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Exploiting blackcurrant juice press residue in extruded snacks

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A B S T R A C T

Extrusion process was developed to exploit blackcurrant juice press residues from industrial side-streams. Press residues obtained from conventional enzymatic pressing, with high content of fiber and seed oil, and novel non-enzymatic juice processing, with high content of sugars, fruit acids and anthocyanins, were extruded with barley flour, oat flour or oat bran. The recipes consisted of blackcurrant press residues (30%), cereal materials (40%) and potato starch (30%) and small amount of sugar and salt. When compared to enzymatic press residue and oat bran, the novel non-enzymatic press residue extruded with barley or oat flour had higher expansion, lower hardness and density, higher redness (a*), lower pH, and higher contents of fructose, glucose and fruit acids, all contributing positively to liking of texture, appearance, and flavor as well as berry-like experience. These characteristics were obtained with more gentle processing parameters, consisting of a lower total mass flow, screw speed and barrel temperature. Female consumers gave lower ratings in flavor, appearance and overall pleasantness for blackcurrant snacks than males. The study presented a sustainable way of utilizing industrial press residues from different processes of berry juice pressing for production of healthy snacks and breakfast cereals.

1. Introduction

The food industry generates a vast quantity of by-products by processing fruits, berries and vegetables. Side streams, such as skins, seeds, stems and cores of the fruits and berries, are rich in various phytochemicals. They include for example fiber and edible oils with valuable polyunsaturated fatty acids important for human health, and thus ought to be utilized more thoroughly (O'Shea, Arendt, & Gallagher, 2012). Currant seeds contain especially significant amounts of γ-linolenic, α-linolenic and stearidonic acids (Johansson, Laakso, & Kallio, 1997), which have positive effects on skin health and on symptoms of atopic dermatitis (Linnamaa et al., 2010). These by-products are currently mainly used as animal feed, or are taken as landfill or for incineration (O'Shea et al., 2012). Potentially more efficient ways to exploit the side-streams would be to use them as colorants and antibrowning additives, as antimicrobial agents to improve the shelf-life, or as flavoring ingredients (Ayala-Zavala et al., 2011; Viuda-Martos, Ruiz-Navajas, Fernándes-López, & Pérez-Àlvarez, 2010). The extracts of phenolic or seed oil fractions are potentially applicable in the food and pharmaceutical industries (Sandell et al., 2009; Wijngaard, Hossain, Rai, & Brunton, 2012).

Extrusion cooking has been widely investigated for exploiting the by-products of food manufacturing. The extrusion process is preferred over conventional cooking due to the distinct textural properties of the end-products, such as a high expansion ratio, low density, crispiness, crunchiness and hardness (Brennan, Brennan, Derbyshire, & Tiwari, 2011; Meng, Threinen, Hansen, & Driedger, 2010), all important parameters for the acceptability of the products for consumers (Patil, Berrios, Tang, & Swanson, 2007). Increasing consumer demand has arisen for nutritious ready-to-eat snack products with enhanced bioactive compounds (Brennan,

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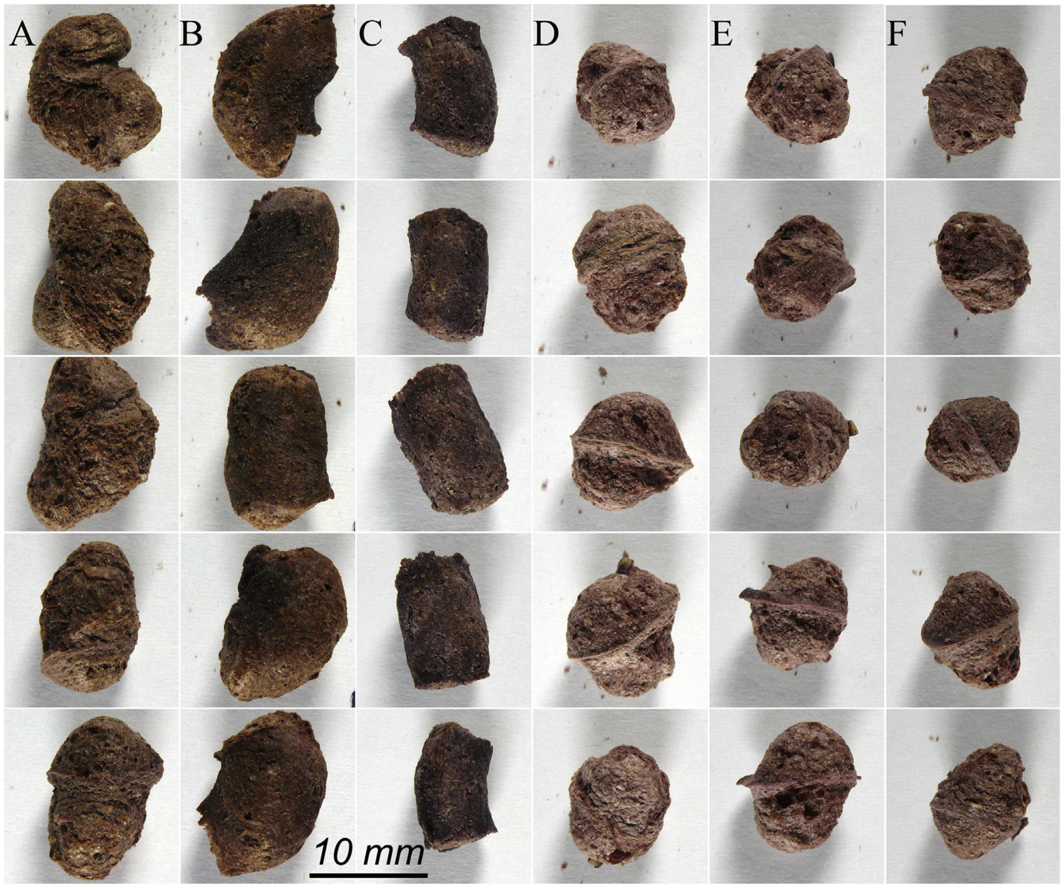

Fig. 1. Five parallel pictures of the samples: enzymatic residue (ER) extrudates A. ER-barley, B. ER-oat and C. ER-oat bran; non-enzymatic residue (NR) extrudates D. NR-barley, E. NR-oat and F. NR-oat bran.

Derbyshire, Tiwari, & Brennan, 2013). Traditional snacks consist mainly of starch, with low dietary fiber and protein contents. The nutritional value of these snacks could be improved by using whole-grain flour with bioactive fruit and berry by-products (Altan, McCarthy, & Maskan, 2008a; Faraj, Vasanthan, & Hoover, 2004; Ma et al., 2012; Potter, Stojceska, & Plunkett, 2013). High contents of dietary fiber, lipids and protein introduce challenges in the extrusion process (Yağcı et al., 2014).

The aim of this study was to investigate a sustainable way to utilize blackcurrant press residues from different industrial juice processes by exploiting extrusion technologies, based on our previous study by Tahvonen et al. (1998). Press residues of the present study were obtained from different industrial pressing processes described earlier (Laaksonen, Mäkilä, Tahvonen, Kallio, & Yang, 2013). The purpose was to gain a high nutritional value from high content of press residue (30%) extruded with barley flour, oat flour or oat bran, but still retain the textural advantages unique to extruded products. To study and explain the hedonic responses of extrudates, a variety of physico-chemical measurements were conducted.

2. Materials and methods

2.1. Extrusion ingredients

Blackcurrants of cultivar ‘Mortti’ grown in Finland in 2011 were processed in 500 – 1300 kg batches for juice production by Saarioinen Oy (Huittinen, Finland) after the berries were separated from leaves and stems (Toripiha Oy, Vesanto, Finland). The enzyme-aided standard protocol with pectinase enzyme and a hydraulic press yielded the press residue ER (Enzymatic Residue) for further extrusion tests. The process contained the steps of thawing, crushing, heating, enzyme addition, incubation, and pressing. In addition, juice and press residue NR (Non-enzymatic Residue) were produced by otherwise following the same protocol as above but omitting the enzyme treatment. Non-enzymatic juice process was performed in duplicate.

The batches of both ER and NR were air-dried at 40 °C (MTT Agrifood Research Finland, Piikkiö, Finland). The dried ER was properly milled to break down the seeds and sieved using a 0.5 mm screen. Potato flour (7%) was used in the milling process to bind the released seed oil and to facilitate the milling. The NR residue was crushed to coarse particles, without aiming to break down the seeds. The other ingredients barley, oat and potato flour, oat bran, and potato flakes were obtained from Leipomo Rosten Oy (Turku, Finland). Sugar and salt were conventional commercial products. Four commercial, extruded breakfast cereals were selected as reference products based on their similarity to our samples in size, shape and texture. Reference 1 was a cocoa cereal (whole grain wheat flour), reference 2 was a spelt cereal, reference 3 was made of whole grain rye and oat flour with sea buckthorn juice, and reference 4 was made of whole grain wheat, rye, oat and barley flour.

2.2. Extrusion process

Six different recipes were used to produce six extrudates (Fig. 1 and Table 1.). The samples were extruded with a Clextral BC 21