The Kinetics of Drying Pasta with Added of Soya Flour

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ABSTRACT

In this study, we examined a dry pasta from a dedicated wheat flour with the addition of soybean flour. Four types of pasta are dried: soup noodles, wide noodles, short noodles and spaghetti at different temperatures of 55°C, 70°C and 80°C. During drying, the change in mass and changes in moisture content was measured. The greatest weight loss occurred in widespread noodles, and the smallest in slaughter noodles. The moisture content after drying, pasta with the addition of soybean meal was 12.5% for all four types of pasta. The drying results do not show significant deviations from the exponential values with which they are compared.

Keywords: *soya flour, pasta, drying*

1. INTRODUCTION

In the world, as well as in our country, pasta and pasta related products are present in human nutrition on a daily basis. Pasta is easily prepared and has a many advantages for consumers such as: low price, excellent nutritional value, countless ways of preparation, the possibility of storing for long period of time after production. The quality of pasta and pasta related products is a very important factor in terms of proper nutrition and placement on demanding markets, both domestic and foreign (Bejarovic, 2001).

Production of pasta can be industrial and handicraft. The industrial production consists of following technological operations: preparation of raw materials for production; dosing of raw materials and various supplements; mixing the dough under vacuum; pressing and shaping of fresh pasta, cutting and placement of fresh pasta; drying (pre-drying, drying and stabilization – cooling); packaging of finished products and transportation of finished products in storage area, (Plavsic et al. 2010).

Drying of pasta is based on the principle of convection - the exchange of heat and moisture between the pasta and the heated air flowing around the pasta. During the drying process the first evaporating moisture from the surface of the dough, and then there is a migration of the moisture from inside the test. As a result of this process leads to the formation of a gradient of moisture content in the center of the pasta and on its surface, and the time required to balance depends on the thickness of the pasta and the speed of diffusion of moisture. The basic parameters of the air that determine the drying speed of the pasta are: temperature, humidity and air flow velocity, (Bejarovic, 2001).

According to the temperatures used for drying the pasta, drying modes can be divided as follows: LT (low temperatures for drying the pasta, 40°C to 60°C), HT (high temperatures for drying the pasta, 60 °C to 84°C), THT (very high temperatures for drying the pasta, 84°C) and Turbo-thermal processes, (Plavsic et al. 2010).

The technological process of producing pasta and pasta related products from flour will not destroy the entire population of microorganisms that are present in flour. Some of them survive those processes and continue their development. Additional materials, water and especially employee hygiene and cleanliness of working surfaces, equipment and tools used in production of pasta and pasta related products represent a significant source of contamination, (Tesanovic, 2010).

The noodle can be dried in a chamber where all parameters of temperature, humidity and ventilation are regulated, Fu (2008). The process also believed to improve the food stability, reduce microbiological activity and minimizes physical and chemical changes during the food storage, (Mayor and Sereno, 2004).

The temperature dependence of the water sorption behavior, particularly the effects of starch gelatinization on this behavior, has not fully been assessed.

The temperature between 75°C to 80°C considered as the ideal temperature for drying without compromising the quality and texture of the noodle. The system that able to maintain the temperature of lower than 80°C was resulted to the production of good quality dried noodles as it will evade the texture damage that consequently increase the noodle brittleness and hardness. Higher the temperature of more than 80°C will make noodle turn into dark in colour. Stated that drying with regulated temperature of 55ºC to 81ºC and air velocity of 1.3 m/s to 2.51 m/s is able to remove 4.6 kg to 5.3 kg of water per day (Macmanus et. al., 2009), From the experiment, (Mamat et al. 2017), it was found that the humidity in drying chamber reduced with the increasing in processing time. Upon 200 minutes of drying operation, air humidity in drying chamber successfully reduced significantly from 80% to 42%. After 400 minutes of drying, the moisture content was constant, after which it fell abruptly.

The paper presents the influence of adding soybean flour at the time of drying pasta. This work shows that the addition of soybean flour in the stains gives good results in terms of drying at the appropriate temperatures.

2. MATERIALS AND METHODS

The basic raw materials for making pasta are flour, water, and eggs. Soybean flour and sodium glutamate were used as additional raw materials.

The used flour for making pasta is T-400, which is produced and packed by a mill in Drazevac, a moisture content of 13.5%, a degree of acidity 2.2 and an ash content of 0.45%, a pH of 5.9.

All trials were done in the laboratory of the Faculty of Technology in Leskovac and the chemical laboratory of the Public Health Institute from Leskovac. Pasta with the addition of soybean flour was made so that the ratio of wheat and soybean flour is 70:30.

As the air temperature is higher, evaporation of the water from the pasta surface is more intense. The pasta was dried in three phases depending on the air temperature:
- Phase I- drying at low temperatures at 55°C for 1.5 hours;
- Phase II - drying with medium high temperatures at 70°C (pre-drying) for 10-20 hours;
- Phase III - drying with medium high temperatures over 80°C.

For the drying of the pasta were used the convective type experimental dryers, which were made by hand. The drying process was carried out by the fact that at the beginning of the drying the temperature in the dryer was 55°C, in order to increase the temperature to 70°C after one drying cycle, and at the end of the drying temperature, the temperature was 80°C. The temperature was increased because the pasta at 55°C showed an insufficient dryness, at 70°C it was partially dried, while at 80°C the pasta showed the real effect of dried pasta.

Pasta samples with corn flour were dried for a period of 270 minutes. The weight and moisture content were read after 15, 30, 45, 60, 75, 90, 120, 150, 210 and 270 minutes.

Statistical analysis of data is represented by the model of exponential dependence.

$$y = y_0 + A_1 e^{-(x/t_1)} \quad (1)$$

using the program Origin Version 4.0.

Amplitude A and values x are associated parameters.

3. RESULTS AND DISCUSSION

Soya flour is obtained from soya mining. Proteins found in soya flour are rich in essential amino acids and therefore give good nutritional value. Due to the high protein content, soybean flour has a yellow color, absorbs and binds a large amount of water so that the yield is large, thus achieving that the pasta with the addition of soya flour has an improved value.

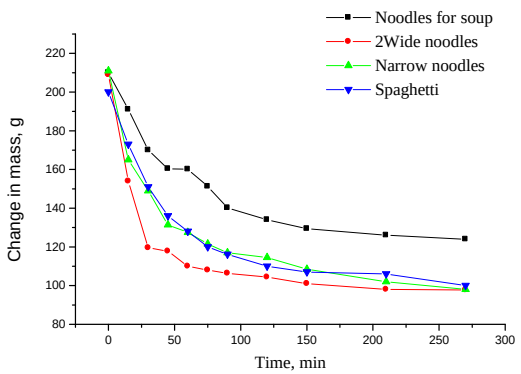
Table 1 shows the results of drying of pasta containing soybean flour and dried at 55°C.

Table 1. Change in mass and change in moisture content during drying pasta with soybean flour at 55°C

Time, min	Change in mass, g				Change in moisture content, %			
	Noodles for soup	Wide noodles	Narrow noodles	Spaghetti	Noodles for soup	Wide noodles	Narrow noodles	Spaghetti
0	210	209	211	200	90.5	88.91	91.91	95
15	191	154	165	173	84	79.5	83.5	91
30	170	119.5	149	151	77	60.2	71.2	84.5
45	160.4	117.8	131.4	136	70	55	57.2	71.9
60	160.1	110	127.5	128	62.2	38	50	61.4
75	151.2	108	121.5	120	51.7	24	31.1	54
90	140.2	106.4	117	116.2	33.8	18.9	26.4	41.7
120	134	104.4	114.5	110	27	16	20	32
150	129.4	101	108.5	107	17	15.9	18.7	22.8
210	126	98	102	106	17	13.1	15	20
270	124	97.8	98	100	14.6	13	14.9	19.2

Based on the results in Table A.1, it can be concluded that the weight of pasta has decreased steadily after all time intervals. The largest reduction in weight was observed in narrow noodles (113 g), and at least in noodles for soup (86 g).

The experimental results from Table 1 are shown graphically in Fig. A.1 and Fig. A.2.



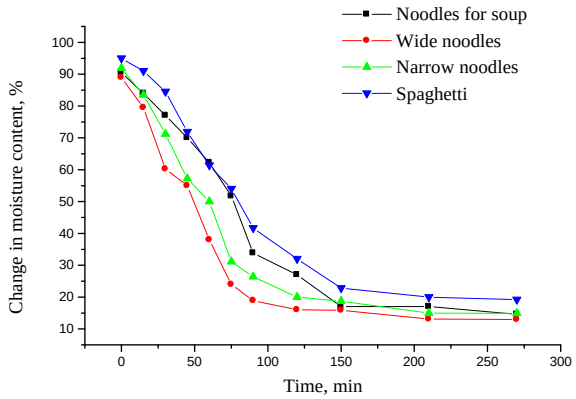


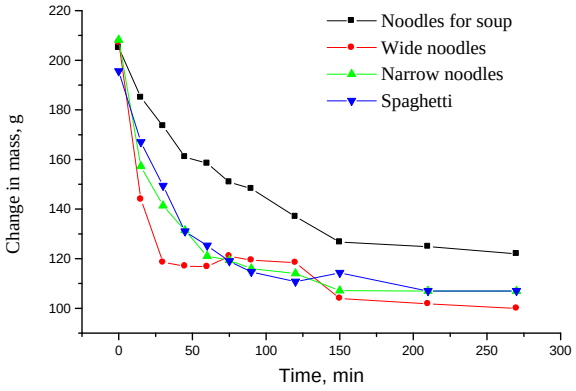
Fig. 1. Changing the weight of pasta on 55°C Fig. 2. Changing the moisture content of pasta on 55°C

The moisture content in the pasta with soybean flour gradually decreased during all measurement intervals. The flow mode is such that during 270 minutes the pasta is dried to a humidity ranging from 13 to 19.2%. The strongest moisture was recorded at wide, and the smallest in spaghetti.

The second stage of the pasta drying is more demanding and represents the main drying at a temperature of 70°C from 10 to 20 hours.

Table 2. Change in mass and change in moisture content during drying pasta with soybean flour at 70 °C

Time, min	Change in mass, g				Change in moisture content, %			
	Noodles for soup	Wide noodles	Narrow noodles	Spaghetti	Noodles for soup	Wide noodles	Narrow noodles	Spaghetti
0	205.1	207.2	208.2	195.6	87.3	86.9	96.5	86.7
15	185	144	157.2	167	85	67.3	77.3	81.7
30	173.5	118.5	141.4	149.4	80.3	57	69.4	72.6
45	161	117	131.4	131	72	47.9	50.5	61.2
60	158.4	116.8	121	125.3	61.5	33	41.3	57
75	150.9	121	119.4	119	54.3	21	29.7	47.5
90	148.2	119.4	116	114.7	31	20.2	25.3	38
120	137	118.4	114	110.7	25.3	19	18.9	28.7
150	126.7	104	107.1	114.3	16	14.9	16.4	21
210	124.9	101.8	107	107	14.9	13	13.8	19.8
270	122	100	107	107	13	13.9	13	19



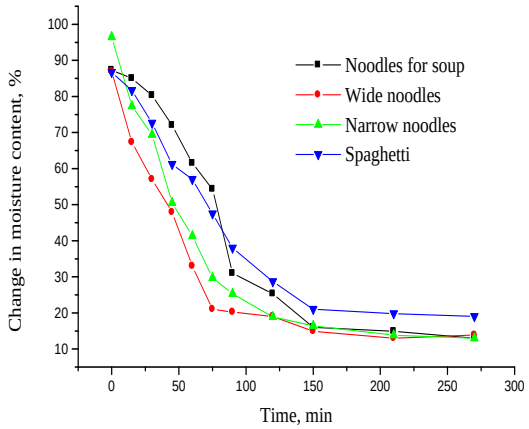


Fig. 3. Changing of mass of pasta on 70 °C Fig. 4. Changing the moisture content of pasta on 70 °C

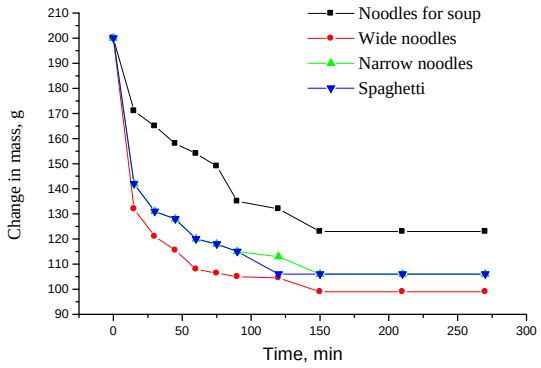
The highest moisture was recorded in spaghetti, accounting for 19%.

Table 3. Change in mass and change in moisture content during drying pasta with soybean flour at 80 °C

Time, min	Change in mass, g				Change in moisture content, %			
	Noodles for soup	Wide noodles	Narrow noodles	Spaghetti	Noodles for soup	Wide noodles	Narrow noodles	Spaghetti
0	200	200	200	200	85.91	85.91	85.91	85.91
15	171	132	142	142	84.2	80.5	73.5	92
30	165	121	131	131	73.7	53.6	51	83.8
45	158	115.5	128	128	61	40.3	44.9	74.6
60	154	108	120	120	54.4	22	28.6	60.2
75	149	106.4	118	118	45.6	18	24.5	54
90	135	105	115	115	21	14.6	18.4	32.4

120	132	104.5	113	106	15.8	13.4	14.3	20.7
150	123	99	106	106	12.5	12.5	12.5	20.7
210	123	99	106	106	12.5	12.5	12.5	20.7
270	123	99	106	106	12.5	12.5	12.5	20.7

The largest loss of mass in the case of wide noodles, and the smallest in noodles for soup.
From Table 3 it can be seen that the moisture content of the pasta has dropped to 12.5% in noodles for soup, wide noodles and narrow noodles (in spaghetti the moisture has 20.7%), which is a pasta stabilization phase, which has already been determined and after 150 minutes of pasta drying at 80°C. The moisture was distributed appropriately throughout the whole of the pasta, equalizing the moisture content of the pasta.
The graph in Figure 5 shows a change in the weight of the pasta with the drying time in the final drying phase. In Figure 6 shows that the pasta humidity dropped to 12.5%, which represents the phase of stabilization of pasta, bringing the pasta achieve a satisfactory level of humidity during the drying at a temperature of 80°C.



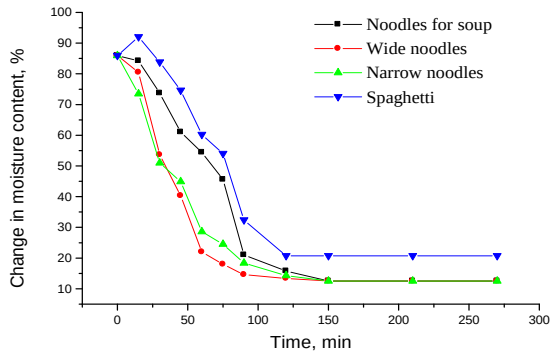
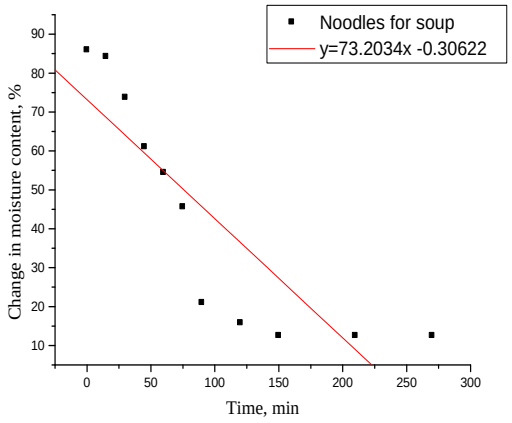


Fig. 5. Changing the weight of pasta on 80°C Fig. 6. Changing the moisture content of pasta on 80°C

Petitit et al. (2009) suggest that when drying pasta at low temperatures, the quality of pasta depends on the quality and quantity of the protein from the raw material, while only the quantity of protein is responsible for drying at high temperatures for the quality of the pasta. Petitot et al. (2009) reported based on texture measurements that spaghetti dried under high-temperature conditions had better quality after cooking than that dried under low-temperature conditions. The dependence of the properties of cooked spaghetti on drying conditions is due to changes in the inner structure of spaghetti during drying (Zweifel et al. 2003; Cubadda et al. 2007).

Drying pasta at very high temperatures can result in tanning of the pasta. The pasta takes on an intense orange color, which is a consequence of Maillard's reaction and formation of furosine, a harmful, toxic compound. Bonomi et al. (2012) noted that the gluten-free mesh denaturates and becomes insensitive when the pasta is dried at high temperature, which makes the protein fraction less sensitive to changes during cooking. The pasta dried at high temperatures absorbs a smaller amount of water. Baiano et al. (2006) measured the leakage of amylose from the spaghetti dried under low-, high- and veryhigh-temperature conditions during their cooking processes and showed that more amylose leaked from the spaghetti dried at lower temperature.

The results of the curves obtained on the charts were compared with the exponential curve (on the basis of which the obtained results were compared). The obtained results do not have too much deviation from the given exponential curve, which was the goal.



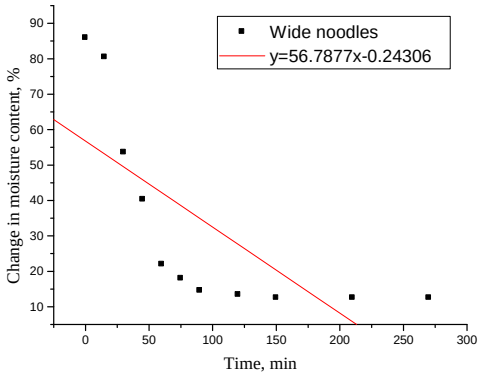
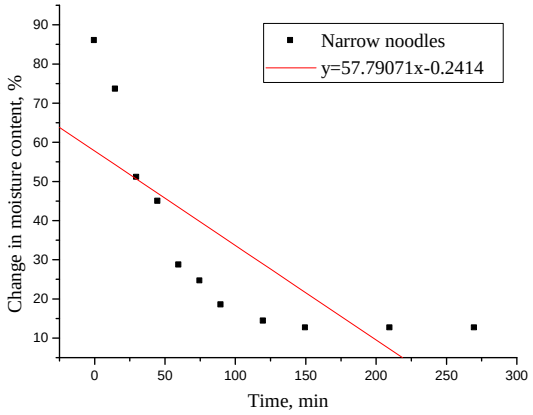


Fig. 6 and 7. Exponential value of change of moisture content with time, (noodles for soup), left and (wide noodles), right



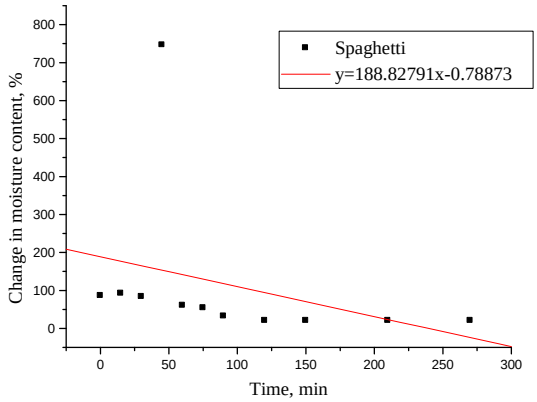


Fig. 8 and 9. Exponential value of change of moisture content with time (narrow noodles) left and (spaghetti) right

In the drying period, the moisture content of the pasta (noodles for soup –Fig. 6, wide noodles –Fig. 7 and narrow noodles – Fig. 8) was linearly decreasing with time. This could be expected because, during drying, there was an increase in the resistance of the diffusion of water from the interior of the pasta to the surface.

Spaghetti after drying at 80°C contained the highest moisture content of 20.7% compared to noodles for soup, wide noodles and narrow noodles with the percentage of moisture is 12.5%, so the tendency of moisture degradation in spaghetti is less steep than other types of pasta (Fig. 9).

4. CONCLUSION

The largest mass loss was recorded in the case of wide noodles, and the smallest in the noodles for soup. The moisture content at the end of drying in the pasta with the addition of corn flour was gradually reduced and at the end of drying it was 12.5% in all four types of pasta. Spaghetti after drying at 80°C contained the highest moisture content of 20.7%.

In the drying period, the moisture content of the pasta (noodles for soup, wide noodles and narrow noodles) was linearly decreasing with time. Spaghetti after drying at 80°C contained the highest moisture content and the tendency of moisture degradation in spaghetti is less steep than other types of pasta.

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