The effect of upstream setting parameters of extrusion-cooking on the physicochemical and functional properties of wheat flour extrudate

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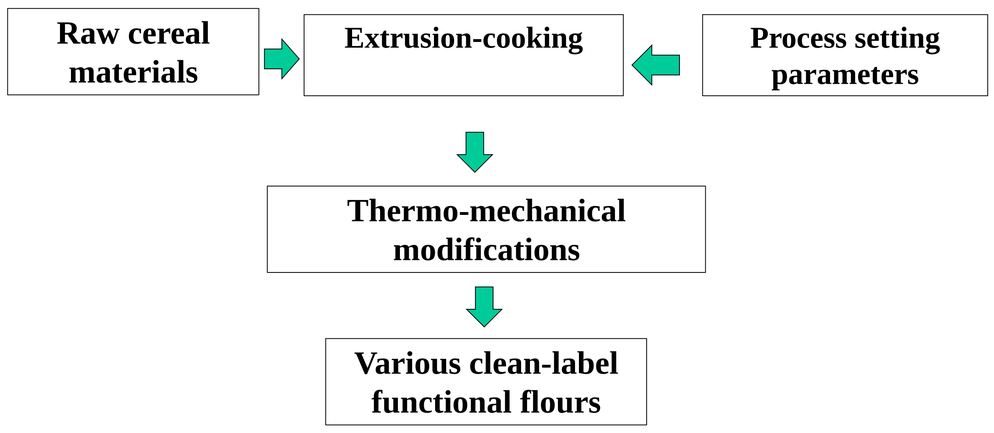
Introduction

Extrusion-cooking is a widely used food process that induces thermo-mechanical modifications within cereals materials in order to produce products as diverse as infant formula bases, breading base, expanded snack foods and many ingredient used in food industry.

The degree of modifications suffered by cereals material and the properties of extrudate recovered vary with the intensity of parameters applied during the process as well as by their interactions .

The aim of this work was to study the influence of extrusion-cooking setting parameters on physical structure of extrudate and the physicochemical and techno-functional properties of functional wheat flour recovered



Material and Methods

Pilote plant scale extruder used

Co-rotating double screw

L/D= 9:1

Three segment of screw

Two induction coils of 7 and 3kW

Two circular dies = 4 mm

Rotary knife cutting system

Raw material

Native wheat flour of baking quality

Extrusion parameters :

- screw speed,
- barrel temperature
- moisture content of the flour

Experimental design

Run	*Actual values*			*Coded values*		
	Screw speed (X1)	Temperature (X2)	Moisture (X3)	A	B	C
1	100	110	20	-1	-1	-1
2	200	110	20	1	-1	-1
3	100	150	20	-1	1	-1
4	200	150	20	1	1	-1
5	100	130	20	-1	0	-1
6	150	130	20	0	0	-1
7	200	130	20	1	0	-1
8	100	130	25	-1	0	0
9	200	130	25	1	0	0
10	100	130	30	-1	0	1
11	200	130	30	1	0	1

Responses analyzed :

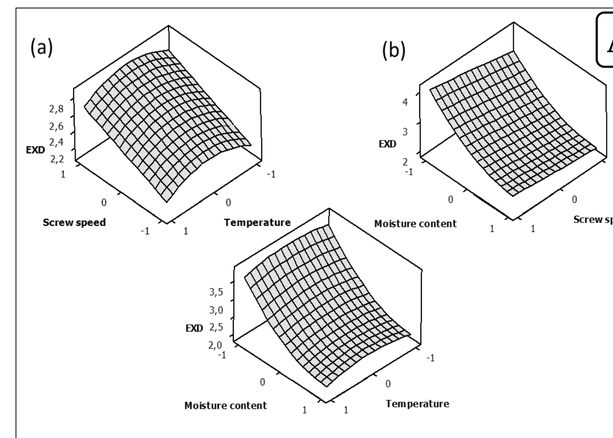
- expansion rate of extrudate (EXP)
- water absorption index (WAI)
- water solubility index (WSI)
- pasting behaviour
- Flow curve of extrudate-water

Responses modellization :

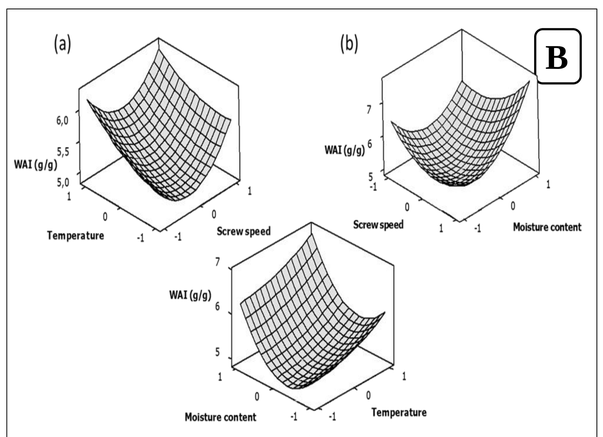
$$Y = a + \sum_{i=1}^{3} biXi + \sum_{i=1}^{3} ciiXi^2 + \sum_{i=1}^{2} \sum_{j=i+1}^{3} dijXiXj$$

Results

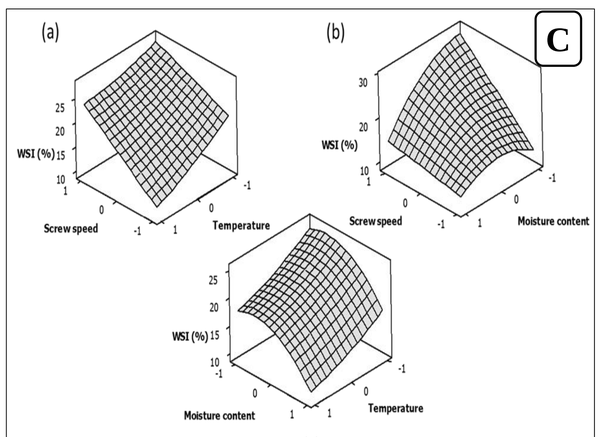
1. Expension rate (EXT)



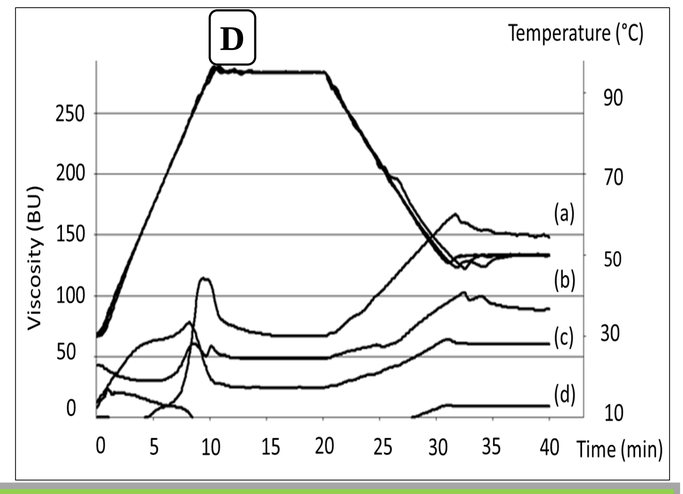
2. Water absorption index (WAI)



3. Water solubility Index (WAI)



4. Pasting behaviour



Results show that screw speed and moisture content of the flour have a linear effect on wheat extrudate expansion. The water binding capacity of extrudate mainly depends on barrel temperature and moisture content of the flour. High screw speed combined with initial low moisture content of flour increase significantly the Water solubility index of extrudate probably because of starch dextrinization. Hot paste viscosity of extruded wheat flours was far lower than native one analysed by Micro Visco-Amylo-graph, meaning that starch is partially pregelatinized during an extrusion treatment. Initial viscosity was also higher for extruded flours than native one.

5. Flow curves of native and extruded flours

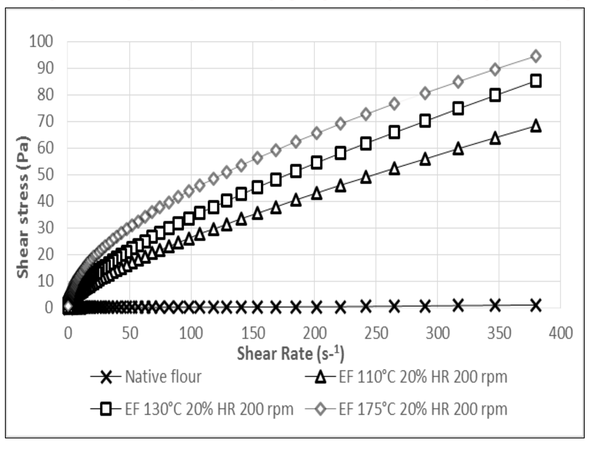


Fig : *Effect of barrel temperature*

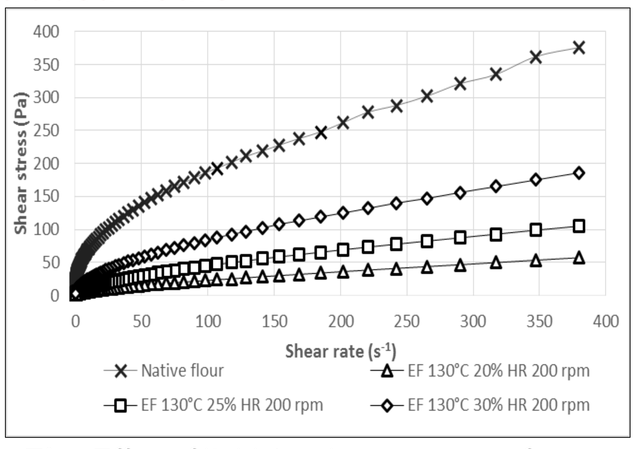


Fig : *Effect of iinitial moisture content after a supplemental hydrothermal treatment (95 ° C)*

Flow curves of water dispersion of extruded flours show a rheofluidifiant behaviour and vary depending on barrel temperature and moisture content.

6. Predicting models

Models	R^2	F
$EXP = 2.635 + 0.229A - 0.768C - 0.076AC - 0.173B^2 + 0.388C^2$	0.999	481.38
$WAI = 5.492 - 0.202A + 0.468B + 0.565C + 0.192AC + 0.608C^2$	0.914	2.657
$WSI = Y4 = 20.20 + 5.02A - 3.67C + 1.5AB - 3.4AC$	0.991	28.127

EXD is linearly affected by A and C , quadratically by B2, C2 and by the interaction (AC).

WAI is affected by linear (A, B, C), quadratic (C2) and interaction (AC) terms

WSI is affected by both linear (A, C) and interaction (AB and AC) terms

Conclusions

Extrusion-cooking of flours induces physico-chemical modifications which make wheat flour relevant as cold binder and viscosifying agent in several food industry applications. The rate of functionality induced during this process may be manage by a safe determination of process setting parameters

Aknowlegements

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