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Unconventional Sources of Food: Chemical Composition of Rubber Seed (*Hevea Brasiliensis*)

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ABSTRACT

Rubber seeds (Hevea brasiliensis) *were analysed for fat, protein, total and soluble carbohydrates. The protein content was 182 g kg^{-1} (dry weight basis (dwb)); comparison of the content of essential amino acids with published data on isolated soya bean protein indicated that rubber seeds were lower in lysine, but higher in cystine and methionine. The fat content (ether extract) was 218 g kg^{-1} dwb; 81% of the fatty acids were unsaturated. Total carbohydrate content was 494 g kg^{-1} dwb while the methanol-soluble carbohydrate content was 136·8 g kg^{-1} dwb with sucrose (65%) predominant. In addition, in descending order, galactose, an unknown sugar, fructose, two other unknown sugars, maltose and glucose were found. The possibility of using rubber seeds as human or animal food is suggested.*

INTRODUCTION

The diet of an average rural Nigerian is deficient in several nutrients, notably protein. The country has varied and abundant potential food materials which, if adequately utilized, may meet some of the population's basic dietary requirements.

This paper reports on an investigation into the potential use of para rubber seed (*Hevea brasiliensis*) as a source of protein, oil and carbohydrate. The rubber seed, which is not currently consumed, is

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abundant and wasted. It would provide protein, oil and carbohydrate for human and animal use.

MATERIALS AND METHODS

The rubber seeds (*Hevea brasiliensis*) used in this study were picked fresh from a rubber plantation. The seed coats were removed from the seeds, followed by grinding to pass through a 40-mesh sieve (aperture size, 0·42 mm). Oil was extracted from the sample under reflux for 8 h with petroleum ether (40–60 °C boiling point). Fat content, moisture, crude fibre and ash contents were determined according to the method of the AOAC (1980).

Gas–liquid chromatography of fatty acids

Component fatty acids were determined after methylation of the sample (AOAC, 1980) with a Pye 104 gas–liquid chromatograph using a flame ionisation detector, operated isothermally at 183 °C. The column (1·5 m long with an 0·4 mm internal diameter) was packed with 12% PEGS on acid-washed Chromosorb W. Flow rates were: nitrogen carrier, 33 ml min^{-1}, hydrogen, 35 ml min^{-1} and air, 700 ml min^{-1}.

Total nitrogen content

Total nitrogen content of the sample was determined by digesting with a sulphuric acid–potassium sulphate–mercuric oxide mixture as described by Fleck & Munro (1965) and the ammonia in the digest was determined colorimetrically using one Auto-analyser (Technicon Instrument Co. Ltd) as described by Smith & McAllan (1970).

Amino acid analysis

The samples were analysed for amino acids using an ion-exchange automatic amino acid analyser (Model JCL–5AH; Japan Electron Optics Lab. Co. Ltd, Tokyo, Japan) as described by Spackman *et al.* (1958).

Methionine and cystine values were based on analysis of hydrolysates prepared after treatment of the samples with performic acid (Moore, 1963).

Analysis of soluble carbohydrates

The extraction of sugar, the preparation of the stock solution and the hexamethyldisilazane derivatives of sugars were the same as described by Li & Schuhmann (1980) with some modifications (Achinewhu, 1986).

Gas–liquid chromatography of soluble carbohydrates

A Pye 104 gas–liquid chromatograph equipped with a flame ionisation detector was used. The glass column (2·1 m × 6·4 mm inside diameter) was packed with 3% w/w OV–101 on 80/100 mesh Chromosorb W and preconditioned for 48 h. The injector and detector temperatures were maintained at 300 °C and the oven temperature was programmed at 5 °C from 110 °C to 300 °C with a 30 min hold at 300 °C. The flow rates were: nitrogen carrier gas, 30 ml min^{-1}; H_2, 30 ml min^{-1}; and air, 300 ml min^{-1}. Gas chromatographic peaks were identified by comparison of retention times with those of standard sugars. The area of the peak for each sugar was recorded and the sugar contents were quantified (AOAC, 1980) and expressed as grams of sugar per kilogram of sample on a dry weight basis.

Determination of total carbohydrates

Total carbohydrates were determined colorimetrically by the anthrone method after digestion with perchloric acid as described by Osborne & Voogt (1978).

RESULTS AND DISCUSSION

Table 1 shows the proximate composition of the seeds. The amounts are similar to published figures for other Nigerian foodstuffs such as African breadfruit (Oyenuga, 1968; Edet *et al.*, 1985) and locust bean (Eka, 1980).

Fatty acids composition of the oil extracted from the rubber seeds is given in Table 2. The seed gave an ether extract of 218 g kg^{-1}. The fatty acid composition comprised 18·9% saturated fatty acids, mostly palmitic acid and stearic acid, and 81·1% unsaturated fatty acids, mostly oleic, linoleic and linolenic acids. The fatty acids composition is in agreement with the results of Gunstone & Hilditch (1964). Rubber seed contained higher total unsaturated fatty acids than African oil bean and

TABLE 1
Proximate Composition of Rubber Seeds (*Hevea brasiliensis*) (g/kg dry weight) ± SE (Mean) of Five Determinations

Moisture (wet weight)	63·0 ± 1·5
Crude protein	182·0 ± 3·2
Fat (ether extract)	218·0 ± 3·5
Crude fibre	12·0 ± 0·8
Ash	28·0 ± 1·2
Total carbohydrates	494·0 ± 4·3

mucuna beans (75% and 60%, respectively; Achinewhu, 1982*a*), melon seeds and African breadfruit (69% and 60% respectively; Achinewhu, 1982*b*). Two essential fatty acids, linoleic and linolenic acids, were high and rubber seed could be a good source of these acids in human nutrition.

Because of the high unsaturation of the fatty acids, the oil could be used for the manufacture of margarine, soap and cosmetics.

TABLE 2
Fatty Acids Composition of The Rubber Seed Oil

Fatty acid		*(Per cent total oil) ± SE (means of four determinations)*
Saturated		
	14:0 Myristic	0·15 ± 0·002
	16:0 Palmitic	8·68 ± 0·3
	17:0 Margaric	0·07
	18:0 Stearic	9·85 ± 0·2
	20:0 Arachidic	Trace?
	22:0 Behenic	0·09
	Total	18·8 ± 0·5
Unsaturated		
	18:1 Oleic	23·3 ± 0·8
	18:2 Linoleic	37·1 ± 1·2
	18:3 Linolenic	20·4 ± 0·9
	Total	80·8 ± 2·9
	Total fatty acids	99·6 ± 3·4
	Per cent saturated	18·9
	Per cent unsaturated	81·1

TABLE 3
Amino Acids Composition of The Rubber Seed
± SE (Mean) of Four Determinations

Amino acid	*g/kg crude protein (N × 6·25)*	*Isolated soya bean protein (Achinewhu & Hewitt, 1979)*
Lysine	34·8 ± 1·3	61·4
Histidine	16·9 ± 0·6	26·8
Arginine	91·7 ± 2·5	90·9
Aspartic acid	86·8 ± 1·6	127·0
Threonine	26·7 ± 1·1	42·6
Serine	39·7 ± 1·3	60·9
Glutamic acid	121·0 ± 3·1	207·0
Proline	39·2 ± 1·5	56·3
Glycine	32·4 ± 1·7	43·4
Alanine	41·8 ± 1·2	44·0
Cystine	36·6 ± 1·6	11·4
Valine	65·5 ± 2·2	51·7
Methionine	24·5 ± 0·5	12·0
Isoleucine	27·8 ± 1·2	54·8
Leucine	51·9 ± 1·8	86·6
Tyrosine	24·2 ± 1·2	35·0
Phenylalanine	34·9 ± 1·5	61·9

The crude protein content of the sample was 182 g per kilogram dry matter. Amino acids composition of the rubber seed is given in Table 3. Compared with isolated soya bean protein (Achinewhu & Hewitt, 1979), the rubber seed contained less essential amino acids—lysine, isoleucine, leucine, phenylalanine and threonine. Isolated soya bean protein was selected for comparison because it is a plant protein of increasing importance in human and animal nutrition and especially in its use in the manufacture of textured 'meat' products. Its protein quality has been shown to be high (Achinewhu & Hewitt, 1979).

Rubber seed may be a good source of valine and sulphur amino acids; the latter are lacking in many plant proteins used in practical diets.

Figures 1 and 2 show the chromatographic peaks of the standard sugars and the rubber seeds. There were nine clear and defined sugar peaks of the sample (Fig. 2). Table 4 shows the sugar content of the peaks. The seed contained mostly sucrose, which formed 64·8 % of the total soluble carbohydrate, followed by galactose (8·5 %), fructose (6·5 %),

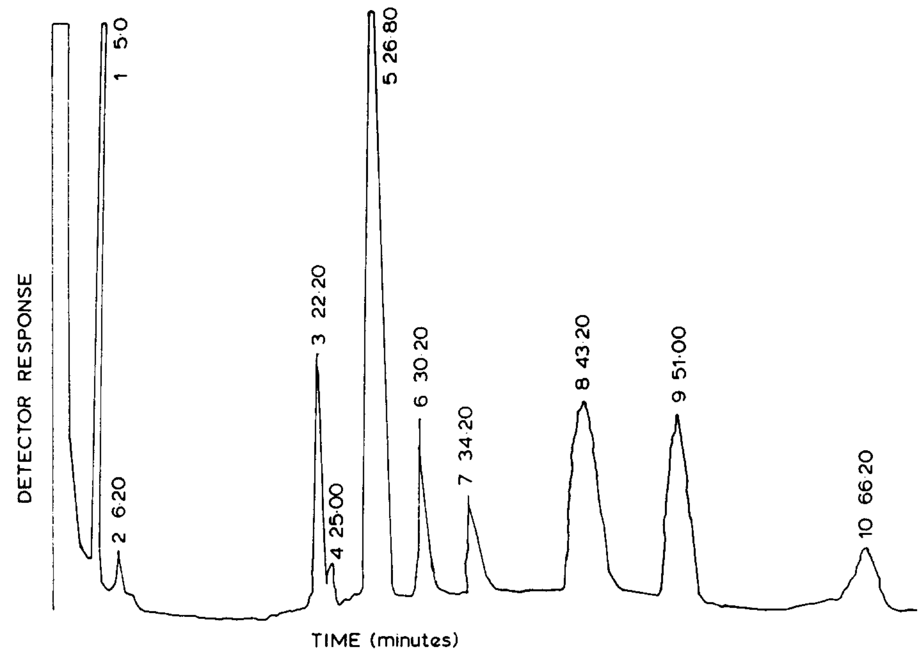

Fig. 1. Chromatogram of trimethylated (TMS) derivatives of sugar standards. 1: fructose; 2: galactose; 3: glucose; 4: glucose and galactose; 5: β-phenyl-D-glucopyranoside; 6: sucrose; 7: maltose; 8: raffinose; 9: stachyose; 10: verbascose.

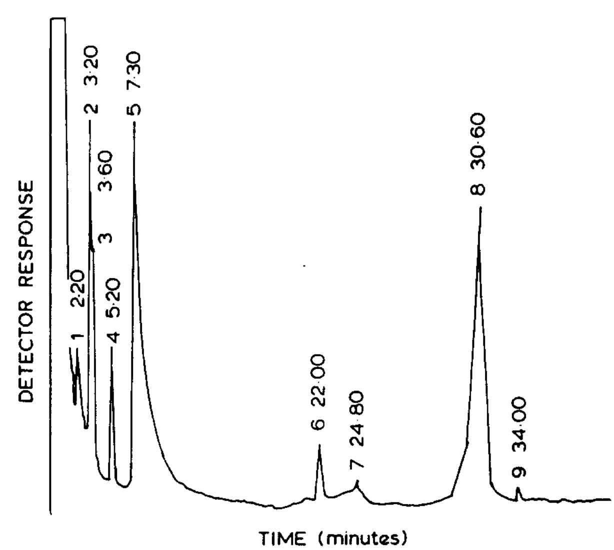

Fig. 2. Chromatogram of trimethylated (TMS) sugar extracts from rubber seed.

TABLE 4
Methanol Soluble Carbohydrate Composition (g/kg Dry Sample) of Rubber Seeds ± (Mean) of Five Determinations

Peak No.	*Sugars*	*Concentration (g/kg dry sample)*	*Per cent total soluble carbohydrates*
1	Unknown	4·0 ± 0·008	2·9
2	Unknown	10·0 ± 0·3	7·4
3	Unknown	5·6 ± 0·2	4·1
4	Fructose	8·8 ± 0·3	6·5
5	Galactose	11·6 ± 0·5	8·5
6	Glucose	3·2 ± 0·03	2·4
7	Glucose + Galactose	0·64 ± 0·001	0·5
8	Sucrose	88·0 ± 1·2	64·8
9	Maltose	4·0 ± 0·03	2·9
Total soluble carbohydrates		136·0 ± 2·6	
Per cent total carbohydrates		27·5	

maltose (2·9 %) and glucose (2·4 %). Two unidentified sugars with fairly high concentrations (7·4 % and 4·1 %), appearing before fructose, may be pentoses. Arabinose, ribose and xylose have been identified at retention times preceding fructose in sugar standards in which they are contained (Sweeley *et al.*, 1963; Mason & Glover, 1971).

Sucrose and other soluble sugars have been found in edible seeds. Shallenberger *et al.*, (1967) showed that soya bean contained sucrose (4·5 %) as one of the principal sugars. Glucose, galactose and fructose were present in trace amounts. Fleming (1981) reported a composition of total soluble sugars of 6·2 % in navy bean, 7·9 % in red kidney bean and 7·2 % in green lentil. Odunfa (1983) also found sucrose (31 mg/g dry weight), galactose, fructose, glucose and xylose in locust bean. Achinewhu (1986) has similarly found sucrose, galactose, fructose and glucose in African oil bean seed, melon and fluted pumpkin seeds.

Rubber seeds, with fairly high contents of essential amino acids, polyunsaturated fatty acids and soluble sugars, may be a potential source of plant food supplying these three principal nutrients for animals and, perhaps, humans. Studies are in progress to assess the nutritive quality of the seeds and their possible toxic effects.

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