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Individual Lipids and Proximate Analysis of Various Foods. 5. Candy Bars

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Candy bars of various types, purchased in the Washington, D.C., area, were analyzed for fatty acids, sterols, *cis,cis*-methylene interrupted polyunsaturated triglycerides, water, protein, ash, and total fat. The data show a wide range in the amount of the same fatty acid found in similar type candy bars, indicating that mixtures of different oils were used in the manufacture of the candy bars. There is also considerable variation among candy bars for any one particular component, such as water, which ranged from 1.9 to 17.6 g/100 g, and protein, which ranged from 1.4 to 14.2 g/100 g. The data suggest that hydrogenated fats and oils are widely used, as indicated by cis,cis-polyunsaturated trilinolein values, which are generally considerably lower than the total polyunsaturated fatty acid values.

Interest in chloesterol and saturated vs. unsaturated fatty acids has increased in recent years. More information on the analysis of popular types of foods consumed by the public is desirable. Compositional data for candy bars are virtually nonexistent in the scientific literature. One general entry for candy bars can be found in the U.S. Department of Agriculture Handbook No. 8 (Watt and Merrill, 1963). Although U.S. Department of Agriculture Handbook No. 456 (Adams, 1975) gives values for candy bars, these are calculated values based on ingredients rather than data based on analysis of the candy bars themselves. Other widely used food composition tables such as the Heinz Nutritional Data (1972) do not include candy bars. Considering the wide use of such products, the composition of candy bars is of considerable interest to nutritionists and dietitians who are calculating the nutrient intake of teenagers who tend to consume large quantities of these foods and of patients who are instructed by their physicians to modify their fat intake. Data on other types of food products in this study have been reported previously by Hubbard et al. (1977), Newkirk et al. (1978), Sheppard et al. (1978), and Rudolf et al. (1978). This paper, the last in the series, reports the analysis of candy bars of various types. Measurements were obtained for water, total fat, fatty acids, protein, ash, sterols, and *cis,cis*-methylene interrupted polyunsaturated triglycerides.

MATERIALS AND METHODS

Brand-name candy bars were obtained from local supermarkets in Washington, D.C. The 20 different products purchased in duplicate were Nestles Crunch, York Peppermint Patties, Peter Paul Mounds, Tootsie Roll Midgies, Snickers, Reese's Peanut Butter Cups, Hersheys with Almonds, Baby Ruth, Butterfinger, Clark Bar, Almond Joy, Junior Mints, Brach's Chocolate Covered Raisins, Hersheys Krackel, Raisinettes, Mr. Goodbar, Three

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Table I. Fatty Acid Content (g/100 g of Product) of Candy Bars[a]

candy bar	fatty acid methyl esters										total sat.	total poly-unsat.	*cis,cis*-trilino-lein
	C10:0	C12:0	C14:0	C14:1	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3			
1	0.3	3.1	1.4	ND[b]	1.7	ND	2.0	5.1	3.3	0.1	8.4	3.4	2.3
2	0.2	3.5	1.3	ND	2.4	ND	2.2	5.7	4.5	ND	9.6	4.5	3.9
3	ND	0.3	0.2	Tr[c]	3.8	Tr	3.4	8.7	3.1	0.2	7.6	3.3	2.0
4	ND	0.4	0.4	0.1	5.3	0.1	5.4	9.3	3.7	0.3	11.4	4.0	4.0
5	ND	0.5	0.6	0.2	6.4	0.3	7.0	11.6	2.0	0.2	14.5	2.2	1.1
6	ND	0.2	0.3	ND	5.2	ND	5.1	12.8	5.2	0.3	10.7	5.5	3.1
7	0.1	3.3	1.2	ND	1.5	ND	1.8	4.2	2.6	0.1	7.8	2.7	2.2
8	ND	0.5	0.7	0.2	7.2	0.3	8.2	9.1	0.9	0.2	16.6	1.1	0.6
9	ND	0.2	0.2	0.1	2.6	0.1	2.6	4.2	0.4	0.1	5.6	0.5	0.1
10	ND	0.3	0.4	0.1	3.3	0.1	3.6	4.5	0.4	0.1	7.5	0.5	0.1
11	ND	0.4	0.6	0.2	5.7	0.2	6.4	7.6	0.8	0.1	13.0	0.9	0.5
12	ND	0.4	0.6	0.2	6.5	0.2	7.6	8.3	0.9	0.2	15.0	1.1	0.3
13	ND	2.3	1.8	ND	2.6	ND	2.1	5.4	1.0	ND	8.7	1.0	Tr
14	0.1	3.3	1.3	ND	2.7	ND	3.0	3.6	0.4	ND	10.3	0.4	0.2
15	ND	0.2	0.1	ND	1.7	ND	1.4	3.7	0.1	ND	3.3	0.1	Tr
16	ND	Tr	Tr	ND	2.1	ND	3.4	3.1	0.4	Tr	5.4	0.4	Tr
17	ND	0.2	0.2	0.1	3.6	ND	4.3	5.1	0.6	0.1	8.2	0.7	0.1
18	ND	0.2	0.2	ND	2.8	ND	4.1	3.9	0.4	ND	7.2	0.4	Tr
19	0.2	1.0	0.5	Tr	0.4	Tr	0.2	0.3	0.1	ND	2.3	0.1	Tr
20	0.2	1.0	0.5	ND	0.3	ND	0.2	0.2	0.2	ND	2.0	0.2	0.1

[a] Values are the averages of duplicate analyses. [b] ND = none detected. [c] Tr = trace = <0.1 g/100 g of product.

Table II. Proximate Analysis and Sterol Content of Candy Bars[a]

candy bar	proximate analysis, g/100 g of product					sterols, mg/100 g of product			
	water	protein	ash	total fat	carbo-hydrate	chole-sterol	campe-sterol	stigma-sterol	sito-sterol
1	5.2	9.8	1.81	18.7	64.5	ND[b]	4	5	21
2	5.3	12.1	1.47	22.4	58.8	33	ND	ND	17
3	6.4	10.6	1.77	20.9	60.4	ND	ND	ND	27
4	1.9	14.2	1.71	27.2	55.1	17	Tr[c]	15	23
5	2.4	10.0	1.74	31.1	54.9	20	ND	ND	32
6	2.6	12.4	2.16	30.4	52.6	Tr	ND	Tr	46
7	5.5	5.3	0.9	16.2	72.1	ND	Tr	Tr	22
8	2.6	7.5	1.4	28.8	59.8	19	ND	15	27
9	5.8	3.4	1.4	11.0	78.5	11	ND	Tr	16
10	6.6	4.5	1.3	13.7	74.0	ND	ND	ND	15
11	2.9	6.9	1.75	23.7	65.6	19	Tr	17	24
12	2.6	6.6	1.45	26.2	63.2	19	ND	19	26
13	7.7	5.0	1.1	20.2	66.0	Tr	ND	ND	8
14	15.4	3.9	1.2	15.9	63.7	ND	ND	ND	14
15	9.2	1.4	0.41	7.4	81.9	ND	ND	ND	Tr
16	5.4	1.7	0.41	9.7	82.8	ND	Tr	1	8
17	17.6	3.9	1.43	14.8	62.4	Tr	ND	ND	Tr
18	5.7	3.6	1.2	14.0	75.5	2	1	2	12
19	8.5	4.5	1.85	2.9	82.4	7	ND	ND	Tr
20	7.8	2.3	0.83	2.8	86.4	ND	ND	ND	3

[a] Values are the averages of duplicate analyses. [b] ND = none detected. [c] Tr = trace = <1 mg/100 g of product.

Musketeers, Kraft Caramels, Hersheys Chocolate, and Milky Way. (The tabular data for these products do not reflect this order of listing). They were classified into the following groups based on the label ingredients: peanuts or almonds and cocoa (1–5); peanut butter and cocoa (6 and 7); milk chocolate and cocoa (8–10); chocolate and rice (11 and 12); coconut and semisweet chocolate (13 and 14); chocolate and peppermint (15 and 16); chocolate and raisins (17 and 18); caramel type (19 and 20). Samples were homogenized in a Waring blender and stored at −2 °C until extracted. The extraction procedure using chloroform–methanol has been previously described by Sheppard et al. (1974). The methyl esters of the fatty acids were prepared by the Association of Official Analytical Chemists (AOAC) procedure (1975) as modified by Solomon et al. (1974). The preparation of the butyrate derivatives for the sterol analysis has been described by Sheppard et al. (1974). Official methods of the AOAC (1975) and methods described by Sheppard et al. (1974) were used for the remainder of the analyses. A sufficient amount of sample was taken for the extraction step so that approximately 1 g of fat was recovered. All samples were analyzed in duplicate.

RESULTS AND DISCUSSION

The data in Tables I and II indicate a wide variation among products. For example, in Table II the water content of the samples ranges from 1.9 to 17.6, protein from 1.4 to 14.2, and total fat from 2.8 to 31.1 g/100 g. In Table I the fatty acid ranges are the following: C12:0, trace to 3.5; C16:0, 0.3–7.2; C18:0, 0.2–8.2 g/100 g of product. These differences were observed among similar type candy bars containing essentially the same ingredients according to the wrapper label. Samples 1–5 are similar type candy bars. The content ranges were as follows: water, 1.9–6.4; protein, 9.8–14.2; total fat, 18.7–31.1 g/100 g of product. The ranges in fatty acid content were as follows: C12:0, 0.3–3.5; C16:0, 1.7–6.4; C18:0, 2.0–7.0; C18:1, 5.1–11.6 g/100 g of product. When similar type candy bars were compared, it was also observed that the amount of two or three

fatty acids in one candy bar was high, whereas in another comparable type bar the same fatty acids were low. This indicates that various manufacturers used different types of oils and/or mixtures of oils in varying proportions in their formulations.

The total polyunsaturated fatty acids were generally fairly low when compared to the amount of saturated fatty acids (Table I). In most instances the *cis,cis*-methylene polyunsaturated fatty acids calculated as trilinolein were considerably lower than the total polyunsaturated fatty acids, indicating that hydrogenated fats and oils are widely used by candy bar manufacturers.

The cholesterol found in some of the candy bars is probably due to the milk or milk products used in their manufacture since the labels do not declare any animal fat. Coconut, palm kernel, and palm oils and cocoa butter can contribute to the cholesterol content since they contain small amounts of cholesterol and they are listed on the ingredient labels. Sitosterol, a plant sterol, was found in all the candy bars, indicating that vegetable oils are used in their formulations.

Over 50% of the ingredients in the candy bars are carbohydrates (found by difference), ranging from 52.6 to 86.4 g/100 g.

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Polyphenol Oxidase of Dates

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Polyphenol oxidase was purified from an extract of Deglet Noor dates by $(NH_4)_2SO_4$ precipitation, followed by two successive DEAE-cellulose columns, which resulted in a 510-fold increase in specific activity. The purified preparation contained no monophenolase activity and catalyzed the oxidation of only *o*-dihydroxyphenols. The enzyme had maximal activity over a wide pH range, 4.5–6.5, and was relatively heat stable. KCN and thiourea were potent inhibitors. Its substrate specificity was tested on 22 phenols.

Browning is one of the most important quality changes associated with ripening of dates. The color darkens during postharvest processing and storage. Although a broad range of colors is acceptable, color uniformity within a single package or among packages is an important quality factor for consumer acceptance.

Maier and co-workers (Maier and Schiller, 1959, 1960, 1961a,b; Maier and Metzler, 1965a,b; Maier et al., 1964a) have demonstrated three different systems involved in browning of Deglet Noor dates: (1) sugar browning, (2) enzymic oxidative browning of polyphenols, and (3) oxidative browning of tannins. They have shown that the enzymic oxidation of polyphenols is responsible for browning of the fruit during ripening and also contributes somewhat to browning during processing and the early stages of storage.

Catechins and dactylifric acid are the principal polyphenolic enzymic browning substrates present in dates, particularly green dates (Maier and Metzler, 1965b; Maier et al., 1964b). Soluble and insoluble procyanidin tannins are also present, but they are not enzymic browning substrates (Maier and Metzler, 1965a). The concentration of polyphenols decreases steadily during fruit ripening and storage as browning proceeds (Maier and Metzler, 1965a).

Because of the occurrence of caffeoylshikimic acids (dactylifric acids) in dates rather than caffeoylquinic acids (chlorogenic acids) and the importance of polyphenol oxidase in browning of the fruit, we have purified polyphenol oxidase and studied its properties, particularly its substrate specificity.

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EXPERIMENTAL SECTION

Materials. The dates (Deglet Noor variety, *Phoenix dactylifera* L.) used for isolation of polyphenol oxidase were grown at the U.S. Date and Citrus Station, Indio, CA. Samples were harvested at an early red stage and kept at −20 °C until used.

Extraction and Purification of Polyphenol Oxidase. Seven dates taken randomly from storage were pitted, sliced into small disks, and blended in 200 mL of 0.1 M potassium phosphate buffer at pH 7.0 containing 0.5% poly(vinylpyrrolidone). The resulting mixture was centrifuged at 20000*g* for 10 min, and the supernatant was dialyzed against running H_2O for 16 h at 2 °C. The dialysate was then brought to 0.9 saturation with $(NH_4)_2SO_4$