Dietary fibre is a common and important ingredient of a new generation of healthy food products demanded more each day by customers. Dietary fibre increases the nutritional value of bread but usually at the same time alters rheological properties of dough and, finally, the quality and sensorial properties of bread. The present work investigates the effect of some purified dietary fibres from different origins (orange, pea, cocoa, coffee, wheat and microcrystalline cellulose) on the rheological properties of wheat flour dough and the final quality of breads. The study of the rheological behaviour of the dough was performed by means of a consistograph and an alveograph. Bread quality was determined by means of texture, colour and specific volume measurements after baking under controlled conditions. The influence of fibre on bread sensory evaluation was established. Dietary fibre additions, in general, had pronounced effects on dough properties yielding higher water absorption, mixing tolerance and tenacity, and smaller extensibility in comparison with those obtained without fibre addition (in the control bread). Regarding the effect on bread properties, the fibre always enhanced the shelf life, as textural studies revealed. Sensory evaluations revealed that dietary fibres, with the exception of those from coffee and cocoa, can be added to flour at the level of 2% without deterioration of the bread palatability in comparison with white flour bread. Additions of 5% could imply the use of some additives to correct the rheological properties of dough.

Keywords Dietary fibre · Rheology · Baking · Wheat flour dough · Bread quality.

Introduction

Nowadays, there is a growing demand for a new generation of healthier food products which at the same time have excellent sensory qualities [1]. The diet of developed countries is at present deficient in fibre, which leads to numerous health complications [2]. Today there are two reasons to add fibre to baked products: the increase of dietary fibre intake and the decrease of the caloric density of baked goods [3].

Dietary fibre is the remnant of the edible part of plants and analogous carbohydrates that are resistant to digestion and absorption in the human small intestine, with complete or partial fermentation in the human large intestine. It includes polysaccharides, oligosaccharides, lignin and associated plant substances. Dietary fibre exhibits one or more of either laxation (faecal bulking and softening, increased frequency and/or regularity), blood cholesterol attenuation, and/or blood glucose attenuation [4]. The functional properties of fibres depend on the fibre source and the type and degree of processing [5,6].

A great number of dietary fibre sources are available to bakeries today, some of them with a relatively high level of soluble dietary fibre (SDF). The presence of a SDF fraction in dietary fibre can provide improved physiological functions in addition to the functional effects provided by the insoluble dietary fibre (IDF) fraction [6,1]. Many authors have studied the use of high percentages of different kind of dietary fibre in baking but they have usually found important detriments to dough handling and bread quality, unless some food additives were used. The main problem of dietary fibre addition in baking is the important reduction of loaf volume and the different texture of the breads obtained. Chen et al. used apple fibre in bread making and observed that the addition of 4% hydrated apple fibre reduced loaf volume by 14% [7]. Pomeranz et al. used cellulose, wheat brans and oats hulls as fibre sources in bread-making and observed that the final volume of breads was lower and with different texture than fibre-free bread [8]. Krishnan et al. tested commercial oat brans and observed that inclusion de-
creased the bread loaf volume [9]. Likewise, Sievert et al. tested a soy polysaccharide blend (10%) in Chinese steamed bread and observed a detrimental effect on volume and texture [10]. Soluble and insoluble dietary fibres have also been added to cakes and other cereal products different to bread [11, 12, 13].

Frequently, some additives such as vital gluten and surfactants [14], sodium stearoyl-2-lactylate (SSL) [9, 15] or bromate and SSL [16] are used to counteract the deleterious effect of fibre addition on the dough handling characteristics, loaf volume reduction and acceptability of the bread. These additives improve the overall quality of fibre-supplemented bread but, in general, there still remain pronounced differences to white bread.

Keeping in mind the necessity of increasing dietary fibre ingestion (especially in Western societies) and taking into account that customers demand healthier foods but at the same time with high sensory quality, this research work was mainly focused on the possibility of offering breads with an improved nutritional value and simultaneously with high consumer acceptance, but without food additives. This work includes a systematic study on the effect of fibres of different origin on the rheological properties of dough. Low quantities (2%–5%) of dietary fibres from different origins (pea, cocoa, coffee, orange, wheat and microcrystalline cellulose) were added to wheat flour and the effects on the handling characteristics of dough and the quality of bread were studied.

Materials and methods

Materials

Commercial blends of Spanish wheat flour (12.84% protein) were obtained from the local market. Fibres from different origins were generously gifted by Campi y Jové (Barcelona, Spain). The fibres tested, together with the distributor’s reference number, were: orange fibre (OF 400/30), pea fibre (ID 90), cocoa fibre (ID 67), coffee fibre (ID 68), microcrystalline cellulose (L 102) and wheat fibre (WF 200 and WF 600/30). Two different wheat fibres were tested in order to study the influence of fibre size. The WF 200 fibre has an average fibre length of 250 μm (in this work it will be called wheat-L) while the WF 600-30 has an average fibre length of 35 μm (wheat-S). Table 1 summarises the composition of dietary fibres provided by manufacturer.

Methods

Dough rheological characteristics

Consistograph test was performed using a Consistograph NG (Tripette et Renaud, France) following the supplier specifications [17]. The following consistograph parameters were automatically recorded by a computer software program: water absorption (HA, water required to yield dough consistency equivalent to 1700 mb of pressure in a constant humidity measurement), dough development time (TPr, time to reach maximum consistency in an adapted humidity determination with a maximum pressure of 2200 mb), tolerance (Tol, time elapsed since dough consistency reaches its maximum until it decreases down to 20%), decay at 250 s (D250, consistency difference, in mb, between height at peak and to that 250 s later), decay at 450 s (D450, consistency difference, in mb, between height at peak and its value 450 s later). Decay at 250 s and 450 s are related to dough mixing stability. Higher stability means lower D250 and D450 values.

Alveograph test was performed using an Alveograph MA 82 (Tripette et Renaud, France) following the standard method [18] at adapted hydration. The following alveograph parameters were automatically recorded: tenacity or resistance to extension (P), dough extensibility (L), curve configuration ratio (P/L) and the deformation energy (W).

The average results of two separate determinations are presented in all cases.

Bread-making procedure

A straight dough process was carried out for preparing the bread samples. A basic bread formula, based on flour weight, was used: 2000 g of flour (14% moisture content basis), water up to 1700 mb consistency, 4% compressed yeast and 2% salt. When fibres were added, they replaced 2% or 5% of flour. The dough was mixed for 15 min, divided into 600 g pieces, hand-moulded and sheeted, put into tin pans for 75 min at 29 °C and 70% RH. Bread was baked in an electric oven for 35 min at 215 °C. Bread quality attributes were evaluated after cooling for 2 h at room temperature.

Evaluation of bread quality

Bread quality analysis included: weight, volume (determined by seed displacement in a loaf volume meter), crumb firmness, crumb and crust colour and sensorial analysis.

Crumb firmness was measured using a TA-XT2 texture analyser (Stable Microsystems, Surrey, UK) provided with the software “Texture Expert”. In order to establish the evolution of the bread quality during storage, texture measurements were also performed. An aluminium 25 mm diameter cylindrical probe was used in a “holding-until-time” compression test. The probe speed during the test was 2 mm/s and the compression distance 10 mm. The resulting peak force was measured in grams. In bread texture determinations, ten different slices of 25 mm thickness were measured. The averaged result is presented.

Colour was measured using a Minolta spectrophotometer CN-508i (Minolta, Japan). The tristimulus values were automatically calculated from the spectrum by means of a computer program. Results were expressed in the CIE L*a*b* colour space and were obtained using the D65 standard illuminant and the 2° standard observer (CIE 1931). All colour determinations were made 10×5 times: crumb or crust colour was checked at ten different points on each piece of bread and every point was measured five times. Averaged results are presented.

Sensory evaluation

Sensory evaluations of bread were conducted by 40 panellists, consisting of Agricultural Engineering College staff and students.

Table 1 Standard dietary fibre composition (% dry basis)

<table>
<thead>
<tr>
<th>Origin</th>
<th>TDF</th>
<th>IDF</th>
<th>SDF</th>
<th>Starch</th>
<th>Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcrystalline</td>
<td>99</td>
<td>99</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>cellulose</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pea</td>
<td>88</td>
<td>78.3</td>
<td>9.7</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Cocoa</td>
<td>67</td>
<td>43.6</td>
<td>23.4</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>Coffee</td>
<td>68</td>
<td>44.2</td>
<td>23.8</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Orange</td>
<td>66</td>
<td>36</td>
<td>32</td>
<td>23</td>
<td>7</td>
</tr>
<tr>
<td>Wheat-L</td>
<td>97</td>
<td>94.5</td>
<td>2.5</td>
<td>0</td>
<td>0.4</td>
</tr>
<tr>
<td>Wheat-S</td>
<td>97</td>
<td>94.5</td>
<td>2.5</td>
<td>0</td>
<td>0.4</td>
</tr>
</tbody>
</table>

TDF total dietary fibre determined by the AOAC method, IDF insoluble dietary fibre, SDF soluble dietary fibre