Reassessment of Some Fruit and Vegetable Pectin Levels

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ABSTRACT

Several reviews of pectin as a soluble fiber have included unreliable tables of pectin content for fruits and vegetables. Values given for ranges of pectin content in the fresh, edible portion are actually presented in original reports variously as peel pectin content, dry weight values, soluble rather than total pectins, and some values have been for unripe fruit. This has resulted in reporting pectin levels for some products that may be 2-10 times higher than other published data on the same product. This report examines the original sources and errors of such data and, when available, provides other more substantiated published values.

Key Words: pectin, fruit, vegetable, citrus

INTRODUCTION

CONSIDERABLE EVIDENCE suggests that dietary supplementation with pectin may reduce levels of serum total cholesterol, decrease low density lipoprotein cholesterol, and moderate the glucose response (Baker, 1994; Reiser, 1987). Pectin supplements may be used to achieve these goals but they are bulky, often difficult to consume, and are otherwise non-nutritious. Dietary pectin levels approaching physiological effectiveness could conceivably be attained via judicious selection of foods, providing the benefit of additional nutrition. Thus, considerable importance is placed on accurate estimates of pectin amounts provided by various fruits and vegetables and their component parts. Such information would permit dietary augmentation with natural foods, avoiding the need for supplementation with refined pectin.

Pectin content values published and cited for some fruits and vegetables are substantially in error. Several pectin values are erroneously higher than other, more accurately substantiated published values. A 1978 review of the potential of pectin as a dietary fiber featured a table of fresh weight pectin contents of several fruits and vegetables, expressed as calcium pectate (Table 1) (Campbell and Palmer, 1978). Although presented in the context of dietary fiber, it was not specifically stated that the tabular values were for the edible portions. No attribution for the data was given, although Kertesz' 1951 book on pectin was cited as reference. The following year, another review of the potential pharmacological value of pectin contained a similar table listing the calcium pectate content of many of the same fruits and vegetables (Zilversmit, 1979). These pectin contents were specifically indicated to be for the fresh weight edible portion. Of 14 values analogous to those given in Campbell and Palmer, 13 were attributed by Zilversmit to Kertesz (1951), and one to Kawabata and Sawayama (1973). However, when the values from Zilversmit are compared to averages of ranges from Campbell and Palmer (Table 1), it is apparent that all 14 of Zilversmit's values were derived from the same database. Some of these data have since been cited in another publication (Reiser, 1987).

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Examination of the original references reveals that few of the pectin level ranges listed by Campbell and Palmer and averaged by Zilversmit were actually presented as ranges, or expressed as calcium pectate. In most cases, the values provided by Campbell and Palmer as ranges may be found in Kertesz' text, and were misrepresented to varying degrees. Eight of the values were given in Kertesz' study as pectic acid rather than calcium pectate, incurring an error of several percent. More importantly, three of the values from Kertesz were for soluble rather than total pectins, one for protopectin content, three for pectin content of unripe fruit, and two for specific tissues of a vegetable. One pectin value listed in Campbell and Palmer and in Zilversmit as an average was reported by Kertesz as the high value for a single variety. One value listed in Campbell and Palmer as the maximum pectin level for a fruit was reported by Kertesz as its minimum. The most significant misrepresentation occurred with five values given by Campbell and Palmer as pectin ranges for fresh weight. In Kertesz, four of these were for pectin contents of inedible fruit peel, and the other was a dry weight value.

To prevent further dissemination of such unreliable, spurious values, a review was performed to examine the apparent sources and errors of these ''ranges,'' and to provide more substantiated published data. Discussions of specific products are presented in approximate order of the degree of deviation of their pectin content from more established, reliable values.

Comparisons of pectin contents

Grapefruit. Range given in Campbell and Palmer: 3.30–4.50%. The values given for fresh weight pectin levels in citrus fruits by Campbell and Palmer and by Zilversmit are among the most egregiously incorrect. The range quoted by Campbell and Palmer for grapefruit is reported in Kertesz as a range of total pectin levels for Marsh seedless grapefruit *peel*. Also, none of Kertesz' discussion of pectin levels in grapefruit pertains to the edible portion of the fruit. Far more reliable values for pectin content of grapefruit edible portions were given by Sinclair and Crandall (1954), who reported pectin (as calcium pectate) constituted 0.3% of grapefruit pulp fresh weight. Similarly, Atkins and Rouse (1958) and Wenzel et al. (1956) found pectin levels (as calcium pectate) in cut grapefruit sections ranged from 0.24–0.27% and 0.34–0.51%, respectively (Table 2). These values were slightly lower than that found by Braddock and Graumlich (1981), who reported 0.65% pectin (as AGA) in juice sacs from Marsh grapefruit. Cut sections have segment membranes removed, and consumption of grapefruit segments with membranes would no doubt provide additional pectin (Baker, 1994). Braddock and Graumlich (1981) separated the edible portion of Marsh grapefruit into juice, seeds, juice sacs, and membrane, and found that membranes constituted 28% of the edible portion, and were 4% pectin. If consumed with juice sacs, the membranes could add another 1% pectin.

Lemons. Range given in Campbell and Palmer: 2.80–2.99%. As with grapefruit, these values appear in Kertesz' discussion of lemon *peel*. Again, Kertesz made no mention of pectin levels in the edible portion of lemon fruit. A more reliable analysis of

Table 1—Comparison of fresh weight pectin content values from Campbell and Palmer (1978) (expressed by the authors as calcium pectate) with values from Zilversmit (1979)

	Campbell and Palmer		
Product	Range	Average	Zilversmit
Apples	0.71–0.84	0.78	0.78
Apricots	0.71–1.32	1.02	1.00
Bananas	0.59–1.28	0.94	0.94
Beans	0.27–1.11	0.69	0.70
Blackberries	0.68–1.19	0.94	0.94
Carrots	1.17–2.92	2.04	2.00
Cherries	0.24–0.54	0.39	0.39
Dewberries	0.51–1.00	0.76	nl[a]
Grapes	0.09–0.28	0.19	0.19
Grapefruit	3.30–4.50	3.90	3.90
Lemons	2.80–2.99	2.90	2.90
Loganberries	0.59	0.59	0.59
Oranges	2.34–2.38	2.36	2.36
Raspberries	0.97	0.97	0.97
Squash	1.00–2.00	1.50	nl
Sweet potatoes	0.78	0.78	0.78

[a] nl: not listed

fresh peeled lemon fruits for pectin content was 0.63%, expressed as anhydrogalacturonic acid or AGA (Vollendorf and Marlett, 1993).

Oranges. Range given in Campbell and Palmer: 2.34–2.38%. These values do *not* appear in any of the discussion of orange fruit by Kertesz, and their derivation is unknown. The values suggest they may have been derived from assays of peel or extracted wet pulp. For example, Rouse (1953) reported pectin (as calcium pectate) in wet centrifuged pulp of four cultivars of oranges ranging from 1.5–2.5%. The pectin value cited by Kertesz for the edible portion of orange (0.86%) was incorrectly derived from the work of Money and Christian (1950). An examination of the original reference shows the value was for bitter oranges. The range for sweet oranges was somewhat lower, 0.25–0.76%, average 0.59%. This was in excellent agreement and confirmed by the work of Ross et al. (1985), who found 0.57% pectin (as AGA) in orange flesh.

Beans. Range given in Campbell and Palmer: 0.27–1.11%. Although both values were found in Kertesz' discussion, neither represents a range to be expected in fresh beans. The 0.27% was the grams of total pectin per 100 *beans*, not per 100g of beans. The upper range value of 1.11% was a *dry* weight value for the percent total pectin in snap beans. Fresh green beans were analyzed for pectin by Ross et al. (1985), who reported levels from 0.43–0.63%, as AGA. Dried beans would obviously be higher in pectin levels. Vollendorf and Marlett (1993) reported total pectin levels of bean cultivars ranged from 1.4–29%, dry weight basis. However, pectin levels of the same beans after cooking ranged from 0.27–0.63%, quite similar to levels reported in freshly cooked beans.

Carrots. Range given in Campbell and Palmer: 1.17–2.92. *No* range of fresh weight pectin values for carrots was given by Kertesz, although the 1.17 and 2.92 values appeared in a table. The 1.17 value was not a minimum value for pectin, but the percentage of *protopectin* in carrot stele (core). The 2.92 value represented total pectic substances of carrot cortex, rather than whole carrot. These values were higher than later determinations of pectins in carrots. Kawabata and Sawayama (1973) reported 0.63% total calcium pectate in fresh carrot. Similarly, Greve et al. (1994) found 0.71–0.76% pectin (as AGA) in two cultivars, and Fuchigami et al. (1995) reported 1.0% pectin (as AGA) in a Japanese cultivar. Ross et al. (1985), working with an unknown cultivar, obtained values from 0.72–1.01%, as AGA, quite close to the 0.86% derived from the data of Voragen et al. (1983).

Apples. Range given in Campbell and Palmer: 0.71–0.84% pectin, as calcium pectate. These values appear in Kertesz, but they were given as *minimum* levels of *pectic acid* found in eating and cooking apples, respectively. The same table gave the ranges in pectic acid content for eating apples as 0.71–0.93%, and for cooking apples, 0.84–1.60%. A more extensive compilation of pectin content analyses in apples was given by Money and Christian (1950), who reported a range of 0.14–0.96% (average 0.53%) pectin as calcium pectate in 58 samples of eating apples, and a range of 0.19–0.79% (average 0.55%) in 40 samples of cooking apples. Later reports of calcium pectate levels ranged from 0.63–1.15 (average 0.79%) in nine cultivars of apples from India (Gautam et al., 1986), and from 0.32–0.72% in seven cultivars from Japan (Kawabata and Sawayama, 1974a). Pectin levels (as AGA) of Golden Delicious apples were reported from 0.28% (Forni et al., 1989) to 0.54% (Voragen et al., 1983) to 0.63% (Glenn and Poovaiah, 1990), while the levels of pectin (as AGA) declined from 0.35 to 0.25% during ripening of Cox's Orange Pippin apples (Knee, 1973). Ross et al. (1985) reported a range of pectin (as AGA) in two cultivars of 0.39–0.49% (Table 2).

Apricots. Range given in Campbell and Palmer: 0.71–1.32%. This range was cited in Kertesz, but the values were for pectic acid. Calcium pectate contains 7.6% calcium, therefore calcium pectate yields would be from 5–10% higher than starting pectinic acid weights (Kertesz, 1951). Values from Money and Christian (1950) were quite similar, with a range from 0.42–1.32%, average 0.99%, as calcium pectate.

Bananas. Range given in Campbell and Palmer: 0.59–1.28%. Both values are found in Kertesz. The lower range value was total pectic substances (as calcium pectate) of *unripe* Lacatan bananas, while the higher value was for total pectic substances of this cultivar after 5 days storage in a ripening room. Values for this and two other cultivars ripened for 9 days ranged from 0.58–0.89% (average 0.73%). Kawabata and Sawayama (1974a) examined bananas from three countries, and found levels of calcium pectate from 0.55–0.68%, with an average of 0.63%. This was in good agreement with the range of 0.5–0.7% pectin which had been reported by Garces Medina (1968). Wade et al. (1992) later reported total uronic acid levels of bananas decreased from 1.02% to 0.44% during 8 days ripening.

Blackberries. Range given in Campbell and Palmer: 0.68–1.19%. These values appeared in Kertesz as ranges for fresh weight pectin values from five samples of blackberries, but were expressed as *pectic acid* rather than calcium pectate, as indicated by Campbell and Palmer and by Zilversmit. A more extensive study of 30 samples of established cultivars reported calcium pectate from 0.40 to 1.19%, average 0.63% (Money and Christian, 1950).

Cherries. Range given in Campbell and Palmer: 0.24–0.54%. In Kertesz's discussion of cherry pectins these values were ranges of *pectic acid*, rather than calcium pectate, for four samples of cherries in a single study. A more extensive study cited by Kertesz (Money and Christian, 1950) gave average values of 0.16, 0.32, 0.28 and 0.31% calcium pectate for Morella, black, red and white cherries, respectively. The range for 46 samples was 0.01–1.15%. Voragen et al. (1983) reported 0.52% pectin (as AGA) in morello cherries, while Facteau (1982), in a study of fresh Lambert cherries from 5 orchards and Bing cherries from 4 orchards, reported AGA levels of 0.34–0.40% and 0.36–0.46%, respectively.

Dewberries. Range given in Campbell and Palmer: 0.51–1.00%. The 0.51 value from Kertesz was for *soluble*, rather than total pectin content of a single sample of ripe berries. The 1.00 value was total pectin for *unripe* berries.

Grapes. Range given in Campbell and Palmer: 0.09–0.28%. These values were cited by Kertesz from a study of pectin levels in ripening grapes. The 0.09 value was for *soluble* pectins of mature Zinfandel grapes, while the 0.28 value was for *soluble* pectin levels of immature Tokay grapes. A graph of total pectin values for maturing Concord grapes given by Kertesz showed levels of ~0.65% in mature fruit. This was in close agreement with and confirmed by work of Silacci and Morrison (1990), who reported total pectin levels in two wine grape cultivars of

Table 2—Published values for pectin contents of fruits and vegetables listed in Table 1

Food	Pectin content[a] %	as	Comments	Reference
Apples	0.14–0.96	CaP	eating cvs., 58 samples	Money & Christian (1950)
Apples	0.19–0.79	CaP	cooking cvs., 40 samples	Money & Christian (1950)
Apples	0.63–1.15	CaP	9 cvs., some tropical	Gautam et al. (1986)
Apples	0.28	AGA	Golden Delicious cv.	Forni et al. (1989)
Apples	0.54	AGA	Golden Delicious cv.	Voragen et al. (1983)
Apples	0.63	AGA	Golden Delicious cv.	Glenn & Poovaiah (1990)
Apples	0.39–0.49	AGA	Two unnamed cvs.	Ross et al. (1985)
Apples	0.25–0.35	AGA	Cox's Orange Pippin	Knee (1973)
Apricots	0.42–1.32	CaP	44 samples	Money & Christian (1950)
Bananas	0.44–1.02	GA	Ripening of Williams cv.	Wade et al. (1992)
Bananas	0.55–0.68	CaP	Cvs. from 3 countries	Kawabata & Sawayama (1974a)
Bananas	0.58–0.89	CaP	3 cvs., ripened	Kertesz (1951)
Bananas	0.5–0.7		ripe	Garces Medina (1968)
Beans	0.43–0.63	AGA	fresh green beans	Ross et al. (1985)
Beans	0.27–0.63	AGA	dried, cooked	Vollendorf & Marlett (1993)
Blackberries	0.40–1.19	CaP	30 samples, cultivated cvs.	Money & Christian (1950)
Carrots	0.72–1.01	AGA	Two samples, unknown cvs.	Ross et al. (1985)
Carrots	0.63	CaP		Kawabata & Sawayama (1973)
Carrots	0.86	AGA	unknown cv.	Voragen et al. (1983)
Carrots	0.71–0.76	AGA	two cvs.	Greve et al. (1994)
Carrots	1.0	AGA	Kuroda Gosun ninjin cv.	Fuchigami et al. (1995)
Cherries	0.34–0.40	AGA	Lambert cv., 5 groves	Facteau (1982)
Cherries	0.36–0.46	AGA	Bing cv., 4 groves	Facteau (1982)
Cherries	0.01–1.15	CaP	4 cvs., 46 samples	Money & Christian (1950)
Dewberries	0.70		One sample, total pectins	Kertesz (1951)
Grapes	0.7–0.8	AGA	Two wine grape cvs.	Silacci & Morrison (1990)
Grapes	0.65		Concord (approx. from graph)	Kertesz (1951)
Grapes	0.12–0.17	CaP	Four cvs.	Kawabata & Sawayama (1974a)
Grapefruit	0.24–0.27	AGA	Cut sections	Atkins & Rouse (1958)
Grapefruit	0.34–0.51	AGA	Cut sections	Wenzel et al. (1956)
Grapefruit	0.30	CaP	Two samples	Sinclair & Crandall (1954)
Grapefruit	0.65	AGA	Marsh cv.	Braddock & Graumlich (1981)
Lemons	0.63	AGA	unknown cv.	Vollendorf & Marlett (1993)
Oranges	0.57	AGA	One sample, unknown cv.	Ross et al. (1985)
Oranges	0.25–0.76	CaP	8 samples	Money & Christian (1950)
Raspberries	0.10–0.88	CaP	264 samples	Money & Christian (1950)
Squash	0.67		Winter squash, one cv.	Kertesz (1951)
Sweet pot.	0.78		At harvest	Kertesz (1951)
Sweet pot.	0.61	AGA	unknown cv.	Vollendorf & Marlett (1993)

[a] (CaP = calcium pectate; AGA = anhydrogalacturonic acid)

0.7–0.8%, as AGA. However, Kawabata and Sawayama (1974a) found a much lower range from 0.12–0.17% as calcium pectate, in four cultivars.

Loganberries. Value given in Campbell and Palmer: 0.59%. This value was cited by Kertesz, from the work of Money and Christian (1950).

Raspberries. Average value given in Campbell and Palmer: 0.97%. In Kertesz, this was the *high* value for one cultivar of raspberry. Kertesz quoted the more expansive study of Money and Christian (1950). In an examination of 264 samples of raspberries, they found pectin contents of 0.10–0.88%, average 0.40%. This was in excellent agreement and confirmed by a later study, which found 0.34% pectin as AGA in Sirius raspberries (Voragen et al., 1983).

Squash. Range given in Campbell and Palmer: 1.00–2.00%. These values did not appear in Kertesz. However, he gave a small range of values for a single cultivar, with total pectic substances reaching 0.67% at maturity, 0.66% after storage, and 0.69% after canning.

Strawberry. No values for this fruit were given by Campbell and Palmer. Zilversmit listed Kertesz as the source of a value of 0.75%, but this appeared to have been derived from Kawabata and Sawayama (1974a). Kertesz cited three studies, giving ranges of pectin levels in ripe strawberries of 0.60–0.73%, 0.21–0.55%, and 0.35–0.44%. Later values were within these ranges: Voragen et al. (1983), Senga Sengana cv., 0.49% as AGA; El-Zoghbi (1994), Tioga cv., 0.16% as AGA; Bartley and Knee (1982), unknown cv., 0.27% as AGA.

Sweet potatoes. Average value given in Campbell and Palmer: 0.78%. This value appeared as total pectin for sweet potatoes in Kertesz. However, Zilversmit attributed this value to Kawabata and Sawayama (1973), who did not report on sweet potato in the cited study. The value was in close agreement and confirmed by a later analysis by Vollendorf and Marlett (1993), who found 0.61% pectin as AGA in baked, peeled sweet potatoes.

Watermelon. Campbell and Palmer did not give values for watermelon. Zilversmit mistakenly attributed a value of 0.18% to Kertesz, when it appears to have been derived from Kawabata and Sawayama (1974a). The only fresh weight value for watermelon pectin given by Kertesz was almost an order of magnitude less, 0.02% for total pectic substances.

Reassessing pectin levels

Many pectin values reported in Campbell and Palmer and in Zilversmit were incorrectly derived, presumably from Kertesz (1951). More accepted values from published data are in some cases only slightly different. For example, based on more extensive and later assays, the ranges for pectin levels in apples and apricots should be wider, and the average for apples should perhaps be lowered from 0.78% to around 0.55% (Table 2). Pectin levels in mature bananas appear to be lower, rather than higher (Wade et al., 1992); therefore their average values were skewed higher by incorporation of the value from Campbell and Palmer. Analysis of cultivated blackberries by Money and Christian (1950) suggests the range of expected pectin values should be widened, and the average adjusted downward from 0.94% to 0.63%. Values given by Campbell and Palmer for cherries appear acceptable, with later data falling within these limits. Average pectin levels of grapes were underestimated by Campbell and Palmer at 0.19%, since both Concord (Kertesz, 1951) and wine grape cultivars (Silacci and Morrison, 1990) show an average pectin content of ~0.7%. However, the study of Kawabata and Sawayama (1974a) reported pectin levels in grapes (0.12–0.17%) quite similar those given by Campbell and Palmer. Conversely, the pectin level of raspberries was overstated by Campbell and Palmer at 0.97%, when analyses by Money and Christian (1950) of 264 samples gave an average of 0.40%.

For most of these fruits, misestimates of pectin levels were not extreme. Also, many are not generally consumed in quantities to provide notable amounts of dietary fiber. For those fruits and vegetables perceived to contribute appreciable dietary fiber, such as apples, carrots, grapefruit and oranges, incorrect pectin values may misguide efforts to accurately calculate daily fiber intake. The average value of 2.0% pectin for carrots published by Campbell and Palmer, seriously overstates the level of pectin. Examination of values reported in later studies (Table 2) suggest a more reasonable content of 0.8% pectin.

Citrus fruits are strongly associated with pectin, inasmuch as a substantial portion of commercial pectin is derived from citrus peel. It is unfortunate that values for citrus peel pectin levels have been misidentified or misinterpreted as pertaining to the edible portion. For lemon, the result is to give values 150% higher than found in fruit flesh; for orange, 300% higher than values established by Money and Christian (1950) and Ross et al. (1985); and for grapefruit, almost 1000% higher than published values (Sinclair and Crandall, 1954; Wenzel et al., 1956; Atkins and Rouse, 1958). Should such values be accurate, consumption of a physiologically active level of 6g of pectin could be provided in the recommended single serving size (Hegenauer and Tucker, 1990b) of 170g of grapefruit pulp. Instead, it has been calculated that at least 1kg of grapefruit edible tissue would need to be consumed to reach this level of pectin (Baker, 1980, 1994).

Recognition that values for grapefruit pectin cited by Campbell and Palmer (1978), Zilversmit (1979) and Reiser (1987) have been erroneously derived from peel pectin data should enable more reasonable and reliable values to prevail. However, another source of potentially misleading data on pectin levels of fresh orange and grapefruit has developed. In response to an FDA solicitation of nutrient data for raw fruits and vegetables, the Produce Marketing Association commissioned several studies on various fresh produce items. Two of these, the Orange Nutrition Study (Hegenauer and Tucker, 1990a) and the Grapefruit Nutrition Study (Hegenauer and Tucker, 1990b), provided extensive analytical data on the fresh fruit. These interim data have been accepted by the FDA to supplant USDA Handbook 8 data.

Specific pectin assays were not run on either orange or grapefruit in these studies, but total, soluble and insoluble dietary fiber values were determined by the method of Prosky et al. (1988). Although previous work showed total dietary fiber levels in orange flesh of ~1.3% (Ross et al., 1985), Hegenauer and Tucker (1990a) reported 4.41% total fiber. Of this, 73.7% was found to be water-soluble fiber, the majority presumed to be pectin. This implies a fresh weight pectin level approaching 3.25%, which is far higher than previously reported values of 0.57–0.59% (Money and Christian, 1950; Ross et al., 1985). This also suggests that 24.6% of the total dry matter would be soluble fiber. This contradicts the findings of Olson et al. (1987), who reported orange flesh contained only 6.5% soluble fiber on a dry matter basis.

The implausibility of a 4.41% fresh weight fiber level in the edible portion of oranges becomes apparent upon closer examination of the data. Both Navel and Valencia oranges for the Orange Nutrition Study were purchased at various retail outlets throughout the USA to represent typical mature shipped fruit. Fiber, ash, protein, and fat concentrations were determined by AOAC procedures, but carbohydrates were determined by difference rather than by direct measurement of sugars. As a result of the large measured fiber content, the carbohydrate level was found to be only 7.37% of fresh weight. Since carbohydrates were determined by difference, this value would include not only all soluble sugars, but also citric acid. Thus, actual sugar levels would almost certainly be <7%. This level is inconsistent with the sugar levels reported in mature oranges of either cultivar. California Navel oranges had mean sugar levels, for fruit grown on 13 different rootstocks of 9.53% (Sinclair, 1961). Similarly, an extensive study of Florida Valencia oranges showed that fruit picked from March 1 to June 13 averaged 8.75% total sugars (Sinclair, 1961). It seems improbable that fruit with sugar levels as low as reported in the Orange Nutrition Study could have been purchased. Some error in analysis of fiber resulted in an anomalously high soluble fiber level.

Similarly, the Grapefruit Nutrition Study reported 4.01% total dietary fiber in the edible portion, 78.2% of which was soluble fiber. This infers a pectin level of ~3.14%, although pectin was not specifically mentioned. This contradicts previous studies of pectin in the edible portion, which reported levels ranging from 0.24–0.51% (Atkins and Rouse, 1958; Sinclair and Crandall, 1954; Wenzel et al., 1956).

Future research needs

Some values for pectin content of fresh citrus and carrot have been erroneously high, but this should not be taken as an indication that these products are low fiber sources. For example, consumption of fresh citrus fruit or carrot can provide significant dietary fiber (Table 2). It is unfortunate that many studies have expressed pectin content on a dry weight basis, without providing the fresh weight/dry weight ratio so fresh weight values could be calculated. Expressing pectin contents on a dry weight basis eliminates variation due to differing moisture contents. However, it does not allow the consumer to calculate total quantities consumed. The few studies that have calculated citrus pectin levels on a fresh weight basis should be reinforced with more complete studies on currently grown cultivars.

Bananas are the major fruit consumed in the temperate zone (Forsyth, 1980), and account for 30% of fresh fruit consumption in the U.S (Karst, 1995). Accurate knowledge of banana pectin and fiber content would encourage their inclusion in dietary management. Both Wade et al. (1992) and Kawabata and Sawayama (1974b) noted a decrease in pectin levels occurring during ripening of bananas. Given the relatively wide range of consumer preferences for maturity level at consumption (Forsyth, 1980), more information is needed on pectin levels at various stages of ripening.

The limited information on bean pectin and fiber levels has been derived from relatively few cultivars. Considering the variety of beans consumed from several genera and species, and the various maturity stages consumed (immature in pod, mature green seeds, dried seeds) (Table 2), more information is needed about bean fiber and pectin values. The work of Vollendorf and Marlett (1993) greatly expanded knowledge of fiber content in dried bean cultivars, with the advantage of also measuring pectin levels in beans as cooked. Ideally, pectin or soluble fiber content of all major bean cultivars should be determined at the maturity stage(s) usually consumed. When soluble fiber or pectin contents of beans are reported, the specific cultivar, genus and species, and state of maturity should be defined. A similar situation exists with squash, where several species and numerous cultivars are grown which differ widely in physiological maturity at harvest. When values are reported for specific named cultivars, the genus and species should be given, and the cultivar should be differentiated as a summer or winter squash.

The values for pectin content of grapes given by Kertesz (1951) and Silacci and Morrison (1990) were in agreement, but neither relate to most commonly consumed fresh table grapes. Both differ substantially from the results of Kawabata and Sawayama (1974a). Pectin levels of seedless table grape cultivars commonly consumed would be of more value in calculating dietary pectin intake.

In conclusion, unrealistically low pectin values for a specific food do a disservice to the consumer and the producer, by potentially biasing dieticians, nutritionists and others concerned with dietary fiber against that food. Unrealistically high values do an even greater disservice because they may cast doubt on the reliability of food labeling data. With the high interest in all forms of fiber, including pectin, more substantiated data on pectin levels in fresh-consumed fruit and vegetable cultivars is needed.

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