❀ Seeds of the East African Savannah Bush *Balanites orbicularis* as a Possible New Source of Lipids for Commercial Use

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ABSTRACT

The fruits of the native East African savannah bush *Balanites orbicularis* Sprague were analyzed for their chemical composition. The seeds of these fruits were found to be rich in triacylglycerols with a high content of oleic and linoleic acids. Due to the high essential fatty acid content and the absence of toxic cyclic and oxy fatty acids, the oil from these seeds could be an extremely valuable form of nutrition. The significance of this plant is discussed briefly pertaining to its importance as a food and energy source in countries with arid regions.

INTRODUCTION

According to the latest estimates from the World Bank, today's population of 4.6 billion will almost double to 8.3 billion by the year 2025. In order to assure an adequate food supply for future generations, increased food production is needed desperately. One should not allow the overproduction in some highly developed countries to conceal the present difficulties we have in supplying adequate nutrition to many parts of the world. This problem cannot be solved by relying on intensive plant and crop protection measures to increase crop yields on the presently cultivated acreage, because most Third World countries are not able to afford these costly measures. A possible alternative is the cultivation of new crops which are capable of surviving and thriving in soils and climates generally regarded unsuitable for agriculture. In this respect, the East African savannah bush *Balanites orbicularis* could be of importance.

MATERIALS AND METHODS

Extraction and Identification of Lipids

The lipids were extracted from the seeds under backflow, after boiling for one hr in a 1:1 methanol/chloroform mixture and then dissolved in diethylether. Identification of the individual lipids was achieved by thin layer and column chromatography methods described previously (1-3).

Analysis of Fatty Acids

The lipids were saponified with 0.5 N methanolic NaOH. The fatty acids subsequently were converted to methylesters with 5% methanolic HCl. The resulting methylesters were examined by gas chromatography using columns either of ethyleneglycol-succinate or Reoplex 400 as the stationary phase (Gas chromatograph: F and M Scientific, Hewlett-Packard, 5750).

RESULTS AND DISCUSSION

Balanites orbicularis Sprague is a many stemmed, armed shrub or a small tree (to 15 ft) belonging to the Zygophyllaceae family. The fruits are round, resembling a date, and approximately 3 cm in diameter (4), having a high sugar content and a mild, pleasant taste. The seed is surrounded by a thin nutshell of about 2 cm in diameter. The seeds enclosed within the nutshell comprise 60% of the dry weight of the fruit and have a high storage lipid content. The seed weight is 31% ether soluble lipids. This, calculated to the dry weight of the fruit, indicates that the entire fruit has an 18% lipid content.

The main components of the seed lipids were triacylglycerols, typical storage lipids of seeds, which were determined by thin layer and column chromatography (Table I). Triacylglycerols account for 96% of the lipids. Traces of the membrane lipids phospho- and glycolipids were found, accounting for less than 1% of all lipids. The following phospholipids were identified: phosphatidylcholine, phosphatidylinositol and phosphatidylethanolamine. The well-known monogalactolipids, digalactolipids and sterylglycosides represent the glycolipids found.

A gas chromatographic analysis of the fatty acids showed that they have the typical chain length of storage lipids of higher plants (Table II). 86% of the fatty acids have an 18 carbon-atom chain, whereas 13% have only 16 carbon-atoms. Oleic acid and linoleic acid represent a high portion of the fatty acids and were the only unsaturated fatty acids found. Besides these essential fatty acids, monoenoic and dienoic acids, no other unsaturated fatty acids were detected. Neither toxic cyclic fatty acids nor oxy fatty acids were detected. Stearic and palmitic acids were the only saturated fatty acids found. Consequently, the fatty acid composition of the lipids of this fruit corresponds to the typical fatty acid composition of storage lipids from other higher plants (5).

The fruit is covered by a thin wax layer. By weight, this layer does not account for more than 0.25% of the total weight of the fruit. Furthermore, the seed lipids contain

TABLE I

Composition of *Balanites orbicularis* Seed Lipids

Name of lipid	Content in percent
Triacylglycerol	95.7
Phosphatidylcholine	0.4
Phosphatidylinositol	0.3
Phosphatidylethanolamine	0.1
Monogalactosyl diacylglycerol	0.2
Digalactosyl diacylglycerol	0.2
Steryl glycerides	0.1
Waxes	3.0

TABLE II

Fatty Acid Composition of the Lipids of Native *Balanites orbicularis* Seeds

Common name fatty acid	No. of carbon atoms and of double bonds	Content in percent
Myristic	C14:0	1.0
Palmitic	C16:0	12.7
Stearic	C18:0	13.9
Oleic	C18:1	44.3
Linoleic	C18:2	28.1

approximately 3% wax. A methanolyzation, followed by gas chromatographic analysis of the fatty acid fraction, showed that besides the fatty acids mentioned in the table there were several unknown components contained in the waxes.

The nomads are said to have collected these fruits in former times and pressed oil out of them, which they used for cooking and medicinal purposes. The oil supposedly has a mild laxative effect. This oil is no longer used today, due to the availability of less work intensive substitutes.

Even though the seeds of the East African savannah bush are not used presently, this oil represents a source of nutrition which could be used in countries with arid regions. If one succeeds in cultivating *Balanites orbicularis* intensively, eliminating the minimal sapogenin content (6,7) and making genetic improvements, the countries with arid regions could build a basis for domestic food production with the help of this new crop.

As in the case of the Canadian rapeseed oil, this seed containing a high source of energy also could be used for fuel. Furthermore there could be the possibility of commercially using this plant's oil as a source of primary energy once other energy sources have been depleted.

ACKNOWLEDGMENTS

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☘Identification of Adduct Radiolysis Products From Pork Fat

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ABSTRACT

Mass spectrometric evidence is given to show the formation of adduct radiolysis products in pork fat. A variety of adduct radiolysis products were identified. Only the major recombination products are considered and discussed herein. These compounds consist of triglyceride dimers, propanedioldiester-triglyceride adducts, propanedioldiester dimers and branched alkyl substituted triglycerides.

INTRODUCTION

Evidence for the formation of adduct radiolysis products in pure triglycerides has been given in previous studies (1-4). Recently, formation of adduct radiolysis products from ethyl palmitate and ethyl oleate has been reported (5). In these earlier studies, model compounds were chosen in order to elucidate the mechanism for the formation of adducts induced by gamma-irradiation. This study is concerned with the identification of adduct radiolysis products found in pork fat. Based on studies showing a similarity in the formation of other radiolysis products in various meats, viz. beef, chicken and ham (26), similar adducts may be expected to form in all meat fats. The results of this study provide an insight into the nature of the adduct radiolysis products formed in a natural fat and are wholly consistent with the prior knowledge of both the radiation chemistry and mass spectrometry of triglycerides and related compounds.

EXPERIMENTAL

Analysis of the high molecular weight radiolysis products was carried out on a 3 gm sample of ground pork irradiated at 3 Mrads with Co^{60} at −45 C under vacuum (10^{-3} Torr). The irradiated sample was freeze dried and then extracted in a soxhlet assembly using diethyl ether as solvent.

Separation of the appropriate fraction from the extracted fat was achieved by means of a size exclusion liquid chromatographic (SEC) column employing Styragel 60 Å and 100 Å (Waters Associates, Inc.), as the stationary phase (2-4). The fraction containing the adducts was collected and evaporated for further analysis.

Mass spectrometric analysis of the adduct fraction was carried out by means of a solid insertion probe on a Kratos Model number MS50 Mass Spectrometer equipped with a fast atom bombardment (FAB) ionization source accessory.

The sample was applied to the probe both neat and in a matrix of 2,5-dipentylphenol (DPP) and ionized by 6 KV xenon atoms. The spectrum was scanned at the rate of 100 sec per decade over a mass range of 200-1800 with a mass resolution of 1:2000. The matrix was found to enhance the sensitivity of the spectrum, but did not change the ionic composition of the spectrum nor the relative abundances of the ions.

The identity of the characteristics of the spectra obtained from a sample run with and without the matrix under the same spectrometer operating conditions is shown in Figure 1. The sample is a mixture of the radiolytic adducts formed in pure tripalmitin (4) and separated by SEC in the same manner as the pork adduct fraction described above. The portion of the spectrum shown in Figure 1 depicts the cluster of peaks around the predominant propanedioldiester (PDDE) ion, m/z 551, from tripalmitin dimer adduct. The peaks are analogous to those seen in Figure 4 for the PDDE ions corresponding to the triglyceride dimer adducts in the pork fat sample. The com-

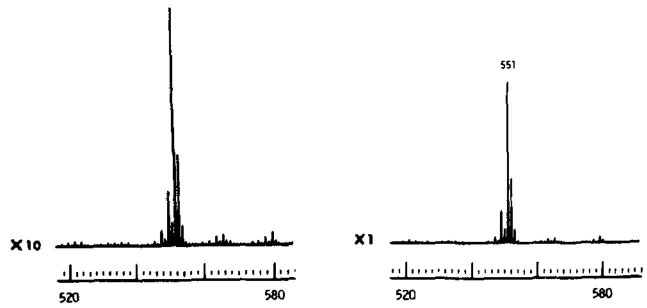

FIG. 1. Portion of a fast atom bombardment mass spectrum in the region of m/z 551 of a sample of tripalmitin dimer adduct. Left, no matrix; right, in a 2,5-dipentylphenol (DPP) matrix.