Spectral evaluation of anti-staling enzymes

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Introduction

Staling of bread refers to the deteriorating changes occurring in bread during storage. Changes examined in this study were the increase in firmness of the bread crumb due to: starch retrogradation, changes in the gluten phase, loss of water. Staling of bread have been studied by a number of experimental methods including differential scanning calorimetry (DSC), Ultrasound measurements (US), X-ray diffraction (X-RAY) and nuclear magnetic resonance (NMR) and the textural changes has been measured by Texture Analyzer (TA). In this study the aim was to find a sensitive rapid spectroscopic method capable of measuring the textural changes in bread that occur during storage. Whole wheat bread with or without added anti-staling enzymes (Novamyl® or BAN®) were measured by FT-IR and NIR spectroscopy. When this method is established it should be able to decide whether the bread is fresh or staled and if the anti-staling enzymes that was added was sufficiently effective.

Materials and Methods

The bread was regular white bread of which some had added enzymes (BAN®, Novamyl® and Novamyl variant). The 180 wheat bread (Control with no enzyme, BAN®, Novamyl® and Novamyl variant) were measured with a texture TA, NIR and FT-IR during storage for 23 days after baking. The TA measurements resulted in two parameters; firmness and elasticity. Bread samples for the texture analyser were cut into 4.5 x 4.5 x 4.5 cm cubes. All measurements were in triplicate. The centre of the bread slices was stamped out and placed in the sample cup. NIR spectra were obtained from 400-2500 nm. FT-IR measurements were in the range of 4000 cm^{-1}-700 cm^{-1} and used resolution 4 cm^{-1} with 64 scans. Background scanning was recorded by measuring air in a cleaned ATR using 128 scans. The bread sample was squeezed towards the ATR crystal by a heavy lead block. Data analysis was made with LatentiX version 2.0. PCA models were established for the NIR and IR spectral data using different pre-transformations. PLS models between spectral-data and textural reference data were developed.

Results and Discussion

Results showed that FT-IR spectroscopy was suitable to predict the degree of staling, whereas NIR spectroscopy was able to differentiate between the enzyme treatments and predict the degree of staling. Results are interpreted in great detail and while the FT-IR results could be directly related to starch retrogradation the NIR results were of more holistic nature.

Conclusion

NIR spectroscopy proved useful to monitor staling in wheat breads and explained amylopectin being retrograded and recrystallized. Good PLS regression between the NIR spectra and resilience data from TA showed that NIR can be used to predict the rate of staling. Chemometrics was a useful tool to distinguish the staling characteristics between the different enzymes used. The samples with added enzymes displayed similar behaviour, but to different degrees, proving that the enzymes were different in anti-staling efficiency.

Reference paper as:
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