RHEOLOGICAL PROPERTIES OF WHEAT FLOUR DOUGH

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Summary

Wheat flour dough is one of the most complex rheological systems, which has been studied by a number of cereal scientists, food technologists, and rheologists through many decades. Research on fundamental rheological properties of wheat flour dough appears to be increasing in importance recently because of the application of continuous and automatic food processing operations such as extrusion, MDD bread making, and sheeting in modern bakery industries.

Among all of the cereal flours only wheat flour dough has unique viscoelastic properties. These viscoelastic properties are necessary to produce the spongy structure of bread loaf after the flour is mixed with water, fermented by yeast and baked (Hoseney and Rogers, 1990). Also the unique properties of wheat flour make it suitable for breadmaking because gas cells can be retained in the dough during mixing and proofing (Janssen, 1995). Wheat cultivars often differ, however, in their breadmaking performances. Gluten proteins are largely responsible for these differences (Janssen, 1995).

A possible correlation between fundamental rheological properties of wheat flour dough and processing conditions during breadmaking, notably MDD mixing behaviour and sheeting, was focused on in this study.

Rheological measurements including Dynamic Oscillation, Shear Stress Growth Test, Relaxation Test, Planar Extensional Flow Test, and Extrusion Test were carried out to study the rheological properties of wheat dough.

Results from both small and large deformation tests, showed that the fundamental rheological properties of flour dough mainly depend on the sample moisture content and the energy used to mix the dough, known as work input. Small deformation tests (Dynamic Oscillation) showed that optimum-mixed dough had a slightly higher elastic behaviour (higher storage modulus G' and lower phase angle (δ)). Rheological properties of non-mixing dough were also determined. Non-mixing dough was prepared by mixing flour and ice finely ground. Moisture distribution of non-mixing dough was very difficult to control because the dough

needs to be mixed with very fine ice particles to reach a good distribution when the dough is warmed up. Non-mixing dough gave similar values of storage modulus than mixed doughs. However, moisture content of non-mixing dough was lower than that of mixed dough despite the same water absorption was used as the amount of ice utilised was calculated taking into account in density.

Results of large deformation tests, namely the Shear Stress Growth Test, the Planar Extensional Flow Test and the Extrusion Test showed that there were significant differences among doughs prepared with different mixing conditions (under-mixed, optimum-mixed and over-mixed dough). The rheological properties were also depending on the type of flour used.

Slippage of the dough samples during the measurement was minimised by using sandpaper attached to the test plates. Serrated plates and smooth parallel plates were also used to compare with the results obtained using sandpaper.

It was found water absorption affects the fundamental rheological properties of dough dramatically. Decreasing water absorption increased the storage modulus G' and decreased the phase angle.

Confocal microscopy was used to observe the difference among Bakers (a strong flour) and Soft flour (a weak flour) dough prepared with various mixing conditions. A new deep frozen and cutting method was used to prepare the specimen. There were clear and significant differences between optimum MDD mixed dough and dough prepared with other level of mixing energy. Microscopy showed that optimum developed doughs had an uniform and well-developed structure.

Sheeting has a similar function as mixing but is more gently. Results showed that sheeting could develop dough. Using both weak flour (Halo) and strong flour (Beta) large deformation tests (Shear Stress Growth Test and Planar Extensional Flow Test) showed very consistent results and the presence of an optimum number of sheeting passes. This optimum appeared to agree whit the optimum determined by a baking test.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES