Cashew Fatty Acids[1]

Geraldo A. Maia[2], W. H. Brown, F. M. Whiting, and J. W. Stull
The University of Arizona, Tucson

Abstract. **Cashew (*Anacardium occidentale* L.) nut neutral lipids, glycolipids and phospholipids were isolated by silicic acid column chromatography. Each lipid class had characteristic fatty acid distributions with phospholipids being higher in palmitic and oleic acids, and glycolipids being higher in linoleic acid. Comparative esterification methods indicated that cashew apple juice contained significant amounts of free lauric acid. Oleic and linoleic acids occur in almost identical amounts in cashew nut testa whereas oleic acid predominates in the kernel. Comparison of fatty acid distributions in pulp and peel from red and yellow cultivars of cashew apple at immature and mature stages shows some differences, with notable increases in oleic acid during maturation and decreases in linoleic and linolenic acids.**

The cashew tree is unique because of its "false fruit," the swollen peduncle or hypocarp, commonly known as cashew apple. It is pear shaped or rhomboid to ovate, varying from 6-10 cm in length, and bright yellow to red. It has a waxy skin, is juicy with spongy pulp and musklike fragrance. The "apple" is very astringent until fully ripe when it is sub-acid to acid and edible. This structure is actually the receptacle for the true fruit, the cashew nut (12). Although the principal food obtained from the cashew tree is the nut, the apple is either consumed fresh or processed into several food products. The apple has considerable nutritional importance due to its high ascorbic acid content (8, 9, 10).

While some information is published concerning the fatty acid content of the cashew nut (1, 5, 13), there is a lack of such data for specific lipid classes as well as for component parts of the nut and apple. Such information may have nutritional importance as well as being of interest for fundamental genetic or taxonomic relationships. The fatty acid composition of cashew apple juice, of testa, of immature and mature cashew apple and of various classes of nut lipids was studied.

Shelled, unroasted cashew nuts were obtained from a processing plant in Fortaleza-Ceara, Brazil. These served as the source of kernel and testa material. The cashew apple juice was prepared in a food processing plant in Fortaleza-Ceara, Brazil. Juice preparation involved extraction, dearation (75°C for 2 min at 600 nm Hg), homogenization (100 atm), heat treatment (98°C for 96 sec), packaging in clear glass containers and cooling to 26°C. Pedunculum material was obtained from 2 trees at the School of Agronomy in Fortaleza-Ceara, Brazil. These trees, one giving red cashew and the other yellow, have a history of producing sweet rather than sour cashew apples. The immature cashew apples chosen had not quite attained full size. After picking, the peduncles were frozen (−10°C) with the nuts still attached. Peeling was accomplished by submerging the frozen cashew apple in water (26°C) for 2-3 sec to thaw the peel. The peel was removed with a knife and tweezers to prevent contamination from possible oil on hands. Fatty acids were determined in lipids extracted from red mature peel and pulp, red immature peel and pulp, yellow mature peel and pulp, yellow immature pulp. The material from yellow immature peel was lost during shipment.

Lipid extraction was by the method of Bligh and Dyer (2). Nut lipid material was fractionated by silicic acid column chromatography (14). No detectable levels of phosphorus were found in the neutral lipid and glycolipid fractions based on the reaction with molybdenum blue spray which is specific for phospholipids (3). Fatty acid methyl esters for gas-liquid chromatography (GLC) analysis were prepared by using a BF_3-methanol esterification procedure (11). For cashew apple juice lipids, a second esterification method was used to characterize free vs. glyceride fatty acids. In the second method, a sodium methoxide esterification procedure was used (7).

Ester samples were injected into a Micro Tek (Tracor, Inc., Austin, Texas) gas chromatograph model DSS 170 equipped with a dual flame ionization detector, 2 glass columns (0.4 cm internal diam x 1.65 m long) packed with 15% diethylene glycol succinate (DEGS) on 60-80 mesh Chromosorb W. Carrier gas used was Argon at 0.281 kg/cm^2 (flow rate – 60 ml/min). Column temperature was 175°C and sample size was approx 0.5 μl. Ester identification was made by comparison with standard compounds injected under the same conditions. Relative amounts of each ester were determined by peak area comparisons as calculated by an Infrotonic Model CRS-108 integrator (Infrotonic Corp., Houston, Texas). Replicate reproducibility for individual fatty acid analysis was found to lie well within ± 10% except for those acids present in amounts less than 1%, when reproducibility was somewhat more variable.

In unroasted cashew nuts, a comparison of the fatty acid composition of the neutral lipids, phospholipids, and glycolipids fractions shows that the phospholipid fraction had the highest palmitic acid value (Table 1). The only fraction that showed detectable amounts of arachidic acid were the neutral lipids. Linoleic acid was predominant in the glycolipid fraction. The values for most of these fatty acids are close to those of Kinsela (6) for cucumber and peppers.

Total fatty acids in the sample of cashew apple juice showed a significant amount of lauric acid (Table 2). Transesterification with sodium methoxide converts glyceride but not free fatty acids to methyl esters (7). Since the lauric acid peak was detected in less than 1% amounts by the sodium methoxide method, it appears that this acid occurs as a free rather than glyceride fatty acid in the juice lipids. The presence of free lauric acid could be explained as being due to possible endogenous lipase action during the preparation of the juice prior to heat

Table 1. Percentage composition of fatty acids of unroasted cashew nut neutral lipid, phospholipid, and glycolipid fractions.

Fatty acid	Neutral lipid	Phospholipid	Glycolipid
Capric	0.5	0.4	–
Lauric	0.1	1.0	0.2
Myristic	0.1	1.0	0.5
Palmitic	9.0	14.5	10.4
Palmitoleic	0.9	1.2	1.2
(Hexadecadienoic)[z]	0.2	0.6	2.0
iso-Stearic	0.1	–	–
Stearic	7.4	6.3	7.9
Oleic	63.9	64.0	57.8
Linoleic	16.4	11.0	20.0
Arachidic	1.0	–	–
Linolenic	0.4	tr[y]	tr

[z]Common name not available.
[y]Trace = $<0.1\%$.

[1]Received for publication October 7, 1974. Arizona Agricultural Experiment Station Technical Paper No. 2370. Supported in part by Grant/AID la-145 (Brazil Contarct).

[2]Present address: Escola de Agronomia, University of Ceara, Fortaleza, Brazil. Part of a dissertation submitted in partial fulfillment of the requirements for the PhD degree at the University of Arizona.

Table 2. Percentage composition of fatty acids of cashew apple components, juice, testa and comparative kernel values.

Fatty acid	Red mature pulp	Red immature pulp	Red mature peel	Red immature peel	Yellow mature pulp	Yellow immature pulp	Yellow mature peel	Juice	Testa	Kernel[z]
Capric	tr[y]	–	tr	tr	6.6	tr	1.2	–	–	–
Lauric	0.8	tr	0.1	0.2	0.2	0.2	0.5	23.7	0.2	–
Myristic	0.5	0.2	0.4	0.3	0.3	0.2	0.5	0.4	0.3	–
Myristoleic	0.2	–	0.4	–	0.1	tr	1.3	1.3	–	–
Palmitic	18.5	26.5	21.3	23.9	15.0	19.3	17.6	14.9	16.4	7.5
Palmitoleic	1.3	1.5	1.5	1.0	1.5	1.2	2.0	0.7	1.1	–
(Hexadecadienoic)[x]	0.3	0.2	0.2	tr	0.2	0.1	0.2	0.4	1.4	–
iso-Stearic	0.3	tr	0.1	tr	tr	tr	tr	–	–	–
Stearic	1.2	0.5	3.0	3.0	0.8	0.5	1.5	0.9	6.4	4.5
Oleic	64.4	51.2	65.4	49.3	65.8	64.3	68.3	50.6	35.3	73.7
Linoleic	2.5	11.6	3.2	10.8	2.2	5.9	3.2	1.7	30.4	14.3
Arachidic	tr	–	tr	–	0.6	–	0.5	–	–	–
Linolenic	6.0	8.3	3.3	9.5	3.8	6.5	2.4	4.7	5.8	tr
Gadoleic	4.0	–	1.0	–	2.9	2.0	1.2	2.0	1.6	–
(Eicosadecadienoic)[x]	–	–	–	–	–	–	–	–	0.8	–

[z]Values from Barroso, et al. (1). [y]Trace = <0.1%. [x]Common name not available.

treatment.

The major fatty acids found in cashew nut testa were palmitic, stearic, oleic, linoleic and linolenic (Table 2). It is interesting to note that oleic and linoleic acids occur in almost identical amounts which differ from their distribution in the kernel, where oleic acid predominates (1). In addition, testa lipids had detectable amounts of 8 additional fatty acids from lauric through eicosadecadienoic that were not detected in the kernel.

Cashew apple peel and pulp showed varying fatty acid composition trends (Table 2). Mature red fruits tended to be higher in palmitic, stearic, and linolenic fatty acids and lower in capric than mature yellow fruits. During maturation, red peel, red pulp and yellow pulp show a decrease in the amounts of linoleic and linolenic acids with some increase in oleic. These results agree with those found by Goldstiein and Wick (4) in a study of the lipids in ripening bananas. These authors found that the ripe banana pulp showed higher amounts of oleic than the unripe, but that linoleic acid was found to be higher in the unripe pulp. There was a threefold decrease in linoleate as the banana matured.

Palmitic acid decreased slightly during maturation of the red and yellow cashews. The immature cashews showed higher unsaturation than the corresponding mature parts. Further, linoleic and linolenic acids decreased during maturation (Table 2).

Literature Cited

1. Barroso, M. A. T., F. M. Whiting, W. H. Brown, and J. W. Stull. 1973. Fatty acids of Brazilian cashew kernels. *HortScience* 8:99.
2. Bligh, E. G., and W. J. Dyer. 1959. A rapid method of total lipid extraction and purification. *Can. J. Biochem. Physiol.* 37:911-917.
3. Dittmer, J. C., and R. L. Lester. 1964. A simple specific spray for the detection of phospholipids on thin-layer chromatograms. *J. Lipid Res.* 5:126-127.
4. Goldstein, J. L., and E. L. Wick. 1969. Lipids in ripening banana fruit. *J. Food Sci.* 34:482-484.
5. Jacqmain, D. 1959. La noix d'anacarde. *Oleagineux* 8-9:527-536.
6. Kinsella, J. E. 1971. Composition of the lipids of cucumber and peppers. *J. Food Sci.* 36:865-866.
7. Luddy, F. E., R. A. Barford, and R. W. Reimenschneider. 1960. Direct conversion of lipid components to their fatty acid methyl esters. *J. Amer. Oil Chem. Soc.* 37:447-451.
8. Maia, G. A., and J. B. Soares. 1970. Gradientes de acidez, acucares e acido ascorbico no caju. *Bol. Cear. Agron.* 11:25-29.
9. ———, L. F. F. Holanda, and C. B. Martins. 1971. Estudo quimico e tecnologico da banana e do caju. *Bol. Tec. Inst. Pesq. Expt. Agrop. Nord.* 3:31-47.
10. ———, ———, and ———. 1971. Caracteristicas fisicas e quimicas do caju (*Anacardium occidentale* L.). *Cien Agron.* 1:115-120.
11. Metcalfe, L. D., A. A. Schmitz, and J. R. Pelka. 1966. Rapid preparation of fatty acids esters from lipids for gas chromatographic analysis. *Anal. Chem.* 38:514-515.
12. Morton, J. F. 1961. The cashew brighter future. *Econ. Bot.* 15:57-78.
13. Pereira, A., and M. M. Pereira. 1963. Composicao quimica da castanha de caju. 4. Presenca do acido palmitoleico no oleo de amendoas de *Anacardium occidentale* L., revelada por cromatografia em fase gasosa. *Estud. Agron.* 4:133-140.
14. Rouser, G., A. N. Siakotos, and S. Fleischer. 1966. Quantitative analysis of phospholipids by thin-layer chromatography and phosphorus analysis of the spots. *Lipids* 1:85-86.

Effects of Scion and Rootstock on Mineral Nutrient Content of Leaves of both Scions and Rootstocks of Sweet Cherry[1]

M. A. Axford, M. N. Westwood, and M. H. Chaplin[2]
Oregon State University, Corvallis

Abstract. **The nutrient content of rootstock and scion leaves from trees of 'Napoleon' and 'Corum' sweet cherry (*Prunus avium* L.) growing on Stockton Morello (*Prunus cerasus* L.) and East Malling Mazzard F12-1 (*Prunus avium* L.) was analyzed. The concentration of Ca was greater in 'Corum' on F12-1 than on Stockton Morello. Rootstocks interacted with scions for K, P, Mg, Fe, Cu, B, and Zn.**

In citrus the rootstock tends to influence the nutrient content of the scion more than does the scion itself (6, 11). In apple (1, 10) and pear (8) the nutrient content of the scion is affected as much by the scion as by the rootstock. Christensen (4) found few and small differences in nutrition of sweet cherry scions related to mazzard and mahaleb rootstocks.

This study was conducted to see what effect clonal rootstocks East Malling mazzard F12-1 and Stockton Morello had on the nutrient content of leaves of 'Napoleon' and 'Corum' and also the effect of scion on the nutrient content of rootstock leaves. A major objective of this experiment was to determine if there is a difference in efficiency of nutrient uptake as measured by leaf nutrient content between the two rootstocks. Rootstocks more efficient in nutrient uptake would be of value in establishing orchards that produce fruit at a lower cost.

Sampling was done on trees at the Lewis-Brown Horticultural Research

[1]Received for publication Jan. 12, 1975. Oregon Agricultural Experiment Station Tech. paper 3955.

[2]Department of Horticulture.