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SENSORY ANALYSIS OF BISCUITS FROM EINKORN FLOUR, BARLEY FLOUR, EINKORN FLAKES AND WHEAT FLOUR IN DIFFERENT PROPORTIONS AND DIFFERENT SUGARS

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SUMMARY
Sensory assessment has an irreplaceable role in developing a new product. Sensory senses can help to determine whether the product is acceptable for consumption or not. Biscuits are products which are consumed by groups of people from different ages. When producing biscuits, wheat flour is usually used as one of the main raw materials for their production and sucrose is used as sweetener. The aim of this study is to determine the sensory characteristics of new kinds of biscuits produced by using different types of flour (barley flour, einkorn flour and einkorn flakes) and different sweeteners (sucrose and glucose solution).

The sensory assessment was made by implementing the method of scoring. With the help of weighted scores, biscuits are categorized in the certain category of quality. 48 different types of wheat flour biscuits, barley flour, einkorn flour and einkorn flakes in different proportions (30:70, 50:50, 70:30 and 100) were analyzed. Sucrose and glucose solution were used as sweeteners. The sensory analysis was made by 15 people at the University of Ruse Angel Kanchev branch Razgrad, Bulgaria. The achieved results were statistically elaborated. The completed sensory analysis showed that majority of produced biscuits belong to the category of very good quality (3.5 – 4.5). The statistic elaboration of data showed that different types of flour and different types of sugar had influence on the sensory characteristics of produced biscuits ($p < 0.05$).

Considering the achieved results it can be concluded that using other types of flour (barley flour, einkorn flour and einkorn flakes) and other sweeteners (sucrose and glucose solution) can produce new types of biscuits, which will have good sensory characteristics and satisfying sensory quality.

INTRODUCTION

Sensory assessment is a science discipline which is used to evoke, measure, analyze and interpret human reactions to products based on the senses (Lawless and Heymann, 1988). Good taste, together with other characteristics, is one of the most important criteria for choosing the food product (Heiniő et al., 2016). Sensory analysis deals with problems related to the evaluation of products offering a science approach which leads to complete and appropriate information about sensory quality of the products (Mandić and Perl, 2006). Eating is a dynamic process: ingredients change over time, i.e. changes in food occur during chewing (Heiniő et al., 2016). Food with cereals like biscuits, crackers or muesli is one of the largest sources of energy in human nutrition, especially for children (Simpson et al., 2012). One of the biggest nutritive problems nowadays is consuming large amounts of sugar, which causes serious health problems (Zoulias et al., 2002).

Biscuits are one of the most often consumed baking products (Nakov et al., 2016a), they can be distinguished by a specific structure (Zoulias et al., 2002) and are made from flour, oil, sugar (Zoulias et al., 2002; Popov-Raljić et al., 2013) and other components, and are characterized by a long shelf-life(Nakov et al., 2016; Mousa and Mousa, 2014). The main disadvantage of biscuits is that they harm balanced diet. Nowadays, in order to solve this problem, lots ofbiscuits made from different types of grains (barley, buckwheat, oat etc.) are offered on the market (Izembaeva et al., 2013). Flour, necessary for producing baked products, has to be of optimum quality appropriate for the certain product (Belitz et al., 2009).

White wheat flour is the flour which is usually used in baking industry. Wheat flour for making biscuits has to contain 9 - 10% proteins and a small amount of gluten (Dabija and Paius, 2015). Einkorn wheat *(Triticum monococcum* L*.)* is one of the oldest grains suitable for organic farming. The benefit of the einkorn wheat is notably smaller compared to other types of wheat. Because of the low gluten of this type of wheat, its flour is used for making biscuits (Nakov et al., 2016b). Barley is the fourth cultivated grain in the world. It is usually grown for producing malt and as animal feed. It is used very little in human nutrition. Researches have shown that barley contains a large amount of dietary fibres, especially soluble dietary fibres *β*-glucans (Gupta et al., 2011). Flakes are made in Europe from many different cereals such as rye, barley etc. Einkorn flakes can be used for making breakfast, bread and biscuits (Bartolucci, 2015).

Sucrose is generally used as a sweetener. Sucrose, known as "common sugar" is one of the most important food sugars (Coultate, 2009). Sucrose is a standard for the intensity and quality of sweetness and all other sweet substances are compared to it (BeMiller, 2011). Tendency of constant increase of using different sweeteners as a substitute for sucrose has been noticed all over the world. Sweeteners as substitute for sucrose include: glucose, fructose, sugar alcohols

(sorbitol, mannitol, xylitol), honey etc. Glucose is a simple sugar or monosaccharide and it is a main source of energy. Glucose provides 4 calories per gram and is responsible for the sweetness of baked products. In baking industry, glucose is used mainly for improving the flavour i.e. as a sweetener. Secondary functions of glucose include imparting moisture and tenderness to baked goods (Internet source - glucose).

MATERIALS AND METHODS

Sensory assessment is made according to a method presented by Popov- Raljić et al. (2005), according to which appearance (surface, shape and crashes of biscuits) is assessed, and there is a visual assessment of structure, chewing, odour and taste of biscuits. According to this type of assessment, every characteristic is assessed with one grade from 1 to 5. Lack of this type of assessment is compensated by the importance quotient (importance factor). Weighted grades are calculated with the help of this equation (1), which is used to calculate the total quality of the product.

$$weighted\ grades = grade \cdot importance\ factor \qquad (1)$$

German standards (Deutsche Landwirtschafts-Gesellschaft) for sensory assessment (**Table 1**) are based on calculating the achieved average quality number (2):

$$\frac{\sum weighted\ grades}{\sum importance\ factors} = quality\ number \qquad (2)$$

All parameters are assessed with grades from 1 to 5, 1 being the lowest grade and 5 being the highest with the method of scoring (grading). The total amount of importance factors is 20, and according to the European Organization for Quality Control, frame method is the only method for grading all food products (Primorac, 2006). Sensory analysis of produced biscuits has been made by 15 people who were previously appropriately trained for sensory assessment. Sensory assessment has been conducted at the University of Ruse "Angel Kanchev" branch, Razgrad Bulgaria. According to the DLG method, the analyzed products can be classified in several groups.

Table 1 Product categorization according to DLG method

Quality category	Average weighted grades limits
Excellent quality	4.5 – 5.0
Very good quality	3.5 - 4.5
Good quality	2.5 – 3.5
Not meet requirements regarding quality	< 2.5

Statistical analysis
Statistical analysis of calculated weighted grades has been made with the help of *XLSTAT* 2017 and *Microsoft Office Excel* 2013 programs. During processing, the results in *XLSTAT* 2017 program, analysis of variance (*ANOVA*) and Fisher`s Least Significant Difference test (LSD) with an importance factor (significance) of 95% (p<0.05) have been used.

RESULTS AND DISCUSSION
Sensory assessment is a science discipline which helps analyze the composition of food (appearance, odour, texture and taste) by assessing human reactions (Internet source: Food – a fact of life).
Sensory properties are first, and often the only parameters according to which most customers assess the food quality. Sensory or organoleptic properties of food as an aspect of quality are connected to the sense of tastiness which food gives when consuming it, and include all properties which can be perceived through the senses of eyesight, odour, taste, touch, and even hearing (Koprivnjak, 2014).

Table 2 Weighted grades from the sensory assessment of biscuits with glucose solution and sucrose sweeteners and total quality number of analyzed biscuits

Appearance assessment (surface, shape and crashes)	Visual assessment of the structure	Chewing	Odour and taste assessment	Quality number	Sample
14.60	18.67	16.27	39.60	4.46	100%WF
13.80	18.13	16.00	33.00	4.05	30%WF+70%B
13.60	16.00	16.27	32.40	3.91	50%WF+50%B
13.60	17.60	16.80	33.60	4.08	70%WF+30%B
13.40	16.27	16.53	39.00	4.26	100%B
9.20	16.80	15.47	36.00	3.87	30%B+70%E
10.60	15.20	15.47	38.40	3.98	50%B+50%E
11.80	15.20	15.47	36.60	3.95	70%B+30%E
13.40	17.47	16.27	35.40	4.03	30%WF+70%E
12.60	17.87	16.53	34.20	4.06	50%WF+50%E
10.60	15.20	14.67	37.80	3.91	70WF+30%E
9.40	16.53	16.27	37.20	3.97	100%E
11.00	16.00	16.27	37.80	4.05	30%E+70%EF
12.00	16.00	16.00	35.40	3.97	50%E+50%EF
11.80	15.47	17.33	41.40	4.30	70%E+30%EF
10.40	16.80	16.27	32.40	3.79	100%EF

*WF-Wheat flour; B-Barley flour; E-Einkorn flour; EF- Einkorn flakes
**average value of weighted grades from 15 assessors

According to product categorization shown in **Table 2**, it can be concluded that all 16 different types of biscuits which have glucose and sucrose in their production belong to the group of very good products. Biscuits from 100% wheat flour have the largest quality number (4.46), whereas biscuits from 100% einkorn flakes have the lowest quality number (3.79).

Table 3 Weighted grades from the sensory assessment of biscuits with glucose solution sweetener, and total quality number of analyzed biscuits

Appearance assessment (surface, shape and crashes)	Visual assessment of the structure	Chewing	Odour and taste assessment	Quality number	Sample
12.00	15.71	14.57	26.36	3.43	100%WF
10.20	14.13	13.60	26.40	3.22	30%WF+70%B
10.00	13.60	14.13	26.40	3.21	50%WF+50%B
11.00	16.27	14.40	25.80	3.37	70%WF+30%B
11.00	10.40	13.87	25.20	3.02	100%B
11.60	14.67	15.20	33.60	3.75	30%B+70%E
12.80	16.00	14.40	26.40	3.48	50%B+50%E
10.00	13.87	15.20	35.40	3.72	70%B+30%E
11.20	14.93	15.47	34.80	3.82	30%WF+70%E
12.00	16.00	13.87	29.40	3.56	50%WF+50%E
10.60	14.93	14.40	30.60	3.53	70WF+30%E
13.40	14.13	15.47	33.60	3.83	100%E
12.00	15.20	15.73	31.20	3.71	30%E+70%EF
11.60	16.53	15.73	32.40	3.81	50%E+50%EF
10.40	14.13	15.73	32.40	3.63	70%E+30%EF
11.40	14.40	15.20	33.60	3.73	100%EF

*WF-Wheat flour; B-Barley flour; E-Einkorn flour; EF- Einkorn flakes
**average value of weighted grades from 15 assessors

According to the quality numbers of biscuits with glucose as a sweetener shown in **Table 3**, the results showed that biscuits made from barley flour and einkorn flour (30:70; 70:30), wheat flour and einkorn flour (30:70; 50:50; 70:30), 100% einkorn flour, 100% einkorn flakes, as well as biscuits made from einkorn flour and einkorn flakes (30:70; 50:50; 70:30) belong to the group of products with a very good quality. Other products belong to the group of good quality.

Table 4 Weighted grades from the sensory assessment of biscuits with sucrose sweetener and total quality number of analyzed biscuits

Appearance assessment (surface, shape and crashes)	Visual assessment of the structure	Chewing	Odour and taste assessment	Quality number	Sample
13.80	18.67	16.80	33.00	4.11	100%WF
11.80	13.60	16.00	30.60	3.60	30%WF+70%B
11.20	14.67	14.67	36.60	3.86	50%WF+50%B
12.00	15.73	16.00	32.40	3.81	70%WF+30%B
12.80	17.33	15.47	37.20	4.14	100%B
10.20	17.87	16.00	39.60	4.18	30%B+70%E
10.80	13.87	16.00	42.00	4.13	50%B+50%E
10.80	17.60	16.80	40.20	4.27	70%B+30%E
8.40	12.80	14.93	32.40	3.43	30%WF+70%E
11.40	16.80	16.80	37.20	4.11	50%WF+50%E
11.20	17.07	12.53	32.40	3.66	70WF+30%E
8.80	11.20	11.20	25.20	2.82	100%E
9.20	13.87	15.73	30.00	3.44	30%E+70%EF
9.00	12.27	13.33	30.60	3.26	50%E+50%EF
8.60	14.40	16.00	32.40	3.57	70%E+30%EF
12.00	16.27	16.53	39.00	4.19	100%EF

WF-Wheat flour; B-Barley flour; E-Einkorn flour; EF- Einkorn flakes
**average value of weighted grades from 15 assessors

In order to determine the category of quality in which products can be divided regarding biscuits with only sucrose as a sweetener, only biscuits made from 100% einkorn flour and 50% einkorn flour, and 50% einkorn flakes are classified in the group of good products, while the others are classified in the group of very good products (**Table 4**).

During statistical data processing, firstly it has been determined whether there is a statistical difference between samples. The results from the same are shown in **Table 5**.

From **Table 5** it can be seen that regarding different mixtures of flour, there is a statistically significant difference ($p < 0.05$), and the same is true for sugars i.e. different types of flour and different types of sugar influence the sensory assessment of biscuits.

Table 5 Results of the statistical data analysis

	Mixtures of flour	Sugars
Lambda	0.854	0.893
F (Observed values)	4.068	10.290
DF1	28	8
DF2	2551	1414
F (Critical value)	1.481	1.945
***p*-value**	< 0.05	< 0.05

Results from the analyses of variance are shown in **Table 6** in order to present the statistically significant difference between biscuits made from different categories of flours and mixtures (p<0.05).

Table 6 Analysis of the differences between categories with a confidence interval of 95% for all parameters of different flour mixtures

Category	Appearance assessment (surface, shape and crashes)	Visual assessment of the structure	Chewing	Odour and taste assessment
White flour	13.800±0.47[a]	18.022±0.61[a]	16.089±0.57[a]	33.800±1.42[abc]
Barley flour	12.400±0.47[b]	14.668±0.61[bc]	15.289±0.57[ab]	33.800±1.42[abc]
White flour: Barley flour	11.911±0.27[bc]	15.526±0.35[b]	15.319±0.33[ab]	30.800±0.82[c]
White flour: Einkorn flour	11.267±0.27[cd]	15.674±0.35[b]	15.052±0.33[ab]	33.800±0.82[abc]
Einkorn flakes	11.267±0.47[cd]	15.822±0.612[b]	16.000±0.57[a]	35.000±1.42[ab]
Barley flour: Einkorn flour	10.867±0.27[cd]	15.674±0.35[b]	15.556±0.33[ab]	36.467±0.82[a]
Einkorn flour: Einkorn flakes	10.622±0.27[d]	14.874±0.35[bc]	15.763±0.33[a]	33.733±0.82[abc]
Einkorn flour	10.533±0.47[d]	13.956±0.61[c]	14.311±0.57[b]	32.000±1.42[bc]

*Values in the same column with different exponents (a-d) have statistically significant difference (p<0.05) ANOVA, Fisher`s LSD.

Statistically significant results regarding the appearance assessment (surface, shape and crashes) can be seen in **Table 6** and it can be concluded that results from wheat flour, barley and einkorn flour together with a mixture of einkorn flour and einkorn flakes are statistically significant i.e. different (p<0.05). During visual assessment of the structure, it can be noted that biscuits from wheat flour are statistically significant regarding all other types of biscuits. Statistical processing of the results for chewing has shown that only biscuits from wheat flour and einkorn flour are statistically different. Biscuits made from the mixture of white flour and

barley flour are statistically different from biscuits made from barley flour and einkorn flour regarding the odour and taste.

Table 7 Analysis of the differences between categories with a confidence interval of 95% for all parameters of different sugars

Type of Sugar	Appearance assessment (surface, shape and crashes)	Visual assessment of the structure	Chewing	Odour and taste assessment
Sucrose and glucose solution	12.196[a]	16.495[a]	16.117[a]	36.250[a]
Glucose solution	11.533[b]	15.357[b]	15.350[b]	34.600[a]
Sucrose	11.021[b]	14.728[b]	14.800[b]	30.175[b]
Values in the same column with different exponents (a-b) are statistically significantly different (p<0.05) ANOVA, Fisher`s LSD.				

Results showed that regarding appearance assessment (surface, shape and crashes), visual assessment of the structure and chewing, there has been statistically significant difference between biscuits with the sucrose and glycose syrup mixture and biscuits with individual sweeteners. Regarding odour and taste, biscuits with sucrose as a sweetener have been statistically different from biscuits with other types of sweeteners. Statistically significant difference is determined in biscuits with sucrose as a sweetener.

CONCLUSIONS
From the conducted analysis, it has been determined that the highest weighted grades had biscuits from 100% wheat flour. If biscuits are examined according to the type of sweetener separately, it can be concluded that biscuits with 100% wheat flour and mixture of sucrose and glucose as a sweetener, have the highest quality number, but together with other biscuits from this group, belong to the group of very good products.

The lowest quality grades have been noticed in the group of biscuits with glucose as a sweetener and part of these biscuits belong to the group of good products, while others belong to the group of very good products. In this group, biscuits from 100% einkorn flour are the products with the highest quality grades (3.83).

With biscuits with only sucrose as a sweetener, almost all types of biscuits belong to the category of very good products (except biscuits from 100% einkorn flour (2.82) and biscuits from 50% einkorn flour and 50% einkorn flakes)).

From the results of statistical analysis, it has been concluded that regarding sensory parameters: appearance assessment (surface, shape and crashes), visual

assessment of the structure and chewing, biscuits with sucrose and glucose syrup as sweeteners are significantly different. When determining the influence of different mixtures of flour on the sensory assessment, it has been determined that according to sensory parameters: appearance assessment (surface, shape and crashes), visual assessment of the structure and chewing, biscuits made from wheat flour are statistically different from the biscuits made from others flours or mixtures.

We consider that all types of biscuits have satisfying quality as it has been shown from the sensory analysis. The use of barley flour, einkorn flour and einkorn flakes in biscuit production can contribute to the production of new types of biscuits with characteristics of functional food.

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