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Rheological properties of wheat flour substitutes/alternative crops assessed by Mixolab

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Abstract

Wheat is one of the most common cereals used in the world. However, due to greater public awareness of celiac disease and gluten intolerance as well as consumers demands for healthy food and variety in food products, in many widely consumed staples, such as bread, wheat flour is fully or partially replaced with flour from other cereals, pseudocereals or legumes. Although wheat flour alternatives are readily available in the market, these products are often of inferior quality. The aim of this paper was to predict the suitability of alternative crops such as rice, corn, buckwheat, amaranth and soya for the production of quality bread. Their rheological properties were studied, and compared to the properties of wheat flour which served as a benchmark. The tested alternative cereals, pseudocereals and legumes were selected in order to represent the widely used ones in gluten-free products as well as the ones found to be nutritionally improved according to recent publications. Moreover, the differences between wheat and buckwheat flour, and their wholegrain counterparts were also studied. The determination of rheological properties of wheat flour dough as well as the dough from other raw materials (rice, corn, buckwheat, amaranth and soya) was performed by Mixolab. According to results obtained by Mixolab measurements, flours from different raw materials exhibited Mixolab profiles which greatly differ from wheat flour profile. Samples of rice and both types of buckwheat flour expressed the most similar rheological behaviour to wheat flour. However, since, there was no tested material which exactly mimic wheat flour dough properties, it was concluded that their mixtures would give the optimal rheological profile. Although it is a very challenging task to mimic wheat flour unique breadmaking properties, it is possible to create products having similar rheological behaviour to wheat flour dough, but improved functional properties.

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Keywords: gluten-free flours; Mixolab; rheology; wheat flour alternatives

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1. Introduction

Wheat is one of the most common cereals used for breadmaking. However, bread prepared from wheat flour dough is considered to be nutritionally poor [1].

Partial replacement of wheat flour with non-wheat flours improves the nutritional quality of bakery products and satisfies consumers' demands for healthy food and variety in food products. Moreover, in recent years there has been increasing interest in replacing common gluten-free formulations made from refined gluten-free flour, starch and hydrocolloids with those enriched with functional gluten-free ingredients [2, 3]. Namely, application of pseudocereals such as amaranth, quinoa and buckwheat resulted in gluten-free breads with an increased content of important nutrients such as protein, fiber, calcium, iron, vitamin E and polyphenols [2]. Also, according to Sabanis & Tzia and Traynham et al. [1, 3] soybean flour can compensate for the lysine and other biologically active components (isoflavones) deficiency of wheat flour.

On the other hand, in many countries where wheat is not a major domestic crop, substitution of the wheat flour with flours from other cereal grains such as corn and rice is done due to economic reasons [4, 5]. Except being the second most widely produced cereal crop, corn flour contains high levels of many important vitamins and minerals [6]. Similarly, rice is a staple food for more than half of world population [7]. It is also characterize with bland taste, white colour, ease of digestion, and hypoallergenic properties [8].

However, substitution of wheat flour with flours from other raw materials will alter rheological properties of dough, as well as the quality of baked product. It is well known that proteins encountered in non-wheat flours lack the ability to form the gluten network responsible for holding the gas produced during the fermentation [9, 10].

Among different rheological techniques, Mixolab has been likely used in many studies for probing dough behavior during processing conditions [11, 12, 13]. By using Mixolab it is possible to record the mechanical changes due to mixing and heating simulating the mechanical work as well as the heat conditions that might be expected during the bread making and bread baking processes. The advantage of using Mixolab is that in a single test one can measure properties of proteins and starch (and associated enzymes).

The suitability of alternative crops for the production of quality bread is mainly examined by measuring the properties of their blends with wheat or some other flour. On contrary, the aim of this paper was to determine the behaviour of pure non-wheat flours obtained from rice, corn, buckwheat, amaranth and soybean, during mixing and heating by using Mixolab. Their rheological properties were compared to the properties of wheat flour which served as a benchmark. The tested alternative cereals, pseudocereals and legumes were selected in order to represent the widely used ones in gluten-free products as well as the ones found to be nutritionally improved according to recent publications. Moreover, the differences between wheat and buckwheat flour, and their wholegrain counterparts were also studied.

2. Materials & Methods

2.1. Materials

Wheat flour, wholegrain wheat flour, rice flour, corn flour, buckwheat flour, wholegrain buckwheat flour, amaranth flour and soybean flour were purchased from local market. The proximate composition of the flour samples is given in Table 1. Moisture and ash content were determined following the ICC methods No 110/1 and 104/1, respectively (ICC, 1996). Kjeldahl method was used to characterize the protein content. Fat and starch were given by Weibull-Stoldt and Ewers methods, respectively.