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REDUCTION OF PAR-BAKED BREAD ADDITIVES BY PROCESS OPTIMIZATION

Aim

Par-baking contributes to the extension of the microbiological and physico-chemical shelf-life of bread. However, once fully-baked, retrogradation sets in and reduces quality quickly, resulting as yet in food waste. Typical properties of stale bread are hardening and drying of the crumb, reduction of crumb cohesion and less resilient crumb. In order to bypass the use of chemical additives (clean label) or advanced packaging, the influence of par-baking on the physico-chemical properties of bread was studied and compared with six commercially available par-baked breads. These commercial breads contained some of the following additives: E262 (sodium diacetate), E412 (guar gum), E471 (mono-and diglycerides of fatty acids), E472e (DATEM, mono- and diacetyltartaric acid esters of mono-and diglycerides of fatty acids).

Method

Additive-free bread rolls (AFBR) were produced with varying par-baking conditions, including baking time (4, 6, 8 min), temperature (150, 750, 200°C), steam (200, 400, 600 ml), packaging and storage temperature. The breads were analyzed under the conditions par-baked (PB), 1h, 24h and 48h after full-baking. Weight (g), volume (ml), crumb moisture content (%), and texture (crust and crumb hardness, springiness, resilience, cohesiveness and chewiness) were recorded.

Results

Cohesion of commercial PB breads and AFBB, 1h after full-baking the values were similar, 0.81 ± 0.01 and 0.79 ± 0.03 (e.g. 200 mL steam). After 24h and 48h cohesion was ± 0.6 for all bread types. Springiness was found to be constant for the commercial breads (± 0.9), whereas a gradual increase in springiness for the AFBR was observed in function of time after full-baking (from 0.8 to 0.95). Moreover, an optimum in springiness was observed for 400 mL steam and frozen storage. Additionally, at 200 mL steam, springiness increased with increasing baking time and temperature. Resilience of commercial bread was significantly higher after 48h compared to the AFBR, resp. ± 0.4 versus ± 0.2. However at 24h, the values were the same for all types: ± 0.2.

Conclusion

These results show that optimization of par-baking can prolong the freshness of par-baked bread and limit the use of additives. Additives in PB bread mainly influence crumb springiness (constant value) and resilience (less crumbly) after 48h. Up untill 24h, there is little difference between the commercial breads and AFBR. A combination of par-baking optimization, frozen storage and MAP-packaging can support the market of clean label par-baked bread.

Experimental design – texture analysis of commercial Kaiser rolls versus additive-free selfmade bread rolls

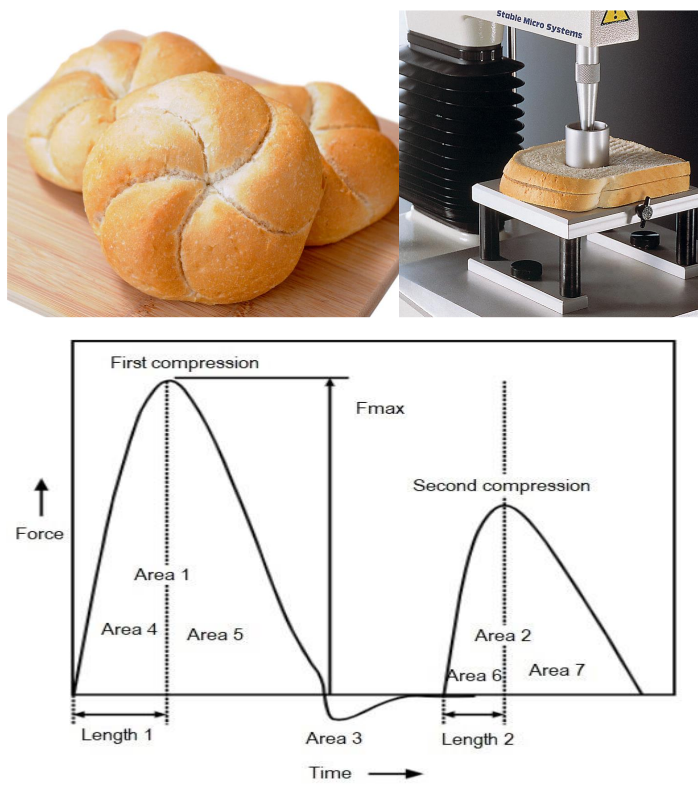

Figure 1: Experimental set-up: Kaiser rolls, texture analyzer and texture profile analysis curve (TPA).

Table 1: Composition of the commercial breads, water, yeast (baker's yeast), salt (iodized salt) and sugar (dextrose) are all the same between recipes.

Name	A	AH	B	C	D	L	AFBR
Brand	Aldi	Albert Heijn	Boni	Carrefour	Delhaize	Lidl	/
Wheat flour	x	x	x	x	x	x	x
Rye sourdough (dried)	x		x	x	x	x	
Malt flour		x	x	x	x		x
Rice flour	x	x	x	x	x	x	
Faba bean flour		x					
Rye flour		x					
Wheat gluten		x					
Rape oil	x	x					
E300	x	x	x	x	x		x
E262	x						
E412				x	x	x	
E471	x	x			x	x	
E472e	x	x	x	x	x	x	
Wheat enzy.				x	x	x	

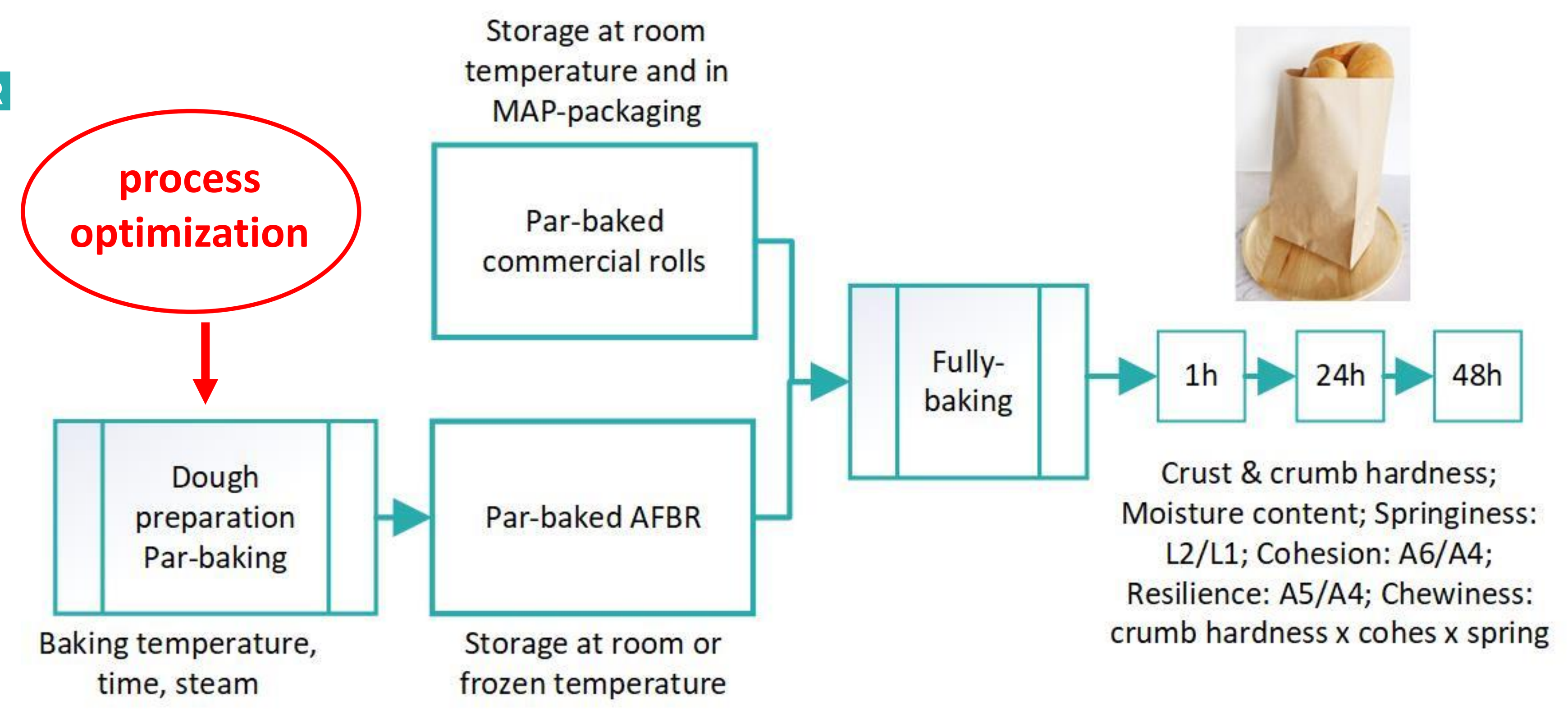

Figure 2: Experimental set-up of the quality evaluation of commercial Kaiser rolls and self-made additive free bread rolls (AFBR): texture analysis of par-baked rolls and after fully-baking and 1, 24 and 48h of storage in paper bags.

Results

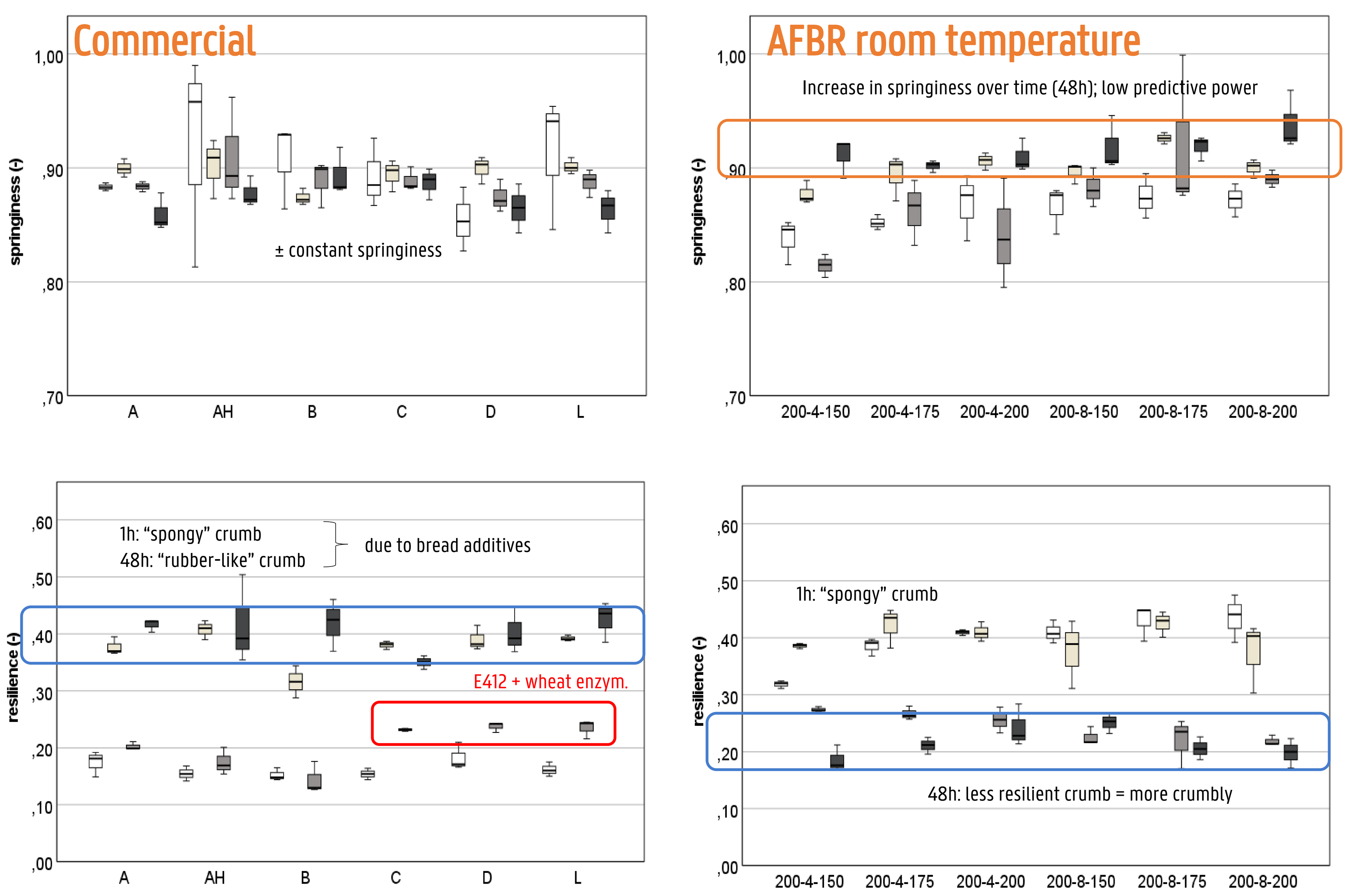

Figure 3: Springiness and resilience of commercial Kaiser rolls (left) and par-baked breads baked at 200 mL steam in function of time: PB (white); 1h (offwhite), 24h (lightgrey) and 48h (darkgrey) after full-baking.

Table 2. GLM of bread characteristics (weight (W), volume (V), specific volume (SV), moisture content (MC), crust hardness (CRUST), crumb hardness (CRUMB), springiness (SPRING), cohesiveness (COHES), resilience (RESIL) and chewiness(CHEW)) in function of baking temperature (bT (°C), /100) and baking time (bt (min)) used in the second baking phase of par-baking, steam (S (mL), /100), storage temperature (sT; value equals 1 for room temperature and 2 for frozen storage) and storage time (st; value equals 2 for 1h, 3 for 24h and 4 for 48h of storage; PB was left out of the GLM).

	W (g)	V (mL)	SV (mL/g)	MC (%)	CRUST (g)	CRUMB (g)	SPRING (-)	COHES (-)	RESIL (-)	CHEW (g)
Intercept	48.74	143.6	3.162	37.60	-757.3[a]	-327.2[a]		1.117	0.649	479.9
bT				5.45						
bt	0.48		-1.800	1.14		-230.8				-131.3
S					207.4					
sT	3.02		-0.226	3.30	-2517.3			-0.073	-0.065	
st	-0.76	-6.0						-0.132	-0.098	
bT x st				-0.63		206.0				
bt x bT	-0.48	1.1	0.130	-0.76	148.2					
bt x st						119.0				63.8
S x sT						33.6				
S x st				-0.05						
sT x st	-0.98			-0.51	1108.1					
R^2	**0.775**	0.188	0.416	**0.780**	**0.640**	**0.731**	< 0.100	**0.882**	**0.864**	**0.631**

Par-baking parameters strongly influences bread weight, moisture content, crust and crumb hardness, crumb cohesion, resilience and chewiness ($R^2 > 0.63$). However, results show that resilience and springiness of commercial bread show different effects over time (e.g. fresh versus stale bread, spongy crumb versus rubber-like crumb). Therefore, these two parameters cannot be directly compared over time without measuring the effect of time. Bread emulsifiers support longer bread freshness (constant springiness and high resilience values in function of time). Furthermore, par-baking time, temperature and storage temperature influence bread staling properties the most. Bread additives have no added value upon 24h of storage after fully-baking (for both breads stored at room temperature or frozen storage).

Conclusion

In all of the six commercial Kaiser rolls, bread additives were used. However, we raised the question whether it is necessary to use bread additives in par-baked bread rolls, which are intended to be baked-off before consumption. In fresh condition (1h after fully-baking), the bread additives showed no additional benefit to the textural quality of the bread rolls. At 24h, bread rolls containing additives had lower crumb cohesion and higher chewiness compared to the AFBR. This particular finding supports again the idea of no need of additives. After 48h, textural quality of bread rolls was strongly influenced by the additives (e.g. increased moisture retention with E412, increased resilience/less crumbly crumb). However, these types of bread are expected to be consumed fresh, preferably within the first hours after fully-baking, so no bread additives are needed to maintain good bread quality.

Table 3. General overview of the results. Comparison of the influence of additives and processing steps on bread quality characteristics. Final conclusion of quality after 1h, 24h and 48h after fully-baking is presented. The green symbols represent the fact that quality of AFBR was similar to commercial bread rolls containing bread additives.

	V (mL)	MC (%)	CRUMB (g)	COHES (-)	RESIL (-)	CHEW (g)
Commercial bread rolls	E472e ↑	E412 (48h) ↑	E412 (48h) ↓ E471 (48h) ↓	E412 (24h) ↑ E472e (48h) ↑	E412↑ E472e (48h) ↑	E412 (48h) ↓ E471 (48h) ↓
AFBR (process)	st ↓	st ↓	bt x st ↑	sT ↓ (frozen storage) st ↓	sT ↓ (frozen storage) st ↓	bt x st ↑
1h		✓	✓	✓	✓	✓
24h		✓	✓		✓	
48h	Lower bread volume without E472e.	Reduction of moisture retention without E412	Crumb hardness of the AFBR is lower compared to the commercial rolls.	Crumb cohesion is lower with additives, but can be increased with E412 (at 24h) and E472e (48h). However, the results show no need of using additives for increasing cohesion.	The use of additives results in a rubber-like crumb, whereas in AFBR staling effect is observed by a decrease in resilience.	Chewiness of the AFBR is lower compared to the commercial rolls

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