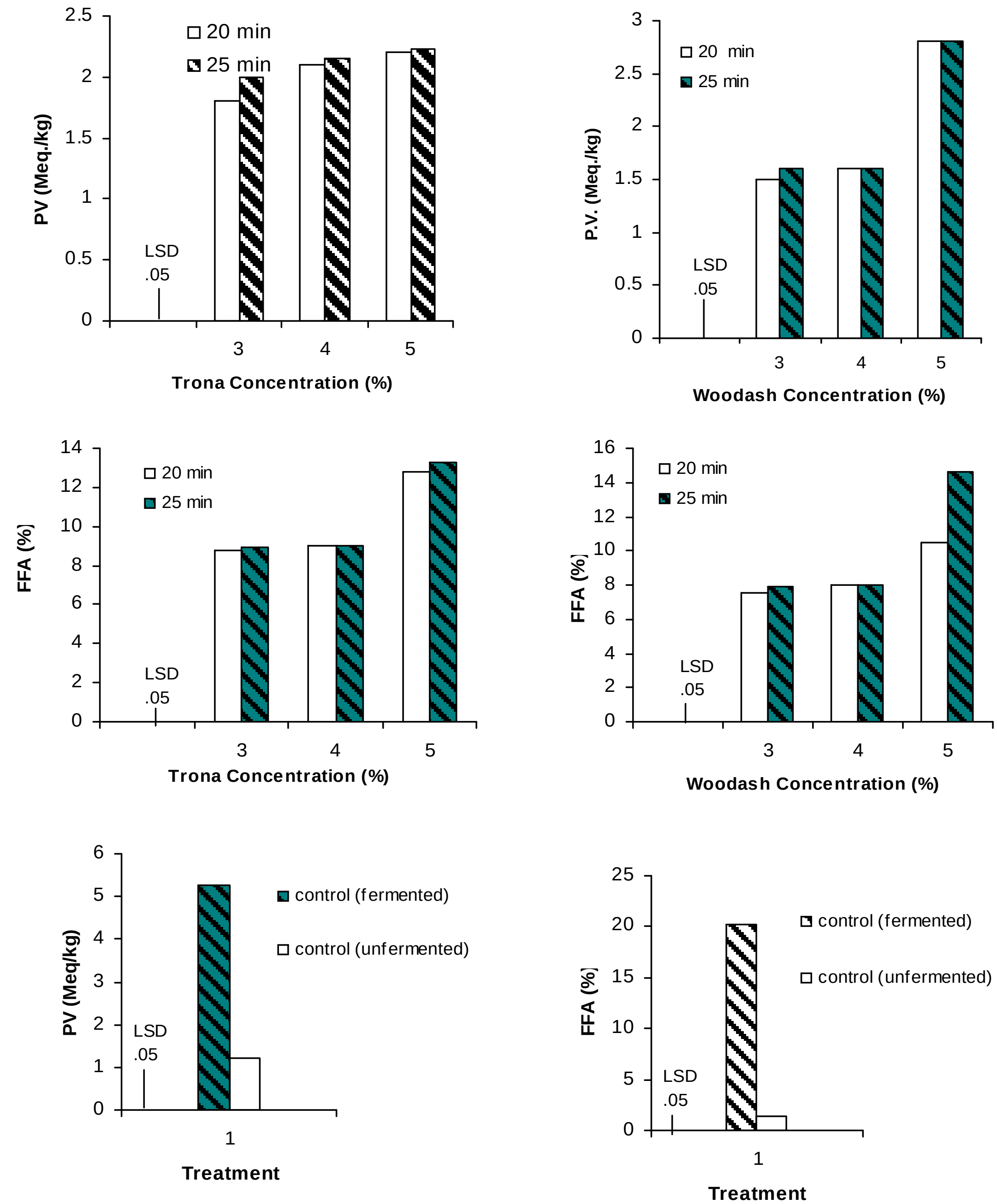

Fig. 2: Effect of demucilaginating treatments on the peroxide value (PV) and Free fatty acid (FFA) content of *Treculia africana* seed ether extract.