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Influence of Some Chemical Properties of Durum Flour on Pasta Quality

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Summary

The pasta made of soft wheat flour is difficult to obtain, and the final product is of significantly lower quality than the product made of Triticum durum flour.

In this paper the influence of chemical properties on pasta quality is determined, and it is compared with the properties of flour made from the soft wheat. Analyses were done with four samples of T. durum and two samples of soft wheat. In all of these samples mass fractions of water, ash, β-carotene, protein, wet gluten, starch, damaged starch, and lipid were determined, and the sedimental test and the activity of α-amylase were analysed. Organoleptic estimation of pasta was done with a group of six assessors who estimated the following: shape, surface condition, smell, taste, stickiness and pasta characteristic during cooking. The obtained results show that the pasta quality can be predicted by the content of protein, wet gluten and starch.

Keywords: T. durum flour, chemical properties, pasta quality

Introduction

Flour made of *Triticum durum* has been used for pasta production worldwide, but in Croatia pasta has been made only from *Triticum aestivum* flour.

With respect to the properties, the flour from *T. durum* is significantly different from the *T. aestivum* flour which is reflected on pasta quality. It refers specially to the content of protein and β-carotene.

The mass fraction of the whole protein in *T. durum* is about 15%, and in *T. aestivum* about 9% *(1)*. Certain investigations show the relation of the protein content and pasta quality *(2)*. Moreover, the protein structure of *T. durum* is different from the protein structure of *T. aestivum*. Bushuk *(3)* showed the presence of some of proteins in two different types of wheat, where it was noticable that *T. durum* had higher gliadin mass fraction (41.1%) than *T. aestivum* (29.6%), while the mass fraction of insoluble glutenin was less in *T. durum* wheats (23.4%) than in *T. aestivum* wheats (35.3%).

The content of β-carotene in *T. durum* ranges from 3.5 to 6 mg per kg, and sometimes even more *(4)*, while the content of β-carotene in *T. aestivum* is significantly less and it ranges from 1.8 to 3.0 mg per kg *(4)*. The higher content of β-carotene influences the colour of final product, and it is one of the reasons for using the grits from *T. durum* as the raw material for quality pasta production.

In this paper the influence of chemical properties of *T. durum* flour on pasta quality was examined. Some investigations were determined with *T. aestivum* flour, and the results were compared.

Materials and Methods

Four samples of *T. durum* flour, D1, D2, D3, D4 and two samples *T. aestivum* flour, K and O, were examined. Samples D1, D2, D3 are mixtures of the Italian *T. durum* flour, and D4 is the Canadian *T. durum* flour. Sample K belongs to flour of new sort *T. aestivum* wheat »Divana« from Križevci. Sample O is *T. aestivum* flour from Osijek.

In all of these samples dimensions of particles were determined by the sieving machine with different holes (0.6 mm; 0.475 mm; 0.355 mm; 0.132 mm).

Chemical analyses included water content and ash content according to the standard methods *(5)*. The wet gluten was determined by hand wash method. The protein content was determined according to Kjeldahl

method. Sedimental test was done according to the Dick and Quick method *(6)*. The content of lipid was determined according to the Weibull-Stoldt method, and the starch content was determined according to the Evers method. Damaged starch was determined according to the modified spectrophotometric Williams-Fegol method *(7)*. Determination of the Hagberg's falling number showed α-amylase activity. β-carotene was determined by extraction in n-butyl alcohol and measurement of light transmission.

The flour was mixed with tap water to obtain a total dough water mass fraction of 32–33%. The dough was processed into pasta using the press (Braibanti, Italy). Two mixtures made of all samples of the flours were made. The first mixture was without eggs, and the second was with three eggs. All samples of the shaped pasta were dried at the temperature of about 37 °C for 12 hours in a chamber dryer with the capacity of 120 kg. Dried and cooled pasta was packed in polypropylene bag by packer (»Dominione«).

Organoleptic estimations of cooked and uncooked pasta were done by a group of six assessors. The following was estimated: the shape, surface condition, smell, taste and stickiness *(5)*.

The pasta characteristic during the cooking was determined by the following parameters: cooking time, cooking loss, volume increase and water absorption.

Results and Discussion

Chemical Properties of Flour

T. durum flour differs from *T. aestivum* flour according to some chemical variables: protein content, β-carotene content and ash content.

The results of chemical analyses are reported in Table 1.

The protein content in *T. durum* is higher than the protein content in *T. aestivum*. The difference in protein content between *T. durum* and bread wheats has been reported by numerous researchers *(8–10)*. The protein content is very important because of influence on the dough forming, and the influence on the final product. The protein content is different in various wheats, it depends on the locality of growth. So the protein mass fraction of Canadian *T. durum* is from 10 to 18% *(11)*, *T. durum* from Turkey has proteins about 10% (9–11%) *(8)*, and Italian *T. durum* has from 11 to 18.5 *(12,13)*. Table 1 shows that samples D3 and D4 had the highest protein content, and the samples D1 and D2 had the lowest protein content.

The samples D3 and D4 had the highest wet gluten content, while the samples D1 and D2 had the lowest wet gluten content, and the flour from *T. aestivum* wheats K and O had the middle wet gluten content. This could be expected since the significant correlation between the content of wet gluten and dry gluten and the protein content is well known.

The ash content of *T. durum* flour samples was higher than that of *T. aestivum* flour (Table 1). The high ash content is explained with higher mineral substance content in endosperm and high content of aleuron in the mill products. Aleuron grinds very easily during the milling because it has less mechanical resistance than endosperm and wrapping. Ground particles mix with endosperm particles, which causes ash content increasing.

The β-carotene mass fraction is higher in the *T. durum* flour than in *T. aestivum* and it represents the fundamental index of the quality for *T. durum* pasta. The β-carotene in Canadian *T. durums* ranges from 5 to 7 mg per kg, in Turkish *T. durum* from 3.5–5.7 mg per kg *(8)*, and in the Indian *T. durum* from 4 to 10 mg per kg *(11)*. Samples D3 and D4 are of medium quality *T. durum* flour, D1 and D2 contain low quality *T. durum* flour, and K and O are typical *T. aestivum* flour according to the β-carotene amounts *(4)*.

The starch and protein contents are related negatively in the wheat. According to this fact the starch content was lower in samples where the protein content was high. The milling causes the damage of starch, and it is more expressive during the *T. durum* milling because of

Table 1. Results of flour chemical analyses

Sample	Water *w*/%	Ash *w*/%	Protein *w*/%	Wet gluten *w*/%	Sedimental value/mm	Lipid *w*/%	Starch *w*/%	Damaged starch *w*/%	Falling number/s	β-carotene *w*/(mg/kg)
D1	13.6	0.37	9.3	23.0	40	0.78	73.07	21.41	312	3.2
D2	13.56	0.43	8.77	21.5	30	0.65	73.07	20.33	324	3.05
D3	13.35	0.86	10.80	28.0	26	0.91	69.51	25.96	440	4.29
D4	13.6	0.79	11.85	35.0	25	1.08	67.87	24.3	335	5.3
K	13.39	0.42	10.72	26.5	36	0.54	71.15	21.9	346	1.84
O	14.17	0.42	9.87	26.0	34	0.78	71.70	21.37	371	2.89

Table 2. Results of sieving

Sample	Particles larger than 0.6 mm (%)	Particles larger than 0.475 mm (%)	Particles larger than 0.355 mm (%)	Particles larger than 0.132 mm (%)
D1	0.00	1.60	9.50	85.00
D2	0.00	0.80	21.80	73.20
D3	0.05	4.60	7.70	68.60
D4	0.00	0.40	15.20	70.40
K	4.20	17.00	26.00	47.00
O	0.00	0.01	1.85	79.10

a more compressed structure of endosperm. Because of that *T. durum* wheats have higher content of the damaged starch than *T. aestivum* wheats. Samples D3 and D4 showed the highest amount of the damaged starch.

Table 2 shows the results of sieve determination which is important because absorption, flour colour, dough forming, and enzymes activity depend on it. Dick and Matsuo *(14)* suggest particle dimensions from 0.150 to 0.350 mm as optimal dimension, and Seiler from 0.250 to 0.350 mm *(15)*. All of the samples had optimal granulation except sample K which had the highest percentage of large particles on the sieve with 0.6 mm holes (even 4.2%).

Quality Factors of Final Products

Table 3 shows the results of pasta cooking with and without eggs. The cooking time is the time after which a continuous white line visible at the centre of pasta during cooking disappears when the pasta is crushed by crushing plate *(16)*. The usual cooking time is 7–25 minutes *(11)*. As is reported in Table 3, the samples were cooked between 12 and 17 minutes.

During cooking the pasta absorbs water. The significant difference between the samples was not determined, and the results were similar to the results of other authors *(11)*. The sample K shows the lowest value, and the sample D1 the highest.

Table 3. Results of pasta analyses during cooking

Sample	Absorbed water V/cm^3	Volume increase/cm^3	Cooking loss/%	Cooking time/min
D1*	189	200	12.19	16.13
D2*	181	190	12.52	17.06
D3*	171	180	6.51	13.38
D4*	173.5	190	5.67	12.58
K*	168	175	6.67	13.50
O*	180.5	190	7.03	15.66
D1**	170.5	180	6.12	13.23
D2**	181.5	190	6.69	17.18
D3**	186	190	5.61	15.5
D4**	181	190	5.70	16.06
K**	177	185	6.03	15.11
O**	187.5	190	5.99	15.23

* without eggs, ** with eggs

The samples with the highest percentage of small particles absorbed more water during the cooking.

From the table it can be seen that all of samples had nearly the same volume growth.

During cooking a part of pasta is overcooked. Samples D1 and D2 had significantly higher cooking loss than other samples which had lower cooking loss with similar values.

In the world, for the pasta quality determined by the organoleptic estimation different objective methods have been used, and the most important is total organic matter (TOM) *(17–19)*. Instrumental measures have also been used *(20–22)*. In Croatia the instrumental measures have not been used, and the method which has been used is not improved *(5)*. The results are presented in Table 4. Only one parameter gave satisfying results, and it was the average estimation for taste and stickiness of pasta without eggs.

Influence of Chemical Factors on the Final Product Quality

Some variables of chemical composition influence the final product quality. So, the protein content, wet gluten content and starch content can serve as indicators of final product quality.

Investigations in this paper showed high correlation between wet gluten content and protein content in agreement with the results of d'Egidio *et al. (23)*. Protein content influenced the cooking time and the cooking loss of pasta without eggs. Increasing protein content caused lower cooking time. If some flour has lower protein content, there is a bigger possibility for cooking loss during the cooking time.

Sedimentation test was very important for many authors *(24,25)*. In this paper no values were obtained which would show relationship with some of final product quality factors, which is in agreement with the investigation of Kovacs *et al. (26)*.

Wet gluten content is a very important factor for the quality of final product. Wet gluten had influence on the cooking time and the cooking loss of pasta without eggs.

Higher protein content has positive influence on pasta quality, but higher starch content has negative in-

Table 4. Results of pasta organoleptic estimation

Sample	Average estimation for outer shape	Average estimation for surface conditions	Average estimation for smell	Average estimation for taste and stickiness
D1*	5.00	15.00	10	15.16
D2*	4.83	15.00	10	16.83
D3*	5.00	9.50	10	19.50
D4*	4.66	11.16	10	20.00
K*	5.00	12.83	10	19.50
O*	5.00	13.33	10	18.50
D1**	5.00	13.33	10	19.00
D2**	5.00	13.33	10	19.50
D3**	4.83	12.50	10	19.50
D4**	4.66	13.33	10	20.00
K**	5.00	11.66	10	20.00
O**	4.83	14.16	10	19.50

* without eggs, ** with eggs

fluence on the cooking time and the cooking loss of pasta without eggs.

The activity of α-amylase had no influence on the pasta quality, which is in agreement with the conclusion of other authors like Dick *et al. (27)*, Donnelly *(28)*, Dexter *et al. (29)*. All of the samples had a low activity of α-amylase.

β-carotene content had no influence on the pasta colour.

Conclusion

Pasta quality can be predicted according to the mass fractions of protein, wet gluten and starch. Parameters which show the relationship with chemical composition are cooking time and cooking loss. The highest quality was found in samples D4 and D3, the lowest quality in samples D1 and D2, and in the middle were the samples K and O. Taking into consideration the fact that samples D1, D2, D3 and D4 are *T. durum* flour, it can be concluded that it is not enough for pasta production that flour is made of *T. durum* wheat. It has to be made of high quality *T. durum* wheat.

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Utjecaj kemijskih osobina durum krupice na kakvoću tjestenine

Sažetak

Proizvodnja tjestenine od krupica običnih pšenica često je otežana, a gotov je proizvod bitno slabije kakvoće od onoga dobivenog od krupica pšenica vrste Triticum durum.

U radu je ispitan utjecaj kemijskih svojstava pšenične krupice T. durum na kakvoću tjestenine, u usporedbi sa svojstvima krupica običnih vrsta pšenica. Ispitivana su četiri uzorka pšenične krupice iz vrste T. durum i dva uzorka krupica iz T. aestivum. U svim je uzorcima određen maseni udio vode, mineralnih tvari, β-karotena, proteina, vlažnoga glutena, škroba, oštećenog škroba, masti te sedimentacijska vrijednost i aktivnost α-amilaze. Senzorsko ocjenjivanje tjestenine provela je skupina od 6 ispitivača, a ocjenjivao se vanjski oblik, izgled, miris, okus i ljepljivost, te ponašanje tjestenine tijekom kuhanja. Dobiveni rezultati pokazuju da se kakvoća gotova proizvoda može predvidjeti prema masenom udjelu proteina, vlažnoga glutena i škroba.