# Impact of annealing conditions on functional properties of wheat flour and microbial growth

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## 1 Introduction

Annealing process is a hydrothermal treatment aiming to change the functional properties of starch. The scaling-up of wheat flour annealing is accompanied by a proliferation of microbial flora that must be controlled.

This control can be achieved through a process implementation that limits the proliferation of harmful microbiota.

## 2 Objectives

The aim of this research was to assess the effects of annealing treatment at two different temperatures and at various pH values on the functional properties of wheat flours and microbial growth.

Native wheat flour

NaOH (pH = 10)
HCl (pH=3)
Control

Annealing: 40/45° C – 24h – 160 rpm – 1:3

Neutralization
Drying

- Microbiology
- Thermal properties
- Crystallinity
- Pasting behaviour
- WAI/WSI

## 3 Materials & Methods

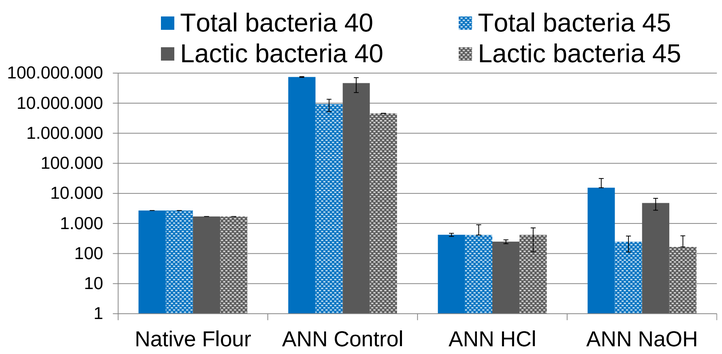
Material: Belgian ecotype wheat flour from Moulins de Statte SA

Methods:

- Microbial concentration (CFU/g): *total bacteria, lactic bacteria, Bacillus cereus, enterobacteri, yeast and molds*
- Thermal properties (DSC)
- Crystallinity (DRX)
- Pasting profiles (RVA)
- Water absorption index after gelatinization (WAI)
- Water solubility index after gelatinization (WSI)

## 4 Results

### Microbial growth




| | T°C | *Entero-bacteria* | *Bacillus cereus* | *Yeast* | *Molds* |
|---|---|---|---|---|---|
| Native flour | - | <10 | <10 | <10 | $1,1.10^3 \pm 0,0.10^0$ |
| ANN Control | 40 | <10 | <10 | <10 | $8,4.10^1 \pm 3,9.10^1$ |
| | 45 | <10 | ~20 | <10 | $7,4.10^1 \pm 5,3.10^1$ |
| ANN HCl | 40 | <10 | <10 | <10 | $1,1.10^2 \pm 5,6.10^1$ |
| | 45 | <10 | <10 | <10 | $5,1.10^1 \pm 7,2.10^0$ |
| ANN NaOH | 40 | <10 | <10 | <10 | $3,7.10^3 \pm 4,1.10^3$ |
| | 45 | <10 | <10 | <10 | $1,8.10^2 \pm 1,7.10^2$ |

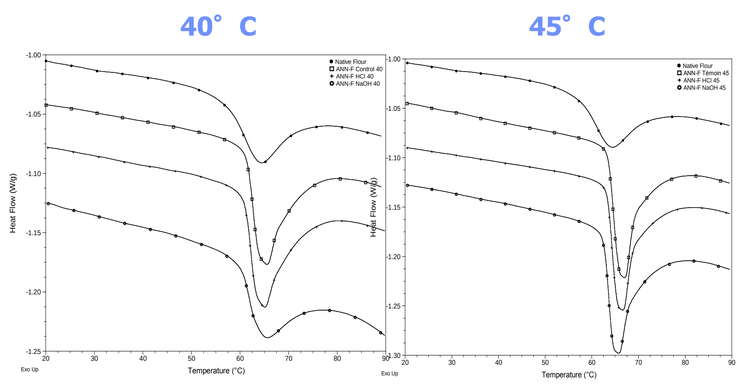
The main contamination of annealed wheat flour at 40 and 45° C is lactic bacteria, developed from the native flour.

Impact of annealing temperature on bacteria growth, especially for Control and NaOH samples.

HCl and NaOH addition limited bacteria growth.

Limited or no growth of *enterobacteria, Bacillus cereus, yeast and molds*.

### Thermal properties



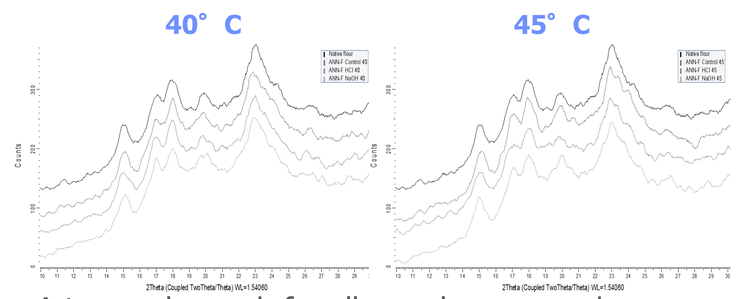

Annealing temperature has a significant impact on thermal profiles especially for NaOH samples.

Annealing induced an increase of To and Tp with a narrower peak and to a greater extent at 45° C.

Tp: Control > HCl > NaOH > Native

Gelatinization enthalpy (ΔH) increased for annealed samples except for NaOH-40.

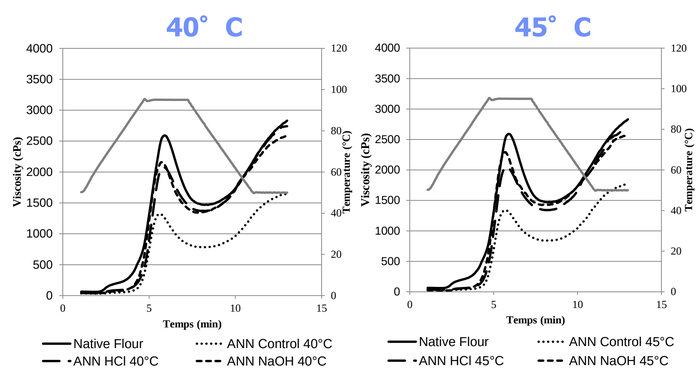
### Crystallinity




A-type polymorph for all samples => no change

No significative difference in the relative degree of crystallinity.

### Pasting properties – $H_2O$



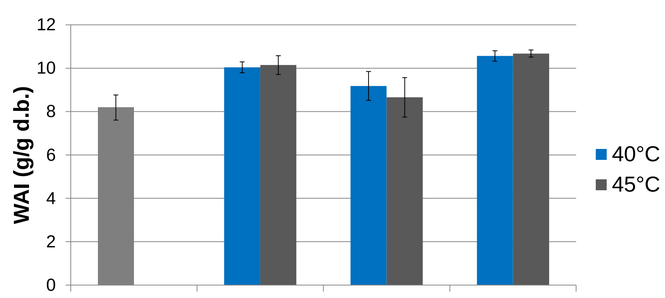

No significative difference between pasting profiles of annealed flours at 40° C and 45° C

Peak: Native > NaOH-HCl > Control

Breakdown: Native > NaOH > HCl > Control

Pasting T° : Native << NaOH < HCl < Control

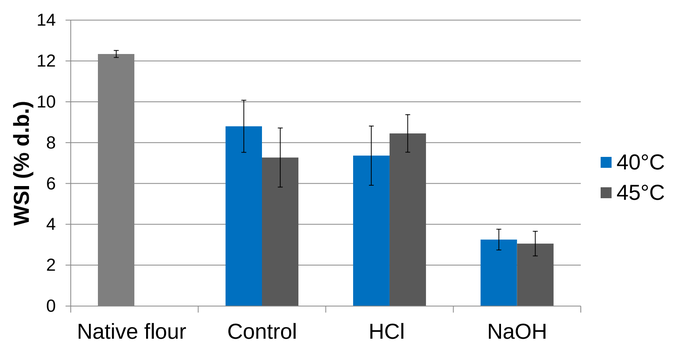
### WAI after gelatinization




WAI increased with annealing treatments in aqueous and in alkaline solutions.

No significative difference between annealing temperatures.

### WSI after gelatinization




Annealing treatments decreased WSI with a greater impact at alkaline pH (NaOH).

## 5 Conclusion

The addition of NaOH and HCl limited bacteria growth compared to the control sample in which lactic bacteria were the main contaminants.

At various annealing temperatures and pH, annealed wheat flours underwent structural and physico-chemical modifications that impacted their functional properties.

These physico-chemical modifications observed in DSC but not in DRX suggested restructuration in the amorph zone.

The new wheat flour functionalities allow a diversification of its use in food applications.

**Aknowledgement**

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