# The role of different ingredients in quality determination of gluten free bread (GLUeLESS)

## (CORNET)

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| **Coordinaton:** | Forschungskreis der Ernährungsindustrie e.V. (FEI), Bonn (Research Association of the German Food Industry) |
| **National Agencies:** | • AiF - German Federation of Industrial Research Associations, Germany<br>• IWT - Institute for the promotion of Innovation by Science and Technology, Flanders/Belgium |
| **Research Association:** | • Flanders´ Food, Brussels/Belgium |
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## Initial situation:

Celiac disease is one of the most prevalent food hypersensitivities in the world, affecting around 1% of the population. The permanent sensitivity towards wheat, rye and barley storage proteins (= gluten) manifests itself by villous atrophy and malabsorption of essential nutrients in genetically susceptible individuals. Affected persons are therefore dependent on gluten-free products. Similarly, persons with non-celiac gluten/wheat sensitivity (NCGS) and wheat allergy need to avoid gluten in their diet. In addition, an increasing number of unaffected people are consuming gluten-free products. The reason for this behavior is a change in the lifestyle of many consumers, as the consumption of gluten-free food is considered healthy and often associated with weight loss.

The production of gluten-free baked goods, especially of gluten-free breads offers numerous possibilities. Formulations based on gluten-free grains (e.g., rice, corn, millet), pseudocereals (e.g. buckwheat) and mixtures of gluten-free starches and proteins (e.g., egg white powder) are possible. Nonetheless, the quality of most gluten-free products currently on the market is worse compared to their gluten-containing counterparts. Especially the texture and the aroma differ from conventional products due to the different ingredients and deviation in functional properties of the raw materials.

Therefore, the aim of the research project was to improve the quality of gluten-free bread. The focus of the investigations was on optimization of the texture, the nutritional value and the aroma of these breads. The influence of various ingredients of gluten-free flours as well as various ingredients and additives in the recipe on perception of texture and aroma was determined and the production process adapted in order to optimize the texture and the aroma with these findings.

## Research results:

As a part of the project two gluten-free recipes, one for rice bread (based on rice flour) and one for starch bread (based on cassava starch, potato starch and egg white powder; ratio: 6.75/2.25/1) were defined as standard recipes. Furthermore, a direct comparison to wheat bread was performed for the examination of the aroma. Aroma profiles generated using a sensory panel test illustrated the differences between the crumbs and crusts of the different bread types. Typical odor characteristics of wheat bread (malty, yeasty and roasty/popcorn-like) were less pronounced in the gluten-free formulations. The rice bread was strongly reminiscent of rice, while the starch bread had an egg-like, sulfurous note.

By means of a sensomics approach, differences in the aroma composition between the gluten-free breads and wheat bread were identified. The rice bread distinguished itself mainly by its characteristic aroma compound 2-aminoacetophenone from wheat bread. The intensities of the crust aroma compounds p-vinylguaiacol and maltol formed during the baking process were significantly lower in the rice bread crust than in the wheat bread crust. The starch bread differed from wheat bread mainly by the lower impact of lipid degradation products (e.g., (*E,E*)-2,4-decadienal) and vanillin. This is due to the substitution of the cereal flour by a starch-protein mixture, which lacks the lipid fraction and other aroma compounds. In addition, the crust aroma compound maltol was less relevant in the starch bread than in the wheat bread.

In order to follow the release of aroma compounds from the bread matrix, a chewing simulation linked with a proton transfer reaction mass spectrometer (PTR-MS) was developed. The following mass traces and corresponding aroma compounds were chosen: m/z 71 (3-methyl-1-butanol), m/z 89 (methylpropanoic acid, butanoic acid), m/z 103 (2- & 3-methylbutanoic acid), m/z 105 (2-phenylethanol) and m/z 139 (γ-nonalactone). The aroma release behavior was observed by static measurement, by chewing motion, and by chewing motion after saliva addition. The investigations revealed an increase in the aroma release as affected by the chewing motion which can be explained by the surface expansion of the sample. Saliva addition caused a decrease of the aroma release, depending on the polarity of the analytes. Intensity differences between the samples were attributed to the differences in their aroma compound concentrations, which is why the release from the starch bread crumb was the weakest. The aroma compound release tended to decrease after storage for 24 h, especially in the rice and wheat bread crumbs. However, the release from the starch bread crumb increased after storage which could be related to the stabilization of the crumb structure which was very sticky directly after baking.

The influence of oat oil with enriched polar lipid content on the quality of the gluten-free rice and starch bread recipes was determined by means of baking tests, volume and texture measurements as well as sensory tests. In the rice bread, the oat oil caused an increase in volume and a decrease of the crumb firmness, but only small changes in sensory properties were observed. However, the oat oil caused a decrease of the starch bread volume, which went along with a stabilization of the otherwise sticky, non-elastic bread-crumb and an improvement of the sensory properties by weakening the egg-like smell. In addition, a slower crumb firming was observed during storage of both bread types due to the oat oil addition.

For functionalization of proteins with respect to their application in gluten-free bread recipes, plant proteins based on soya and pea were texturized using the high-moisture-extrusion (HME) at temperatures of up to 150 °C. The protein structure is modified during this process and new inter-molecular interactions are generated. For this purpose, soya protein isolate was treated in the extruder at different conditions and the products obtained were comprehensively characterized. Later on, this was also carried out for the pea protein isolate in a similar way. Using the texturized soya proteins for the preparation of the gluten-free breads at project partner KU Leuven, less firm breads with a higher volume were obtained compared to the application of the untreated soya protein. Despite the proteins, also rice flour was pre-treated by hydrostatic high pressure (up to 200 MPa) and/or roller-dried in an aqueous flour suspension for a gelatinization of the rice starch. However, the influence of the ingredients pre-treated in this way was rather low with respect to the quality of the final breads.

Furthermore, it was investigated which parameters are suitable to describe the manufacturing process of the gluten-free doughs independently from the equipment used in laboratory scale. Such parameters would enable an upscaling of the dough mixing processes into the industrial practice. For this purpose, the concept of the re-

presentative shear rate during mixing was applied. The calculated parameters for the laboratory mixing process can be directly transferred to the industrial scale providing the same mixing intensity.

## Economic impact:

The insights gained in the project and the first systematic assessment of the influence of various ingredients on the quality of gluten-free breads will allow, in particular the SMEs, to develop new formulations and new processes for the production of gluten-free breads more quickly. For the manufacturers of production facilities, the possibility to design special mixer systems for the growing gluten-free market was offered. So far, the further development of gluten-free products has largely been based on the "trial and error" principle, which can now be replaced by targeted, knowledge-based use of alternative raw materials on the basis of the project results. Thus, SMEs can react quickly to fluctuations in the quality of raw materials and increasingly demanding consumer expectations. Consequently, in the future, gluten-free breads with improved textural properties, a more pleasant mouthfeel, a more attractive crust browning and improved freshness can be produced. In addition, the nutritional value of the products is improved through the use of innovative raw materials and production processes to prevent deficiencies and to ensure adequate nutrient supply.

## Publications (selection):

1. FEI-Schlussbericht 2018.
2. Franke, K.: GLUeLESS - Die Rolle verschiedener Inhaltsstoffe in der Qualitätsbestimmung von glutenfreiem Brot. Jahresber. DIL 2017/18, 96-97 (2018).
3. Mihu, C. et al: Gluten-Free Bread, Only Better. Eur. Bak. & Bisc. 4, 8-9 (2018).
4. Böswetter, A. & Köhler, P.: Studien zur Charakterisierung des Aromas von Reis- und Stärkebasierten glutenfreien Backwaren. Jahresber. Dt. Forschungsanst. Lebensmittelchem., ISBN 978-3-00-056386-7, 122-125, (2017).
5. Böswetter, A., Scherf, K., Schieberle, P. & Köhler, P.: Studien zur Aromastofffreisetzung aus glutenfreien Broten im Vergleich zu Weizenbrot. Leibniz-LSB@TUM, ISBN 978-3-00-058295-0, 40-42 (2017).
6. Franke, K.: GLUeLESS - Die Rolle verschiedener Inhaltsstoffe in der Qualitätsbestimmung von glutenfreiem Brot. Jahresber. DIL 2016/17, 94-99 (2017).

## Further informations:

Leibniz-Institut for Food Systems Biology at the Technical University of Munich
Prof. Dr. Thomas Hofmann/
Dr. Katharina Scherf
Lise-Meitner-Straße 34, 85354 Freising
Tel.: +49 8161 71-2928
Fax: +49 8161 71-2970
E-Mail: k.scherf.leibniz-lsb@tum.de

German Institute of Food Technologies (DIL)
Dr. Volker Heinz/Dr. Knut Franke
Prof.-von-Klitzing-Str. 7, D-49610 Quakenbrueck
Tel.: +49 5431 183-140,
Fax: +49 5431 183-450
E-Mail: k.franke@dil-ev.de

Research Association of the German Food Industry
GFPi/FEI EU-Office
Dr. Jan Jacobi
47-51, Rue du Luxembourg,
B-1050 Brussels/Belgium
Tel.: +32 2 28208-40
Fax: +32 2 28208-41
E-Mail: gfpi-fei@bdp-online.de

Flanders' Food
Erwin Lamot/Veerle Rijckaert
43 Kunstlaan, B-1040 Brussels/Belgium
Tel.: +32 2 788 43 64
Fax: +32 2 788 43 68
E-Mail: erwin.lamot@flandersfood.com

KU Leuven
Laboratory of Food Chemistry and Biochemistry
Jan Delcour/Ellen Fierens
20 bus 2463 Kasteelpark Arenberg, B-3001 Leuven/Belgium
Tel.: +32 16 32 15 81
Fax: +32 16 32 19 97
E-Mail: Jan.delcour@biw.kuleuven.be

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