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Retention of oxalates in frozen products of three *brassica* species depending on the methods of freezing and preparation for consumption

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ABSTRACT

The investigation showed that fresh brassicas: Brussels sprouts, broccoli, green cauliflower and white cauliflower respectively contained 50 mg, 67 mg, 72 mg and 95 mg oxalates in 100 g fresh matter. Soluble oxalates constituted 70%, 40%, 40% and 54% of total oxalates respectively. The cooked product obtained from traditionally prepared frozen vegetables (blanching-freezing-refrigerated storage-cooking) contained 45–66% of soluble oxalates. The product obtained from frozen vegetables produced using the modified method (cooking-freezing-refrigerated storage-defrosting and heating in a microwave oven) contained more oxalates than that obtained using the traditional method. The oxalate: calcium ratio in fresh vegetables varied considerably: 0.63 (Brussels sprouts); 1.10 (broccoli); 1.27 (green cauliflower); and 2.42 (white cauliflower). In products prepared for consumption the ratios were lower. The proportion of calcium bound as calcium oxalate differed between the vegetables investigated, but the treatments applied did not influence this parameter. The apparent retention of oxalate overestimated the true retention.

Retention des oxalates dans les produits surgelés à base de plusieurs espéces de brassica selon les méthodes de congélation et de préparation avant la consommation

Mots clés : Oxalates ; Brassica ; Frais ; Cuit ; Congelé ; Préparation ; Consommation

1. Introduction

Oxalate is a component considered to be an antinutrient as well as a toxin (Libert and Franceschi, 1987). It can render some mineral nutrients unavailable by binding them to form insoluble salts which are not absorbed by the intestine. Soluble oxalates primarily bind calcium, but also iron and magnesium (Noonan and Savage, 1999). The main sources of dietary oxalate are

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plants and plant products. Consumption of large amounts of oxalates can cause oxalosis and an elevated urinary oxalate excretion. According to Holmes and Kennedy (2000) the contribution of dietary oxalate to urinary oxalate is between 10 and 72%, and Williams and Wandzilak (1989) postulate that up to 75% of kidney stones are composed primarily of calcium oxalate. In a study involving radiocalcium, Weaver et al. (1997) showed that calcium absorption by premenopausal women was generally reflected oxalic acid content.

Brassicas are not generally characterized as high oxalate vegetables, which may explain why no data can be found concerning their oxalate content. As a result of recommendations made by nutritionists, however, the proportion of plant products in the diet is increasing owing to health concerns associated with the excessive consumption of animal products and because of the widely promoted benefits of increased consumption of fruits and vegetables rich in phytochemicals (Rowland, 1999).

Plants of the cabbage family, including Brussels sprouts, broccoli and cauliflower, form part of the daily diet in many countries. They supply many essential components, such as vitamins and mineral constituents as well as being an important source of amino acids (Gębczyński and Lisiewska, 2006; Gębczyński and Kmiecik, 2007; Kmiecik et al., 2007).

These vegetables require thermal processing before consumption; they can also be preserved, thus allowing year round consumption. Cooking or preliminary treatments before processing are carried out with the use of water, causing leaching of soluble oxalates to the medium but not affecting the level of insoluble oxalates. As previous studies showed, all the species used in the experiment provide very good raw material for the preparation of frozen products of the convenience food type (Gębczyński and Lisiewska, 2006; Gębczyński and Kmiecik, 2007; Lisiewska et al., 2009). These products have comparable levels of antioxidative compounds and similar sensory qualities to traditionally frozen vegetables.

The aim of the present investigation was to compare oxalate retention in two types of frozen products obtained from three vegetables species of the brassica group using either the traditional or the modified method. In the latter case, the product met the requirements of a convenience food, requiring only defrosting and heating in a microwave oven before consumption, thereby considerably shortening preparation time.

2. Materials and methods

2.1. Material

The studied material included of four species of *Brassicas*: Brussels sprouts – *Brassica oleracea* var. *gemmifera* L. (Lunet F_1 cv.); broccoli – *B. oleracea* var. *italica* Plenck (Lord F_1 cv.); green cauliflower – *B. oleracea* var. *botrytis* L. (Trevi F_1 cv.) and white cauliflower – *B. oleracea* var. *botrytis* L. (Planita F_1 cv.).

The content of components was determined in fresh vegetables (A); after blanching (B); after boiling in 2% (w/w) brine of table salt to consumption consistency (C); and in frozen products after 0 and 12 months of storage at −20 °C and then prepared for consumption. Frozen products from B were boiled in brine, this yielding D (after 0 months of storage) and F (after 12 months of storage); and frozen products from C were defrosted and heated in a microwave oven, yielding E (after 0 months of storage) and G (after 12 months of storage).

2.2. Cultivation measures

The vegetables were grown in an experimental field of the Department carrying out the presented study. The field was in good horticultural condition; it lies on the western outskirts of Krakow in southern Poland. The cultivation was conducted on brown soil with the mechanical composition of silt loam in the third year after manure fertilization. The pH of the soil in H_2O was 7.08, with humus content of 1.66%, nitrogen 24 mg NO_3/dm^3, phosphorus 53 mg/dm^3, potassium 101 mg/dm^3 and calcium 1020 mg/dm^3.

The fertility of the soil and the nutritional requirements of the crops have been taken into account, doses of mineral fertilizer were applied as given in Table 1. Cultivation measures included sprinkler watering, mechanical weed control and, where necessary, protective treatments against diseases and pests. The harvest time is also given in Table 1.

2.3. Preparation of the raw material

Directly after harvest, mean samples representing the whole batch of the material were taken for analysis and preparation of the frozen products. All the vegetables were cleaned in running, tap water. The study covered the

Table 1 – Doses and kinds of mineral fertilizers used in vegetables growing and dates of harvest.

Vegetable species	Mineral fertilizer (kg/ha)			Date of harvest
	N	P_2O_5	K_2O	
	ammonium nitrate, 34% N	superphosphate, 46% P_2O_5	potassium chloride, 60% K_2O	
Brassicas				
Broccoli	150	100	150	01.10
Brussels sprouts	120	80	150	13.10
Green cauliflower	150	100	150	28.09
White cauliflower	150	100	150	03.10