Investigations of fracture mechanics of crisp wafer breads with spreads of different water activity

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Introduction

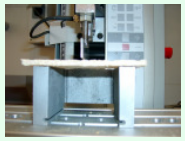
Snacks and fast food based on crisp wafer bread are part of the upcoming generation of shelf-stable baked "food to go". The development of new products in this category requires an approach that involves the recipe of the bread material and a generation of spreads that shows low water activity in special emulsions or dispersions.

Thorough investigation of wafer breads as well as conventional spreads or spreadable materials gives hints to the required properties of the materials that have to be used for the new generation of wafer bread snacks with spreads.

Materials and Methods

Three different types of crisp wafer bread, based on wheat flour, potato starch/buckwheat flour (gluten-free), and wheat flour/rye bran (fibre-enriched), were investigated for their water activity and fracture behavior after equilibration at 55-60 % humidity and 22 C. All breads had the same diameter. Two spreads with different a_w-values, German Butter® and processed cream cheese

(Milkana Sahne, Kraft Foods, Germany), were applied to one slice and covered with another. Fracture mechanics and water activity were measured under the same conditions as above. Applied forces and compression length were measured by a Zwick material analyzer, type Basic-Line (Zwick, Ulm) equipped with a blunt rectangular metal blade (70x2 mm²) and TextXpert software up to a F_{max} of 100 N at a tool rate of 500mm/min. All results are an average of 10-15 single measurements.



Results and Discussion

Irrespective of their composition all wafer breads from freshly opened packages had a water activity of 0.33.

After equilibration, the a_w-value of the wheat-based wafer breads rose significantly, whereas the fibre-enriched formulation showed the lowest values, followed by the gluten-free species (Table 1).

Table 1. Water activity of wafer breads with and without spreads after equilibration at 55–60 % r. h. and 22 °C during 24 h.

Spread	Wheat-based	Gluten free	Fibre-enriched
None	0.47	0.45	0.37
Butter	0.63	0.59	0.56
Cream cheese	0.60	0.59	0.55

Despite of the differences in a_w-value, break force and compression were scarcely influenced compared to the fresh bread (data not shown).

Water activity of the spreads was 0.82 for butter and 0.91 for cream cheese, respectively. Independently of their own water activity, butter (outer phase: oil) and cream cheese (outer phase: water) generated an almost similar increase of a_w within the same wafer bread species.

Break force vs. compression of the gluten-free bread with and without spreads are shown as average curves in Figure 1. The average break force (F_{max}) and the length of compression (L_{Fmax}) are summarized in Table 2.

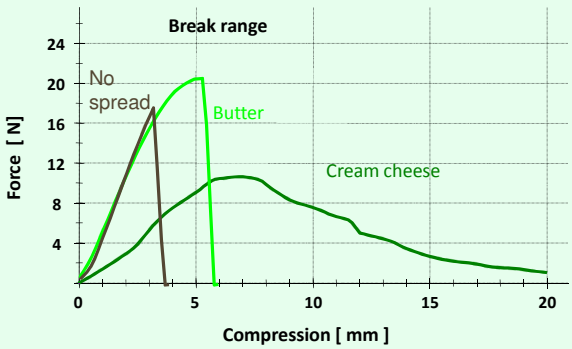


Figure 1. Break force vs. compression of gluten-free potato starch/buckwheat flour wafer breads without and with butter or cheese

Whereas butter increased the break force, the influence of cream cheese was opposite. Both spreads, however, rendered the breads somewhat more elastic, as indicated by the longer compression length before the break point.

This effect was more pronounced when cream cheese was used. Compared to the other wafer breads, the fibre-enriched was the least resistant against water uptake from the spreads but showed the lowest resistance against fracture. The gluten-free wafer bread was the most resistant to fracture.

Table 2. Break force and compression length of wafer breads and with and without spreads after equilibration at 55–60 % r. h. and 22 °C during 24 h.

Spread	Wheat-based		Glutenfree		Fibre-enriched	
Parameter	F_{max} [N]	L_{Fmax} [mm]	F_{max} [N]	L_{Fmax} [mm]	F_{max} [N]	L_{Fmax} [mm]
None	8.72	1.69	18.31	3.24	7.43	1.64
Butter	11.07	2.60	21.62	4.92	9.77	2.15
Cream cheese	4.79	5.36	10.49	6.93	5.31	4.99

Conclusions

Wafer bread with a heterogeneous matrix with dietary fibre was the most brittle and absorbed the most water. The more starch was in the formulation, the crispier was the wafer matrix.

The prolonged contact with a spread of the water-in-oil-type (butter) unexpectedly "strengthened" all wafer matrices and crispiness was retained. In contrast, an oil-in-water emulsion (processed cream cheese) provoked considerable loss of crispiness under the chosen conditions.

Literature

For wafer bread recipes: http://www.gutena.de/knusperbrot.php?res=1024

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