ISSN 1330-9862

(FTB-1410)

original scientific paper

The Relationship Between Protein Fractions of Wheat Gluten and the Quality of Ring-Shaped Rolls Evaluated by the Echolocation Method

Lina Jakubauskiene[1]* *and Grazina Juodeikiene*[2]

[1]Kaunas University of Technology, Food Institute, Taikos pr. 92, LT-51180 Kaunas, Lithuania

[2]Kaunas University of Technology, Department of Food Technology, Radvilenu st. 19, LT-50270 Kaunas, Lithuania

Received: September 8, 2004
Revised version: March 24, 2005
Accepted: June 28, 2005

Summary

This paper presents the results of the relationship between separate protein fractions and the quality of baked ring-shaped rolls. The qualitative and quantitative protein composition of flour derived from some wheat varieties grown in Lithuania has been determined. The protein properties are evaluated by SDS-PAGE. A new method of the analysis of swelling, based on the principle of echolocation, has been used to determine the quality of this specific kind of baked goods. For the application of this method the wheat flour, which is most suitable for the production of ring-shaped rolls, made from the wheat variety *Portal* (Pasvalys PVRS), has been selected. This flour has the following quality parameters: proteins 10.5 %, gluten 22.0 %, gluten index 47 r.u. Correlation between the flour quality parameters and the quality of the final bread product shows that γ-gliadins (r=–0.63), LMM glutenins (r=0.55), HMM glutenins (r=0.63) and the content of gluten (r=0.87) have the greatest influence on the quality of the ring-shaped rolls.

Key words: wheat flour quality parameters, gluten fractions, ring-shaped rolls, swelling and sensory analysis, echolocation method

Introduction

By evaluating the quality of bread making the greatest attention should be paid to the water insoluble proteins of the wheat flour. Different authors relate these proteins to the baking properties of flour and the quality of the baked goods (*1–3*).

Wrigley *et al.* indicated that fractions of glutenins have the strongest influence on the wheat baking properties (*4*). Van Lonkhuijsen *et al.* presented that more hydrophobic gliadins (*e.g.* γ-gliadins) increase the volume of a bread loaf, while gliadins from the more hydrophilic part of the electroforetic spectrum (*e.g.* ω-gliadins) decrease the volume of a bread loaf (*5*).

Ng *et al.* indicated a strong correlation between wheat baking properties and low molecular mass (LMM) glutenin fractions, which has been described by a linear regression equation (*6*). A strong correlation has been found between specific gliadins and the quality of bread products, as well as between individual subunits of high molecular mass (HMM) glutenins and quality of the baked goods (*2,7–9*).

Ring-shaped rolls, a specific wheat bread popular in Lithuania, has been chosen for this work. This product distinguishes itself by its special form (ring), inner structure of the product and low moisture content of the dough (35–40 %). From a reological point of view the dough of the ring-shaped rolls is like a plastically resilient body. In the course of the production of ring-shaped

*Corresponding author; Phone: ++370 37 312 393; Fax: ++370 37 312 393; E-mail: lina.jakubauskiene@takas.lt

rolls a specific technological operation is performed. The half-finished products are treated with steam. Therefore, during baking both baking and drying take place. Due to this procedure the baked products get a specific texture properties.

The aim of the work presented in this paper was to study the correlation between gluten forming polypeptides of some wheat varieties in Lithuania and the quality of special bread in this country (ring-shaped rolls).

Materials and Methods

Wheat

In the initial stage of the work, spring (*Munk*) and winter (*Portal*, *Sirvinta 1*, *Marabu*, *Kosack* and *Zentos*) wheat was harvested at the Plant Variety Research Stations (PVRS) in Kaunas, Pasvalys and Plunge region. The local agrotechnical conditions are presented in Table 1.

Wheat flour

The entire technological process of ring-shaped roll production, from raw material to the final product, was analyzed.

In the initial stage of the study wheat flour (type 550) was milled from quality grains (spring wheat *Munk* and winter wheat *Portal*, *Sirvinta 1*, *Marabu*, *Kosack* and *Zentos*). The chemical composition and technological properties of the flour were evaluated by standard research procedures, published by the International Association for Cereal Chemistry and Technology (ICC) (*10*). In the course of the experiment the following wheat flour quality parameters were determined: protein (*11*), gluten content and quality (*12*), sedimentation value (*13,14*) and starch (*15*).

Analysis of quantitative composition of wheat gluten protein fractions by SDS-PAGE

The analysis of α-, γ-, ω-gliadins, LMM and HMM glutenins was carried out by sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE) (*16,17*). For the analysis of the quantitative composition of proteins, 10 mg of the milled (Laboratory Mill 3100) sample were treated with 1 mL of 10 % SDS solution and heated for 30 min in a boiling water bath. The solution was centrifuged; the obtained supernatant was diluted in mass ratio of 3:1 with buffer solution, and heated again for 3–4 min. For electrophoresis, 12 % separating and 4 % concentrated gels were used (Biorad Instrumentation Manual 1985), in a Protean TM II apparatus (Biorad, USA).

For quantitative determination of proteins the gel was coloured by Coomassie Brilliant Blue-R 250 (*17*). As mentioned in the references (Fig. 1), the intensity of the gel bands is directly proportional to the protein content (*16,17*).

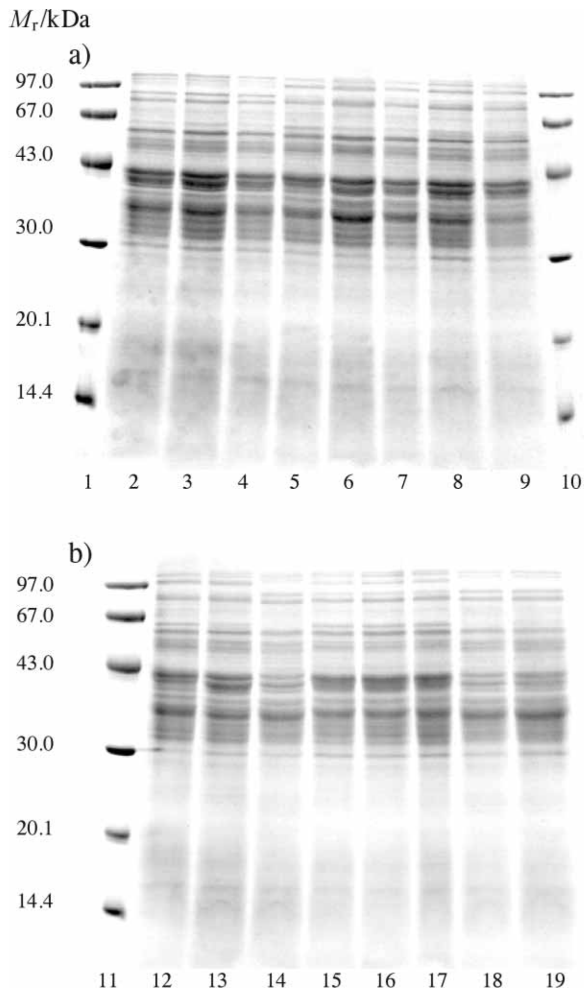

Fig. 1. Electrophoretic spectrum of the standard proteins (1, 10 and 11) and gluten fractions in different wheat varieties (2–9, 12–19)

a) 2 – *Kosack* (Kaunas PVRS), 3 – *Kosack* (Plunge PVRS), 4 – *Kosack* (Pasvalys PVRS), 5 – *Munk* (Plunge PVRS), 6 – *Zentos* (Kaunas PVRS), 7 – *Zentos* (Pasvalys PVRS), 8 – *Portal* (Kaunas PVRS), 9 – *Portal* (Pasvalys PVRS)

b) 12 – *Munk* (Kaunas PVRS), 13 – *Portal* (Plunge PVRS), 14 – *Marabu* (Pasvalys PVRS), 15 – *Sirvinta 1* (Plunge PVRS), 16 – *Sirvinta 1* (Pasvalys PVRS), 17 – *Sirvinta 1* (Kaunas PVRS), 18 – *Marabu* (Plunge PVRS), 19 – *Marabu* (Kaunas PVRS)

Table 1. Local agrotechnical conditions of wheat growing

Plant Varieties Research Station	Kaunas PVRS	Pasvalys PVRS	Plunge PVRS
Soil type	Medium heavy loam	Medium heavy humus rich loam	Medium heavy loam
Soil pH	7.1–7.3	6.1–6.5	5.7–6.1
w(mobile P_2O_5 in soil)/(mg/kg)	208	319	267
w(mobile K_2O in soil)/(mg/kg)	178	374	235
w(humus)/%	2.0–2.4	2.2–3.0	1.8–2.1
Fertilization rate	$N_{60}P_{50}K_{60}$	$N_{90}P_{100}K_{100}$	$N_{70}P_{35}K_{21}$

The exposed gel electrophoretic spectrum was recorded by a densitometer and the content of different protein fractions calculated from the corresponding densitograms. The calibration curves were drawn for each gel to determine the molecular mass of the protein.

In both cases the molecular mass of the standard (reference) protein is on the ordinate and the electrophoretic rate on the abscissa. Functional dependence of these parameters is described by the regression equations for the first and second gels and are respectively $y=114.97–120.9\ x^{0.5}$ and $y=115.78–112.69\ x^{0.5}$. The corresponding determination coefficients are respectively 0.93 and 0.92.

The content of protein (%) is calculated by integrating the area of spike of each protein's component on the densitogram.

The example of the electrophoretic spectrum of the identified protein fraction in the variety *Portal* (grown in Pasvalys PVRS) is presented in Fig. 2.

During the analysis the electrophoretic rate (R_f) of each protein compound was determined in the analyzed sample and according to the calibration curve their molecular mass was calculated.

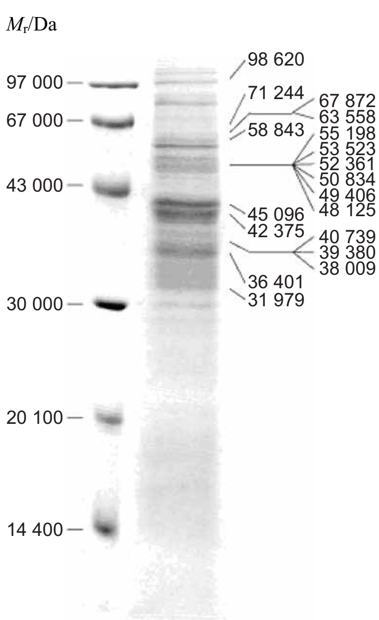

Fig. 2. Electrophoretic spectrum of standard proteins in the wheat variety *Portal* (Pasvalys PVRS)

Preparation of ring-shaped rolls

Experimental baking of ring-shaped rolls was carried out under normal production conditions at J.C. »Kauno duona«. The recipe for the production of vanilla flavoured ring-shaped rolls is presented in Table 2.

The dough was prepared by a single-phase method by mixing all the ingredients in a periodic mixer (mixing machine T2M63) for 15–20 min. The dough was divided into 5–7 kg portions, rolled in a H4M2330 machine and fermented at 26 °C for 10–15 min. This operation was performed on a conveyor belt, where the dough sheet was covered by a linen cloth. The dough was shaped in a B-4-58PS machine and the half-finished product was left to rise on a conveyor rising machine for 1.5–2 h (at 33–35 °C and relative humidity 70 %), followed by a specific ring-shaped roll production operation – sprinkling with a water-steam mixture at 110 °C for 4.5 min. The product was baked in a PXC-25M oven at 220 °C for 14 min.

Table 2. Recipe for vanilla ring shaped rolls

Raw materials	m/kg
Wheat flour	100.0
Water	37.0
Sugar	10.0
Fat	5.0
Pressed yeast	2.0
Salt	1.0

The quality of the ring-shaped rolls was evaluated by sensory analysis and the swelling test. The sensory characteristics of the end products were determined by the method of descriptive sensory analysis (*18,19*). Sensory parameters such as surface colour, taste, hardness, elasticity and mastication were evaluated by the procedure described by Civille *et al*. (*20*).

For the analysis of swelling of the ring-shaped rolls a swelling analysis method coupled with an echolocation procedure, both developed at the Food Products Technology Department of Kaunas University of Technology (KTU), was applied (*21*).

The swelling method determines the volume of absorbed water by the porous matrix (ring-shaped rolls), which changes the water level in a cylinder measuring vessel. The level changes are assessed by a contactless ultrasound level meter, working according to the sound location principle (*22*). This method showed in the past that the swelling intensity of porous matrices (*e.g.* in ring-shaped rolls) differed according to the total volume of absorbed water (V), expressed in relative units (r.u.), and the swelling dynamics (V_d), expressed by mathematical equations (*23*). The results, involving the method above, showed that ring-shaped rolls of different quality also differ in their swelling intensity. The total volume of absorbed water is characteristic of the quality of ring-shaped rolls. Their swelling dynamics (V_d) is described by the above-mentioned mathematical equations. This quality evaluation methodology will be used for the evaluation of ring-shaped rolls prepared from different types of flour.

Results and Discussion

Chemical composition and technological properties of wheat flour

Flour was produced from the most popular wheat varieties in Lithuania suitable for the production of ring-shaped rolls. The results of the flour quality derived from wheat varieties in Lithuania suitable for the production of ring-shaped rolls and the wheat grain quality parameters are shown in Table 3.

Table 3. Lithuanian (raw) grain and flour quality parameters

Wheat variety	Location	*w*(moisture)/%	Sedimentation index/mL	*w*(starch)/%	*w* (protein)/% (d.m.)		*w* (gluten)/%		Gluten index/r.u.	
					Wheat	Flour	Wheat	Flour	Wheat	Flour
Munk	I	13.0±0.3	31.0±0.2	73.2±0.4	12.0±0.5	12.0±0.7	26.8±0.8	27.4±0.2	46.0±0.8	47.0±0.0
	III	11.3±0.9	29.0±0.6	67.7±0.6	11.6±0.2	10.6±0.1	23.2±0.7	23.2±0.4	83.0±0.2	81.0±0.7
Sirvinta 1	I	12.4±0.5	24.0±0.8	75.1±0.3	11.2±0.4	11.2±0.7	24.7±0.2	25.3±0.6	24.0±0.9	24.0±0.3
	II	11.0±0.1	25.0±0.6	71.7±0.7	10.4±0.3	10.4±0.1	25.1±0.5	25.5±0.3	25.0±0.4	25.0±0.2
	III	11.3±0.5	21.0±0.2	70.4±0.2	10.7±0.1	10.7±0.3	26.1±1.1	26.2±0.7	21.0±0.4	22.0±0.7
Portal	I	12.7±0.5	41.0±0.2	71.7±0.6	14.2±0.3	14.2±0.2	32.8±0.5	32.9±0.3	20.0±0.5	20.0±0.2
	II	11.2±0.3	36.0±0.4	76.6±0.6	10.5±0.8	10.5±0.8	21.5±0.6	22.0±0.1	75.0±0.6	74.0±0.9
	III	11.7±0.7	34.0±0.2	72.5±0.2	12.1±0.1	12.1±0.4	31.4±0.7	31.6±0.6	28.0±0.3	29.0±0.1
Zentos	I	12.4±0.3	48.0±0.7	68.7±0.7	12.8±0.8	12.8±0.4	29.2±0.6	29.6±0.6	41.0±0.6	40.0±0.3
	II	11.3±0.3	49.0±0.3	75.5±0.4	11.8±0.2	9.8±0.1	17.1±0.2	17.4±0.3	94.0±0.3	95.0±0.9
Kosack	I	12.8±0.1	19.0±0.6	75.4±0.1	10.3±0.3	10.3±0.2	23.5±0.2	23.7±0.4	22.0±0.5	22.0±0.2
	II	11.0±0.2	16.0±0.1	75.0±0.3	9.4±0.4	9.4±0.9	20.9±0.3	21.1±0.6	20.0±0.3	21.0±0.4
	III	13.1±1.0	19.0±0.4	76.3±0.7	10.6±0.6	10.8±0.4	25.2±0.2	25.3±0.5	24.0±0.8	26.0±0.2
Marabu	I	12.4±1.0	13.0±0.4	73.5±0.1	12.1±0.6	12.1±0.6	16.9±0.8	17.5±0.2	13.0±1.0	13.0±1.0
	II	11.0±0.5	10.0±0.2	78.9±0.6	9.5±0.3	9.5±0.2	12.2±0.5	13.7±0.1	10.0±0.3	12.0±0.1
	III	12.1±0.6	11.0±0.6	75.7±0.4	10.5±0.3	10.5±0.6	13.8±0.7	15.6±0.4	11.0±0.6	11.0±0.5

I – Kaunas PVRS, II – Pasvalys PVRS, III – Plunge PVRS
r.u. – relative units
d.m. – dry matter

The data presented in the table above show that various types of flour of different quality were selected for the experiment. In the analyzed flour samples the total protein was 9.4–14.2 %, gluten 13.7–33.0 %, and the gluten index 11–95 r.u. The highest gluten content was found in the flour produced from *Munk* (27.4 %), *Portal* (32.9 %) and *Zentos* (29.6 %), grown in Kaunas PVRS. The optimal gluten index (GI) is a characteristic of the flour produced from *Portal* (Pasvalys PVRS, GI=74 r.u.) and *Munk* (Plunge PVRS, GI=81 r.u.).

The mass fraction of starch (67.7–76.3 %) in the analyzed samples is inversely proportional to the mass fraction of proteins (r=–0.4). The highest mass fraction of starch in flour was produced from *Marabu* (76.3 %) and *Kosack* (75.73 %).

In most cases the highest gluten index was determined in the samples of wheat and wheat flour that had the lowest mass fraction of gluten. The research carried out by Sip *et al.* (*24*) also indicated that wheat fertilization with nitrogen fertilizers stimulated accumulation of more gluten, but its quality decreased. Various authors indicate that quality of gluten depends on the ratio of protein fractions that forms in grains (*25–27*).

The genotypes of the wheat, used for the flour preparation, mostly differ in protein content. Having taken into consideration the fact that water insoluble proteins take part in the process of dough formation, it is important to evaluate the composition of gliadins and glutenins.

Electrophoretic spectra of water insoluble protein fractions of the studied varieties identified: α-gliadins (31–32 kDa), γ-gliadins (38–42 kDa), ω-gliadins (44–64 and 70–74 kDa), LMM glutenins (36–38 and 42–44 kDa) and HMM glutenins (64–70 and 95–136 kDa) and showed that gluten protein fractions varied in the following ranges: α-gliadins – from 2.2 to 4.1 %, γ-gliadins – from 5.5 to 21.4 %, ω-gliadins – from 32.9 to 47.9 %, LMM glutenins – from 6.6 to 32.0 % and HMM glutenins – from 1.7 to 11.4 % (Table 4).

Quality of ring-shaped rolls and related flour parameters

The results of the quality investigation of ring-shaped rolls produced from different types of wheat flour derived from different wheat varieties are presented in Table 5.

It has been found that the swelling capacity of the analyzed samples strongly depends on the quality of the grain raw material. The ring-shaped rolls made from the flour of the wheat varieties *Munk* (Kaunas and Plunge PVRS), *Portal* (Pasvalys PVRS) and *Zentos* (Kaunas PVRS) are of good quality according to the results of both the sensory and swelling capacity analysis. The total volume of water (V) absorbed by these analyzed samples changes in the interval from 37.2 to 41.9 r.u. The swelling dynamics (V_d) of the samples of this quality group can be described by a linear (*Portal*) or exponential (*Zentos*, *Munk*) equation. The flour used in the production of high quality ring-shaped rolls can be divided into two quality groups. The first group is the flour, which has an optimal gluten index (74–81 r.u.), low gluten content (22.0–23.2 %) and a protein content of 10.5–10.6 %, such as in the wheat varieties *Munk* and *Zentos*, grown in Kaunas PVRS. The second group is the flour which has moderate values of gluten index (40–47 r.u.), high gluten content of (27.4–29.6 %) and protein content of 12.0–

Table 4. Gliadin and glutenin fractions of the studied wheat varieties

Wheat variety	Relative content of gluten protein fractions/%														
	Sulphur-rich									Sulphur-poor					
	α-gliadins			γ-gliadins			LMM glutenins			ω-gliadins			HMM glutenins		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Munk	3.4	–	3.7	12.1	–	13.4	25.0	–	7.1	32.9	–	47.2	6.9	–	3.3
		3.6±0.2			12.8±0.9			16.0±4.2			40.0±10.0			5.1±2.1	
Sirvinta 1	2.4	2.3	2.4	15.2	15.5	8.0	23.4	18.3	28.3	39.3	42.8	40.4	8.4	8.3	7.5
		2.4±0.1			12.9±4.2			23.3±5.02			4.8±.1.8			8.1±0.5	
Portal	4.1	3.5	2.5	15.2	12.1	13.1	12.5	9.4	21.6	43.2	47.9	42.3	2.7	5.9	6.9
		3.3±0.8			13.4±1.5			14.5±6.3			44.5±3.0			5.2±2.2	
Zentos	3.2	3.1	–	16.2	17.3	–	11.8	7.3	–	44.3	46.2	–	1.8	1.8	–
		3.2±0.1			16.5±0.6			9.6±3.2			45.3±1.3			1.8±0.1	
Kosack	2.9	3.2	3.9	21.4	21.9	21.5	6.6	9.4	10.9	43.2	40.7	41.5	3.2	5.5	5.4
		3.3±0.6			21.5±0.2			8.9±3.1			41.8±1.3			4.7±1.3	
Marabu	2.21	2.35	2.9	10.3	5.6	10.3	24.9	32.0	22.1	41.6	40.1	40.3	11.1	10.3	11.4
		2.5±0.4			8.1±0.7			26.3±4.2			40.6±0.8			10.9±1.8	

I - Kaunas PVRS, II - Pasvalys PVRS, III - Plunge PVRS

12.8 %. The wheat varieties *Munk* (Plunge PVRS) and *Portal* (Pasvalys PVRS) meet these quality requirements.

According to the sensory and swelling capacity parameters, the moderate quality ring-shaped rolls can be made from flour of the wheat varieties *Zentos* (Pasvalys PVRS), *Portal* (Kaunas and Plunge PVRS), *Kosack* and *Sirvinta 1*. Their swelling dynamics (V_d) is described by an exponential or composite functional equation. The total volume of adsorbed water (V) is low (6.5–20.6 r.u.). The protein content in these types of wheat flour is 9.4 to 14.2 %, the gluten content 21.1 to 32.9 % and the gluten index 20 to 29 r.u. Ring-shaped rolls, produced from *Marabu* flour, are of low quality. Their swelling dynamics is also described by the above-mentioned composite functional equation. The samples absorb a maximum quantity of water (71.8–109.6 r.u.), and their sensory parameters are unsatisfactory. This wheat flour is characterized by low protein (9.5–10.1 %) and gluten (13.7–17.5 %) content, and a gluten index below 20 r.u.

The experiments show that a change in the parameters characterizing the swelling capacity of ring-shaped rolls, as well as the total volume of absorbed water (V) and swelling dynamics (V_d), fall in the same quality

Table 5. Evaluation of sensory properties of the ring-shaped rolls

Wheat variety for flour production	Location	Quality indices/points					Total volume of absorbed water/r.u.	Rolls quality groups
		Hardness	Elasticity	Mastication	Surface colour	Taste		
Munk	I	5.8±0.4	7.6±0.8	1.8±0.4	4.5±0.5	7.6±0.5	37.2	good
	III	4.4±0.7	7.1±0.8	1.5±0.7	4.9±0.6	7.85±0.5	28.5	good
Sirvinta 1	I	1.7±0.7	3.6±0.8	5.6±0.8	3.4±0.5	4.5±0.8	15.3	moderate
	II	1.9±0.7	3.7±0.7	5.3±0.5	3.6±0.8	2.9±0.6	11.4	moderate
	III	1.8±0.9	3.8±0.9	5.6±0.5	3.8±0.4	3.5±0.7	8.5	moderate
Portal	I	1.8±0.8	4.6±0.7	5.6±0.5	3.2±0.4	3.5±0.8	85.0	moderate
	II	5.2±0.4	9.4±0.5	3.5±0.5	6.5±0.5	9.5±0.5	109.5	good
	III	3.2±0.9	3.6±0.7	5.5±0.5	3.7±0.7	5.0±0.9	71.8	moderate
Zentos	I	5.6±0.7	7.3±0.5	2.4±0.5	5.5±0.7	8.0±0.7	7.4	good
	II	2.8±0.8	5.4±0.5	6.0±0.5	3.0±0.7	3.8±0.6	39.2	moderate
Kosack	I	1.4±0.6	3.6±0.8	5.8±0.6	8.6±0.7	4.0±1.0	6.5	moderate
	II	3.2±0.6	5.6±0.5	5.1±0.5	3.3±0.5	4.5±0.7	20.6	moderate
	III	3.0±0.8	4.9±0.7	5.7±0.7	3.5±0.5	3.6±0.5	20.4	moderate
Marabu	I	9.4±0.5	1.5±0.5	7.4±0.5	1.2±0.4	1.1±0.3	14.1	poor
	II	9.3±0.5	1.3±0.5	8.6±0.5	1.6±0.7	1.6±0.5	41.9	poor
	III	9.3±0.5	1.9±0.6	8.6±0.8	1.7±0.7	1.3±0.5	9.9	poor

I - Kaunas PVRS, II - Pasvalys PVRS, III - Plunge PVRS groups as characterised by the sensory results. Thus, the application of swelling analysis method coupled with the echolocation procedure can be helpful in selecting the wheat for the production of optimal ring-shaped rolls. It has been found that the flour produced from wheat variety *Portal* (Pasvalys PVRS) is the best for the production of these rolls. The protein content is 12.1 %, the gluten content 22.0 %, and the gluten index 74 r.u.

The quality analysis of ring-shaped rolls shows that lower content of flour gluten can be compensated by a better gluten quality and that low gluten quality can be compensated by a higher content of gluten. Results of the research show that the ring-shaped rolls of good quality are produced from flour with low gluten content (22.0–23.2 %) and an optimal gluten quality (gluten index 4–81 r.u.), and of flour with higher gluten content (27.4–29.6 %) and lower gluten quality (gluten index 40–47 r.u.).

In order to establish the influence of individual parameters of wheat flour on the quality of ring shaped-rolls, the correlation between the quality characteristics of wheat flour (total protein content, separate protein fractions, gluten, gluten index, starch, mineral, sedimentation index) and the index of swelling capacity of ring-shaped rolls (total volume of absorbed water, *V*, is shown in Table 5) has been calculated (Table 6).

Table 6. Correlative dependencies between the quality indices of wheat flour and total volume of absorbed water

Chemical composition and technological indices of the grain material	Correlation coefficients (*r*)
w(total protein content)/%	–0.13
w(α-gliadins)/%	–0.41
w(γ-gliadins)/%	–0.63
w(ω-gliadins)/%	–0.18
w(LMM glutenins)/%	0.55
w(HMM glutenins)/%	0.63
w(gluten)/%	0.87
Gluten index/r.u.	0.45
Sedimentation index/mL	0.53
w(starch)/%	0.48

There is a strong positive correlation (*r*=0.87) between the content of gluten in flour and the total volume of absorbed water.

Single gluten protein fractions are different in their effect on the quality of ring-shaped rolls. Some of them (α-, γ-gliadins, LMM and HMM glutenins) influence the quality of ring-shaped rolls, however, the correlation between these fractions and the index *V* is weak. Another protein fraction (ω-gliadins) does not have a significant effect on the quality of ring-shaped rolls (*r*=0.18).

Sedimentation index (*r*=0.53), which characterizes protein quality, and gluten index (*r*=0.45), indicate the gluten quality influence on the quality of the ring-shaped rolls.

We have found that insoluble gluten proteins (*r*=0.87) in the flour, as well as γ-gliadins (*r*=–0.63), LMM glutenins (*r*=0.55) and HMM glutenins (*r*=0.63) had the strongest influence on the quality of this type of products. Therefore, this index should be taken into consideration when selecting wheat for production of flour for ring-shaped rolls.

Conclusions

The correlation between wheat gluten fractions and the parameters, characterizing flour and the quality of the finished product, shows that γ-gliadins (*r*=–0.63), LMM glutenins (*r*=0.55), HMM glutenins (*r*=0.63), and gluten content (*r*=0.87) have the greatest influence on the baking properties of wheat.

Quality analysis made by a swelling analysis method coupled with the echolocation procedure shows that the total volume of absorbed water (*V*) in the ring-shaped rolls of good quality made from *Portal* (Pasvalys PVRS), *Zentos* (Kaunas PVRS) and *Munk* wheat flour, vary from 28.47 to 41.87 r.u. In the ring-shaped rolls of moderate quality made from Zentos (Pasvalys PVRS), *Portal* (Kaunas and Plunge PVRS), *Kosack* and *Sirvinta 1* wheat flour varieties the total volume of absorbed water (*V*) varies from 6.47 to 20.61 r.u. and in the rolls made from poor quality flour (*Marabu*) it varies from 71.7 to 109.5 r.u.

By applying the echolocation method in the quality analysis of finished baked products the following quality requirements were established for the flour raw material (wheat flour of 550 type) used for the production of ring-shaped rolls: protein content (12.1±0.98) %, content of gluten 22.0 % and gluten index 74 r.u. Wheat variety *Portal* was found to be the most suitable because it met closely the above quality requirements.

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Utjecaj proteinskih frakcija glutena pšenice na kakvoću okruglih kruščića procijenjenu ekolokacijskim postupkom

Sažetak

U radu je prikazan utjecaj pojedinih proteinskih frakcija na kakvoću pečenih okruglih kruščića. Utvrđen je kvalitativni i kvantitativni sastav pšeničnoga brašna nekih vrsta pšenice uzgojenih u Litvi. Prema rezultatima SDS-PAGE ocijenjena su svojstva proteina. Da bi se odredila kakvoća tih pečenih kruščića, primijenjena je nova metoda analize dizanja tijesta određena ekolokacijom. U primjeni ove metode odabrano je brašno sorte *Portal* (Pasvalys PVRS) koje je bilo najprikladnije za proizvodnju kruščića, a sadržavalo je 10,5 % proteina, 22 % glutena i glutenski indeks od 47 relativnih jedinica. Uspoređujući sastav brašna i kakvoću pečenih kruščića, ustanovljeno je da γ-glijadini (koeficijent korelacije proteina i volumena apsorbirane vode, r=–0,63), glutenini male molekularne mase (r=0,55), glutenini velike molekularne mase (r=0,63) i udio glutena (r=0,87) najviše utječu na kakvoću pečenih kruščića.