Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Food Science 1 (2011) 505 – 512

Procedia Food Science

11th International Congress on Engineering and Food (ICEF11)

Supplementation of extruded foams with wheat bran: Effect on textural properties

Frédéric Robin[a*,b], Cédric Dubois[a], Heike P. Schuchmann[b], Stefan Palzer[c]

[a]*Nestlé Research Center, PO Box 44, 1000 Lausanne 26, Switzerland*
[b]*Institute of Process Engineering in Life Sciences, Karlsruhe Institute of Technology / KIT, 76161 Karlsruhe, Germany*
[c]*Nestlé Product Technology Centre for Confectionery, YO91 1XY York, United Kingdom*

Abstract

The objective of this study was to investigate the effect of wheat bran concentrations on the mechanical properties determining the texture of extruded carbohydrate matrices. For this wheat flour was extruded under different conditions with an increasing concentration of wheat bran. The mechanical properties were assessed using a three-point bending test and the cellular structure was determined by micro-computed X-ray tomography. Regardless of the bran concentration, the stress at rupture of the extruded foams was positively correlated with their relative density according to the Gibson-Ashby model. At same relative densities and bran concentration, finer structures with higher density of small cells led to a higher mechanical strength of the foams. Expanded foams with added bran at an intermediate level showed increased mechanical strength. This was attributed to the finer cellular structures obtained. The effect of increasing the bran to a higher concentration on the mechanical properties was depending on the cell wall thickness and bran particle dimensions.

Selection and/or peer-review under responsibility of 11th International Congress on Engineering and Food (ICEF 11) Executive Committee.

Keywords: extrusion; wheat bran; fibres; mechanical properties; glass transition

1. Introduction

The effect of dietary fibers on the mechanical properties of extruded foams was reported in a limited number of studies. The effect was found to be fiber type- and concentration-dependant. While soluble fibers, such as pectin, appeared to decrease the breaking force, insoluble fibers such as wheat fibers had an opposite effect [1, 2]. The higher force necessary to rupture extruded starchy-matrices containing wheat fibers was associated to their reduced bulk expansion [1, 2]. The mechanical properties of solid foams are

* Corresponding author. Tel.: +41 21 785 9573; fax: +41 21 785 8554.
E-mail address: frederic.robin@rdls.nestle.com.

Selection and/or peer-review under responsibility of 11th International Congress on Engineering and Food (ICEF 11) Executive Committee.
doi:10.1016/j.profoo.2011.09.077

mainly driven by their bulk dimensions, porosity and shape. Nevertheless, at similar bulk properties (i.e. shape, dimensions and porosity), the mechanical properties may also be modulated by the distribution of the continuous (cell walls) and dispersed (air) phases [3, 4]. Changing the microstructure of extruded foams may allow improving their texture while maintaining similar bulk properties such as dimensions and density. Little has been reported in the literature on the effect of wheat bran on the mechanical properties of extruded foams and the correlation to the cellular and cell wall material properties of such matrices. Understanding this link will enable to generate structures that are delivering an optimal texture for wheat bran-containing products. For this, in this study the relationship between the expansion properties, cellular structure and mechanical properties of extruded foams supplemented with wheat bran was assessed. This was performed by measuring the mechanical properties using a three-point bending test, determining the bulk dimensions, assessing the cellular structure by X-ray tomography and investigating the phases distribution in the cell walls by light microscopy.

Nomenclature

σ	Stress at rupture
ρ	Density
*	Extrudate
D	Relative density
D_s	Die diameter
F	Breaking force
L	Sample length
L_s	Die length
LB	Low bran concentration
MCS	Mean cell size
MCWT	Mean cell wall thickness
MC	Moisture content
HB	High bran concentration
r_e	Sample radius
RF	Refined flour
s	Material

2. Material and Methods

2.1 Materials

Wheat flour type 550 and wheat bran were obtained from Provimi Kliba S.A. (Cossonay, Switzerland). Wheat bran (51.4 % fibers) was added to refined wheat flour (coded RF) (2.8 % fibers) to achieve two fiber levels: 12.6 % (coded LB for low bran concentration) and 24.4 % (coded HB for high bran concentration) (quantified using the AOAC 985.29 method). Two qualities of wheat bran were used: a "fine" (Table 1) bran with an average volume weighted diameter of 224 μm ± 6 μm and a "coarse" (Table