LWT - Food Science and Technology 51 (2013) 331–336

Contents lists available at SciVerse ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

# High hydrostatic pressure influences antinutritional factors and *in vitro* protein digestibility of split peas and whole white beans

Gertrud Linsberger-Martin*, Karin Weiglhofer, Thao Phan Thi Phuong, Emmerich Berghofer

*Department of Food Science and Technology, University of Natural Resources and Life Sciences Vienna, Muthgasse 18, 1190 Vienna, Austria*

ARTICLE INFO

*Article history:*
Received 6 November 2011
Received in revised form
4 November 2012
Accepted 6 November 2012

*Keywords:*
Peas
Beans
Oligosaccharides
Antinutritional factors
High hydrostatic pressure

ABSTRACT

Legumes are of high nutritional value but consumption is low in Western countries due to long processing and antinutritional factors. The development of convenience products can help to overcome these constraints. The present study investigated the effect of high hydrostatic pressure on oligosaccharides, phytic acid and total phenolic acid content, trypsin inhibitor activity and protein digestibility in peas and beans.

Oligosaccharides were significantly reduced through pressurisation by up to 68% in peas and 48% in beans but reduction was lower than in cooked samples (max. 82% in peas and 80% in beans). Phytic acid was reduced by high pressure by up to 36% in peas and 11% in beans. Total phenolic acid content was reduced only in some pressurised peas and beans as compared to untreated peas and beans. Reduction of phytic acid (max. 48%) and total phenolic acids (max. 78%) through cooking was greater than through pressurisation. Trypsin inhibitor activity decreased by up to 100% in peas and 84% in beans during pressurisation. Protein digestibility increased by up to 4.3% in peas when treated at 600 MPa and 60 °C regardless of time and by 8.7% in beans treated at 600 MPa at 60 °C for 60 min.

© 2012 Elsevier Ltd. All rights reserved.

## 1. Introduction

Legumes are a valuable source of carbohydrates, dietary fibre and proteins. The latter is important especially in developing countries. Furthermore, legumes are a good source of vitamins (especially B-group), and minerals such as potassium, zinc, calcium and magnesium (Saha, Singh, Mahajan, & Gupta, 2009). Legumes, which are rich in lysine but poor in methionine (Estrada-Girón, Swanson, & Barbosa-Cánovas, 2005) and cysteine (Han, Swanson, & Baik, 2007), can be mixed with cereals to improve the amino acid pattern of both raw materials (Estrada-Girón et al., 2005). Nevertheless, consumption of legumes is quite low in Western countries. In Europe 2.5 kg pulses (dry legume seeds) per capita per year were consumed in 2007 (last available data), whereof 0.7 kg were beans and 1.2 kg peas (FAO, 2011). Possible reasons are the long preparation and cooking time (Bede, 2007) and antinutritional factors such as protease inhibitors, tannins and phytic acid which decline utilisation, absorption and digestion of nutrients (Saha et al., 2009). Furthermore, flatulence causing oligosaccharides such as raffinose, stachyose and verbascose often restrain consumers from legume consumption. To overcome these restraints the production of convenience products for quick and easy final preparation by consumers is necessary.

Protein digestibility in legumes is lower than in casein or in other animal proteins because of intrinsic structural factors of legume proteins as well as antinutritional factors (Park, Kim, & Baik, 2010). Protease inhibitors in legumes inhibit pancreatic serine proteases and decrease protein digestibility (Guillamón et al., 2008). Tannins react with proteins and form reversible or irreversible complexes (Lampart-Szczapa et al., 2003) which can decrease protein digestibility (Park et al., 2010). Therefore, tannins were formerly considered as antinutritional factors. Nevertheless, tannins which belong to polyphenols have antioxidant, antiseptic (Lampart-Szczapa et al., 2003) and anticarcinogenic properties (Rocha-Guzmán, González-Laredo, Ibarra-Pérez, Nava-Berúmen, & Gallegos-Infante, 2007). Phenolic compounds can be modified through processing which also result in modifications in the antioxidant activity (Dueñas, Hernández, & Estrella, 2009). If phosphorus is present as phytic acid (myo-inositol 1,2,3,4,5,6-hexakis dihydrogen phosphate, $IP_1$–$IP_6$) it cannot be digested properly by humans. Inositol having a high degree of phosphorylation ($IP_4$ to

*Abbreviations:* dwb, dry weight basis; GSO, galactosyl-sucrose oligosaccharides; IVPD, *in vitro* protein digestibility; MPa, Megapascal.

* Corresponding author. Muthgasse 18, 1190 Vienna, Austria. Tel.: +43 1 47654 6250; fax: +43 1 47654 6251.
*E-mail addresses:* gertrud.linsberger@chello.at (G. Linsberger-Martin), emmerich.berghofer@boku.ac.at (E. Berghofer).

0023-6438/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.lwt.2012.11.008

$IP_6$) can generate non-soluble complexes with polyvalent cations like calcium, copper, iron or zinc which decreases bioavailability (Máñez, Alegría, Farré, & Frígola, 2002). Han, Swanson, and Baik (2007) summarized that processing methods such as soaking, cooking, germination or fermentation improve digestibility by the inactivation of protease inhibitors or lectins or by protein denaturation. Emerging technologies such as high hydrostatic pressure processing shall also be investigated for improvement of protein digestibility which would be achieved through opening of proteins which could improve the access of proteolytic enzymes (Han et al., 2007).

The demand for minimally processed, safe and stable food (Hendrickx, Ludikhuyze, Van den Broeck, & Weemaes, 1998) with maximum retention of nutritional components (Guerrero-Beltrán, Estrada-Girón, Swanson, & Barbosa-Cánovas, 2009) and a high convenience value is increasing. Therefore, high hydrostatic pressure processing could be an alternative for food processing (Guerrero-Beltrán et al., 2009). During the development of pressurised food products the reaction of food components such as antinutritional factors or enzymes to pressure needs to be analysed.

Many papers on the effects of various processing techniques on nutritive and antinutritional compounds of legumes have been published. Only a few publications on the effects of high pressure on legumes or products thereof are available. Some focused on the effects of high pressure on soymilk (Jung, Murphy, & Sala, 2008), on preparation or preservation of tofu under high pressure (Arroyo, Peñas, Pedrazuela, & Préstamo, 2005; Préstamo, Lesmes, Otero, & Arroyo, 2000) and many on the microbiological count or decontamination of germinated legume sprouts (Muñoz, De Ancos, Sánchez-Moreno, & Cano, 2006; Wuytack, Diels, Meersseman, & Michiels, 2003). The present paper focuses on the effects of the emerging high hydrostatic pressure technology on various substances in dried peas and beans. The main aim was to determine whether antinutritional factors in peas and beans are reduced and protein digestibility is improved by the application of high hydrostatic pressure, which is the basis for the development of a convenience product with peas and beans using high hydrostatic pressure processing.

## 2. Materials and methods

### 2.1. Raw materials

Dry split peas (*Pisum sativum*) and whole white beans (*Phaseolus vulgaris*) were from Canada and were purchased from Linus Handelsges.m.bH. (Herzogenburg, Austria) and stored at 4 °C until use. Before chemical analyses raw materials were ground with an IKA mill using a sieve with 0.5 mm holes (IKA MF 10, IKA Werke GmbH & Co KG, Staufen, Germany).

### 2.2. High hydrostatic pressure treatment

A $2^3$ factorial screening design of experiments with the experimental factors pressure (100 and 600 MPa), holding time (30 and 60 min) and temperature (20 and 60 °C) including three centre points was carried out for the high pressure treatment of peas and beans (Table 1). Peas and beans were treated in a high pressure pilot plant with an indirect compression system (0.5 L pressure cell, NovaSwiss, Cesson, France; pressure medium Friogel®, antifreeze based on monopropylene glycol, Dehon Services, Vincennes Cedex, France). Temperature was controlled by an external temperature control unit (Unistat 425, Peter Huber Kaeltemaschinenbau GmbH, Offenburg, Germany).

Peas (55 g) or beans (50 g) were filled into small cups (approx. 200 mL, PE-LD 160, Semadeni® AG, Ostermundigen, Swiss) which were then filled up with distilled water. The cups were vacuum packaged in plastic vacuum pouches (SR 120 × 225 PA/PE90, FZ Verpackungen, Vienna, Austria) before pressure treatments. Water uptake of peas and beans was determined after pressurisation.

**Table 1**
Experimental design for pressurisation.

| Peas | Beans | Experimental factors | | |
|---|---|---|---|---|
| | | Pressure [MPa] | Holding time [min] | Temperature [°C] |
| P09 | B09 | 100 | 30 | 20 |
| P07 | B07 | 100 | 30 | 60 |
| P11 | B11 | 100 | 60 | 20 |
| P05 | B05 | 100 | 60 | 60 |
| PCP[a] | BCP[a] | 350 | 45 | 40 |
| P04 | B04 | 600 | 30 | 20 |
| P06 | B06 | 600 | 30 | 60 |
| P08 | B08 | 600 | 60 | 20 |
| P10 | B10 | 600 | 60 | 60 |
| Untreated pea | Untreated bean | – | – | – |

[a] Mean of three centre points (PCP: mean of P01, P02 and P03; BCP: mean of B01, B02 and B03).

### 2.3. Cooking experiments

For comparison cooking experiments (Table 2) were carried out using an induction cooker (Laser 2000; Westfalia Werkzeugcompany, Hagen, Germany). 55 g peas were cooked with 670 g distilled water in a 1.6 L cooking pot and 50 g beans were cooked with 1500 g distilled water in a 2.6 L cooking pot at 100 °C. The ratio of peas or beans to water was chosen based on pretrials to keep all peas or beans in the cooking water. A metal sieve kept all peas or beans in the cooking water.

### 2.4. Chemical composition of the raw materials

Dry matter was determined according to ICC standard No 110/1 (ICC, 1976), ash content according to ICC standard No 104/1 (ICC, 1990) and crude protein content according to ICC standard No 105/2 (ICC, 1994) using the factor 6.25 × N for conversion. Fat

**Table 2**
Test set-up for cooking experiments.

| | Soaking time [h] | Cooking time [min] |
|---|---|---|
| **Peas** | | |
| CP1 | 0 | 20 |
| CP2 | 0 | 30 |
| CP3 | 0 | 35 |
| CP4 | 3 | 20 |
| CP5 | 3 | 30 |
| CP6 | 3 | 35 |
| CP7 | 24 | 20 |
| CP8 | 24 | 30 |
| CP9 | 24 | 35 |
| Untreated | – | – |
| **Beans** | | |
| CB1 | 0 | 70 |
| CB2 | 0 | 75 |
| CB3 | 0 | 80 |
| CB4 | 3 | 70 |
| CB5 | 3 | 75 |
| CB6 | 3 | 80 |
| CB7 | 24 | 70 |
| CB8 | 24 | 75 |
| CB9 | 24 | 80 |
| Untreated | – | – |

Download English Version:

https://daneshyari.com/en/article/6404804

Download Persian Version:

https://daneshyari.com/article/6404804

Daneshyari.com