A multidisciplinary approach to improve the quality of organic wheat-bread chain

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Abstract

The main challenge for organic farmers, millers and bakers is to fulfill consumers' expectations of providing healthy and safe products. The quality of organic grain can be modulated by agronomic modifications on genotypes, crop management, crop rotation and soil fertility, but the milling process and finally the baking process are also key factors in producing bread of high baking quality, nutritional value, taste and flavour. Nitrogen (N) is a key nutrient in achieving acceptable yield levels of sufficient bread-making quality, but previous results have shown that organic wheat tends to have lower protein content, dough mixing tolerance and loaf volume. The selection of genotypes with high N use efficiency, weed competitiveness and disease resistance allowed improving the agronomic performance. Besides protein content and protein composition, the baking performance of organic wheat bread also depended on flour starch damage, amylase activity, ash content and particle size distribution. The milling technique had a critical effect on both baking performance and nutritional value whereas the baking process may improve the bioavailability of minerals through acidification process (sourdough). Finally, this programme allowed to better characterize stakes and constraints of the whole organic wheat-flour-bread chain due to a multidisciplinary approach.

Introduction

Nowadays, the protein content is frequently used as the (unique) predicator of the bread making quality of organic wheat grain. Nonetheless, bread making quality is determined by several factors, namely wheat quality, flour properties and baking process. Previous results have shown that, compared to non-organic wheat, organic wheat has lower protein content, dough mixing tolerance and loaf volume (Gooding et al., 1993). Häglung et al. (1998) emphasised that flour with a protein content of less than 12g per 100g of grains required a longer mixing time for optimum dough development. Furthermore, they noticed that baking bread with an acceptable bread volume was difficult to obtain when flour protein content was lower than 8 g per 100g. As a consequence, artisan bakers adapt their baking processes to organically-grown flours with low protein content while others still request highly standardized flour with high protein content.

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The quality value of organic bread can also be expressed by nutritional value and sensory attributes (flavour and taste). Previous results have shown that nutritional value could be improved through the milling process (Chaurand et al., 2005). The nutritional value of whole-meal is generally considered higher to that of refined flour. Therefore, the sensory attributes depends on flour starch damage, amylase activity, ash content and particle size distribution (Kihlberg et al, 2004). Following recommendations of nutritionists, the future trend for the milling industry will be to produce flours richer in micronutrients and fibres.
This paper looks different ways to improve the baking quality, the nutritional value and the sensory attributes of organic bread through agronomical and food processing ways.

Materials and methods

A French national research programme on *Organic Wheat-Bread* was carried out in 2003-2007 to assess and to adapt crop management and processing methods to improve baking quality, nutritional value and sensory attributes of organic bread (Taupier-Letage et al., 2007). Different methodologies were set up in order (1) to evaluate the influence of crop management (genotype, fertilization management, others…) and environmental conditions on grain protein content and bread making quality, (2) to analyse the effect of the milling technique on the nutritional value and baking properties, (3) to improve the fermentation process of flour with yeast or surdough and, (4) finally, to optimise bread production recipes according to the consumers demand. Then, interviews and focus group provided new knowledge on stakes, requirements and constraints of the different actors (producers, collectors, millers, bakers and consumers) in the *organic wheat-flour-bread* chain.

Results and discussion

Consumer's preferences and attitudes

Sensory test had been realised from two focus groups with usual and occasional consumers (120 panellists in total). Four prototypes and two controls of organic bread differing from the type (French baguette *vs* unsliced bread) and from the milling yield (more or less refined) were tested to evaluate consumers attitudes and preferences. The preference of organic bread consumers is strongly explained by authenticity and healthy dimension in relation with ethical and ecological values of organic production. Usual consumers are stressed by safety and nutritional values linked with ecological principles guarantee by organic certification. Occasional consumers mentioned the need for better consumer information, especially on nutritional value, a better availability of organic bread, a strong authenticity but also a wider diversity. The major contraints for increasing consumption of organic bread are the high consumer price and the poor availability in the mass distribution.

The incidence of crop management on bread making quality

The relationship between grain protein content and baking test appears strongly determined by the genotype. Following the work of Goyer et al. (2005), a new criteria was defined to identify genotypes suitable for organic and low-input conditions as (1) weed competitiveness, (2) quality index with grain protein content and Zeleny reference and (3) yield performance obtained in low-input and organic conditions. Accordingly, a national network of experimental assays has been set up in France to develop a breeding programme for organic wheat. David et al (2005) mentioned that

organic wheat yield and grain protein content (GPC) are strongly influenced by environmental and agronomic conditions. Grain filling of organic wheat varied according to water stress, temperature and soil compaction. Number of kernels was determined by N-deficiency and weed density. The weed density had a negative effect on kernel number leads to nitrogen concentration in grains, increasing GPC. Moreover our data demonstrated the incidence of the cropping system on yield and GPC performance. Arable systems with diversified crop rotation (including cereals, grain legumes and spring crops), regular N fertilization and weeding operations obtained higher results compared to mixed farming systems and extensive arable systems with low N fertilization and no weeding operations. This program provided a better understanding of the interactions of crop rotation, crop management and climatic conditions on yield and grain protein content performance.

The incidence of the milling technique

Flour obtained with stone milling exhibited a higher rate of starch damage compared to roller milling. This result is in accordance with those of Gélinas et al., (2006) who demonstrated that stones tightening reduced flour granulation, increased both starch damage and water absorption but did not change dough mixing stability of whole-meal flour. Conversely, the higher flexibility of the roller milling system allows separating all the parameters which can influence the nutritional value and the functional properties of flours, rate of starch damage, fiber and minerals content as well as the flour granulation. According to our results, at the same milling yield the baking performance of stone-milled flour was inferior to roller-milled flour. Indeed, stone milling is not as much efficient as roller milling to eliminate outer layers accurately. However this less efficiency results in a higher nutritional value for a given flour yield. According to these results, new milling diagrammes were developped to improve the baking quality of flour obtained with stone-milling and to improve the nutritionnal quality of flour originated from roller milling. All the resulting flours answer to the nutritionnal recommendations of the French national programme of health and nutrition (PNNS program).

Increasing fiber content in flour may result in a lower assimilation of minerals complexed by phytates. An optimisation of the fermentation step with surdough allowed to improve both the bioavailability of minerals as well as the sensory attributes of the resulted bread.

Stakes and constraints of the different actors in the wheat-bread chain

Finally, this programme allows us to characterise stakes and constraints of the whole cereal supply chain. Although the grain price is essentially determined by the grain protein content, collectors and millers noticed that the major obstacles for quality improvement are weevils and weeds contamination. Co-operation between organic cereal producers should be encouraged to allow better cleaning & storage, and bulking to create larger quantities for sale. Therefore, co-operation between producers, millers and distributors should be enhanced to fulfill consumer's expectations through innovations and quality improvement.

Conclusions

This program allowed to gather a wide scientific and technical partnership. This multidisciplinary approach resulted in a significant headway in the field of the agronomy and the cereal processing:

- Protein content is not enough by itself to assess and guarantee the baking quality, it is more important to consider the interaction genotype-protein content to develop a grading system for wheat storage and to prepare milling batches. As a consequence, the cropping system appears as a key management tool.
- New milling diagrammes were developped to combine a high milling yield with good nutritional and sensory attributes either on roller milling and stone milling. In these conditions, the fermentation step must be adjusted to increase the micronutrient bioavailability.

Combining all these data leads to propose a range of nutritional and tasty breads well accepted by consumers. Further research should focus to support the following main points: (1) create a national field network to develop technical references and advices, (2) develop innovative methods to assess organic flour and bread and (3) support the development of the organic wheat-bread chain

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