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# EVALUATION OF THE COOKING QUALITY OF SPAGHETTI

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The aim of the present work was to determine the cooking quality of spaghetti. Ten types of commercial spaghetti samples were used for investigations. As the cooking time increased, the values of both parameters examined (shear force and shear work) were observed to decrease. Their highest values were obtained for pastas produced from semolina. The storage of pasta after cooking also caused a decrease in these parameters (the maximum shear force decreased by about 50% in all samples, and the shear work by 72 to 97%, depending on the sample). The results showed the positive correlation between the consistency of pasta described on the basis of sensory evaluation and the values of parameters obtained during shear test of pasta. The results showed that the parameters described on the basis of the shear test of spaghetti well describe the pasta cooking quality in terms of cooking time and time of pasta storage after cooking. This parameters could be useful in the evaluation of the cooking quality of spaghetti and make the quality evaluation more objective.

## INTRODUCTION

Pasta is the most popular corn foodstuff; its consumption has been observed to rise in Poland and other countries. Pasta quality depends mainly on the properties of flour raw materials, especially protein content and quality, and gluten properties [D`Egidio *et al.*, 1990; Novaro *et al.*, 1993]; starch properties are of a lesser importance [Sung & Stone, 2003]. The best raw material for pasta production is durum wheat semolina. It is the most expensive material, thus pasta is often produced from common wheat flour (*Triticum Aestivum*, ssp. *vulgare*), but the product obtained from such flour is characterized by poor cooking quality. In Poland about 50% of pasta is produced from common what flour [Obuchowski & Strybe, 2001].

The external appearance of pasta and other attributes of sensory quality after cooking are the most important criteria of pasta quality evaluation. The appearance assessment includes: colour, specks, surface discoloration and texture (smoothness, white spots, streaks, air bubbles) [Feillet *et al.*, 2000]. Both sensory and instrumental methods are used for texture assessment. They enable determining the effects of different factors (for example the quality of raw material, cooking time or parameters of the technological process of pasta production) on texture changes [Walsh, 1971; Dziki & Laskowski, 2001].

The resistance of pasta to overcooking is especially important. Investigations have indicated that overcooking should be avoided especially in the case of small pasta forms, such as vermicelli. It causes considerable cooking losses and changes in the texture, including reduced firmness [Dziki *et al.*, 2003].

If the parameters of the technological process are inappropriate, it is impossible to obtain a good-quality product, even when the raw material is of the highest quality [Obuchowski, 1997]. Semolina yield also affects the cooking quality of pasta. Pasta produced from semolina obtained mainly from the grain endosperm is characterised by good texture properties after cooking, but overcooking causes a rapid decrease in its firmness. Products obtained from semolina with a higher flour yield, from peripheral parts of the endosperm, have a darker colour and a little worse cooking quality, but are more resistant to overcooking [Feillet *et al.*, 2000; Abecassis, 2001].

Pasta manufacturers today produce hundreds of products of different shapes and sizes. One of the most popular forms is spaghetti. Therefore, the aim of the present study was to determine the cooking quality of spaghetti. To this end, preliminary investigations were undertaken concerning the application of the parameters obtained on the basis of the pasta shear test (shear force and shear work) for the evaluation of spaghetti quality. Since very few studies have reported on this problem, it was also addressed in this research.

## MATERIALS AND METHODS

Ten types of commercial spaghetti samples produced in Poland, Italy and Greece were used as the experimental material. Two products were made from common wheat flour, one from a mixture of semolina with common wheat flour, and the other – from semolina (Table 1). The pastas were produced without the addition of eggs.

The studies included the determination of: moisture content [AACC 44-15A:2000], length, diameter [Dziki *et al.*,

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TABLE 1. Characteristics of the pastas analysed.

| Sample No. | Code of company | Country | Main component | | Moisture (%) | Diameter (mm) | Minimum cooking time ($t_p$) (min) |
|---|---|---|---|---|---|---|---|
| | | | semolina | vulgare wheat flour | | | |
| 1. | I | Italy | + | - | 11.59 | 1.8 | 9.0 |
| 2. | II | Greece | + | - | 11.39 | 1.9 | 12.5 |
| 3. | III | Italy | + | - | 10.45 | 1.8 | 12.0 |
| 4. | IV | Italy | + | - | 10.53 | 1.8 | 11.0 |
| 5. | V | Italy | + | - | 12.15 | 1.7 | 10.5 |
| 6. | VI | Italy | + | - | 11.65 | 1.8 | 11.0 |
| 7. | VII | Italy | + | - | 11.08 | 1.8 | 11.5 |
| 8. | VIII | Poland | + | + | 8.70 | 1.7 | 11.5 |
| 9. | IX | Poland | - | + | 12.35 | 1.7 | 7.0 |
| 10. | X | Poland | - | + | 12.14 | 1.6 | 8.0 |

2003], minimal cooking time of pasta, weight increase index, and cooking losses [Obuchowski, 1997]. A sensory evaluation of pasta before and after cooking was performed by a team of 10 trained panellists according to the grading scale from 1 to 5 (5 mining "best"). Such parameters as odour, taste, shape and consistency were evaluated [Pałasiński, 1997]. The analysis was performed in separate places, equipped with a table for data acquisition. The instrumental method was also used for the evaluation of the texture properties of pasta. Single samples of pasta were put on the bottom plate of a resistance testing machine Zwick Z020, and cut with a knife (1 mm thick) at a crosshead speed of 10 mm/min until the distance between the knife and the plate was 0.1 mm. On the basis of the curves obtained (Figure 1), the maximum shear force and shear work were determined. The investigations were carried out directly after pasta cooking and on samples stored in a fridge for 24 h at a temperature of 8°C. Half an hour before the analysis, the samples were placed at room temperature (22–23°C). The investigations were conducted after the minimal cooking time (recommended by the producer) and after pasta overcooking for 2.5; 5.0; 7.5 and 10 min. The parameters described were calculated as means for five measurements. An analysis of variance was made, and significant differences between means were determined by the Duncan's

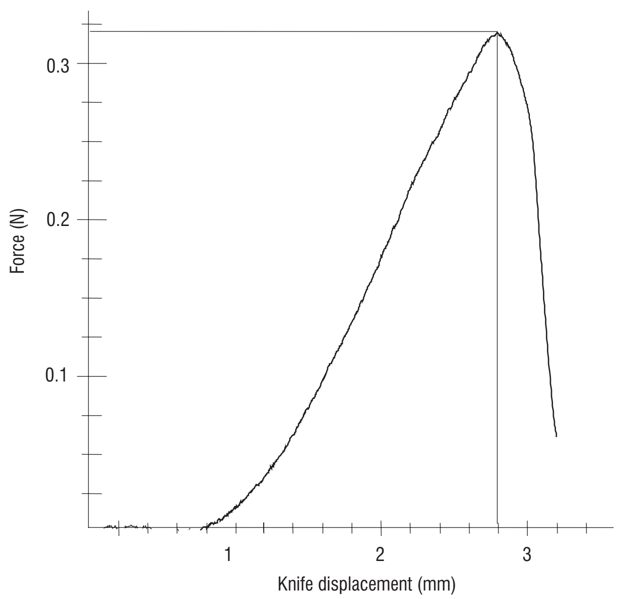


FIGURE 1. An example of a shear curve of pasta.

range test. The correlation coefficients between the indices were also determined and the dependencies obtained were described by multiple regression equations. For all tests, the significance level was 0.05 [Stanisz, 1998].

## RESULTS AND DISCUSSION

All pastas were properly and esthetically packed. There was information about the ingredients and the "best before" period on the package. The external appearance and odour of pasta were desirable. The pastas made from common wheat flour had a lighter colour than those obtained from durum wheat. The moisture content of pasta did not exceed the level of 12.5%. The diameter of pasta before cooking ranged from 1.5 to 1.88 mm, and the minimal cooking time form 7.0 to 12.5 min (Table 1). In most cases, the difference between the minimal cooking time of pasta and the time recommended by the producer did not exceed 30 s. The coefficient of correlation between the minimal time of cooking and pasta diameter was 0.65. The fact that the value of this coefficient was not too high results from other factors, such as the kind of raw materials and parameters of the technological process, which also affected the cooking time of pasta [Riva & Pagani, 2003]. The diameter of spaghetti samples after cooking was similar (2.7 to 2.9 mm).

The highest values of the weight increase index were obtained for spaghetti produced from semolina. This index increased statistically significantly during overcooking from 2.7 to 3.3. A similar tendency (an increase in the index value from 2.6 to 3.0) was observed in the pastas obtained from common wheat flour and overcooked for 2.5 and 5 min. However, a longer time of cooking caused a significant decrease in the weight increase index to 2.6. This can be explained by higher cooking losses in these products (Figure 2). The cooking losses increased during pasta overcooking. After each time of cooking, the pastas obtained from common wheat flour were characterised by the statistically significantly higher cooking losses than the pastas produced form semolina. The cooking losses in the pastas produced from common wheat flour varied from 6.4 to 13.7%, and in semolina products – from 4.9 to 9.2% (Figure 2). However, as the cooking time increased the difference between the cooking losses in spaghetti made from semolina and common wheat flour increased too. Cooking losses are one of the main parameters taken into consideration during the assessment of pasta quality. In a high-quality product they

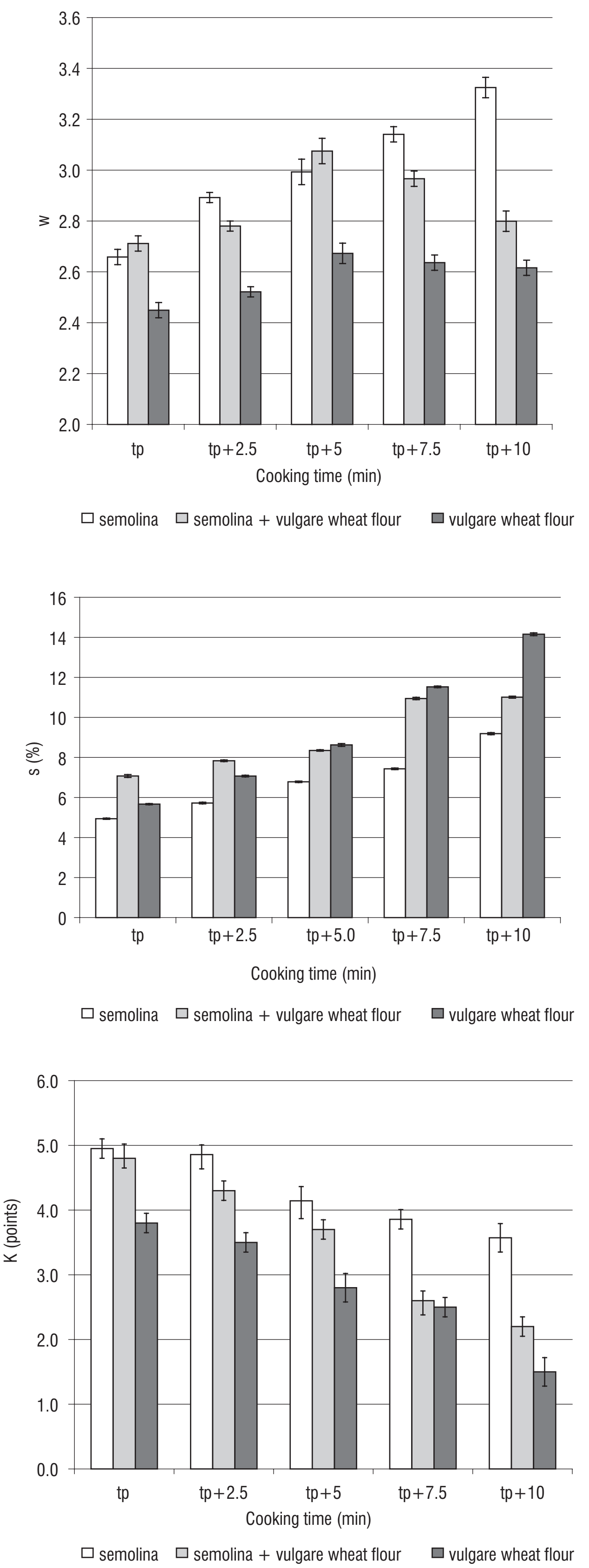


FIGURE 2. Influence of the cooking time on the weight increase index (w), cooking losses (s) and consistency (K) for pastas obtained from different raw materials.

should not exceed 8% of dry matter [Obuchowski, 1997]. Cacak-Pietrzak *et al.* [1997] showed that cooking losses of different types of pasta obtained from semolina ranged from 6.1 to 11.1%.

The cooking losses (s) were described by a regression equation, taking into account the time of cooking (t), weight increase index (w) and pasta diameter before cooking ($d_p$):

$$s_s=0.809 \cdot t-6.366 \cdot w-16.401 \cdot d_p, \quad R^2=0.704 \qquad (1)$$

Apart from the indices in equation (1) and the kind of raw materials, cooking losses depend also on the degree of starch damage. Greater starch damage in semolina is caused by too intensive grain grinding during milling. Consequently, the product obtained from this kind of raw material is characterised by higher cooking losses [Matsuo & Dexter, 1980], especially when starch damage exceeds 15% [Seiler, 1999].

Prolonged cooking resulted in a lower grade for pasta firmness. The pasta produced from common wheat flour received the lowest number of points (Figure 2). The storage of pasta after cooking had a negative influence on consistency changes. Its firmness decreased and glutinousness increased. As a consequence, the product was given a significantly lower grade (on average by two points) for consistency. The time of cooking had no statistically significant influence on the odour, taste and shape of pasta.

Cooking time affected the maximum shear force of pasta. This parameter significantly decreased during overcooking. The lowest values of the maximum shear force were obtained for spaghetti produced from common wheat flour (a decrease from 0.6 to 0.3 N), and the highest for pasta made from semolina (a decrease from 0.7 do 0.5 N). After the minimal cooking time, the values obtained for spaghetti produced from semolina were by 17% higher than those obtained for the product made from ordinary wheat flour. In the case of overcooking, these values were by about 60% higher. The storage of pasta caused a statistically significant decrease in the maximum shear force, by about 50%. However, the product obtained from semolina was characterised by the highest values of these parameters (Figure 3).

Changes in the maximum shear force of pasta made from semolina were described by a regression equation, taking into consideration the cooking losses ($s_s$) and weight increase index (w):

$$F=-0.015s_s-0.268w+1.49; \quad R^2=0.845 \qquad (2)$$

Dexter *et al.* [1983] showed that cooking losses and weight increase index correlated also with stickiness of spaghetti.

The values of the maximum shear force of individual pastas were also correlated with a sensory evaluation of pasta consistency (r=0.864). Similar correlations were observed by other authors [Faridi, 1987].

The course of changes in the shear work (Figure 3) was similar to the course of changes in the maximum shear force. Its highest values were obtained for pasta directly after cooking, and for spaghetti produced from semolina (on average 0.54 mJ), and the significantly lower – for spaghetti made from ordinary wheat flour (on average 0.33 mJ). Medium values were obtained for pasta produced from a mixture of common wheat flour with semolina (average 0.39 mJ). Overcooking caused a statistically significant decrease in the shear work in all samples. Pasta storage had

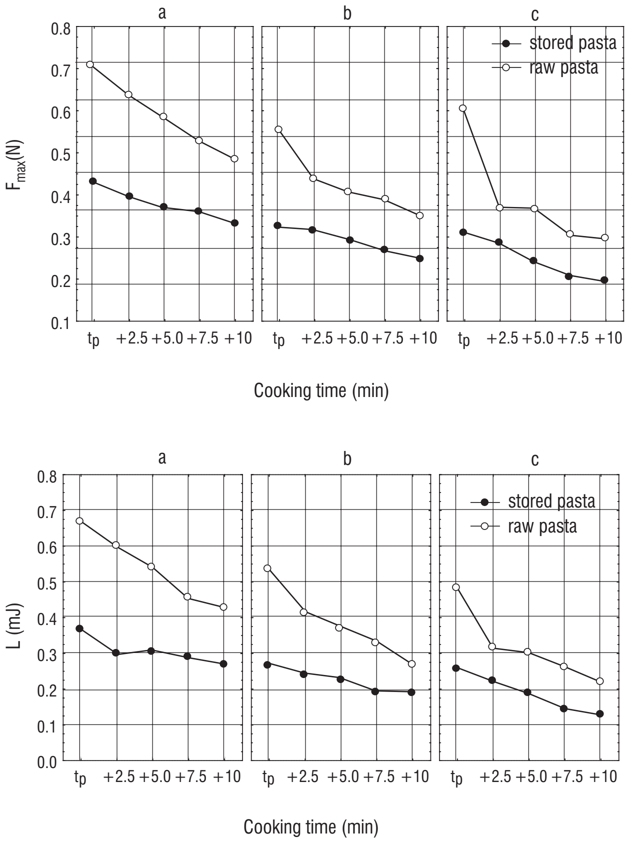


FIGURE. 3. Influence of the cooking time on the maximum shear force ($F_{max}$) and shear work (L) of raw and stored pasta produced from: a – semolina, b – mixture of semolina with common wheat flour, c – common wheat flour.

a similar influence on shear work (a decrease from 72 to 97%, depending on the sample).

Several reactions are initiated during pasta cooking as a result of the heat effect and water uptake (for example protein swelling, starch gelatinization, increase in pasta weight and volume). These reactions have a great influence on the cooking quality of pasta [Del Nobile & Massera, 2000; Feillet, 1984]. Moreover, during storage of cooked pasta, water content becomes evenly distributed over the product cross section. This can reduce pasta firmness, which was confirmed by a sensory evaluation and a shear test of pasta.

The drying process also affects pasta firmness. A higher drying temperature improves the firmness of cooked pasta [Ownes, 2001].

## CONCLUSIONS

1. The cooking losses increased during pasta overcooking. After each time of cooking, the pastas obtained from common wheat flour were characterised by the highest cooking losses. As the cooking time increased the difference between the cooking losses in spaghetti made from semolina and common wheat flour increased too.

2. The factors which have a significant influence on cooking losses were: time of cooking (positive correlation), weight increase index and diameter of pasta before cooking (negative correlation). The dependence obtained was described by the multiple regression equation ($R^2$=0.704).

3. As the cooking time increased, the maximum shear force and shear work decreased. The highest values of these parameters were obtained for pastas produced from semolina. The storage of pasta also caused a decrease in these parameters.

4. The values describing pasta consistency, obtained on the basis of a sensory evaluation, were correlated with those obtained on the basis of the shear test.

5. The results showed that the parameters described on the basis of the shear test of spaghetti (shear force and shear work) well describe the cooking quality of pasta in terms of cooking time and time of pasta storage after cooking. These parameters could be useful in the evaluation of the cooking quality of pasta and make the quality evaluation more objective.

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## OCENA CECH KULINARNYCH MAKARONU TYPU SPAGHETTI

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Celem pracy było określenie cech kulinarnych makaronu typu spaghetti. W szczególności przeprowadzono badania wstępne nad wykorzystaniem parametrów uzyskanych na podstawie testu cięcia (siły cięcia i pracy cięcia) do oceny cech kulinarnych spaghetti. Materiał do badań stanowiło 10 makaronów handlowych. Wykazano, że wraz z wydłużeniem czasu gotowania zmniejszały się wartości maksymalnej siły cięcia, oraz pracy cięcia makaronu. Najwyższe wartości tych cech uzyskano dla makaronów otrzymanych z semoliny. Przechowywanie makaronu również wpłynęło na spadek tych parametrów (maksymalna siła cięcia zmniejszyła się średnio o 50% dla wszystkich próbek, a praca cięcia od 72 do 97% w zależności od próby). Wyniki pomiaru konsystencji spaghetti uzyskane na podstawie oceny sensorycznej dobrze korelowały z wynikami otrzymanymi na podstawie testu cięcia. Wykazano, że parametry określone na podstawie testu cięcia spaghetti (siła cięcia i praca cięcia) dobrze opisują zmiany cech kulinarnych makaronu w zależności od czasu gotowania i przechowywania po ugotowaniu, i mogą być wykorzystane do obiektywizacji oceny jakości kulinarnej spaghetti.