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INVESTIGATION ON THE USE OF HEMP FLOUR IN COOKIE PRODUCTION

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Abstract

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The aim of this research was to study the potential use of hemp flour in the making of cookies. A method for producing sugar cookies with improved organoleptic and physicochemical properties was developed. The results of a sensory evaluation of a new type of product are presented. As a result of the study, characteristic descriptors for organoleptic quality analysis have been developed to aid the evaluation of the ready product by its main quality parameters (taste, flavor, color and surface condition), as well as determine the product's doneness, chewiness and shape. Based on the spider plot of organoleptic properties of the cookies, an improvement in the doneness property was found when replacing 10 and 20% of hemp flour with corn flour. On the total score, gluten-free cookies made from hemp flour and corn flour at an 80:20 ratio showed high quality scores, their total scores being second after traditional cookies made using the basic recipe. A recipe for gluten-free sugar cookies made with hemp flour was created based on the conducted optimization. It has been determined that adding corn flour to the cookie recipe changes their sensory characteristics in addition to improving texture and physicochemical properties.

Key words: sugar cookies; hemp flour; quality; organoleptic evaluation; production technology

Introduction

In recent times humanity has been encountering a congenital disease caused by intolerance to wheat protein (gluten) more and more frequently. Gluten sensitive celiac (from Greek coeliakia; koilikos – intestinal, suffering from an intestinal disorder) is an autoimmune disease affecting the small intestine with systematic autoimmune symptoms (Lähdeaho et al., 2005). Celiac is synonymous with intestinal infantilism, gluten enteropathy, idiopathic steatorrhea and nontropical sprue. The terms "celiac syndrome" or "secondary celiac" do not exist (Zanoni et al., 2006).

Advanced celiac might require lifelong treatment. Celiac is most often connected to conditions related to malabsorption syndrome, including osteoporosis, diseases affecting the central and peripheral nervous system, pancreatic diseases, internal bleeding, and gynaecological disorders. Some of those conditions might be completely or partially cured after introducing a gluten free diet (for example, infertility can be treated completely). Celiac patients who do not adhere to a gluten-free diet are a lot more prone to certain types of cancer, especially cancers such as gastrointestinal lymphoma.

A genetic predisposition to celiac is apparent: 5-10% first degree relatives (parents, offspring and siblings) can develop gluten enteropathy. The disease affects both sexes and can manifest at any age starting with children (as soon as cereals are introduced to the diet) and well into old age (even among those who consume cereals on a regular basis) (Vishnyak, 2009). No medication exists for the treatment of celiac. The only way for those suffering from celiac is to keep to a gluten-free diet.

Celiac is caused by an intolerance to one of the components of wheat protein – prolamin. Cereal grain proteins contain 4 fractions: albumins, globulins, prolamins and gluteins. The latter two are also called "gluten". Gluten is a water insoluble group of proteins with low lipid, sugar and mineral content. Prolamins found in different grains have different names: gliadins in wheat, secalinins in rye, gordeins in bar-

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ley, avenins in oats, etc. The question of avenin in oats is still debated. The highest concentration of prolamins is found in wheat, barley and rye (Welander et al., 2010).

Due to this, production of specialized gluten-free dietary products is being developed, as well as recipes for flour confectioneries, that meet the hedonic requirements of food products, where foods are consumed because of their consumer attributes — taste and flavor.

Gluten-free flour confectionery food engineering is characterized by 2 main trends. The first one is focused on creating products based on naturally gluten-free raw materials, most of them plant-based (gluten-free cereals, pseudo cereals, beans, nuts, edible roots, etc.) Practically most gluten-free foods are made using technologies following this trend. The second, biocatalytic trend is oriented towards removing or modifying gluten in raw materials containing gluten.

The use of hemp seeds ground to whole meal flour is considered promising (Švec et al., 2015).

Hemp flour is a non-traditional gluten-free plant-based raw material. Hemp can be used as a raw material in the production of over 40 thousand types of products for the medical, food, textile, paper, construction, aviation, fuel and other lines of industry. The West is seeing a real boom around this culture: not only is it a focus of interest for private businesses, it is also the focus of large-scale government programs (Leizer et al., 2000).

Even countries that did not used to grow hemp (Canada, Australia) have begun growing it (Rosenthal, 1994).

The dietary and medicinal properties of hemp seed oil were always held in high regard. Currently different countries are conducting intensive research of the properties of hemp seed oil, including ones following the dedicated program by the International Hemp Association (Fleming and Clarke, 1998). Hemp seeds contain 30-32 % oil, which is among the best food oils when ranked by their fatty acid profile. Fatty acids participate in the synthesis of prostaglandins, leukotriens and tromboxans, which regulate important bodily functions: arterial blood pressure, individual muscle contractions, body temperature, trombocyte aggregation (Callaway et al., 1996).

In that context, the aim of this research was to study the possibilities of using hemp flour in the production of cookies.

When choosing raw materials for developing the recipe for sugar cookies for celiac sufferers,

standard requirements of the CODEX STAN 118-1979 by the Joint FAO/WHO Expert Committee of the Codex Alimentarius Commission, in accordance with which gluten-free products are foods that contain less than 20 mg/kg of gluten.

Materials and Methods

A technological decision to replace wheat flour with gluten-free hemp flour was made. The recipe for "Prazdnichnoe" sugar cookies represented in Table 1 was used as a base (Koryachkina, 2006).

Table 1
The recipe for "Kukuruzka" sugar cookies

Raw ingredient name	Dry matter content, %	Expenditure rates, kg in test weight
Wheat flour	85.5	419.11
Wheat flour (to prevent sticking)	86.0	27.7
Sugar	99.85	167.64
Margarine	60.0	352.05
Chicken egg	27.0	58.68
Table salt	97.0	1.68
Sodium hydrocarbonate	50.0	0.838
Total		1027.70
End result	96.0	1000.0

Materials used in our study include:

- dried and ground hemp seeds;
- model cookie samples made using the recipe. Cookies made using a basic recipe were used as control (ingredients: wheat flour, sugar, margarine, chicken egg, table salt and sodium hydrocarbonate); cookies made by completely replacing wheat flour with hemp flour were used for the trial sample.

Alkalinity was calculated by neutralising the acid contained in the weighted sample by using sodium hydroxide (potassium hydroxide) in the presence of phenolphthalein until it turns pink.

Moisture content was determined by drying the product test sample at a certain temperature and calculating the loss of mass in relation to the mass of the sample before drying.

Water absorption capacity was determined by measuring the mass of the flour confectionery products when submerged in water at a temperature of 20°C for a set amount of time (Skurikhin and Tutelyan, 1998).

All measurements were repeated three times. Statistical analysis was performed using the following software packages: Microsoft Excel XP, Statistica 8.0. Statistical error did not exceed 5% (at a 95% confidence level).

Results and Discussion

Hemp flour production method

In the first stage of this study a method for producing hemp flour was developed and the resulting product's nutritional value was measured.

Whole hemp seeds were cleaned from contaminants and dust in a grain separator, run through magnets to clean from metallic contaminants, washed out with tap water, sent to open grain roasters, dried for 15 minutes at a temperature of 80-90°C in the seed mass until they reached the moisture level of 8%.

Dried seeds were then cooled to room temperature and sent to the grinder to be ground into a powder. Hemp flour is a grayish-green powder with brown particles, a pleasant nutty taste and flavor, and a slight crunch when chewing the outer layer particles (Leson, 2006).

Developing the technology for producing cookies with hemp flour

In the second stage of this study a technology for producing cookies with the addition of hemp flour was created.

The technology for the making of sugar cookies includes the following stages: preparing raw ingredients for production; preparing the emulsion, kneading dough, forming the pieces, baking the semi-finished product.

- Preparing the emulsion: the ingredients are placed in a mixing container: sugar, margarine, eggs, salt. The ingredients are mixed for 15 minutes until the mixture reaches an even structure.
- Kneading the dough: the dough is mixed based on the ready emulsion by adding flour and baking soda. Mixing is done for 1 minute
- Forming the pieces: the dough is rolled on a table covered in a layer of flour until it is 6-7 mm thick, and then cut or stamped with a cookie cutter; the pieces are placed on baking sheets
- Baking the products: done in a deck or cabinet oven at a temperature of 180-200k°C over 10-15 minutes

The effect of hemp flour on the quality of sugar cookies was evaluated by measuring changes in organoleptic and physicochemical properties.

A profiling method using descriptive analysis of the results was used in the organoleptic analysis. To illustrate the scores, the evaluated properties were illustrated as organoleptic property spider plots for the sugar cookies.

As a result of the study, characteristic descriptors for organoleptic quality analysis have been developed to aid the evaluation of the ready product by its main quality parameters (taste, flavor, color and surface condition), as well as determine the product's doneness, chewiness and shape.

The results of the sensory analysis of replacing wheat flour with hemp flour are illustrated in Figure 1.

All test samples of hemp flour and wheat flour sugar cookies had a regular shape.

Sugar cookies made using the basic recipe had high quality scores, as is evident based on the results of the sensory analysis.

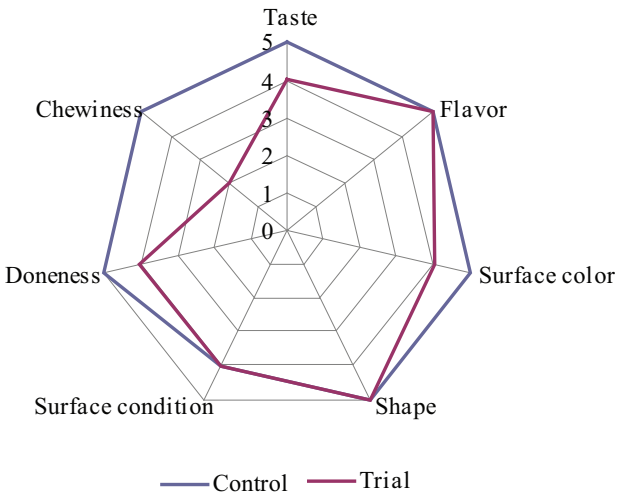

Fig. 1. A spider plot of organoleptic properties of sugar cookies made using the basic and trial recipes

The study has revealed that replacing 100% of the wheat flour with hemp flour leads to a significant lowering of the scores of the ready products.

In light of this, to improve cookie quality, part of hemp flour was replaced with corn flour, which does not contain gluten either.

Trial cookies made using hemp flour were used as a control sample.

Gluten-free sugar cookies made with a partial replacement of hemp flour with corn flour were made with different percentage ratios (Table 2).

Table 2

Mixture ratio in making sugar cookies with hemp flour partially replaced by corn flour, %

Raw ingredients	Variant					
	Control	1	2	3	4	5
Hemp flour	100	90	80	70	60	50
Corn flour	-	10	20	30	40	50

The effect of increasing corn flour content on the physicochemical properties of sugar cookies and total score is shown in Table 3 and Figure 2.

When replacing 10 to 50% of hemp flour with corn flour in the gluten-free sugar cookie recipe, an increase in water absorption capacity of the cookies was noted. Alkalinity and moisture content parameters showed insignificant changes.

When corn flour content was increased from 10 to 50%, the cookies gained a lighter golden color. When comparing the profiles of cookie samples made with the addition of corn flour, differences in properties such as doneness, chewiness and surface

Table 3

The effect of corn flour on the quality parameters of sugar cookies made with hemp flour partially replaced by corn flour by variant

Parameter	Variant					
	Control	1	2	3	4	5
Alkalinity, degree.	1.8	1.8	1.7	1.8	1.8	1.8
Moisture content, %	8.8	9	9	8.9	8.7	8.7
Water absorption capacity, %	126	136	168	151	162	160

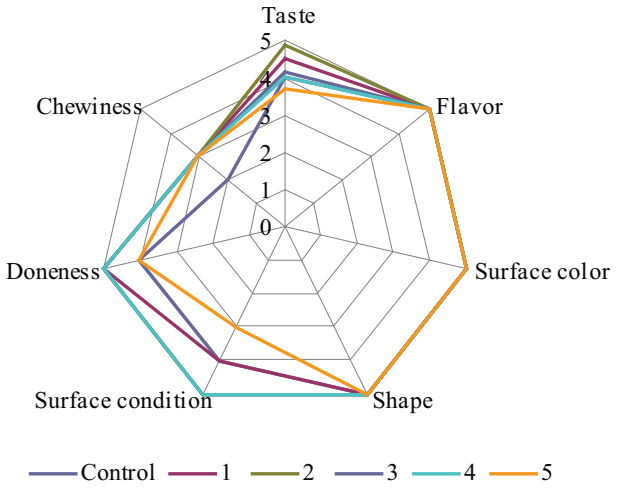

Fig. 2. A spider plot of the organoleptic properties of gluten-free cookies made with hemp flour partially replaced by corn flour

condition were noted.

The cookie sample with the addition of 20% corn flour showed the highest surface condition score. Further increasing the corn flour dosage (up to 50%) has led to a significant decrease of this score. Consequently, the optimal corn flour content has been determined to be 20%.

Conclusions

Based on the spider plot of organoleptic properties of the cookies, an improvement in the doneness property was found when replacing 10 and 20% of hemp flour with corn flour.

When evaluating by organoleptic and physicochemical properties, cookies with 20% of hemp flour replaced with corn flour were rated the best. On the total score, gluten-free cookies made from hemp flour and corn flour at an 80:20 ratio showed high quality scores, their total scores being second after traditional cookies made using the basic recipe.

A recipe for gluten-free sugar cookies made with hemp flour was created based on the conducted optimisation. It has been determined that adding corn flour to the cookie recipe changes their sensory characteristics in addition to improving texture and physicochemical properties.

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