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PERSPECTIVES AND CHALLENGES OF USING BREAD WITH A FUNCTIONAL COMPONENT INULIN HPX

SUMMARY

Functional nutrition is a concept of nutritional science for which it has been proven to have special health effects, so the constant innovation of functional products contributes to the development of the modern food industry. The paper examines the influence of the addition of Inulin HPX on the sensory quality of bread in order to obtain a new functional product that can improve the nutrition of the population, as well as the catering offer of the destination. Different proportions of Inulin HPX in the amount of 0%, 7.5% and 15% were used for the production of bread dough, as a substitute for part of the flour in the basic raw materials. The goal of the research was to analyze the impact of the functional component Inulin HPX on the sensory (volume, texture, color, smell and taste) and nutritional properties of bread, as well as the acceptance of the new functional product by consumers through a demand survey in the territory of the city of Kotor, Montenegro. Based on the test results, the bread with the functional component of 7.5% Inulin HPX has the best sensory characteristics and a high level of acceptance by consumers. This pilot study can serve as a basis for the marketing of a new functional product on the market of Montenegro intended for consumers who care about healthy lifestyles. One of the conclusions is that it can be a part of improving the menu of restaurants that promote healthy food, but also catering establishments within the framework of wellness and health tourism in Montenegro.

Keywords: bread, Inulin HPX, functional food, tourism, Montenegro

INTRODUCTION

In a technologically developed society, as a consequence of the modern way of life, which is characterized by a lack of free food, more and more fast

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food is consumed, food with high energy value and insufficient intake of food contaminants. This type of diet as well as reduced physical activity have led to the spread of some health problems such as: diabetes, obesity and digestive system diseases (Saka *et al*., 2021). In recent decades, consumer demands in the field of food have been changing rapidly. Consumers are becoming increasingly educated about the importance of food, the connection between food quality and health, and today food is not only intended to satisfy hunger and provide the necessary nutrients for the normal functioning of human organisms, but care is taken to prevent diseases related to nutrition but also to improve the physical and mental health of consumers (Siró *et al*., 2008). For this reason, the demand for functional food is increasing, and this can be explained by the increase in health care costs, the increase in people's life expectancy and the desire of the elderly population to improve the quality of life in their later periods of life (Siró *et al*., 2008). These facts have increased the interest in functional food, that is, to enrich food products with functional components.

When looking at the chronology of the history of human nutrition, until recently people produced food directly from natural resources. In the last hundred years, food technology began to take the main role and produce an unlimited number of food products from original foods (natural resources). The term "functional food" is a relatively new direction in the way of eating and refers to the concept of nutritional science, rather than a specific type of new food. Functional food is one of the main food categories in the global health and wellness market, and is becoming the main focus of new product development in the food industry (Khan, *et al.*, 2013). There is no single and generally accepted definition of functional food, but all definitions have in common that functional food is considered to be those foods that are characterized by a balanced ratio of nutrients that should satisfy the nutritional and health needs of consumers, while not having negative effects during consumption. The positive effect of functional food in a short period of time is difficult to observe, because the effects are measurable only after a period of several years of consumption.

The modern concept of functional food began in Japan. A major research project on the functions of food began in the early 1980s in Japan, and has led to the world's first policy on the legal approval of functional foods as "foods for specific health uses" (Shimizu, 2019). In 1991, the Ministry of Health, Labor and Social Welfare of Japan introduced regulations on functional food under the name "Food for Specified Health Uses" or FOSHU. After the introduction of functional foods, many clinically proven FOSHU products with health benefits were developed and launched on the market (Iwatani & Yamamoto, 2019).

Understanding food as medicine is not new. In ancient Greece, the philosopher Hippocrates, the father of medicine, is also known for the catchphrase "Let Food be your Medicine and Medicine be your Food" (Yoldaş İlktaç, & Hızlı, 2019; Fatić *et al*., 2020) with which he gave a unique explanation about the connection between food and health. During the 19th century, the philosophy of "food as medicine" was neglected and coincided with the great

expansion of the pharmaceutical industry. In the 20th century, nutrition again assumes an important role in the prevention of some diseases and the improvement of health.

Modern society at the beginning of the 21st century is characterized by numerous challenges such as: increasing the price of medical services, prolonging human life, the development of science and new technologies, and all of this has the effect of changing the lifestyle.

When considering the enrichment of food products with functional components, the choice is on bread because it is a suitable food item, it is consumed daily in all dietary regimes and is an integral part of all catering menus (Filipović *et al*., 2020). By replacing flour or part of flour with different functional components, which contribute to improving the nutritional composition, the final product results in a high-quality product with certain health benefits (Al-Ansi *et al*., 2022). Rye bread play an increasingly important role in a healthy diet, is recommended in the diet of diabetics and people with high blood pressure , and rye play a very important role in providing complete functional nutrition for humans and domestic animals (Popović *et al*., 2022).

The functional properties of bread can be improved by the proper use of added raw materials, such as Inulin HPX which is a commercial dietary fiber derived from chicory (Helianthus tuberosus). Inulin or oligofructose is a natural dietary fiber isolated from various types of plants, chicory root, dandelion, onion and garlic, artichokes, bananas, aloe. Inulin is a linear chain composed of 2 to 60 fructose units connected by β (2-1) bonds to the terminal glucose unit and has prebiotic properties. There are two types of dietary fiber, water-soluble and water-insoluble. Insoluble dietary fibers are cellulose, some fractions of cellulose, resistant starch, lignin, oligofructose, waxes, inulin, and soluble dietary fibers are of endogenous origin, some pectins, β glucans, of exogenous origin, gum arabic, guar gum, locust gum, etc. Knowing the differences between soluble and insoluble dietary fibers is useful for understanding their action in food products. Most grains contain a large percentage of insoluble dietary fiber, with the exception of oats and barley, while a large proportion of soluble dietary fiber is mainly found in fruits and vegetables (Nelson, 2001).

The modern attitude of nutritionists implies the preparation of a healthy and nutritionally valuable meal, in which grain products are the most represented. The American Dietetic Association, in addition to daily amounts of dietary fiber, also recommends an appropriate ratio of insoluble/soluble fiber, which should be 3:1. The recommendations of the Food and Drug Administration (FDA) for the daily intake of nutrients and dietary fiber are related to the average daily energy intake. For moderately physically active women, teenage girls, a daily dietary fiber intake of 25 g/8.4 KJ (2000 kcal) and 30 g dietary fiber/10.5 KJ (2500 kcal) is recommended for men, teenage boys (Guillon *et al*., 2000).

From the aspect of tourism, in the field of catering, functional food is especially interesting for the catering menu of facilities that deal with the offer of

healthy food, and the concept of functional nutrition follows modern trends in nutrition, especially in the field of wellness and health tourism (Vujačić, 2011).
When we consider the diet of tourists, in addition to specific dietary needs, there are tourists with special individual habits related to healthy lifestyles, which are not related to medical needs. For tourists with medical needs, dietary needs increase daily depending on food sensitivities, allergies, celiac disease, diabetes or other needs related to their medical condition (Andrews *et al*., 2010). Today, in the hospitality industry, questions related to functional products in the restaurant offer are increasingly being asked, given the recognition of functional products and the knowledge of the impact of these products on health, balancing and maintaining the maximum physiological functions of consumers (Milner, 2000; Roberfroid, 2002).

In these pilot studies, we started from the basic hypothesis that functional products are an integral part of the modern way of eating and that they have their place in the catering offer of Montenegro.
The goal of the research was to analyze the impact of the functional component Inulin HPX on the sensory (volume, texture, color, smell and taste) and nutritional properties of bread, as well as the acceptance of the new functional product by consumers through a demand survey in the territory of the city of Kotor, Montenegro.

MATERIAL AND METHODS

Material

The following raw materials were used for the production of bread with a functional component: wheat flour (T-500, Danubius, Novi Sad), baker's yeast (manufacturer "Alltech-Fermin" Senta), salt (So produkt, Stara Pazova), Inulin HPX commercial product produced by "ORAFTI Active Food Ingredients", Belgium.

Bread production

The bread was mixed according to the standard AACC method (Kaluđerski & Filipović 1998). The composition of the bread dough is as follows: flour 100%, 92.5% and 85%, functional component (Inulin HPX) 0%, 7.5% and 15%, salt 2.0% and baker's yeast 2%. The experimental design is shown in Table 1.

Table 1. Experimental bread production plan with inulin HPX

	Amount of inulin HPX		
	0%	7,5%	15%
	Sample 1	**Sample 2**	**Sample 3**
Flour (g)	300	277.5	255.0
Inulin HPX(g)	0	22.5	45.0
Salt (g)	6	6	6
Baker's yeast (g)	6	6	6
Water (g)	166,2	150,3	143,4

Sensory evaluation

Sensory analysis of bread with inulin was performed according to the current standard ISO 4121:2002. Six trained evaluators identified the descriptors and evaluated the sensory characteristics of the bread using a 6-point scale (0 = unacceptable, 1 = poor, 2 = acceptable, 3 = good, 4 = very good, 5 = excellent). The list for the sensory evaluation of bread with Inulin HPX consisted of 5 descriptors, where two descriptors related to the quality of the bread (volume and texture), two descriptors to the aroma (taste and smell) and one to the color.

Nutritional composition of bread

The basic chemical composition (content of proteins, starch, lipids, minerals and cellulose) was determined according to the standard AOAC method (2000), the dietary fiber content was determined according to the AOAC method (1990).

Descriptive analysis

The results of the influence of Inulin HPX on the nutritional quality of bread was performed by statistical analysis of variance ANOVA, and the significance of the difference was tested by Tukey's test using the StartSoft Statistica 10 statistical program.

Standard rating

The standard rating or "Score" analysis uses maximum and minimum measurement parameters for the normalization of the response values which transfers responses from their dimensional system to a new dimensionless system that enables further mathematical processing of different types of response. (Jayalakshmi & Santhakumaran, 2011). The maximum value of the normalized score represents the optimal value of all the combined analyzed responses and indicates the optimal amount of added inulin in the bread formulation.

$$S_{ki} = \frac{\left(x_{ki} - x_{k\min}\right)}{\left(x_{k\max} - x_{k\min}\right)} \quad \text{k= 1-9}$$

Where the X_k values are: volume, texture, color, smell, taste, proteins, minerals, cellulose, total fiber.

$$S_{ni} = 1 - \frac{(y_{ni} - y_{n\min})}{(y_{n\max} - y_{n\min})} \text{ k=1-3}$$

Where the *Y*ni values are: starch, lipids, energy value.

The normalized responses give a "Score" or "Quality Score", where the highest value S represents the optimal value of all the analyzed sensory and nutritional parameters of the bread and indicates the optimal amount of inulin in the bread.

$$Si = 0.12 \cdot S1 + 0.18 \cdot S2 + 0.06 \cdot S3 + 0.18 \cdot S4 + 0.06 \cdot S5 + 0.1 \cdot S6 + 0.06 \cdot S7 + 0.02 \cdot S8 + 0.02S9 + 0.04S \cdot 10 + 0.08S \cdot 11 + 0.08 \cdot S12$$

$$\max[S_i] \rightarrow optimum$$

Consumer survey

Acceptability of bread with a functional component on the market was examined by a consumer survey. Consumers in the territory of the city of Kotor, Montenegro rated two types of bread: bread with 0% Inulin HPX and bread with 7.5% Inulin HPX. Based on a random sample, consumers answered the questions with "yes" and "no" (Table 3), how they liked the new bread with 7.5% inulin HPX. The consumer test was conducted by distributing bread samples to randomly selected consumers (300) of different socio-demographic characteristics, of which four questions were of a general nature and three questions were specific, referring to bread with 7.5% Inulin HPX.

RESULTS AND DISCUSSION

Sensory evaluation is an important parameter for defining the quality of the finished product because it contributes to the assessment of the degree of acceptability of the new product by consumers, which reduces the risk of failure in terms of product acceptance on the market and its placement in catering facilities. Figure 1 shows the sensory evaluation of bread with the addition of a functional component. The parameter volume and texture of the bread in the control sample (1) were evaluated with almost the highest score "excellent" (4.77 and 4.67), while the addition of Inulin HPX as a functional component in the amount of 7.5% in bread (sample 2) tends to decrease the quality of bread, volume and texture compared to the sample 1, but it was rated as "very good" (3.87 and 4.23), which indicates that the bread has good quality despite the addition of the functional component. The addition of 15% to inulin to bread leads to a significant decrease in quality in terms of volume and texture of bread by about 2.5 quality scores in (2.0 and 1.8) compared to the control sample. The addition of Inulin HPX in the amount of 7.5% and 15% does not visually change the color of the bread, it even leads to an increase in the brightness of the bread compared to the control sample, which is a desirable contribution. The results of the analysis of the taste and smell of bread with a functional additive showed that the addition of 7.5% and 15% of inulin HPX to bread has a positive effect on the taste and smell of bread, contributes to a slight increase in these parameters compared to the control sample (1). This shows that the added functional component does not change the characteristic taste and smell of the bread.

Based on the chemical composition of bread with the addition of a functional component, there is a statistically significant decrease in the content of protein and starch compared to the control sample. This is a direct consequence of replacing part of the flour with a functional component in the raw material composition of the bread dough (Table 2). The Tukey test shows that increasing

the amount of Inulin HPX (7.5% and 15%) does not result in a statistically significant change in the content of lipids, mineral substances and cellulose, while there is a statistically significant increase in the content of dietary fiber. These data also indicate that the addition of the functional component (Inulin HPX) changes the nutritional composition of the bread, i.e. that there is a decrease in energy value from 8% to 15% and an increase in dietary fiber content, which is in accordance with the recommendations of nutritionists and the World Health Organization (WHO 2003) that nutrition should be enriched with dietary fiber and reduce the energy value of products. In order to assess the impact of the addition of the functional component on the sensorial and nutritional properties of the bread, the amount of the additive was optimized (Figure 1 and Table 2) and based on the standard score, bread with 7.5% Inulin HPX has the best score(0,62).

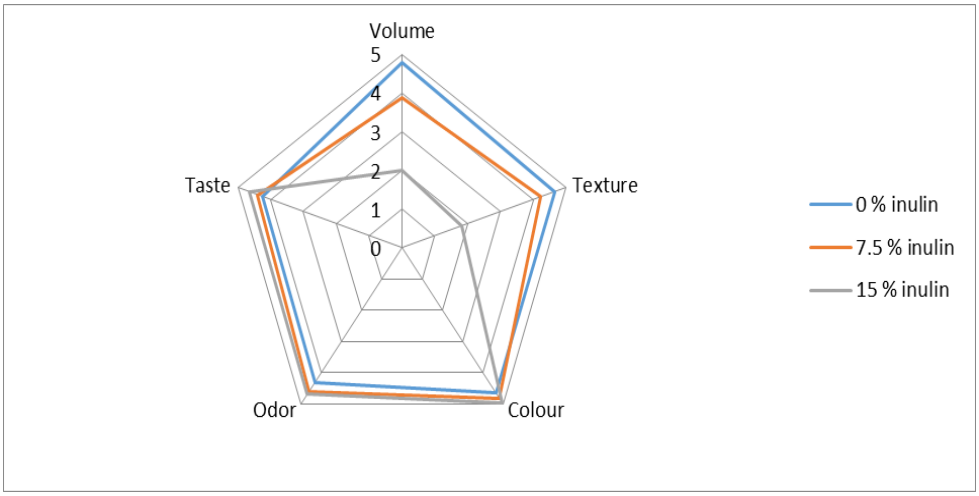

Figure 1. Sensory properties of bread with a functional component

Based on the highest score (table 3), the acceptance of bread with 7.5% Inulin HPX by consumers of different socio-demographic characteristics, who answered the questions anonymously through a survey, was examined. Based on the analyzed results (table 3), it can be seen that more than half of the respondents pay attention to the nutritional (58%) and energy (67%) value of the product, which indicates that they take care of what they buy and consume. 83% of respondents are ready to consume bread with a functional component if it has a positive effect on health and 61% of respondents are ready to compromise on the quality of the food product if it contributes to improving health. These analysis data on functional food show us that the respondents take care of their health and are aware of the importance of nutrition and health which provides the opportunity for both technologists to create new products and catering facilities to market these products. 77% of the analyzed respondents have a positive attitude about the likeability of bread with Inulin, and 75% of the

respondents would buy this bread. 64% would be willing to pay a higher price for bread if it is beneficial for health. The high percentages on the likeability of bread with 7.5% Inulin HPX show us that this bread can be found on the market as well as in restaurants and hotels and is intended for people who care about nutrition and health.

Table 2. Nutritional composition of bread with a functional component

	Amount of inulin		
	0%	7,5%	15%
Chemical composition			
Protein content (%s.m)	12,23±0,44^{c}	11,04±0,18^{b}	10,02±0,31^{a}
Starch content (%s.m)	76,16±0,97^{c}	67,65±0,69^{b}	60,51±0,47^{a}
Lipid content (%s.m)	0,76±0,07^{a}	0,77±0,01^{a}	0,74±0,02^{a}
Mineral matter content (%s.m)	0,70±0,06^{b}	0,69±0,05^{a}	0,74±0,06^{a}
Cellulose content (%s.m)	0,28±0,08^{a}	0,39±0,01^{a}	0,38±0,01^{a}
Total fiber content (%d.m)	0,41±0,02^{a}	4,43±0,33^{b}	9,26±0,51^{c}
Nutritional composition			
Increase in fibers compared to the control sample	-	7,06	14,11
Fiber content in 100g of bread	0,69±0,21	12,06±1,0	24,10±1,27
Energy of 100g of bread (J)	1536,3	1401,3	1303,1
Total score	0,41	0,62	0,60

^{abc} Different letters in the exponent in the same row of the table indicate a statistically significant difference between values, at a significance level of $p<0.05$ (based on post-hoc Tukey's HSD test)

Table 3. Consumer attitudes regarding bread with a functional component

Question number	**Question type**	**Questions**	**Yes (%)**	**No (%)**
P 1	**Functional effect**	**Is it important to you that bread has improved nutritional value?**	58	42
P2		**Is the energy value of the product important?**	67	33
P 3		**Would you consume bread with a functional component if it positively affects your health?**	83	27
P 4		**Are you ready to compromise on the quality of bread with a functional component if you know it has other positive effects?**	61	39
P 5	**Bread with a functional component**	**Do you like bread with HPX inulin?**	77	24
P 6		**Would you buy bread with inulin HPX?**	75	25
P 7		**Are you willing to pay a higher price for bread with inulin if it is good for your health?**	64	36

CONCLUSIONS

Based on the results of the pilot research on the impact of Inulin HPX as a functional component on the quality of bread in order to improve the health and tourism of Montenegro, it can be concluded that the addition of the functional component affects the volume and texture of bread, improves the nutritional composition and reduces the energy value of bread by 8.8% and 15.2%. The average consumption of 250 g of bread with 7.5% Inulin HPX (which has the highest standard rating of 0.62) provides 30.5 g of fiber, which meets the daily human needs for dietary fiber in a daily meal. This indicates the optimal amount of supplements and the positive impact of the applied functional supplement. Based on the results of a consumer test in the city of Kotor, Montenegro, this bread has a high degree of likeability (77%) and acceptance (75%), so it can be placed both on the market and in the catering industry of Montenegro. These pilot studies can be the basis for placing a new functional product on the market, especially interesting for consumers who take care of healthy lifestyles, and it can also be part of improving the menu of restaurants that promote healthy food, as well as catering facilities within the wellness and health tourism of Montenegro.

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