DEVELOPMENT OF A GLUTEN FREE SOURDOUGH BAKERY PRODUCT

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Abstract

The population of gluten sensitive people has been gradually rising in the last decades. The food industry especially the bakery industry has to develop more gluten free products to satisfy the consumers demand. However, the quality of these products differ from the quality attributes of a standard glutenious bakery product. Therefore the aim of our research was to develop a good quality gluten free sourdough product with 3 different gluten free flours: millet, brown rice and a commercial available mixture (Belbake). We investigated the differences in moisture content, the bake loss, the texture and the sensory properties of the products. According to our results in the case of the moisture content the brown rice sample had the highest, while the millet gave the lowest value. The bake loss measurement gave reverse results. In the texture analysis the brown rice sample was the softest, but the millet and the Belbake had better results in resilience and in springiness. Also in the sensory analyses the Belbake product was found to be the best by the judges. However there were no significant differences between them. In conclusion the product development of a gluten free sourdough bakery product was successful. Further research is needed to investigate the shelf life of the products.

Keywords: gluten free, sourdough, millet, brown rice

Introduction

The food industry like lots of other industry is constantly changing, due to the newer trends, food intolerances and different illnesses, which occur in the World. These changes sometimes mean big challenges, however, it also provide opportunities to develop new, diversified and healthier foods. In the 21th century the consumer's lifestyle and eating habits have been changing and to the new demands all food companies - including the bakeries - have to adapt. International studies proved, that the gluten sensitivity is one of the most common lifelong disorders, which concern 1 % of the European population (Mustalahti et al., 2010). According to Singh and their co-workers (2017) this number is even higher nowadays. They found that the presence of the sensitivity in global is 1,4 % based on serological tests and 0,7 % based on biopsy.

Many people self-diagnoses themselves with gluten sensitivity, which is most of the time not confirmed by a special doctor, but we could surely claim that nowadays the number of gluten sensitive people is raised, also according to the forecast this number will be rising further in the future. Zorzi and their co-worker (2020) wrote in their research that predictably between 2020 and 2027 the demand for gluten free products will be increased with 9,2 %, in which the gluten free bakery products will be in the biggest ratio. In the other hand the gluten free diet is getting more and more popular and lots of people start to follow these eating habit without having the food intolerance. Also in small households it is often observed, that if one person is affected in the food intolerance, the other members of the family switch also to this diet, to make the meals and the shopping easier. Due to the above mentioned reasons the bakery industry must use new ingredients, technologies or methods to make more and better quality products for the gluten sensitive consumers (Biró et al., 2019). One method for development of a gluten free bakery is well known and exist since the ancient times: the making of sourdough. Several research proved that this method could be effective for making gluten free breads and other bakery products (Rozylo et al, 2015; Moroni et al., 2009; Di Cagno et al.; 2010; Picozzi et al., 2016).

In the industry they often use wheat or rye to make sourdough, however, these grains are not gluten free, therefore other grains or pseudocereals are needed to use for the production of these kind of products (Szedljak I., 2018). From the gluten free grains the sourdough and even the dough making is not easy, due to the missing gluten-forming proteins in the flours, however the challenge is feasible. Unfortunately there are only a few research about this topic.

Two well-known grain could be used for development a gluten free bakery product, one is millet the other one is brown rice. Millet is an ingredient that has a pleasant taste, an alkaline effect, it is rich in fibre, a good source of plant protein and it has an outstanding nutritional value (Léder F, 2013). The other grain is rice which is now grown everywhere around the World (Rosell and Marco, 2008). The rice is one of the best-known gluten free grain next to the maize and it is one of the most important ingredients in the gluten free kitchen. It has a lower protein content than the wheat, however among grain proteins it has the most beneficial amino acid composition. The brown rice flour is digested slower than the white wheat flour and the white rice flour, which means, that it has a lower glycemic index, therefore it is recommended for diabetics (Internet 2).

The aim of our study was to find out which one of the above mentioned flours (brown rice flour or millet) is the most suitable for the development of a gluten free sourdough bakery product. The goal was to achieve a good quality product, which could be a cheaper alternative to the shops gluten free products.

Material and Methods

In our research, we used 3 different kinds of flour, millet, brown rice and a commercially available gluten free flour mixture (Belbake: mixture of rice flour and starch). Our products contained 350 g flour, 85 g sourdough, 4 g sugar, 8 g salt, 5 g yeast, 75 g sour cream, half egg, 30 g olive oil and 100 ml water. All the ingredients were commercially available. The only difference between the products were the type of the used flour.

For making our products first we needed to make the sourdough, which was spontaneously fermented at 25-27 °C and only made from flour and water (1:1 ratio). It was fed for 4 days. In the 5th day we kneaded together our ingredients. After the dough was ready we divided it to achieve around 115 g products. The dough was leavened for 40 minutes in a controlled environment (at 32°C and 80 % of relative humidity). Then the samples were baked for 16 minutes at 180°C. After cooling in room temperature for a half hour the moisture content, bake loss, texture and sensory properties were measured.

Moisture content, bake loss

Moisture content was measured with Sartorius MA 50 automatic moisture content measuring device. We put 2,5 g sample into the device which is than drying the samples at 105°C till achieving the weight equilibrium. All samples were measured 3 times.

For calculating the baking loss we measured the weight of the formed dough before baking and after the baking when it was cooled down. Than we used the following equitation:

$$Bake\ loss\ (\%) = \left(\frac{Dough\ weight}{Baked\ product\ weight} - 1\right) * 100$$

Texture analyses

The samples' texture were analysed with Stable Micro System TA-XT2i universal texture measurement device. We applied the Texture Profile Analyses (TPA) method to investigate the bakery products. A 20 mm diameter plate as probe was used. The method imitates the human chewing with 2 compression circles. The initial speed of the measuring probe was 1mm/s, the text speed was 5mm/s. The compression was 40% of the original heights. The measurements were done 5 times, each sample was 25 mm high. From the measured curves the software calculated the hardness, adhesiveness (negative work between the two cycles), cohesion (Area 2/Area 1), springiness (Distance 2/Distance 1), gumminess (Hardness*Cohesiveness), chewiness (Hardness*Cohesiveness*Springiness) and resilience (Area 4/Area3).

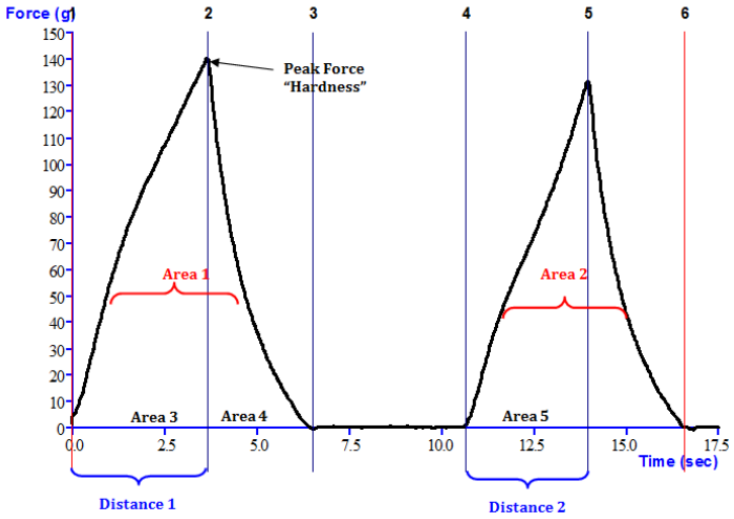

Figure 1:TPA curve (Internet 1)

Sensory analyses

Sensory analyses were done by 37 untrained people, among them one was gluten sensitive and 3 were lactose sensitive. Most of the judges have already tasted gluten free and sourdough products. They had to judge the products in 7 different attribute in a 1-5 scale, where 1 was the worst and 5 was the best. The attributes were: odour, colour, crust, crumb, taste, after taste and overall liking.

Statistics

The results were statistically analysed with one-way ANOVA (p=0,05). If there were significant differences Games-Howell and Tukey post-hoc test was carried out.

Result and discussion

Moisture content

The samples average water content was between 35 and 38 %.

Table 1: Moisture content results

Sample	Average
Millet	35,97% ± 0,071
Belbake	36,39% ± 0,915
Brown rice	37,47% ± 0,523

Our result (Table 1) show that the brown rice sample had the highest while the millet had the lowest water content. According to the ANOVA there were significant differences among the

samples. The post-hoc test showed that the brown rice and the millet sample's water content value was different.

Bake loss

Table 2 summarises the result of the bake loss calculation, the average loss was between 7,2-8,2 %.

Table 2: Bake loss results

Samples	Initial weight (g)	Final weight (g)			Average (g)	Bake loss (%)
		1	2	3		
Millet	115	106,51	106,37	106,05	106,31	**8,17**
Belbake	115	106,81	107,62	106,32	106,92	**7,56**
Brown rice	115	107,08	106,90	107,57	107,18	**7,29**

The millet sample had the highest value and the brown rice sample had the lowest value, which is in an inverse relationship with the water content results. In the industry these values would not be considered as an outstanding bake loss.

Texture analyses

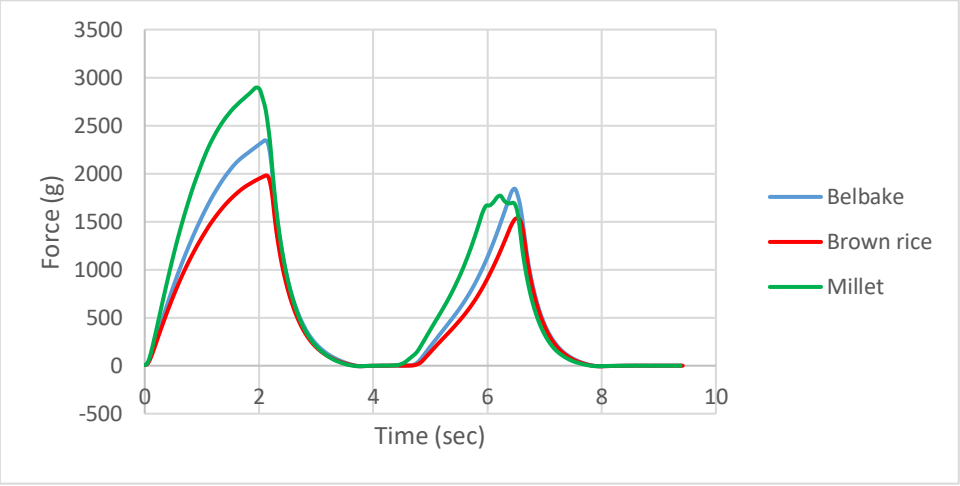

Figure 2: Meausred average TPA curves (n=5)

Figure 2 shows the average TPA curves of the different samples. From the curves we could see that in the first compression cycle the millet sample gave the highest force value, however in the second cycle the Belbake. In case of the millet product the difference of the second and the first force was bigger than in the case of the Belbake product, which here indicate that the crumb

was easier to chew. Among the 3 different bakeries the brown rice one results was the best, these samples crumb was the softest and had the loosest structure.

From the curves the software calculated different texture properties which are shown in table 3.

Table 3: Calculated values from the TPA measurment

	Belbake	Brown rice	Millet
Hardness (N)	23,08 ± 1,667	19,48 ± 1,67	29,01 ± 0,92
Adhesiveness (gs)	-1,044 ± 0,55	-0,741 ± 0,301	-1,436 ± 0,41
Cohesion (-)	0,51 ± 0,013	0,498 ± 0,017	0,49 ± 0,025
Springiness (%)	94,61 ± 7,64	92,313 ± 1,49	97,33 ± 5,72
Gumminess (N)	11,78 ± 0,95	9,71 ± 0,995	14,17 ± 1,04
Chewiness (N)	11,16 ± 1,46	8,96 ± 0,85	13,82 ± 1,67
Resilience (%)	26,75 ± 1,79	25,45 ± 1,30	24,63 ± 1,75

According to our results the millet sample had the highest while the brown rice sample had the lowest values in case of hardness, gumminess and chewiness. The adhesiveness and the gumminess is highly correlated attributes, it specify how much the dough stick to the measuring probe after compression. The chewiness of the sample indicate that from the 3 sample the brown rice one is easier to chew and to consume, which we could also see in Figure 2. In cohesion and in resilience the Belbake sample had the highest value, this means that this bakery product regains its original height or shape better. However in springiness the millet sample was the best. We could see that the products which had higher chewiness value was better in springiness. The statistical analyses (ANOVA) showed that there were significant differences in hardness, gumminess and chewiness. In these parameters each sample gave significant differences (post-hoc), only in chewiness between the Belbake and brown rice were no difference.

Sensory analyses

All of the product resulted in good sensory values in all attributes (Figure 3), the judges found the Belbake sourdough product to be the best according to the overall liking. However there were no significant differences among the products in neither attributes. Based on the used ingredients we calculated the price for each sample. According to that there was also no big differences among the products, the millet rolls would be a little bit more expensive than the others. However, the calculated prices were cheaper than other gluten-free bakery product in the market. This provide a free choice for the bakery industry that which products worth to produce in technological and economical point of view.

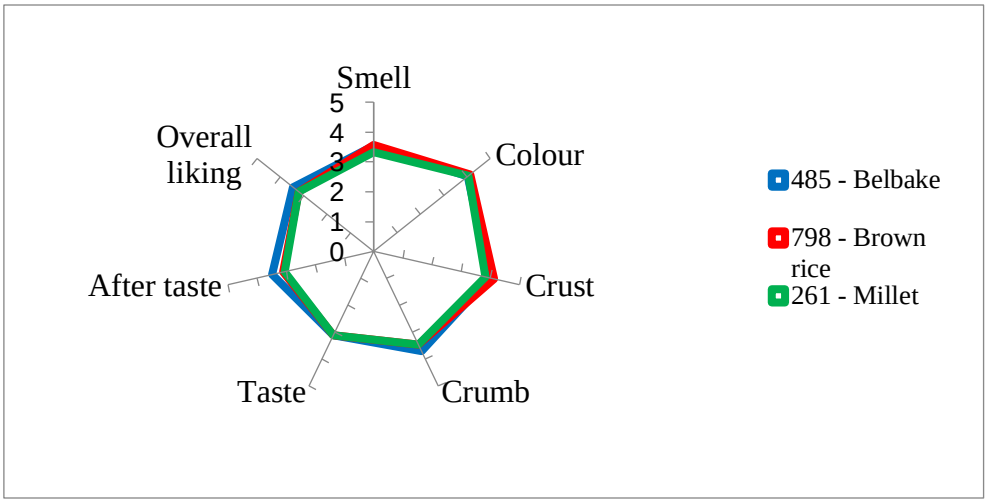

Figure 3: Sensory analyses result

Conclusion

The possibilities of a gluten free sourdough bakery product development were examined. We used brown rice flour, millet flour and a commercially available flour mixture (Belbake). We investigated the differences in moisture content, the bake loss, the texture and the sensory properties of the products. In the case of moisture content after baking the brown rice sample had the highest and the millet had the lowest value. The bake loss showed a reverse result, due to the inverse relationship. According to the TPA results the brown rice sample in all texture attributes gave the smallest values. In the hardness it is beneficial, because it means that this sample had the softest texture, which could be due to the higher water content of the sample. However in resilience and in springiness it is disadvantageous. In these attributes the Belbake and the millet products was better. The sensory result also showed that the judges found the Belbake sample to the best, but there were no big differences between the samples.

In conclusion our product development was successful. Our results indicate that there were no huge differences among the products in all attributes and this provide a free choice to the bakery industry that which production worth it in technological or economical point of view. Further research is needed to investigate the self-life of the products.

References

Biró, B., Fodor, R., Szedljak, I., Pásztor-Huszár, K., Gere, A. (2019) Buckwheat-pasta enriched with silkworm powder: Technological analysis and sensory evaluation, *LWT - Food Science and Technology* 116 (2019) 108542

Di Cagno, R., Barbato, M., Di Camillo, C., Rizello, C. G., De Angelis, M., Giuliani, G., ... Gobetti, M. (2010) Gluten-free Sourdough Wheat Baked Goods Appear Safe for Young Celiac

Patients: A Pilot Study. *Journal of Pediatric Gastroenterology and Nutrition*, *51*, 777-783. DOI: 10.1097/MPG.0b013e3181f22ba4

Internet 2: Nemzeti Agrárgazdasági kamara Élelmiszeripari kézikönyv 2. Gluténmentes élelmiszerek (2018) http://nak.hu/kiadvanyok/kiadvanyok/2613-glutenmentes-elelmiszerek/file

Internet 1. Overview of Texture Profile Analysis Chapter 4. What does TPA measure? https://texturetechnologies.com/resources/texture-profile-analysis

Léder, F. (2013) A köles „reneszánsza". A köles hagyományos és új élelmiszeripari technológiái, előadásjegyzet. Budapest.

Moroni, A. V., Bello, F. D., & Arendt, E. K. (2009) Sourdough in gluten-free bread-making: An ancient technology to solve a novel issue? *Food Microbiology*, *26*, 676-684. DOI: 10.1016/j.fm.2009.07.001

Mustalahti, K., Catassi, C., Reunanen, A., Fabiani, E., Heier, M., McMillan, S., Murray, L., Metzger, M. H., Gasparin, M., Bravi, E., Mäki, M., & Coeliac EU Cluster, Project Epidemiology (2010) The prevalence of celiac disease in Europe: results of a centralized, international mass screening project. *Annals of medicine*, 42(8), 587–595. DOI: 10.3109/07853890.2010.505931

Picozzi, C., Mariotti, M., Cappa, C., Tedesco, B., Vigentini, I., Foschino, R., & Lucisano, M. (2016) Development of a Type I gluten-free sourdough. *Letters in applied microbiology*, *62*. DOI: 10.1111/lam.12525

Różyło, R., Rudy, S., Krzykowski, A., & Dziki, D. (2016) Gluten-Free Bread Prepared with Fresh and Freeze-Dried Rice Sourdough-Texture and Sensory Evaluation. *Journal of Texture Studies*, *47*. DOI: 10.1111/jtxs.12180

Singh, P., Arora, A., Strand, T.,Leffler,D., Catassi, C., Green, P., Kelly, C., Ahuja, V., Makharia, G. (2018) Global Prevalence of Celiac Disease: Systematic Review and Meta-analysis. Clinical Gastroenterology and Hepatology. DOI:16. 10.1016/j.cgh.2017.06.037.

Szedlják I. (2018) Gluténmentes élelmiszerek, előadásjegyzet. Budapest

Zorzi, C. Z., Garske, R. P., Flôres, S. H., & Thys, R. C. (2020) Sunflower protein concentrate: A possible and beneficial ingredient for gluten-free bread. *Innovative Food Science & Emerging Technologies*, *66*.