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Changes in the content of low molecular weight carbohydrates in frozen immature bean seeds depending on type and method of processing prior to freezing

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ABSTRACT

Immature seeds of five bean cultivars (flageolet-type and those intended for dry-seed production) were evaluated for changes in the content of water soluble carbohydrates due to freezing, storage and preparation for consumption. Analyses were conducted in two differently treated products: 1. blanched, frozen, stored for 0–12 months, then boiled, 2. boiled, frozen, stored for 0–12 months, then microwave heated. Fresh bean seeds contained 2449.3–3182.6 mg total soluble sugars per 100 g of edible portion, of which raffinose family oligosaccharides (RFOs) comprised 43.8–49.3%. The dominant raffinose family oligosaccharide was stachyose. In seeds having undergone either of the above processing methods and then prepared for consumption, the content of total soluble sugars decreased by 51–64% and RFOs by 40–54%, depending on the cultivar. In general, there were no differences in the content of soluble sugars in products prepared for consumption in different way both immediately after freezing and after 12-month storage.

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Changements dans la teneur en glucides à faible poids moléculaire dans des pousses de haricots immatures congelées, selon leur type et selon la méthode de traitement avant la congélation

Mots clés : Haricot ; Glucides ; Oligosaccharides ; Congélation ; Cuisson

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1. Introduction

Due to their nutritive value and functional properties, legumes are recommended as a rich and inexpensive source of protein, carbohydrates, vitamins, and mineral compounds (Leterme, 2002; Lisiewska et al., 2008). They are also suitable for use in industrial processing and catering as well as in the home to prepare such dishes as soups, croquettes, salads, paste, and sauces (Leterme, 2002; Schneider, 2002).

Legume seeds are commonly harvested and processed at the stage of “physiological” maturity, or, like French bean, when the pods are green; however, some species, such as broad bean, green pea, grass pea and vegetable soybean, can be harvested at wax maturity (Cazetta et al., 1991; Korus et al., 2003; Lisiewska et al., 2008). Common bean can also be harvested and processed at this stage (called “flageolet”), when the seeds are still green or light-green and require a shorter cooking time than dry seeds but are fully developed in well-filled pods of appropriate hardness (Saldivar et al., 2010). However, due to their high water content, such seeds should be consumed directly after harvest or preserved by freezing or sterilization (Castillo et al., 2010). Freezing is a superior method for retaining the sensory characteristics of the raw material as well as nutritive compounds such as vitamins, proteins, mineral compounds and carbohydrates (Slupski, 2011a, 2011b). Vegetables require blanching prior to freezing; furthermore, after freezing they are usually cooked before being consumed, which means that they are subjected to thermal processing in water twice. A technological modification (cooking bean seeds prior to freezing) allows products to be obtained which require thermal processing in water only once. Such products meet the requirements of convenience food: after frozen storage, they merely require defrosting and heating to consumption temperature in a microwave oven (Gębczyński and Kmiecik, 2007; Lisiewska et al., 2008; Slupski, 2010). The production of convenience, “ready-to-eat” frozen vegetables, including bean seeds, can contribute to increased vegetable consumption (as recommended by dieticians) and create new markets for producers (Schneider, 2002).

However, modifications in processing can bring about other changes in the chemical composition of a product and may also have positive or negative effects on its sensory attributes. The extent of such changes depends chiefly on the species, cultivar, edible part and stage of maturity of the raw material. Therefore, each type of raw material should be assessed (Gębczyński and Lisiewska, 2006; Gębczyński and Kmiecik, 2007; Lisiewska et al., 2008).

Water soluble sugars including raffinose family oligosaccharides (RFOs) (e.g. raffinose, stachyose and verbascose) are essential components of legumes. Due to their α -galactosidic linkages and the absence of enzymes capable of breaking them down into monosaccharides, they are non-digestible for humans and monogastric animals, causing digestive problems such as flatulence (Mulimani and Devendra, 2000). On the other hand, their presence in a diet stimulates the growth of bifidobacteria in the colon, making them biologically active components of a natural food with various health-promoting properties. Despite the number of studies on oligosaccharides, there is little current data on the content of soluble

carbohydrates in the immature seeds of common bean and the extent to which it is reduced by culinary and technological treatment.

The aim of this work was to determine soluble sugar content in the seeds of three flageolet-type bean cultivars and two cultivars intended for dry-seed production but also, in this experiment, harvested before reaching full physiological maturity. The evaluation was carried out for raw seeds, seeds after freezing and frozen seeds after 12 months storage. Two types of frozen product were included: one using the traditional method (blanching before freezing), and the other a modified process (cooking before freezing), which results in a convenience product (do-it-for-me, ready-to-eat) requiring only defrosting and heating in a microwave oven. Frozen products were analysed after preparation for consumption.

2. Materials and methods

2.1. Seed samples

Material for this study was five bean seed (*Phaseolus vulgaris* L.) cultivars, harvested at incomplete ripeness, in the following forms: raw seeds and prepared for consumption frozen seeds obtained by two freezing methods (blanched before freezing (treatment I) and boiled before freezing (treatment II)). The samples were evaluated after 0 and 12 months of storage.

The research included a Polish-bred flageolet cultivar, Mona (‘Polan’ KHiNO); two Dutch-bred flageolet bean cultivars, Alamo and Flaforte (Pop Vriends Seeds BV); and two cultivars traditionally grown for dry seeds, Igołomska (‘Polan’ KHiNO) and Laponia (‘PlantiCo’ HiNO Zielonki). The suitable maturity stage of seeds for freezing was determined in preliminary study. It was characterized by dry matter content of about 40 g per 100 g of edible portion.

The beans were grown in an experimental field belonging to the research department that carried out the study. The field is located in southern Poland, on the western outskirts of Krakow. The beans were harvested when the dry matter seed content reached the predetermined level, which occurred after about 90 (88–94) culture days. After harvest, seeds were shelled and sorted, and soluble sugars content was evaluated in the raw material. For technological processing the other parts of seeds were used.

2.2. Processing beans

According freezing method applied, the raw material was subjected to blanching (treatment I) or boiling (treatment II) prior to freezing. Blanching was carried out in tap water, in a stainless steel vessel, with a raw material:water ratio of 1:5 by weight, at 96–98 °C, for 3 min 15 s for Igołomska and Laponia cultivars, and 3 min for the others. These conditions decreased catalase and peroxidase activities below the level of 5% of the initial activity (Bahçeci et al., 2005). Catalase enzyme activity was measured by titrimetric method as described by Ciszewska et al. (1997). Peroxidase activity was assayed by the spectrophotometrical procedure given by Bergmeyer (1974).

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