EVOLUTION OF FLOUR PROPERTIES DURING STORAGE UNDER DIFFERENT TEMPERATURES

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PRESENTATION

In the cereal industry, it is often necessary to store flours for an indefinite amount of time. According to the quality of the infrastructures, it is sometimes difficult to ensure a proper storage environment for cereal products which can affect the properties of flours. The objective of this study is to evaluate the evolution of the rheological properties and functionalities of flours during storage under different conditions.

MATERIAL AND METHODS

Samples of wheat (Apache) were milled using the CHOPIN CD1 experimental mill. Two different milling processes were used in order to obtain white flour and whole meal flour (standard protocol: AACC 26-10.02 and adapted protocol for making whole meal flour).

Both samples were separated in three fractions which were stored under three different temperatures (4°C, 20°C and 30°C) all other conditions being equal (same container type, not watertight to allow water evaporation and kept in the darkness to avoid uncontrolled oxidations). The moisture content (NF EN ISO 712) and rheological quality of those samples was followed during four months every two weeks:

- Mixing and pasting behaviors were assessed according to the Chopin+ protocol using the Mixolab® (AACCI Method 54-60.01). Derived parameters such as water absorption capacity, protein weakening (C2), viscosity peak (C3), amylase activity (C4) and starch retrogradation (C5) were determined.
- Solvent retention capacity profiles were assessed using the SRC-CHOPIN®. Derived parameters such as Water (Wa), Sucrose (Su), Lactic Acid (LA) and Sodium Carbonate (SC) Solvent Retention Capacity (SRC) were determined.

RESULTS & DISCUSSION

Moisture content was highly impacted over time by the storage conditions (Figures 3 & 4) for all the tested flours:

- At 4°C: No significant change was detected after 16 weeks of storage.
- At 20°C: The moisture content gradually decreased. This phenomena becomes significant from week 10.
- At 30°C: The moisture content was strongly impacted. The decrease becomes significant from the 2nd week.

Mixolab and SRC-CHOPIN testing adjusts for moisture content, the following variations are not due to a simple loss of water.

First, it should be noted that no significant change is detected at 4°C for the white flour whatever the type of measurement. Second, the SRC results show that the retention capacity of the glutenins (LA) for the whole meal flour increases while it remains stable for the white flour (Figure 5). The pentosans retention capacity (Su) increases linearly at 30°C whatever the type of flour tested (white flour: R²=0.87, whole meal flour: R²=0.90) (Figure 6).

CONCLUSION

The study shows that the flours properties are changing during storage. Those changes depend on the type of flour and on the storage conditions. Storing a flour at 4°C has no impact during at least 4 months. In general, whole meal flour is more sensitive to the storage impacts than white flour which is consistent with the literature. The findings show that there is still a lot to understand on the impact of storage conditions on the rheological properties of wheat flours. The Mixolab measures the evolution of the rheological properties while the SRC permits the measurement of the functionality of a stored flour.

Figure 1: Mixolab curve obtained with the standardized “Chopin+ protocol” (80 rpm) 5 different phases.

Figure 2: Process for running the SRC-CHOPIN.

Figure 3 and 4: Moisture content evolution. White flour on the left; Wholemeal flour on the right.

Figure 5: Stability evolution. Wholemeal flour on the left. White flour on the right.

Figure 6: White Flour and Wholemeal flour comparison – 30°C Storage – Glutenins Retention capacity evolution on the left. Pentosans on the right.
Impact of Different Fibers on Dough Rheological Behavior

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PRESENTATION
During the past decade, fibers were introduced in the cereals industries processes with the aim to improve nutritional benefit of traditional wheat food. Advantages of consuming fiber include the production of healthful compounds during the fermentation, acceleration of transit time, lower cholesterol levels and the reduction of colon cancer risk.

MATERIAL AND METHODS
Different types of fibers have been tested during this study:

- 4 soluble fibers (Main sources: S1 = wheat, S2 = corn, S3 = acacia gum and S4 = chicory)
- 3 insoluble fibers (Main sources: S5 = apple, S6 = citrus, S7 = wheat and S8 = oat)

These fibers were incorporated at different concentration (1/2 recommended dose, 1 recommended dose, 2 recommended dose) on the same common wheat flour and were analyzed with the Mixolab (standard protocol AACC 54-60.01, ICC173, ISO 17718) (Figure 1 and Table 1). For comparison, the flour was also analyzed pure without any fiber.

RESULTS & DISCUSSION

The results show that soluble fibers reduce water absorption while the insoluble fibers increase it. 4 fibers (2 soluble and 2 insoluble), strengthen the gluten network resistance during dough heating when they are incorporated at a certain concentration (which is different for each fiber). Although most of tested fibers do not induce changes on starch gelatination, 2 soluble fibers showed a negative action and 1 insoluble a positive action.

2 soluble fibers showed the ability to enhance starch retrogradation capacity (thus potentially decreasing the end product shelf life) whereas the 4 insoluble and 1 soluble were able to counteract the retrogradation speed. This study shows that every fiber has its own effect on dough rheological behavior. There is no common trend inside soluble and insoluble fibers but one specific behavior for every fiber.

CONCLUSION

The Mixolab is an interesting tool for evaluating fibers impact on dough behavior. It can be a great asset for R&D teams trying to determine the best performing fibers-enriched formula. It can be used either to improve or modify existing formulas or for developing new fiber-enriched products.
IMPACT OF SALT REDUCTION ON THE RHEOLOGICAL PROPERTIES OF WHEAT DOUGH

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PRESENTATION

Salt has always been a very commonly used product for both food preservation and taste enhancement. Excess sodium intake is a factor contributing to high blood pressure and is associated with cardiovascular disease and stroke (World Health Organization, 2005). Bread is one of the main source of salt intake. Indeed, a simulation carried out by AFSSA’s Food Consumption Observatory showed that a 25% drop in salt added to bread would lead to an overall consumption reduction of 6%. In addition to its effects on health, salt has recognized impacts on doughs rheological properties. The cereal industry has every interest to anticipate these effects in order to adapt formulations and/or processes. Consequently, the objective of this study is to evaluate the impact of salt reduction on the overall quality of the dough.

MATERIAL AND METHODS

3 wheat flours with various rheological properties (weak, medium and strong) were used to evaluate the impact of salt reduction. They were analyzed using the Alveograph (AACC 54-30.02), the Mixolab (“Chopin+ protocol” AACC 54-60.01) and the Rheo F4 (CHOPIN protocol) in order to have an overall characterization of the impact on the rheological properties. Different salt doses (5%, 3.5%, 2.5%, 1.5%, 0.5% and 0%) were added in order to cover the usual range used in industry.

RESULTS & DISCUSSION

The Alveograph results show a decrease of the tenacity (20.1% decrease on average on the P value) which is symptomatic of the diminution of ionic bonds between the salt and the gluten network (constant hydration analysis) (Figure 4). The elasticity index also decreases linearly as the addition of salt decreases too, further demonstrating that, with salt, the gluten network is enhanced and allows for a more efficient return to the original state (Figure 5). Hydration and mixing step will need to be adapted to process dough with lower salt content.

The RheoF4 shows that salt reduction allows the dough to develop faster (Figure 6) while the total volume of produced gas increases (for strong flour: from 716 ml at 5% to 1869 ml at 0%) (Figure 7). This is to be related to the fact that salt decreases the water activity and increases the osmotic pressure, which results in the release of water from the yeasts, and consequently in a decrease in activity (F. Dal Bello, E. Sheehan, EK Arendt & al., Food Research International · August 2009). Proofing time will need to be shorten to process doughs with lower salt content.

The hot phase of the Mixolab highlights the fact that salt reduction causes the gelatinization of the starch to appear sooner and less intensely (Figure 8), in fact, the required time to enter the gelatinization phase decreases linearly which can be explained by the effect of salt on the decrease in water activity. Less salt means more water available for the gelatinization to appear sooner. Starch retrogradation is less intense without salt (35.5% decrease on average on the CS-C4 value) (Figure 9) which is contrary to the known effects of salt. Further studies need to be conducted to conclude about this observation. In any case, baking step and shelf life of the final product will be impacted by salt reduction.

CONCLUSION

The study shows that all the properties of the tested doughs are impacted by salt reduction. The intensity of the effects can vary according to the flour used and the incorporation dose. The Alveograph evaluates the impact of salt reduction on the gluten network, the RheoF4 on the proofing properties and the Mixolab on the dough properties through mixing and temperature changes. They are complementary tools which can be used to evaluate the impact of salt reduction on dough rheological behavior.