Milk Powder Composite Flour

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Contributor: Younes Noutfia

Chickpea (Cicer arietinum L.) is an important grain legume with a multitude of nutritional and health benefits. Indeed, it contains a high proportion of non-digestible carbohydrates and contains a rich variety of phytochemicals, including natural antioxidants such as phenolic or flavonoid compounds that decrease oxidative stress and inflammation related to many chronic ailments. The fortification of bakery products with chickpea flour has already been employed and appears to be promising in particular for the functional food market. The addition of chickpea flour to wheat flour improves the quality of protein, fiber, and mineral content of the bread. Unfortunately, a threshold of 5 to 10% of chickpea flour is imposed in order to not lose some organoleptic qualities such as chewiness, limiting the nutritional improvement that this legume could bring to bread.

Keywords: flat bread ; mixture design ; chickpea ; milk powder ; nutritional fortification ; organoleptic enhancement

1. Overview

Flour quality is influenced by the nature of the gluten and its various components. Gluten free flour made of pulses is known to enhance the nutritional quality of wheat flour. However, its addition can compromise the rheological and sensorial attributes of the bread. We used mixture design to optimize nutritional and technological qualities of a wheat–chickpea flour blend by adding milk powder as a natural organoleptic improver. A total of thirteen flour blends were prepared by incorporating 10 to 30% chickpea flour and 10 to 20% milk powder to wheat flour. Our results showed that the optimal flour blend consisted of 60% wheat, 24% chickpea, and 16% milk powder. Farinographic parameters of the optimal dough blend remained on par with those of the control dough (100% wheat flour), thereby preserving its bread-making quality. Sensory analysis of breads made from the optimal flour blend revealed no significant difference ($p \leq 0.05$) from wheat flour for crumb and chewiness. Appreciation was brought to the appearance, crust, aroma, and taste in the optimized bread. This study suggests that chickpea flour can be suitably incorporated into bread wheat flour up to a percentage of 24% with 16% milk powder to produce bread with optimal nutritional quality while improving its sensory attributes and consumer acceptability.

2. Wheat–Chickpea

Pulses are increasingly being recognized worldwide as healthy foods [1]. They are good sources of protein, vitamins, minerals, and beneficial dietary fibers for human gut health [2][3]. The World Health Organization (WHO) has recommended the frequent consumption of pulses in order to reduce serum cholesterol levels and the risks of coronary heart disease and cancer in humans [4]. This unique nutritional and health potential imparts upon pulses an important role to address issues related to the triple burden of malnutrition. Thus, the FAO of the United Nations Organization celebrated 2016 as the International Year of Pulses [5] with the aim of drawing attention to the nutritional and health benefits of pulses and strengthening the paradigm shift towards including more of this nutritional powerhouse in diets all over the world [6]. In this context, systemic attention has been given to the research of new technologies for introducing them into cereal-based foods as healthy ingredients. Pulses, especially when blended with cereals, offer a promising alternative source for nutritional and functional proteins and will carry nutritional benefit to a wide range of the population that is increasingly interested in pulse utilization [7]. The addition of pulse flour into wheat flour is a difficult task from a technological point of view because of the absence of gluten [8] as well as in relation to sensory properties, in particular, flavor and texture, which are very important in the developed world, where consumers have extremely discriminating tastes [1].

Chickpea (*Cicer arietinum* L.) is an important grain legume with a multitude of nutritional and health benefits [9]. Indeed, it contains a high proportion of non-digestible carbohydrates and contains a rich variety of phytochemicals, including natural antioxidants such as phenolic or flavonoid compounds that decrease oxidative stress and inflammation related to many chronic ailments [10][11]. The fortification of bakery products with chickpea flour has already been employed and appears to be promising in particular for the functional food market [12]. The addition of chickpea flour to wheat flour improves the

quality of protein, fiber, and mineral content of the bread. Unfortunately, a threshold of 5 to 10% of chickpea flour is imposed in order to not lose some organoleptic qualities such as chewiness [13][14][15], limiting the nutritional improvement that this legume could bring to bread. This is mainly due to gluten dilution caused by the addition of chickpea flour into wheat flour. In fact, a low content or a lack of gluten may deteriorate bread quality given that gluten is a protein of major importance in baked products because of its contribution to the viscous and extensibility properties that positively influence the overall quality of bread making [16][17].

Milk powder is widely used in bread formulation due to its nutritional and technological roles [18][19]. Its incorporation into gluten free products is all the more accentuated given the distinguished quality of its ingredients, in particular, proteins and minerals ensuring a network development similar to that formed by the gluten, ensuring dough stability [20]. It also improves the mouth feel and the overall acceptability of the formulated breads [21]. For this double role, milk powder was used as a third ingredient with the objective of optimizing the nutritional and technological quality of wheat–chickpea flour blend through the mixture design methodology. Rheological and sensorial qualities of the optimized dough mixture and bread were assessed and compared to bread wheat as a control.

3. Technological Quality of Flour Mixture

The regression equation of the zeleny volume was of a linear order (p = 0.002) and was positively influenced by the addition of wheat flour. This makes sense given the nature of the added ingredients. The addition of chickpea flour and milk powder caused the dilution of the gluten provided by wheat flour. Bojnanská and Urminská [22] also reported a lower zeleny value with the addition of natural gluten free ingredients in wheat flour.

Concerning the yellow index, the regression equation was of a quadratic order (p = 0.0002), where the chickpea ratio had the most significant effect on increasing this parameter among the linear terms that were succeeded by wheat flour, while milk powder had a diluting effect. Binary terms (AC and BC) indicated a positive interaction on the yellow index. These results are in agreement with the results of Yıldırım and Karaboğa [23], who demonstrated that the addition of chickpea flour to bread wheat flour increased the yellow index (b*).

4. Blend Optimization

The optimization of the flour mixtures was based on the mathematical equation of Derringer and Suich [24]. This operation consisted of looking for the concomitant graphical and numerical optimum involving the addressed answers for the nutritional (proteins, lipids, carbohydrates, Fe, Zn, P, polyphenols, and scavenging activity) and technological (zeleny volume, yellow index) levels. The ingredients were set as independent factors by maximizing the level of incorporated chickpea flour and minimizing the level of bread wheat flour and milk powder. According to the numerical optimization, the optimal point corresponded to the mixture composed of 60% bread wheat flour, 23.8% chickpea flour, and 16.2% milk powder. The graphical optimization of the mixture revealed the same proportions obtained by the numerical optimization, corresponding to a desirability of 0.77.

5. Conclusions

The milk powder not only boosted the nutritional potential of the mixture, but it also improved the overall bread making quality of the chickpea–bread wheat mixture in comparison to that of wheat bread by enhancing its rheological and sensorial qualities in regard to chewiness and crumb, which remained unchanged and thus overcame the technological inconvenience of the addition of chickpea flour. This opens the way for future in-depth research on the effect of milk fractions (caseins, whey, etc.,) on the nutritional and rheological quality of cereal–legume composite flours as well as the behavior of milk proteins in this matrix.

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