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Use of dried pumpkins in wheat bread production

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Abstract

Pumpkins belong to the family of *Cucurbitaceae*. They are classified to *Cucurbita pepo*, *Cucurbita moschata*, *Cucurbita maxima* and *Cucurbita mixta*, according to the texture and shape of their stems. The nutritional value of pumpkin fruits is high, varies from one species or cultivar to another. Pumpkins are reach in vitamins C, B_1, B_6, K, and in mineral substances. There are no data found about vacuum microwave dried pumpkin application in wheat bread production. The main purpose of the research was to evaluate quality parameters of microwave vacuum dried pumpkins and to verify its application in wheat bread production. Following quality parameters of pumpkins and bread made with pumpkin additive were evaluated: moisture content (oven – drying method), vitamin C content (iodometric), carotenoid content (spectrophotometric), reducing sugars (LVS 252:2000), colour changes (ColorTec-PCM), total fat content (ISO 6492:1999), degree of bread liking (ISO 4121:2003), bread baking loss and dry off. Quality parameters of non dried pumpkins were: content of reducing sugars − 2.40 g·100 g^{-1}, vitamin C – 0.26 g·100 g^{-1}, carotenoids – 0.50 mg % (in dry matter). The technological parameters for pumpkins drying in vacuum microwave drier were used: pressure (70–50 mmHg), speed of tumbler – 6 rpm, one working cycle and three stages. During the pumpkins drying process a decrease in the following parameters was observed: moisture content – 10.5 times, vitamin C content – 2.0 times; increase of yellowness (b*) value – 1.5 times. The optimal dried pumpkin additive to the wheat dough was 10% of the total flour amount. The wheat bread sample with dried pumpkins additive is richer in carotenoids and reducing sugars comparing to control wheat bread sample. The results of sensory analyses using hedonic rating demonstrated that a higher degree of liking was attributed to the bread sample with dried pumpkins additive (7.3) comparing to control wheat bread sample (6.7).

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Keywords: Pumpkins; wheat bread; microwave-vacuum drier

1. Introduction

Pumpkins belong to the family of *Cucurbitaceae*. They are classified to *Cucurbita pepo*, *Cucurbita moschata*, *Cucurbita maxima* and *Cucurbita mixta*, according to the texture and shape of their stems [1].

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The nutritional value of pumpkin fruits is high but varies from one species or cultivar to another. Thus, in the fresh mass of the fruit, total content of carotenoids, a major contributory factor in the high nutritional value of pumpkins, ranges from 2 to 10 mg·100 g^{-1}, the content of vitamins C and E accounting for 9–10 mg·100 g^{-1} and 1.03–1.06 mg·100 g^{-1}, respectively. Pumpkin fruit is also a valuable source of other vitamins, e.g., B_6, K, thiamine, and riboflavin, as well as minerals, e.g., potassium, phosphorus, magnesium, iron, and selenium. Pumpkin flesh is a delicious and fully appreciated additive in a diversity of products for children and adults. Pumpkin fruits mainly are being processed to obtain juice, pomade, pickles and dried products [2].

Drying constitutes an alternative to the consumption of fresh fruits and vegetables, and allows their use during the off-season. It is one of the most widely used methods for food preservation, and its objective is to remove water from the food to a level in which microbial spoilage and deterioration reactions are greatly minimized. Moreover, besides providing longer shelf-life, it also originates smaller space needs for storage and lighter weight for transportation. The drying of agricultural products can be undertaken in closed equipments (solar or industrial dryers) to guarantee the quality of the final product [3, 4].

Drying with the microwave method under vacuum is a modern, efficient method of food preservation. During vacuum-microwave (VM) drying the energy of microwaves is absorbed by water located in the whole volume of the material being dried. This creates a large vapour pressure in the centre of the material, allowing rapid transfer of moisture to the surrounding vacuum and preventing structural collapse. As a consequence, the rate of drying is considerably higher than in traditional methods of dehydration. A decisive factor enhancing drying rate is the wattage of microwaves. The puffing phenomenon, that accompanies the rapid process of dehydration, creates a porous texture of the food and facilitates obtaining a crispy and delicate texture, and in this way it reduces the product's density as well as shrinkage [5].

Microwaves with their ability to rapidly heat dielectric materials are commonly used as a source of heat. In the food industry microwave is used for heating, drying, thawing, tempering, sterilization etc. In recent years, microwave drying has gained popularity as an alternative drying method in the food industry. Microwave drying is rapid, more uniform and energy efficient compared to conventional hot-air drying [6].

In scientific literature information is found about the pumpkin powder addition to the dough in wheat bread production. Pumpkin powder, introduced initially as a nutritional supplement, has been found to give very large, unexpected, increases in the loaf volume and organoleptical acceptability of wheat bread produced using flour samples with comparatively poor bread making properties. As a result progressive addition of pumpkin powder gave an initial rise and subsequent decrease in loaf volume and panellists scores for organoleptical acceptability increased systematically with increasing loaf volume [7].

The main purpose of the current research was to evaluate quality parameters of microwave vacuum dried pumpkins and to verify its application in wheat bread production.

2. Materials and Methods

The following materials have been used for the purpose of the research work: wheat flour type 550 (moisture content 14.5%, gluten content 29%, ash content 0.62%), sugar, margarine (vegetable oil and fat content 80%, salt content 1.5%), salt, drinking water, yeast, pumpkins (variety 'Standard orange').

Pumpkins were prepared for drying: peeled, seeds were removed; pumpkin flesh was roughly grated on a shredder (parameters of slices were approximately 2.5cm x 0.5cm x 0.1cm) and placed in a perforated plastic cylinder (Fig. 1 B) with mixer. The initial mass of pumpkins prepared for drying were 3.95±0.01 kg per load.

Pumpkins were dried in a vacuum microwave dryer „Musson-1" (OOO Ingredient, Russia) (Figure 1A). The necessary amount of microwave energy (magnetron minutes) was calculated using empirical formulas when the initial moisture of product is known and the final is estimated.

Prior to the drying process the dryer was programmed at pressure (70 mm Hg upper and 56 mm Hg lower), rotation speed of cylinder – 6 rpm, number of cycles – one cycle, amount of stages – three stage. The temperature of pumpkins at the drying process reached not higher than +35±2ºC.

Drying conditions for processing of pumpkins in a vacuum microwave drier were used during the current research: the first drying stage at 4 magnetrons – energy of 6720 kJ, the second stage at 3 magnetrons – energy of 2310 kJ and the third stage at 2 magnetrons – 714 kJ.

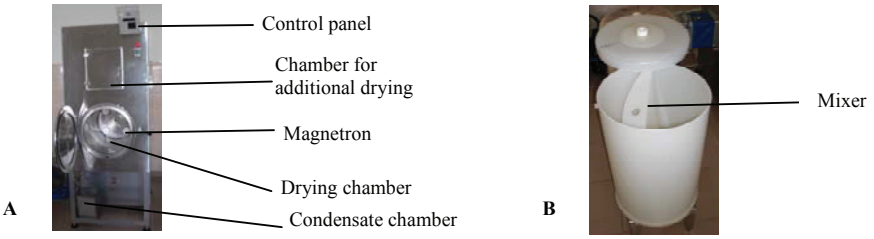

Fig. 1. Microwave vacuum drier – front view (A); plastic cylinder (B)

Following quality parameters of pumpkins and bread made with pumpkin additive were evaluated: moisture content (oven – drying method: at 105°C) [8; 9], vitamin C content (iodometric method) [10], carotenoid content (spectrophotometric method) [11], reducing sugars (LVS 252:2000) [12], colour changes (with ColorTec-PCM) (the colour parameters such as luminance (L*), red saturation index (a*), and yellow saturation index (b*) were evaluated during the experiments) [13], total fat content (ISO 6492:1999) [14], five point scale (Table 1) was used for the evaluation of each quality parameter (appearance, crust, porosity, structure, aroma, and taste) of bread with various amounts of dried pumpkins additive [15], degree of bread liking (ISO 4121:2003) [16], bread baking loss (it forms the highest technological losses in bread baking process – the decrease of bread mass during the bread baking time was calculated), bread dry off (is the loss of bread mass during the cooling).

Table 1. Five point scale for bread quality evaluation [15]

Points	Description
5	Performance of complete quality parameters (very good quality)
4	Inessential deviations (good quality)
3	Pronounced deviations, insignificant defects (satisfactory quality)
2	Significant defects (marginally satisfactory quality)
1	Serious defects (unsatisfactory quality)
0	Product not suitable for eating (no evaluation)

Bread was baked according to the traditional technology [17].

Microsoft Excel software was used for the research purpose to calculate mean values and standard deviations of the mathematical data obtained in the research. The *t-test* was used for sensory data analysis. The results are reported as average from three replications.

3. Results and Discussion

3.1. Quality parameters of non-dried pumpkin.

Experimentally it was ascertained, that: reducing sugars content in dry matter of pumpkins were 2.4±0.10 g $100 \cdot g^{-1}$, vitamin C −0.26±0.09 g·100 g^{-1}, carotenoids −0.50±0.08 mg %. The elevated b* (yellowness) value as 29.54±3.84.

3.2. Quality parameters of dried pumpkins.

The moisture content is the main parameter of food products which influences the storage time. It is known that the shelf life of products with high moisture content is shorter than of products with lower moisture content.

The initial moisture content of non-dried pumpkins was determined equaling to 94.54±0.10%. Therefore it is possible to predict shorter shelf life for such product. Hence pumpkins were dried till the moisture content of 9.00±0.10%. The content of moisture in pumpkins decreased 10.50 times during vacuum microwave drying.

Vitamin C is the least stable of all vitamins and it is easily destroyed during processing and storage. The most harmful factors to vitamin C are the availability of oxygen, prolonged heating in the presence of oxygen and exposure to light [18]. During pumpkin drying process in vacuum-microwave drier the content of vitamin C decreased 2.00 times, what mainly could be explained with thermal instability of vitamin C.

As the results of the current research show, the darkness (luminance) (L*) value of pumpkins during drying is similar to darkness of un-processed pumpkins, what is very positively. Pumpkins do not become darker during drying. The pumpkins yellowness (b*) value increased 1.5 times during drying, comparing to yellowness (b*) value of non-dried pumpkins (29.54±2.81). Such changes could be explained by the decrease of product mass (the decrease of moisture content); as a result the colour pigments concentrate in the dry matter of pumpkins and the colour of product becomes more intensive.

Carotenoids' content changes in pumpkins during vacuum microwave drying were not relevant comparing to carotenoids' content in dry matter of non-processed pumpkins.

3.3. Quality parameters of wheat bread with dried pumpkin additive.

During experiments quality of wheat bread samples with various amounts of added dried pumpkins were evaluated. 10%, 15%, 20% and 25% from the total flour amount of dried pumpkins were added to the wheat dough. As a control sample wheat bread without pumpkins additive was evaluated.

It was established, that the quality of wheat bread decreased increasing dried pumpkins additive to the wheat dough. The highest assessment (5 points) received wheat bread with 10% of dried pumpkin additive. The quality of wheat bread with elevated (over 10% from the total flour amount) dried pumpkins additive became unacceptable, because of worse porosity (pores have irregular forms), stickier bread soft part, and unpleasantly sweetish bread taste. Therefore for the further experiments wheat bread samples with 10% of dried pumpkins additive were used.

The yellowness (b*) value of wheat bread with pumpkins additive soft part were 1.23 times more pronounced comparing to a control sample, mainly because yellow colour of pumpkins. However the lightness (luminance) (L*) value in the experimental bread sample was very similar (Table 2).

In bread sample with pumpkins additive the carotenoid content increased 5.5 times comparing to the control bread sample. Mainly, because pumpkins are rich in the mentioned nutrient.

The moisture content of ready product mainly depends on added water amount during dough making. Experimentally it was found, that the moisture content of the control bread sample and bread sample with

pumpkins additive was very similar, respectively 46.39±0.10% and 46.52±0.10% that conforms to the good quality bread parameters.

Table 2. Colour intensity of bread soft part

Wheat bread sample	L*	a*	b*
Bread with dried pumpkin additive	76.26±2.81	-2.55±1.12	27.09±2.43
Control sample	78.38±3.14	-2.82±1.04	22.10±3.17

Reducing sugars, such as glucose, fructose and lactose are important nutrients in human diets. Glucose, which is abundant in, for example, various fruit and vegetable juices, can be easily and directly assimilated by people. It is an important provider of energy, facilitating the healthy functioning of the human body [19]. The experiments proved that the amount of reducing sugars was 1.6 times higher in bread with pumpkins additive comparing to control (0.85%). Such results may be explained by the elevated reducing sugar content in pumpkins; as a result the bread with pumpkins additive had a higher reducing sugar content.

Fat content in tested bread samples was similar (1.45±0.07%).

Vitamin C was not detected in the control wheat bread sample, but the content of vitamin C in wheat bread with dried pumpkins additive amounted to 0.019±0.003 g 100 g^{-1}, what was not substantial.

The bread baking loss forms the biggest losses in the technological process. The value of baking loss of wheat bread with pumpkin additive decreases approximately by 0.95% compared with the test bread sample (Figure 2), therefore the technological bread weight losses during wheat bread production using dried pumpkin additive could be not significant. According to the experimental results, the values of bread dry off are similar for the test and experimental bread samples: 2.71% and 2.06% respectively (Figure 2).

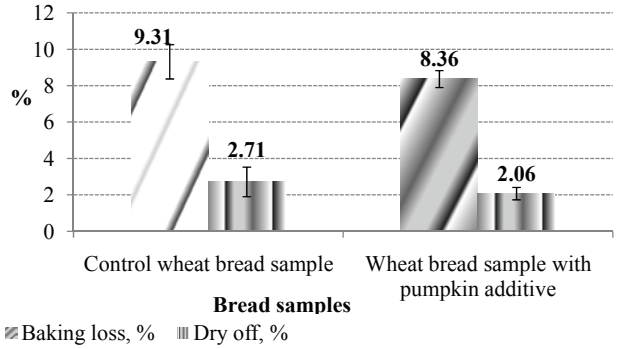

Fig. 2. The changes in the value of dry off and baking loss in bread samples

Consumer research is one of the key activities of consumer goods companies. Through this type of testing, companies determine consumer acceptance or liking, preference, and opinions on the products tested. This is, ultimately, the most important type of information companies use to make product decisions, such as the development and marketing of new products, the reformulation of existing products, the acceptance of suppliers and processes, the establishment of quality control specifications, etc. [20]. The degree of liking of wheat bread with dried pumpkins additive and control whet bread sample (without additives) was examined during experiments. Two bread samples were analysed using

hedonic rating with the purpose to determine which bread sample is tastier. The hedonic rating was used for analyses. The average hedonic rating of bread samples was: for wheat bread sample with dried pumpkins additive – 7.3 and for control wheat bread sample – 6.7. For experimental data analysing *t-tests* were used. It was detected after mathematic data processing, that the $t_{crit.} = 2.045 < t_{cal.} = 2.170$ ($\alpha = 0.05$; $df = 30 - 1 = 29$), it means that there are significant differences in degree of liking between two bread samples ($\alpha \leq 0.05$) – bread sample with pumpkin additive is more tasty than a control bread sample.

4. Conclusion

In research used pumpkins quality conform to the good quality product parameters: the content of reducing sugars was 2.40 g·100 g^{-1}, the content of vitamin C – 0.26 g·100 g^{-1}, the content of carotenoids – 0.50 mg % (in dry matter).

During the pumpkins drying process a decrease of the following parameters was observed: moisture content by 10.5 times, vitamin C content by 2.0 times; increase of yellowness (b*) value by 1.5 times.

After expert sensory evaluation of bread with dried pumpkins additive quality parameters (appearance, bread crust, soft part properties, aroma, and taste) – the best bread sample was chosen; therefore the optimal additive of dried pumpkin to the wheat dough could be 10% from the total flour amount.

The wheat bread sample with dried pumpkins additive is richer in carotenoids and reducing sugars comparing to a control wheat bread sample.

The value of bread baking loss and dry off was not differing significantly for the evaluated bread samples.

The results of sensory analysis using hedonic rating demonstrated that a higher degree of liking was attributed to the bread sample with dried pumpkins additive (7.3) comparing to the control wheat bread sample (6.7).

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