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THE IMPACT OF PRETREATMENT SEMI-PRODUCTS ON THE TEXTURE OF FRIED POTATOES

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A b s t r a c t

The aim of the study was to determine the effects of time and temperature during the pre-treatment in hot water semi-products obtained from potatoes. This treatment results in leaching of reducing sugars and influences on the texture of fried potato products. Studies were carried out on samples of potatoes in the form of slices (having a diameter of 57 mm and a thickness of 4 mm) and sticks having a cross section of 10×10 mm and a length of 100 mm.The semi-products formed had a comparable weight of ca. 10 g. Prepared semi-product were immersed in demineralised water at temperature 20°C, 30°C, 40°C. The immersion time was 5 min, 10 min, 15 min, 20 min.

Ater 10 minutes from frying ended, the products were subjected to loads in which unit cutting resistance values were measured (N:mm-1), which served as the texture indicators. The product shape, temperature of water for washing sugars and treatment time are statistically significant for product texture. Lower texture values are found in the slices. The sample tested significantly differs, in unit cutting resistance values, from other samples subjected to washing ope1ration.

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Introduction

The basic technological processes of production of French fries are classified as: blanching, drying up, stir-frying and frying (ABGLOR, SCANLON 1998). Blanching is one of the most important stages of the manufacturing process chips. In industrial practice used to blanch french fries in water at different temperatures and for different lengths of time (JASWAL 1970, LISIŃSKA, LESZCZYŃSKI 1989) All these processes cause a change in the texture of the finished product.

Texture is one of the most important quality features thermally processed potatoes. It is a feature of a qualitative multidimensional, defined as a general structural characteristics and rheological properties of the product (SURMACKA-SZCZEŚNIAK 2002). Texture is described by a number of parameters, such as hardness, consistency, viscosity, elasticity, adhesiveness, gumminess and chewiness. These parameters are measured instrumentally using a texture analyzer, which enable the various tests consisting in the cutting, crushing, penetration and tensile samples (CIVILLE, SURMACKA-SZCZEŚNIAK 1973). Apparatus for measuring texture are related to sensory evaluation since they are important components which affect the evaluation of the texture of food. Therefore, the correlation between the measurements instrumental and sensory analysis is related, as it enables a more complete interpretation of the results of the sensory properties of the products. This method has been widely used to assess the impact properties of potatoes, pretreatment and process parameters on the texture of the product subjected to thermal processing. The measurement consisted in determining the strength characteristics of the product (eg. French fries) (PEDRESCHI et al. 2004, STONEHAM et al. 2000). Changes in texture properties depend mainly on the chemical composition of the raw material. On the basis of presented in the literature, it can be concluded that the effect on changes in texture potatoes are: dry matter content, and compounds such as starch, polysaccharides, and in particular the compounds of pectin (pectin total protopectin, pectin soluble) that are present in the spaces intercellular, as a binder not woody plant cell wall (TAJNER-CZOPEK et al. 2003, GOŁUBOWSKA, LISIŃSKA 2005). It has been found that potato bulb with a higher dry matter content reflect less water during frying, which leads to increased productivity and, moreover, are more crunchiness and brighter color (LISIŃSKA 2006, LISIŃSKA, LESZCZYŃSKI 1989, JASWAL 1991). The literature shows that chips made from potato bulb with a higher starch content are crisp, tender, low in fat, and their texture is not greasy (LESZCZYNSKI, LISIŃSKA 1985). Potato tubers for french fries should contain 14 to 18% starch, because too much of this ingredient causes unfavorable color changes and the formation of a spongy fried structure during frying. While too little starch

content causes the tubers absorb more fat during frying (TAJNER-CZOPEK et al. 2008). Important from the point of view of the structural characteristics of French fries has a fiber content in potato tubers – the higher, the better the quality of the fries (JARVIS, DUNCAN 1992, ANDERSSON et al. 1994). Research has shown that the heat treatment of potato tubers, among other things, soaking in warm water, a change in the chemical composition of potatoes, and the same texture. It was found that during peeling, blanching and deep-frying content increases protopectin in pectin and potato dry matter (GOŁUBOWSKA, LISIŃSKA 2005).

Soaking in water entails a reduction in the density of semi-finished products for chips (SOBOL 2007a, b, 2009, 2010). On the dynamics of changes in the density of semi-finished products is affected by water temperature and duration of the process (elution time) and physiological age tubers (SOBOL 2007a, b, 2009, 2010). Also, the shape and size of semi-finished products is influenced on the process of soaking in water. The dimension determines the kinetics of diffusion processes, among other sugars and the solid, thus causing lowering of density values. Research has shown that even a 5 minute soaking in water semi reduces the density of technologically significant value (SOBOL 2007b, LISIŃSKA 2006). Lowering of density may result in changes in the conditions of frying, and it affects the consistency of the finished products. It has been found that the structure of the potato change during processing due to water loss and tissue damage. This in turn influences the change of non-starch polysaccharides and lignin. The greatest changes in the tissue of potato result from thermal processes: blanching, drying and pre-frying (GOŁUBOWSKA, LISIŃSKA 2006). The observed amendments are affecting a texture of the product.

Hence the aim of the research was to determine the influence of time and temperature while the pre-treatment in hot water semi- products of the potato on a consistency of fries.

Materials and Methods

Sticks and slices made of Arielle potato specie were used for the tests. Arielle potato is a very early edible B type (general purpose) specie with oval tubers and light yellow pulp. It contains ca. 12.5% starch. The sticks were cut from tubers along the axis connecting the top and bottom part, and slices were cut transversely to that line. The semi-products formed had a comparable weight of ca. 10 g. The strips were square in cross section with 10 mm long sides, with the length 100 mm. The slices were 57 mm in diameter and 4 mm thick. Following the forming, all samples were shortly washed with running

water and wiped with a paper towel. The formed semi-products were immersed in demineralised water at the temperature of 20, 30, 40°C. The immersion time was 5, 10, 15 and 20 minutes. The tested sample contained semi-products without pre-treatment. Samples with the weight of ca. 120 g (12 pieces) were fried in refined rapeseed oil (3 litres) in a deep fryer. Frying temperature was equal for the sticks and slices and it was 170°C. Frying time was selected experimentally in preliminary tests, and it was 7.5 min. for the sticks and 7 min. for slices. After frying, the strips and slices were drained of the excess oil on the fryer basket and paper towels and, 10 min after frying, subjected to load, to measure the unit cutting resistance ($N \cdot mm^{-1}$). The strips were cut laterally (in the middle) and the slices laterally, along the diameter. Unit cutting resistance values were determined by referencing the maximum cutting force to the active blade length. For cutting resistance measurements, a 0.6 mm thick steel knife, sharpened at the angle 14°, was used. The tests were performed with Insight 2 (Insight Testing System) MTS (made in USA) strength testing machine controlled by a PC with the TestWorks 4 control and recording software. The application allows broad use of the machine for testing material strength. The objects tested were fixed horizontally to a stationary table and cut with a knife mounted in the measuring head clamp, moving at constant speed ($10 \text{ mm} \cdot \text{min}^{-1}$). The measurement was continued until complete splitting of a strip or slice. After prior implementation of the procedure for unit cutting resistance calculations in the Test Works 4 software, it continually analysed the results obtained, proposing location of specific points on the plot, including the one corresponding to the maximum force applied in the test. On completion of tests, the program automatically stored the results (HEBDA, FRANCIK 2008, HEBDA et al. 2012).

Test results were statistically processed with STATISTICA 10 software, using variance analysis for factor-based systems, and homogeneous groups in the post-hock tests, were determined with Duncan's multiple range test.

Results and Discussion

On the basis of analysis of variance in the classification triple was found that all adopted experimental factors – a shape of a semi-product, the water temperature, time soaking in water – have had the statistically significant effect on a cutting resistance the tested products. Also, the interaction between the factors – the shape of the semi-products and the time of pre-treatment samples in hot water – was the statistically significant (Tab. 1).

Table 1
Results of one-dimensional significance test, semi-product shape, temperature of water and the pre-treatment time effects on the variations of unit cutting resistance values of the fried products (α = 0.05 significance level assumed)

Quality predictor	Sum of squares	Degrees of freedom	Average square	*F*	*p*
Absolute term	16.99019	1	16.99019	7404.700	0.000000
{1}Product shape	2.99588	1	2.99588	1305.669	0.000000
{2} Temperature	0.02291	2	0.01145	4.992	0.007312
{3}Water sorption time	0.03653	4	0.00913	3.980	0.003613
1·2	0.00602	2	0.00301	1.313	0.270533
1·3	0.02496	4	0.00624	2.720	0.029689
2·3	0.01495	8	0.00187	0.814	0.590471
1·2·3	0.01962	8	0.00245	1.069	0.384455
Error	0.75719	330	0.00229	–	–

The analysis of the obtained results show that the individual resistance of cutting slices (0.13 N · mm^{-1}) are smaller than strips (0.31 N · mm^{-1}) (Fig. 1). The difference in unit values cutting resistances between products of accepted forms is high – resistance to fries are ca. 2.4 times higher than for slices (Fig. 1). Such a large difference may be due to simultaneous interaction of several factors. First of all, a different rate of diffusion of the nutrients contained in the cell juice and leaching solid. Samples in the form of slices are thinner than fries and probably, the process of diffusion and leaching proceeded faster. It could be the case of loss of a weight and a structure of the material, and thus a density and a consistency (SOBOL 2007b).

The differences in consistency of the tested object with different shape can also be sought in different loading orientation of the samples tested and share of tissue in the loading zone. The strips were subjected to transverse load to the centreline (axis between the top and bottom part), with the predominant share of core pulp and internal core cells. The slices were loaded along the longitudinal axis and, at the cutting zone (at the active blade length), cells of cortex pulp, fibro vascular bundles, core pulp and internal core. In the tests carried out by the authors, high consistency was achieved as compared to the results presented by KOWALCZYK and GUSTAW (2009). In this experiment involving coating the semi-products for French fries (with cross sectional dimension 10×10 mm) with hydrocolloidal solutions, while cutting the sample strips, the resistance of 3.22 N was noted. Strips coated with the solutions tested were characterised by much denser texture, from 3.85 to 6.06 N (KOWALCZYK, GUSTAW 2009).

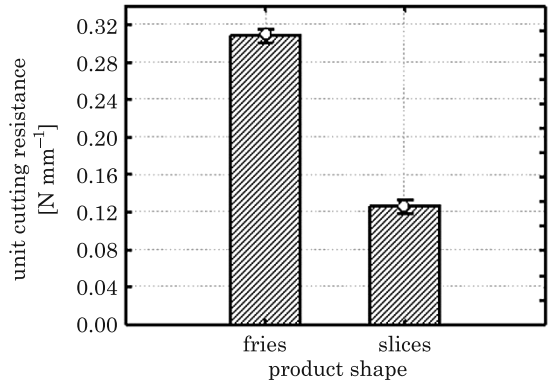

Fig. 1. Effects of product shape on the unit cutting resistance values

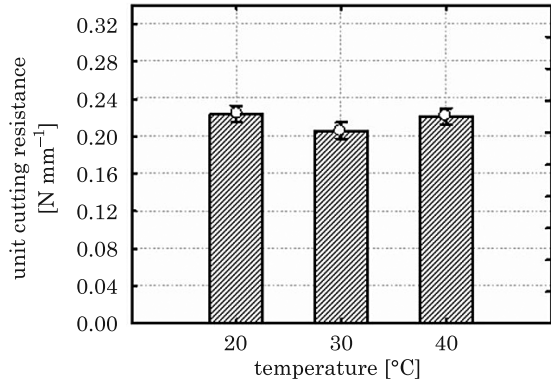

Fig. 2. Effect of the temperature of water on the unit cutting resistance

Analysis of the results of measurement for various temperatures during pre-treatment samples in hot water showed that the use of water baths at different temperatures helped to change the consistency (Fig. 2, 3). Statistically significant changes (on the basis of the test Duncan) were found between the texture of products in the bath at 30°C (0.21 N · mm^{-1}) and those from the other experimental combinations (0.22 N · mm^{-1}) (Fig. 2).

The time pre-treatment semi-products in hot water affected considerably the texture of tested products (Fig. 4, 5, 6). According to the Duncan test, consistency of the test sample (0.23 N · mm^{-1}) differs considerably from other samples texture (0.20–0.22 N · mm^{-1}) (Fig. 4).

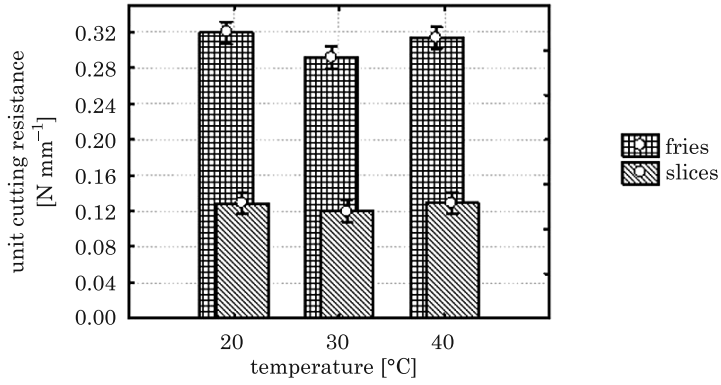

Fig. 3. Effects of the temperature of water on the unit cutting resistance of strips and slices

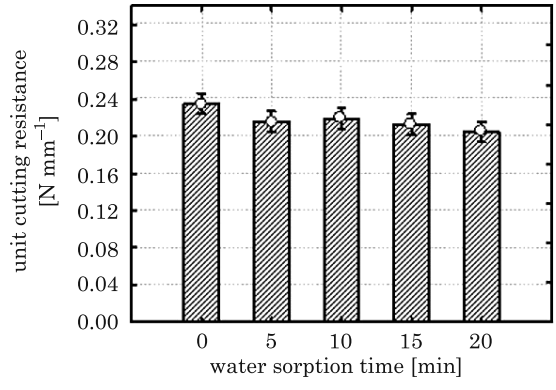

Fig. 4. Effects of the time pre-treatment in hot water on the unit cutting resistance

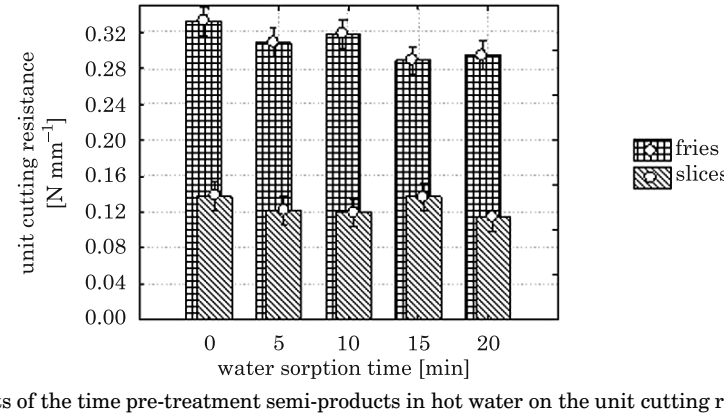

Fig. 5. Effects of the time pre-treatment semi-products in hot water on the unit cutting resistance of strips and slices

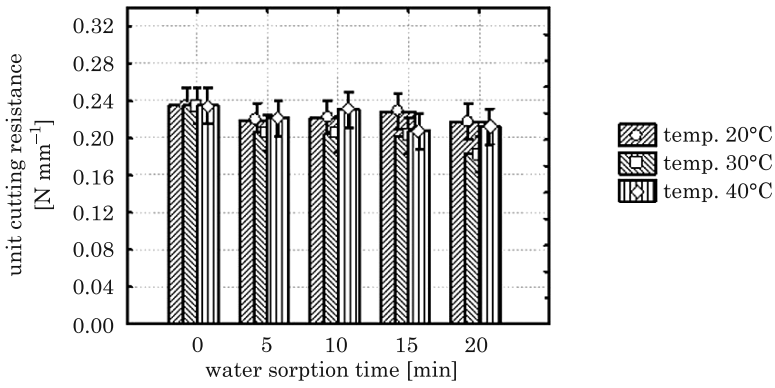

Fig. 6. Effect of the time pre-treatment semi-products in hot water on the unit cutting resistance in the temperature range applied

In the experiment analysed, the value of unit cutting resistance was mostly affected by the product shape (table 1) (Fig. 1, 3, 5), and the effects of other factors were statistically significant, but much weaker (Tab. 1, Fig. 2, 3, 4, 5), and there is no knowledge if this is sensed by the consumer.

Conclusions

1. All the experimental factors assumed, product shape, temperature of water for pre-treatment semi-products of a potate and treatment time are statistically significant for the product texture.

2. Much thinner texture (measured by unit cutting resistance values) have sliced products as compared to the strips.

3. Pre-treatment semi-products in water at temperature 30°C resulted in a decline in unit cutting resistance to the lowest value in the field of research.

4. The time of pre-treatment semi-products in hot water are insignificant for the texture, however, considerable difference occurs as compared to the test sample.

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