WATER-LABILE FLUORIDE IN FRESH RAW VEGETABLE JUICES FROM MARKETS IN NAIROBI, KENYA

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SUMMARY: Analysis of water-labile fluoride in fresh vegetable juices from markets in Kenya was conducted by direct analysis with a fluoride ion selective electrode. Among 20 different vegetable juices, the fluoride content ranged from 1.2 mg F/L to 5.4 mg F/L. Some of the juices contained higher fluoride levels than the limits recommended by the World Health Organization for drinking water. Consumption of vegetable juices for healing therapy has become popular, and it is therefore important to consider the fluoride intake from this source. Calculation of the amount of fluoride that may be ingested from the juices based on the recommended formulations shows that the juices make a significant contribution to daily fluoride intake.

Keywords: Fluoride in juices; Fresh vegetables; Nairobi, Kenya; Vegetable juices; Water-labile fluoride.

INTRODUCTION

In recent years, because of increasing consumption of vegetable and fruit juices, their fluoride content has become an issue of growing concern. Among 26 formulated fruit juices in Kenya, 68% had a fluoride content higher than 1 mg F/L.[1] Out of 43 ready-to-drink juices in the USA analyzed by Stannard et al.,[2] 42% contained more than 1 mg F/L, while Kiritsy et al.[3] reported a range of 0.02 to 2.8 mg F/L in 532 such juices.

High levels of fluoride in fruit juices are usually due to the fluoride in water used in their preparation. Most of the borehole water in Kenya has fluoride levels ranging from 2.5 to 55 mg F/L,[4] which is higher than the WHO recommended maximum of 1 mg F/L.[5] Although considerable research has been conducted on amount of fluoride in fruit juices and beverages in Kenya, relatively little investigation appears to have been made on the amount of fluoride in vegetable juices, in spite of the fact that they have been found to accumulate high levels of fluoride.[6]

The purpose of this work was to determine the water-labile fluoride content in freshly extracted raw vegetable juices in Nairobi, Kenya and to estimate the amount of fluoride consumed per day from the juices.

MATERIALS AND METHODS

Fresh vegetable samples were purchased from different open-air and wholesale markets in Nairobi. They were immediately put into plastic or paper bags, sealed, and transported to the laboratory for analysis that same day. The samples were then washed thoroughly under running tap water to remove all the soil and any foreign particles. They were next rinsed with distilled water and left to drain on a clean surface for 1 hr. They were then chopped up separately into small pieces to

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fit the mouth of the juicer. For some of the vegetable samples, the leaves and stems were chopped separately.

Juice extraction: The chopped samples were fed into a Mommonlex juicer and the juice extracted. Enough vegetables were used to provide 50 mL of juice extract. Extreme care was taken during extraction to avoid contamination. To ensure this, after extraction of one type of vegetable juice, the juicer was washed thoroughly with running water, rinsed with distilled water, and dried before using again.

Fluoride analysis: A 2.00-mL aliquot of vegetable juice was mixed with 2.00 mL TISAB II. The fluoride concentration was determined with a fluoride ion selective electrode (Orion model 96-09) and an Orion model 407A meter according to the Orion method for water analysis.[7] Measurements were made in triplicate.

RESULTS AND DISCUSSION

Fresh raw vegetables are known to be rich in vitamins and minerals such as calcium, iron, potassium, sodium, magnesium, sulphur, phosphorus, and chloride, which are found in different amounts in various vegetables. Fluoride, like these other minerals, is present in different proportions from one vegetable to another. Results of direct analysis of water-labile ionic fluoride in the raw vegetable juices are presented in the Table in order of decreasing F concentration.

As seen in the Table the juices contained a mean fluoride concentration (six different samples per vegetable each analysed in triplicate) ranging from 1.2 mg F/L in capsicum to 5.4 mg F/L in celery. Vegetables such as celery, amaranthus, spinach, kunde, and cabbage had the highest mean fluoride concentrations above 4.0 mg F/L.

Previous workers have reported similar trends in which vegetables were found to contain high total and acid-labile fluoride.[6,8] The fluoride content found in vegetable juices by the direct method used here is lower than either total or acid-labile fluoride.[9] The direct method gives the water-labile fluoride.

Carrots were thinly peeled and the juice of peeled and unpeeled carrots was extracted and analyzed. The juice from unpeeled carrots showed a slightly higher fluoride content of 1.4 to 2.2 mg F/L with a mean of 1.9±0.4 mg F/L, which was 5.3 to 10.5% higher than that of peeled carrots. For juicing purposes, whole carrots are recommended since beta-carotene is found more abundantly near the surface, although the difference is not significant. Kumpulainen and Koivistoinen[10] found that approximately 10.5 to 54.4% of fluoride in bananas was concentrated in the peels.

Extensive research by Walker[11] has shown that the minimum amount of vegetable juice ingested per day by a person undergoing juice therapy is one pint. However, for quicker results, between two to eight pints of vegetable juice per day are recommended. These juices may be taken from one type of vegetable or from mixtures depending on the minerals that the body requires. In one of his publications,[11] Walker proposed formulations showing how the various vegetable juices could be mixed depending on the type of disease. Using the data in the

Table, it is possible to calculate the average amount of fluoride that would be present in some of the formulations. For example, since 1.00 L = 33.8 fl oz, the recommended 16 oz of celery juice contains 2.56 mg F. Similarly, the juice formulation: carrot (7 oz) + parsley (2 oz) + celery (4 oz) + spinach (4 oz), contains 1.80 mg F.

Table. Mean fluoride content of fresh raw vegetable juices

Vegetable	Fluoride mg/L
Celery (*Apium graveolens)*	5.4±0.4
Amaranthus (*amaranthus hybridus)*	5.2±0.9
Spinach *(Spinacea oleracea)*	4.8±0.2
Cabbage *(Brassica oleracea)*	4.6±0.1
Kunde *(Vigna unguiculata*)	4.6±0.6
Parsley (*Petroselium sativum)*	3.4±0.8
Funda mint *(Meathepiperita*)	3.3±0.5
Courghet (*Cucurbita mudullosa)*	2.3±0.4
Radish *(Raphanus sativus)*	2.3±0.8
Saget (*Gyadropsis gynandra)*	2.3±0.2
Lettuce *(Lactuva sativa)*	2.2±0.3
Methi (*Methepiperita*)	2.2±0.1
Paprica (*Capsicum annum)*	2.2±0.2
Beet root (*Beta vulgaris)*	2.0±0.1
Carrot (*Daucus carota*)	1.9±0.4
Tomato (*Lycopersicon lycopersicum)*	1.8±0.1
Cucumber (*Cucumis sativus*)	1.7±0.3
Kale *(Brassica inegrifolia*)	1.4±0.2
Capsicum *(Capsicum annum)*	1.2±0.3

It is evident that, depending on the volume and type of juice taken, vegetable juices can contribute significantly to the daily fluoride intake. Therefore, as the search for natural healing using the juices is contemplated, apart from the vital nutrients needed, the total amount of fluoride consumed from raw vegetable juices should be considered. When the fluoride content in juices is low, it will be relatively safe, but high amounts of fluoride may be detrimental.

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