



Oxalate content of commercially packed salad greens

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Abstract

Salad mixes also known as mesclun contain young leaves of wide range of well known salad plants and also other plant leaves that are otherwise eaten cooked. These salad mixes include young leaves of green beet, spinach and red chard which are known to contain high oxalate contents and are eaten raw in salad mixes. In the samples analyzed small leaves of green beet, spinach and red chard contained the highest levels of total oxalate (mean 694.2 ± 28.6 mg/100 g fresh weight (FW) and soluble oxalate (mean 562.6 ± 52.1 mg/100 g FW). However, the overall levels in the total salad mix were modest because there was an admixture of other young leaves such as endive, bok choy tatsoi and rocket which contained very low levels of total oxalate (mean 24.1 ± 3.7 mg/100 g FW) and soluble oxalate (mean 22.5 ± 2.9 mg/100 g FW) as well as lettuce and mizuna leaves did not contain any oxalate at all. A standard serving of 25 g of a typical salad mix would contain 42.7 mg total oxalate and 34.5 mg soluble oxalate which is a modest amount compared to many other oxalate containing foods.

Key words: Total oxalate, soluble oxalate, insoluble oxalate, salad mix, mesclun mix.

Introduction

Traditionally a green salad is a freshly prepared mixture of lettuce leaves and other leafy vegetables. Convenience shopping and the desire to produce new products have led to the development of salad mixes such as Spring Mix, Salad Mixes and Mesclun Salad. These washed and packaged salad mixes are now a feature of convenience shopping in a wide range of countries. The word mesclun comes from the Provençal region of Southern France and literally means a mixture. Spring Mix and Mesclun Salad appear to be very similar products. The mix in each product varies depending on the time of year and availability of a wide range of leafy vegetables. A feature of the mix is the use of young small leaves of a range of different coloured lettuces, spinach, Swiss chard (also known as silver beet in some countries), radicchio, endive, mizuna and beet leaves. An important feature is that the product is presented washed, packaged and ready to eat. It is also interesting to note that it includes a range of colourful and tasty young leaves that would not normally be eaten raw. It is often claimed that these mixes are very nutritious because the leaves are young and small but no consideration is given to the fact that some of the plants used in the mixture are known to contain oxalates in the leaves (for instance silver beet, beet and spinach leaves) ¹. This may not be a major problem as the salad mix contains a wide mixture of other leaves, such as lettuce, which are oxalate free. However, it may be a little difficult to quantify the oxalate content of the mixture as the composition of the mixture is known to change over the season. This is seen as a positive feature as it keeps the product interesting. The oxalate content of many of the plant leaves used in salad mixes has been determined ^{1, 2}, but mature leaves were analyzed in these studies. It is important to measure the oxalate composition of an example of this product to determine whether the regular consumption of this type of product might be a problem for people trying to reduce their oxalate intake because they have a tendency to form kidney stones.

Materials and Methods

Sample materials: The raw materials for this study were purchased from the local greengrocers or supermarkets in Christchurch, New Zealand in November 2008. Spring Mix and Mesclun Salad are sold in 120 g plastic packs under the Fresh Express brand (Pam's Products Ltd, Roma Road, Mt Roskill, Auckland) and Baby Salad Greens, Mesclun Salad and Fancy Lettuce Blend also in 120 g packs (Krispkut Brand, Progressive Enterprise, Mangere, Auckland). The Mesclun Salad is described as "a famous mix of varied and flavourful mesclun salad leaves, fresh from the field". The ingredients list of these products state that depending on the season the mixes may include minzuna, tatsoi, red chard, rocket, frillice, red cos, green oak, red oak, frisee and curly endive, Lollo Rosso, Lollo Biondi, green cos, spinach leaves and mibuna. After purchase, the salad mixes were sorted into their components and these were identified with reference to Hortus Third ³. The moisture contents were determined on each fraction, in duplicate, by drying in an oven at 105°C for 24 h ⁴. Oxalate contents were determined in triplicate on the finely chopped fresh leaves.

Extraction of total and soluble oxalate: Soluble and total oxalate contents of 2 g of finely chopped fresh leaves were extracted and measured by HPLC, as described in detail by Savage *et al.* ². Insoluble oxalate content (mainly calcium oxalate) was calculated by difference ⁵. Each sample was analyzed in triplicate and all data are presented as a mean mg oxalate/100 g fresh weight (FW) \pm SE.

Preparation of standards: Standards of oxalic acid (Sigma-Aldrich Co., St Louis, USA) were made up in the following concentrations: 1.0, 5.0, 10.0, 20.0, 40.0, 50.0 and 100.0 mg/100 ml and made up in either 2 M HCl (Aristar, BDH Chemicals, Ltd., Poole, Dorset, UK) or Nanopure II water (Barnstead International, Dubuque, Iowa, USA) and then filtered through a 0.45 μ m cellulose nitrate filter (Sartorius AG, Gottingen, Germany).

Table 1. Salad mix, proportion of the leaves of each cultivar in the mixes and the total, soluble and insoluble oxalate content (mg/100 g FW) \pm SE of the leaves.

Common name	Scientific name	% of total (mean \pm SE)	Moisture content (%)	Total oxalate	Soluble oxalate	Insoluble oxalate
Endive	<i>Cichorium endivia</i> L.	26.6 \pm 0.7	92.3	22.4 \pm 4.2	23.5 \pm 0.6	-
Lettuce	<i>Lactuca sativa</i> L.	17.4 \pm 2.4	95.0	- ¹	-	-
Green beet	<i>Brassica rapa</i> L.	12.6 \pm 2.8	93.8	638.9 \pm 22.5	516.3 \pm 28.9	122.6 \pm 24.6
Rocket	<i>Brassica eruca</i> L.	12.0 \pm 0.2	90.6	18.7 \pm 4.1	17.1 \pm 2.0	1.6 \pm 3.4
Mizuna	<i>Brassica japonica</i> L.	10.6 \pm 0.1	91.7	-	-	-
Bok choy tatsoi	<i>Brassica narinosa</i> L.	10.0 \pm 0.7	93.0	31.2 \pm 0.4	26.9 \pm 2.3	4.3 \pm 1.3
Spinach	<i>Spinacia oleracea</i> L.	7.0 \pm 1.6	94.1	708.9 \pm 48.7	666.5 \pm 22.7	42.4 \pm 28.9
Red chard (Silver beet)	<i>Beta vulgaris</i> var. <i>cicla</i> L.	3.8 \pm 0.7	94.5	734.7 \pm 37.2	504.9 \pm 21.4	229.8 \pm 24.5

¹ No oxalate detected.

Recovery study: The recoveries of pure oxalic acid (Sigma-Aldrich Co., St Louis, USA) were studied by adding 50 mg oxalate to each of the water and acid extractions. The samples were extracted and measured using the method described by Savage *et al.* ² and the results were compared with samples with no oxalic acid added. The analysis was carried out in quadruplicate. The mean recoveries for the water and acid extractions were 94.8 \pm 0.4 and 93.6 \pm 0.7%, respectively.

Results and Discussion

The composition of the named salad mixes change over time depending on availability of different salad materials. A feature of all the salad mixes was that they contained small leaves from a wide range of salad plants. The mean composition of the mixes analyzed are shown in Table 1. Endive was the principal component (27%) with other salad leaves making up between 4 and 17% of the total. The mean moisture content of the salad leaves was 93.1 \pm 0.53% confirming that all components were fresh. Mean total, soluble and insoluble oxalate contents of the leaves found in the mesclun salad mix (mg oxalate/100 g FW) are shown in Table 1. Small leaves of green beet, spinach and red chard contained the highest levels of total (mean 694.2 \pm 28.6 mg/100 g FW) and soluble oxalates (mean 562.6 \pm 52.1 mg/100 g FW). The values for total oxalate for young green beet leaves and spinach are comparable to previously reported values ². The total and soluble oxalate values for young red chard leaves in this study are much higher than values of total and soluble oxalate (525.5 and 252.3 mg oxalate/100 g FW, respectively) previously reported for raw mature leaves². Endive, bok choy tatsoi and rocket leaves contained insignificant amounts of total (mean 24.1 \pm 3.7 mg/100 g FW) and soluble oxalate (mean 22.5 \pm 2.9 mg/100 g FW). No oxalate could be detected in the young lettuce and mizuna leaves. In contrast, the review prepared by Noonan and Savage ² gave low values for lettuce ranging from 5 to 20 mg total oxalate/100 g FW.

If a typical composition of the Mesclun and Spring Mix salads is used (Table 1) and it is assumed that a 25 g standard serving is consumed, 42.7 mg total oxalate and 34.5 mg soluble oxalate would be consumed at each serving. Soluble oxalate consists of 80.8% of the total oxalate content. This intake of soluble oxalate would be equivalent to the consumption of 100 g rice bran ⁶ or 200 g cooked carrot ¹. None of these foods is regarded as containing high levels of soluble oxalate but it cannot be claimed that carrots and rice bran contain no oxalates. However, salad mixes are consumed raw and are neither consumed with high calcium containing foods, which would reduce the amount of soluble oxalates absorbed ^{7,8}, nor soaked in water or cooked, which would also reduce the soluble oxalate content of the leaves ^{1,9}.

Conclusions

Mesclun and Spring Mix salads contain a similar mix of young leaves of food plants which are known to contain oxalates. Overall, the levels of oxalate are modest in the total mix because there is a mixture of other young leaves which do not contain any oxalate at all. This study suggests that Spring Mixes and Mesclun salad should be included in the low oxalate food group as defined by Noonan and Savage ². The standard serving size of these products is 25 g and many people consuming a healthy diet might eat these products once a day. The data suggest that they would supply a low intake of total and soluble oxalate and this would be a relatively insignificant intake compared to other oxalate containing foods that may be eaten in the diet.

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References

- ¹Savage, G. P., Vanhanen, L., Mason, M. S. and Ross, A. B. 2000. Effect of cooking on the soluble and insoluble oxalate content of some New Zealand foods. *J. Food Comp. Anal.* **13**:201-206.
- ²Noonan, S. C. and Savage, G. P. 1999. Oxalate of content of foods and its effect on humans. *Asia Pacific J. Clin. Nutr.* **8**:64-74.
- ³Hortus Third 1976. *Hortus Third: A Concise Dictionary of Plants Cultivated in the United States and Canada by the Staff of the L. H. Bailey Hortorium, Cornell University, John Wiley and Sons, New York, USA.*
- ⁴AOAC 2002. *Official Methods of Analysis of AOAC International.* 17th edn. AOAC International, Gathersberg, MD, USA.
- ⁵Holloway, W., Argall, M., Jealous, W., Lee, J. and Bradbury, J. 1989. Organic acids and calcium oxalate in tropical root crops. *J. Agri. Food. Chem.* **37**:337-340.
- ⁶Boontaganon, P., Jehanno, E. and Savage, G.P. 2009. Oxalate content of bran and bran products. *J. Food, Agric. & Envir.* **7**(3&4):204-206.
- ⁷Savage, G. P., Martensson, L. and Sedcole, J. R. 2009. Composition of oxalates in baked taro (*Colocasia esculenta* var. Schott). *J. Food Comp. Anal.* **22**:83-86.
- ⁸Brogren, M. and Savage, G. P. 2003. Bioavailability of soluble oxalate from spinach eaten with and without milk products. *Asia Pacific J. Clin. Nutr.* **12**:219-224.
- ⁹Savage, G. P. and Dubois, M. 2006. The effect of soaking and cooking on the oxalate content of taro leaves. *Intern. J. Food Sci. Nutr.* **5**:376-381.