Comments on quantification of major carotenoids in raw fruits and vegetables by HPLC

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Comments on Quantification of Major Carotenoids in Raw Fruits and Vegetables by HPLC

Sir: As one who is presently revising an extensive review, accepted for publication (Sri Kantha and Erdman, 1987), on legume carotenoids, I found the information provided in two recently published papers in this journal (Bushway, 1986; Khachik et al., 1986) quite informative. I believe that the following comments are pertinent.

(1) I agree with Khachik et al.'s observation that "current food composition tables lack detailed analytical information in that they only provide data on 'carotene' or vitamin A activity." However, it is my opinion that those reporting original data on the carotene content of "several" or "some" green vegetables should also provide analytical data on the proximate compositions of those vegetables. Absence of these proximate composition values (even the basic information such as moisture content, though the carotenoid composition was expressed in milligrams or micrograms/100 g of edible food) will make it difficult for the compilers of food composition tables to match the reported carotene data with the other essential nutrient values.

(2) For completeness and for assisting researchers from countries other than the United States, I would appreciate if Bushway and Khachik et al. could provide the botanical nomenclature of the vegetables to the species level. While Khachik et al. mentioned in their results and discussion that the majority of green vegetables studied in their report belong to the genus *Brassica*, Bushway's report is lacking in the botanical identification of the fruits and vegetables studied.

(3) Khachik et al. reported the losses of *all-trans*-β-carotene and its 15,15′-cis isomer due to microwave cooking for 6 min in brussels sprouts and kale as 15% and 14%, respectively. Table III of their paper also reveals that the loss of total carotenoids due to microwave cooking in brussels sprouts and kale amounts to 40.1% and 31.2%, respectively. Previously, Sweeny and Marsh (1971) reported a 15–20% decrease in carotene content of green vegetables cooked for 30 min. However, other researchers (Panalaks and Murray, 1970; Gomez, 1981; Bushway and Wilson, 1982) reported 24–88% carotene increase during cooking treatment in the carrots and cooked leaves of cassava, cowpea, kale, and amaranthus. We (Sri Kantha and Erdman, 1985) reported some preliminary data that steam blanching for 30 min at atmospheric pressure in an autoclave resulted in significant apparent increase (87–150%) in the β-carotene content of cooked winged bean leaves, carrot, and lettuce, though water blanching for 30 min resulted in 13.2% decrease in β-carotene content in winged bean leaves. Does this mean that microwave cooking leads to rapid degradation and rearrangement of provitamin A carotenoids?

In conclusion, I agree with the observation of Khachik et al. that the degradation, rearrangement, and stereoisomerization of carotenoids are influenced by the degree, length, and the method of cooking. Since the existing reported data are very much conflicting, carefully designed experiments to control the various parameters of cooking could provide better clues in understanding the effect of heat treatment on the provitamin A carotenoids of edible plant products.

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Rebuttal on Quantification of Major Carotenoids in Raw Fruits and Vegetables by HPLC

Sir: I have the following response to the comments of Sri Kantha:

(1) I agree with Sri Kantha that it may be beneficial to report moisture content to have some basis of comparison. I am not convinced that all proximate analyses data are needed.

(2) For countries other than the United States it would be helpful to add the scientific names. This may be something the journal editors would want to consider in the future to better serve a wider audience.

(3) I totally agree that there needs to be experiments designed for looking at cooking effects. But first there need

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to be methodologies developed to look at all the different isomers formed during cooking. This is one reason why we have not looked at cooking as extensively as we have looked at raw products—the inability to separate all the isomers that develop during cooking. As far as Khachik et al.'s method is concerned, it is not as good as our method for separating the isomers of β-carotene. The methodology must be developed for cooked products first and then the planned experiments performed.

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Rebuttal on Quantification of Major Carotenoids in Raw Fruits and Vegetables by HPLC

Sir: Dr. Sri Kantha raises several pertinent and interesting points to which we respond. In regard to Sri Kantha's first two points, which address detail description of foods in scientific publications, we agree and support these general concepts. However, the primary emphasis of our paper was the qualitative aspects of carotenoids in green vegetables; quantitative data were collected from a very limited sampling of several foods and a very limited number of analyses. These data were presented to permit the reader to make preliminary comparisons of the levels of carotenoids in several vegetables and were not intended as a large body of analytical data. Studies that concentrate on the analysis of nutrients in a large number of foods should also provide sufficient ancillary data, i.e., moisture, nitrogen, etc., to allow compilers of food composition tables to match new data with existing data by specific chemical criteria. In regard to publishing botanical nomenclature in concert with food composition data, we agree. However, reviewers of our paper were most insistant that we remove botanical nomenclature in the interest of the conservation of space. This information can be provided upon request. Nonetheless, journal editors and reviewers must be encouraged to permit sufficient descriptive information about foods to be published with composition data so that compilers of food composition tables can present accurate and precise information.

The effect of cooking and processing in fruits and vegetables can be best understood if in dealing with analytical data generated on these foods we realize that the degree to which the oxygenated carotenoids (xanthophylls) and the hydrocarbon carotenoids (mainly, α- and β-carotene) are destroyed is very different. Most of our results to date, including a recent manuscript submitted for review to the *Journal of Agricultural and Food Chemistry*, suggests the following: The destruction of hydrocarbon carotenoids as a result of cooking and processing green and yellow orange vegetables is about 15–20%. However, any vegetable that in addition to hydrocarbon carotenoids contains oxygenated carotenoids suffers more loss due to instability of the xanthophylls not the hydrocarbon carotenoids. Even among the xanthophylls, such data have to be dealt with much more carefully. For example, our data suggest that lutein is much more heat resistant than the epoxycarotenoids; therefore, it is not possible to arrive at a universal destruction percentage for fruits and vegetables as a result of cooking and processing. Depending on the nature and the chemical structure of the abundant carotenoids in various foods, they may exhibit different stability toward cooking. The increased level of β-carotene in the cooked vegetables reported by Sri Kantha can probably be related to the evaporation of the volatiles in raw vs. cooked samples. In our studies of the carotenoid content of raw and cooked vegetables, two identical batches of the well-homogenized raw vegetable are weighed: one batch is extracted raw, and the second batch is cooked and then extracted. If these measures of weight correction have already been employed, the increase in β-carotene level in the cooked vegetables can only be explained in terms of a more efficient extraction of the carotenoids in the cooked vegetables as a result of a more efficient denaturing of the carotenoid–protein complexes. In an attempt to minimize the errors due to varietal differences and experimental and analytical procedures, comparison between the various means of cooking and the levels of carotenoids destroyed must be carried out on the same vegetables employing an accepted extraction and HPLC procedure.

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