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Fatty Acid Composition and Oil Yield in Fruits of Five *Arecaceae* Species Grown in Cuba

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Abstract The present study targeted the whole-fruit oil yield and fatty acid composition from five of the most abundant *Arecaceae* species grown in Cuba. The oil yields (% dry weight), determined by the Soxhlet extraction technique with hexane, were 25.5, 5.3, 6.9, 5.4, and 6.4% for *Roystonea regia*, *Colpothrinax wrightii*, *Sabal maritima*, *Sabal palmetto* and *Thrinax radiata*, respectively. The free fatty acid (FFA) content varied from 2.7 to 6.8%. Fatty acid (FA) profiles of the oils indicated that lauric acid (13.7–44.4%), myristic acid (9.4–22.4%) and palmitic acid (9.2–17.1%) as major saturated FA; whereas oleic acid (9.6–42.7%) and linoleic acid (9.3–17.0%) as major unsaturated FA. *R. regia* fruit seemed the most promising among *Arecaceae* grown in Cuba because of its high oil yield and low oil FFA content.

Keywords Arecaceae · *Colpothrinax wrightii* · Fatty acid · Gas chromatography · *Roystonea regia* · *Sabal maritima* · *Sabal palmetto* · *Thrinax radiata*

Introduction

The *Arecaceae* family, estimated to consist of about 217 genera and about 2,500 species, is indigenous to the tropical and subtropical regions of the world. These plants have multiple uses as they provide timber, fiber, oils, food, wax, wine and dyes [1]. The oils obtained from the fruit of some of the species are very important for their nutritional value and for their relevance to the oil industry [2]. In Cuba, the *Arecaceae* family is represented by more than one hundred species. *Roystonea regia*, *Sabal maritima*, *Sabal palmetto*, *Thrinax radiata*, and the endemic *Colpothrinax wrightii* are among the most abundant species [3].

Colpothrinax wrightii and *Roystonea regia* fruits are commonly used by farmers to feed hogs, but recent researches indicated a potential use of a lipid extract obtained from *R. regia* fruit for the treatment of benign prostatic hyperplasia [4]. This medical use coincides with that of the fruit of another *Arecacea*, *Serenoa repens* [5]. Furthermore, according to folk medicine, the fruit of *Thrinax* and *Sabal* species can be used in the treatment of sexual diseases [6].

Extracting the oils from the seeds is a fairly common practice, but separating the seeds from the fruit does pose some difficulty in the case of these palms, because of the strong adherence of the thin mesocarp to the endocarp [1]. This is one of the reasons why an edible *Roystonea regia* oil industry has failed to develop in Cuba [7]. Whether the seeds or the flesh, or both, are used as the raw material can affect the fatty acid (FA) composition [8], and the nutritional and medicinal properties of the oil. Taking into account the substantial oil content in these fruit mesocarps (e.g., fresh *Roystonea regia* mesocarp contains 10% oil) [7], it could be more efficient to process the dried whole-fruit when extracting the oil.

The oils from these five palms have received very little attention. Only FA compositions of *R. regia* and *S. palmetto* seed oils have been reported [9, 10]. Furthermore, samples in previous studies were collected in botanical gardens located in geographical areas far from the natural habitat of these species [1].

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Thus, the research on the oil yield and FA composition of the whole-fruit lipids of *R. regia*, *C. wrightii*, *S. maritima*, *S. palmetto* and *T. radiata* from a natural habitat could provide with data that better represents the oil composition of *Arecaceae* grown in Cuba. The objectives of the study were to determine the oil yield and fatty acid profiles of five abundant *Arecaceae* species.

Experimental Procedures

Materials

At least ten trees of each of the species (*Roystonea regia*, *Colpothrinax wrightii*, *Sabal maritima*, *Sabal palmetto* and *Thrinax radiata*) were selected and authenticated by Dr. Angela Leyva, director of the National Botanical Garden of Havana. Samples of approximately 1 kg ripe fruits from each of the selected trees were collected in October 2005. The collected samples from each of the species were assembled, dried in a well-ventilated area at room temperature for 15 days, and ground to a fine powder (10 mesh).

Octanoic ($C_{8:0}$), decanoic ($C_{10:0}$), dodecanoic ($C_{12:0}$), tridecanoic acid ($C_{13:0}$), tetradecanoic ($C_{14:0}$), hexadecanoic ($C_{16:0}$), 9-hexadecenoic ($C_{16:1}$), octadecanoic ($C_{18:0}$), 9-octadecenoic ($C_{18:1}$), 9,12-octadecadienoic ($C_{18:2}$) and 9,12,15-octadecatrienoic ($C_{18:3}$) acids were supplied by Sigma (St. Louis, MO, USA). Reagent-grade chemicals, high-purity solvents, and distilled water were also used.

Analytical Methods

The oils from 25 g of each ground sample were extracted in a Soxhlet apparatus for 6 h using *n*-hexane. The solvent was removed at 60 °C under vacuum in a Büchi rotary evaporator. The sample oil yields were determined by gravimetric measurement of the oils and expressed as percentages of the sample dry weights. The same procedure was repeated twice and the three oil samples of each species were assembled and analyzed.

The oil free fatty acid (FFA) contents (calculated as % of oleic acid) and FA profiles were determined according to the AOCS official method [11] and the INA gas chromatographic validated method [12], respectively. The total FA content, expressed as triacylglycerides, was calculated using a lipid conversion factor of 0.956 [13].

Results and Discussion

The oil yield and FA composition found in the studied species are shown in Table 1. *Roystonea regia* was the species with the highest oil yield (25.5%), matching its phylogenetic position in the *Arecoideae* subfamily [1]; where *Elaeis guineensis* and *Cocos nucifera*, two palms with high oil content in their fruits, are. The oil yield in the other species ranged from 5.3 to 6.9%.

Total FA content, expressed as triacylglycerides, ranged from 83.4 to 92.5% (Table 1). Caprylic, capric, palmitoleic and linolenic acid contents in the analyzed species were

Table 1 Oil yields and fatty acid composition of oils from whole-fruit of *Roystonea regia*, *Colpothrinax wrightii*, *Sabal maritima*, *Sabal palmetto* and *Thrinax radiata*

Analytical determination	Species				
	R. regia	*C. wrightii*	*S. maritima*	*S. palmetto*	*T. radiata*
Oil yield[a] (as % of dry weight)	25.5 ± 0.47	5.3 ± 0.15	6.9 ± 0.21	5.4 ± 0.18	6.4 ± 0.20
Saturated acids[b] (as % of total fatty acids)					
Caprylic $C_{8:0}$	0.4	0.1	0.2	0.2	0.2
Capric $C_{10:0}$	0.4	0.1	0.2	0.2	0.6
Lauric $C_{12:0}$	24.1	13.7	17.0	18.7	44.4
Myristic $C_{14:0}$	9.4	16.3	9.7	12.4	22.4
Palmitic $C_{16:0}$	14.7	17.1	9.2	10.2	9.3
Stearic $C_{18:0}$	2.8	3.8	3.6	3.1	3.6
Unsaturated acids[b] (as % of total fatty acids)					
Palmitoleic $C_{16:1}$	0.5	0.2	0.1	0.2	0.0
Oleic $C_{18:1}$	35.1	35.4	42.7	41.0	9.6
Linoleic $C_{18:2}$	12.4	13.0	17.0	13.5	9.3
Linolenic $C_{18:3}$	0.1	0.4	0.3	0.4	0.6
Total fatty acids[b,c] (as % of oil)	92.5	89.6	90.9	84.7	83.4
Free fatty acids[b,d] (as % of oil)	2.9	4.3	6.8	5.2	2.7

[a] Values are averages ± standard deviation of three independent determinations

[b] Values are averages of three analyses

[c] Expressed as triacylglycerides

[d] Expressed as oleic acid

lower than 0.6%; and stearic acid content was lower than 3.8%. Table 1 also shows lauric acid (13.7–44.4%), myristic acid (9.4–22.4%) and palmitic acid (9.2–17.1%) as the major saturated FA in the samples; whereas oleic acid (9.6–42.7%) and linoleic acid (9.3–17.0%) as the major unsaturated FA.

The highest content of lauric and myristic acids was observed in *Thrinax radiata* oil, which on the other hand, showed the lowest content of oleic and linoleic acids. Although this palm has a low oil yield, its high lauric and myristic acid content could be interesting as they demonstrated pharmacological activity in both forms, in the free form and in the ester form [5, 14].

The composition of major FA in *R. regia* oil was similar to the composition reported for *Serenoa repens* lipid extract: 24% of $C_{12:0}$, 11.6% of $C_{14:0}$, 8.7% of $C_{16:0}$, 33.2% of $C_{18:1}$ and 3.6%of $C_{18:2}$ [5]. This similarity could explain the potential use of *R. regia* lipid extract in the treatment of benign prostatic hyperplasia [4].

The oil FFA content of the studied palms ranged from 2.7 to 6.8% (Table 1). The low FFA contents observed, mainly in *T. radiata* and *R. regia* oils, are probably due to the thin mesocarp of the studied fruits, which makes possible a rapid loss of water during the drying process and consequently, the inactivation of lipase enzymes.

This could be considered an advantage of these fruits over other palm fruits with fleshy mesocarps (e.g., *E. guineensis*), which need a quick post-harvest processing, including the inactivation of the lipase enzymes [15]. The whole-fruit of these palms could be used in oil production without fruit pre-treatment and seed separation.

Taking into account the high oil yield obtained from *R. regia* fruit and the low oil FFA content, as well as the great abundance of this palm in Cuba, is probably the most promising of the five species, not only as a pharmaceutical active ingredient source but also as an edible oil source.

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