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Yambean Fatty Acids, Oligosaccharides and Pectic Materials

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ABSTRACT: A study of yambean was carried out to show the composition and nutritional potentials of its fatty acids, rafinose family oligosaccharides, dietary sugars and peptic materials. The total fat content (3%) was composed of 54.6% saturated fatty acids. Yambean oligosaccharides comprised stachyose (3%), raffinose (1.3%0 and sucrose (2.9%). Pectic material yields were cold water extract (2.8%), hot water extract (*.9%) and oxalate extract (8.5%). Their galacturonic acids were esterified to 80, 76 and 70 degrees respectively. Since the monomers of the three yambean pectic extracts were more than 50% esterified they were all classified as pectin.

Key Words: Minced meat; Beef; Meat quality; Bacteriological counts; Spoilage organisms; Meat preservation.

Introduction

The African yambean is an important grain legume belonging to the family papilionaceae. The pilse legume is indigenous to parts of East; Central and West tropical Africa (Duke *et al.*, 1977; NAS, 1979). The plant has never performed well as sole crop and therefore it is culturally planted close to yam stakes on which both growing yam and yambean are supported (Okigbo, 1975).

Although some varieties of yambean with brown or speckled brown testa exist, the most widely grown and consumed in the villages is the slightly greyish variety with glossy appearance and brownish hilum. All existing yambean varieties have been shown not to differ significantly in their nutritive value and physical features (Apata and Ologhobo, 1990). They are all known to be naturally glossy, hard and resistant to cooking. There are many reports in the literature on the African yambean's nutritional value, cookability and on the morphology, functionally and *in vitro* amylolysis of its unmodified starch (Ezueh, 1984; Asuzu and Undie, 1986; Nwokolo, 1987; Abbey and Berezi, 1988; Agunbiade 1996, 1998; Agunbiade and Longe, 1996, 1998; 1999).

This article aimed at providing data on yambean fatty acids, oligosaccharides and pectic materials and their nutritional significance.

Materials and Methods

Treatment of yambean prior to analysis

Dry yambean (grey-type) was cleaned of all extraneous matter. A portion of the bean was ground in a laboratory mill to pass through a 452um sieve mesh, kept in screw-capped bottles and stored in a deep freezer pending use for analysis in the course of this study.

Analytical methods

Determination of fatty acids

Yambean oil was extracted with n-hexane using soxhlet extraction technique (AOAC, 1992). Transmethylation was by the method of Metcalfe *et al* (1966). The fatty acid composition was quantitatively estimated by gas-liquid chromatography (PYE Unicam 304 series). Operating conditions were:-

Carrier gas, Nitrogen at 40psi;
Flame producers - hydrogen at 17psi; Oxygen at 6psi;
Column temperature 180°C, Injection temperature 200°C;
Detection temperature 250°C (flame ionization);
Stationary phase - DEGS on CHROMOSORE W. Hp 100 - 120
Chart speed - 300mm/h.

Extraction of oligosaccharides

The rapid extraction technique of Van Den *et al* (1986) was used. The extract and combined filtrates from four washings were pooled together and centrifuged at 1,610 x g for 15 min. The clear filtrate was concentrated under vacuum at 50°C to a known volume (25 ml).

Qualitative estimation of oligosaccharides

Chromatographic separation of yambean oligosaccharides was carried out by a modified unidirectional descending method described by Akpapunam and Markakis (1979) using a mixture of ethyl acetate: acetic acid: water in the ratio 4:1:1 (Vaisey and Unrua, 1964) as the eluting solvent. With the glass cover on, the entire tank was covered with dark cloth and the chromatogram left to run for 19 hours. Placing the chromatography tank in the dark served to prevent any eventual adverse effects of ultraviolet light on the mobility of both the eluting solvent and the eluates.

The chromatogram (Fig. 1) was air dried and sprayed with a mixture of 50ml of 95% ethyl alcohol, 1ml of aniline and 35ml of 0.2m oxalic acid (Shallenberger and Moores, 1982). After air drying for 30min., the chromatogram was developed for 10min. at 110°C in an oven. The sugars appeared as brown spots and were identified by comparison with the corresponding sugar standards. The mobility of each sugar was expressed as R_f being ratio of distance moved by test sugar extract and the distance moved by the eluting solvent (Shallenberger and Moores, 1957). R_f was replaced by R_G when the solvent was allowed to run over serrated edge of the chromatogram (Akpapunam and Markakis, 1979).

Quantitative estimation of oligosaccharides

The paper chromatogram segments containing yambean sugar spots corresponding to the standard sugar spots were cut to uniform sizes. A whatman No 1 paper without sugar spots was also similarly cut to size. All paper cuts were separately eluted with water and made up to 50ml volume each. The eluates were reacted with phenol-sulphuric acid using the colorimetric method of Dubois *et al*. (1956) and then measured on a Bausch and Lamb spectronic 20 at 490nm. The absorbance of each eluate was converted to oligosaccharide concentration by means of reference curves. The absorbance of the eluate from the No 1 whatman paper alone was used for calculating absorbance interference.

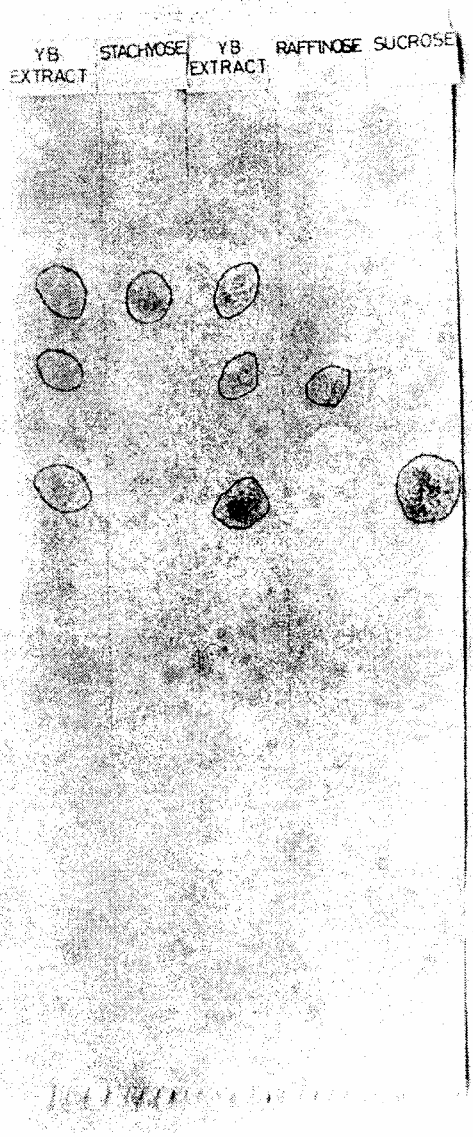

Plate 1: Chromatogram of yambean sugar extracts and standard oligosaccharides.

Estimation of pectic materials

Cold water, hot water and oxalate extraction techniques of Bhat and Tharanathan (1986) were used. After concentrating the extracts under vacuum at 50°C they were cooled and crystallized using ethanol, acidified to pH 2.0 with the addition of dilute hydrochloric acid. Methyl esters and the degree of esterification of the extracted pectic materials were measyred by the alkaline demethylation techniques of Kujawski and Tuszynski (1987) and Chou and Kokini (1987). The Uronic acid content of each extract was estimated by the carbazole colorimetric technique (Dietz and Rouse, 1952).

Results and Discussion

Fatty acid profile of yambean

Table 1 shows the composition of the fatty acids. Yambean is a typical pulse and therefore not regarded as a source of oil. In contrast to 0.9 - 1.3% previously published (Okigbo, 1975; Ezueh, 1984) values up to total 3% lipid have also been reported (Okigbo, 1975; Agunbiade and Longe, 1996). The fatty acid profile of yambean indicates a ratio of 1.2:1 of saturated to unsaturated fatty acids. These results are however, different from values reported by Nwokolo (1987), showing the unsaturated fatty acids to be about 2.4 times as high as the saturated fatty acids. The difference in the present and previously reported ratios of yambean saturated and unsaturated fatty acids are probably due to varietal differences. Preponderence of saturated fatty acids in yambean suggests a remarkable resistance of its lipid to oxidative rancidity since uptake of oxygen is related to unsaturation.

Table 1: Fatty acids of yambean.

Number of carbon atoms	Fatty acids	% Composition
14.0	Myristic	18.70 ± 1.3
16.0	Palmitic	26.65 ± 1.3
18.0	Stearic	9.25 ± 0.3
18.1	Oleic	24.10 ± 0.8
18.2	Linoleic	18.33 ± 0.3
18.3	Linolenic	2.97 ± 0.1

Value are mean of duplicate determinations ± standard deviation (SD).

Concentration aand nutritional significance of yambean oligosaccharides

Table 2 shows the R_f, R_G and composition of the yambean sugar extracts cacculated from paper chromatography. Quantitatively, the R_f and R_G values of the reference sugar standards and those of yambean sugar extracts were similar. The concentration of oligosaccharides of yambean is in the order stachyose > sucrose > raffinose. Several reports have shown that the most abundant oligosaccharides in legumes are stachyose, sucrose and raffinose, with stachyose ranging from 1.96 to 3.6; sucrose from 0.93 to 3.0 and raffinose in the range of 0.44 to 1.1% (Van Den *et al*., 1986; Tanaka *et al*; 1975; Silva and Braga, 1982; Jood *et al*., 1985). The oligosaccharide composition of yambean also falls within these reported ranges. Raffinose family oligosaccharides constitute a dietary nuisance being implicated in flatulence commonly observed in man and experimental animals (Reddy *et al*., 1980; Jood *et al*., 1986;

Nnanna and Phillips, 1990; Agunbiade, 1991). Since they are not digested in the gut, they accumulate in the lower intestine where they undergo bacterial fermentation. The flatus produced by fermentation of these dietary sugars may result in production of noxious gases, Nausea, cramps, diarrhoea and discomfort (Tanaka *et al*., 1975; Reddy *et al*., 1980; Rackis, 1975). This socio-physiological discomfort, brought about by flatulence, is one of the constraints limiting the consumption of legume seeds (Nnanna and Phollips, 1990). It is noteworthy that several traditional cooking methods, which are highly effective in reducing or completely removing flatulus causing sugars, have been developed (Reddy and Salunkhe, 1980; Ologhobo and Fetuga, 1988).

Table 2: R_f and R_G and concentration of the alcohol-soluble sugars of yambean.

Sugar	R_f	R_G	Concentration
Standard Stachyose	0.28 ± 0.01	0.25 ± 0.00	-
Yambean Stachyose	0.27 ± 0.00	0.23 ± 0.00	3.02 ± 0.04
Standard Raffinose	0.39 ± 0.02	0.30 ± 0.02	-
Yambean Raffinose	0.39 ± 0.03	0.30 ± 0.00	1.30 ± 0.05
Standard Sucrose	0.55 ± 0.03	0.42 ± 0.02	-
Yambean Sucrose	0.54 ± 0.01	0.41 ± 0.01	2.94 ± 0.00

Values are mean duplicate determinations ± SD

Characteristics and nutritional significance of yambean pectin

Table 3 presents the data on the yield and composition of methoxyl group, alpha 1 - 4 linked galacturonic acids and degrees of esterification (DE) of the pectin fractions from yambean. The water soluble pectin (both cold and hot water extracts) constitutes about 58% of the total pectin. The proportion of the total extracts not soluble in water, therefore, represents the oxalate extracted pectin. The DE in the three extracts vary only slightly. The galacturonic acid percentage of the cold water extract is the lowest but has the highest DE. The oxalate extract, on the other hand, has the highest galacturonic acid, methoxyl ester (alcohol) content byt the least DE. Alpha 1 - 4 linked galacturonic acid, the principal constituent of pectin, is prone to enzymatic breakdown or esterification. In compliance with the criterion proposed by Pilknik and Rombouls (1979) all yambean pectic fractions were classified as pectin rather than being generally referred to as pectic substances since their monomers were more than 50% esterified. The higher DE of the cold water extract compared to the other two fractions agreed with the report of Chesson and Munro (1982) in respect of bean and clover.

The number of methoxyl groups has been used as an index of gelling property of pectins (Braverman, 1973). The more the methoxyl groups, the greater the gel formation. Thus, the oxalate extracted pectin with DE of 70, would be expected to set slightly less than either the cold water or hot water extract. The importance of pectic materials in the nutrition of monogastric animals has been well elucidated with feeding experiments (Furda, 1979). The ability of fibre to bind dietary materials such as calcium, magnesium or iron has been attributed to the molecular weight, the degree of esterification or acetylation and/or to the functional carboxyl groups of the pectic materials (Furda, 1979). Both low and high methoxyl pectic materials have been reported to exhibit mineral binding characteristics (Platt and Clydesdale, 1987). Their mineral binding strength is deemed to rest mainly on the distribution pattern of the free carboxyl groups (Furda, 1979) or on the difference in their physical structures rather than their differences in terms of the amounts of available carboxyl groups (Platt and Clydesdale, 1987). Thus,

pectins with block-wise distribution of carboxyl group, have greater affinity towards Ca ions than those with statitial distribution of free carboxyl groups (Furda, 1979).

Table 3: Pectin components of yambean.

Parameter	Cold water extract	Hot water extract	Oxalate extract
Yield of pectin (%)	2.83 ± 0.03	8.90 ± 0.40	8.50 ± 0.30
Galacturonic acid (%)	0.09 ± 0.00	1.79 ± 0.03	2.50 ± 0.05
Methoxyl ester (mg)	15.62 ± 0.40	13.54 ± 0.04	23.39 ± 0.70
Degree of esterification	79.60 ± 0.60	76.00 ± 0.50	70.00 ± 0.70

Values are means of triplicate determinations ± standard error (SE).

High viscosity of the gut contents of pectin or guar gum fed rats has been reported to result in inhibition of intestinal uptake of lipids, blood cholesterol, bile salts and a complete barrier to efficient lipolytic activity (Judd and Truswell, 1985). Such effects consequently lead to faecal excretion of lipids, cholesterol and bile salts (Lin *et al*., 1957) and reduction of serum and liver cholesterollevels (Agunbiade and Longe, 1998; Judd and Truswell, 1985; Lin *et al*., 1957; Chang and Johnson, 1970; Tsai *et al*., 1976; Slavin and Marlett, 1980; Khan *et al*., 1981)

Conclusion

In this study, yambean has been shown to contain lipid with higher percentage total of saturated fatty acids and substantial proportions of high methoxyl pectin and stachyose. A typical, traditional fibre-rich, and low -fat yambean food preparation is potentially an anticholeterolemic diet. High percentage of rancidity-lowering saturated fatty acids may confer better storability on a bean powder specially prepared as a food recipe. A complete or partial removal of raffinose family oligosaccharides also stands to improve digestibility and hence nutritional value of the yambean. However, the knowledge of the physical structure or distribution of the free carboxyl groups of yambean pectin in relation to the mineral binding properties is yet unknown.

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