Influence of Drying Temperature and Farina Blending on Spaghetti Quality[1]

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ABSTRACT

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A study of the influence of drying temperature on spaghetti quality indicated that increasing the drying temperature improved spaghetti color, increased firmness values, and decreased cooking loss and cooked weight values. Increasing the proportion of hard red spring (HRS) wheat farina in farina-semolina blends brought about an increase in firmness and a decrease in cooking loss, cooked weight, and spaghetti color. When the hard red winter (HRW) farina content was increased, firmness values did not change significantly, but color, cooking loss, and cooked weight values decreased as in the HRS samples. The firmness values of samples containing HRS farina were higher than those of samples containing HRW, whereas the cooking loss values were lower. These data, based on limited samples, indicate that good quality spaghetti can be made from semolina-farina blends, but blends using farina obtained from HRS wheat produce spaghetti superior in quality to spaghetti from HRW farina-semolina blends.

High-temperature drying of pasta products has been discussed by several workers (Braibanti & C.S.p.A. 1980; Buhler-Miag, Inc. 1979; Manser 1978, 1980). Major emphasis, however, has been placed on bacteriological aspects, and little information has been provided on the quality of spaghetti dried by high temperatures.

The use of nondurum wheats for pasta production has been reported in a few published studies (Irvine 1965, Kessler 1978, Sheu et al 1967). These reports provide information on the quality of spaghetti obtained from farina derived from nondurum wheats, but the information is limited.

The purpose of this study was to examine the effects of high-temperature drying on spaghetti quality as well as to investigate the use of farina-semolina blends for making spaghetti.

MATERIALS AND METHODS

Farina and Semolina Samples

One sample each of commercial hard red spring (HRS) wheat farina, hard red winter (HRW) wheat farina, and durum wheat semolina was used for this study. The farina samples were obtained from Bay State Milling Company, Leavenworth, KS, and the semolina sample was obtained from the North Dakota State Mill and Elevator, Grand Forks, ND. Ash and granulation data on the farina and semolina samples are shown in Table I.

Blends were prepared that contained the durum semolina and 0, 5, 10, 20, 40, 60, 80, and 100% of each class of farina.

Spaghetti Samples

Spaghetti was processed on a semicommercial (25 lb/hr) pasta extruder (DeMaco) under the following conditions: die temperature, 37° C; extrusion rate, 20 rpm; absorption, 31%; and vacuum, 20 in. of Hg.

Spaghetti was dried in an experimental pasta dryer (Gilles et al 1966). The control samples were dried at 40° C, with the relative humidity decreasing linearly from 95 to 60% during the entire 18-hr drying cycle. The high-temperature drying cycles consisted of two stages (Table II).

Spaghetti Quality

Spaghetti color was determined with a Hunter Color Difference Meter by a method described by Walsh (1970).

Cooking quality was determined using three cooking times (10, 15, and 20 min). The spaghetti (10 g) was broken into lengths approximately 5 cm long and was cooked in 300 ml of boiling, distilled water. Spaghetti firmness was measured with an Instron Universal Tester, using a procedure described by Walsh (1971).

Mixograms, ash content, and Kjeldahl protein content (N × 5.7) were determined as described by the American Association of Cereal Chemists (1962).

RESULTS AND DISCUSSION

The mixograms (Fig. 1) indicated that the two farina samples had similar mixing strength, whereas the semolina was substantially weaker. The protein content of the durum wheat

TABLE I
Ash and Granulation Data on Farina and Semolina Samples

	HRS Farina (%)	HRW Farina (%)	Durum Semolina (%)
Ash[a]	0.35	0.33	0.67
Granulation			
Over 40 mesh	32.3	14.9	20.7
Over 60 mesh	64.2	80.7	61.5
Over 80 mesh	2.6	3.1	12.8
Over 100 mesh	0.3	0.6	3.1
Through 100 mesh	0.6	0.7	1.9

[a] 14% moisture basis.

TABLE II
Conditions Used for Spaghetti Drying

Drying Temperature (°C)	Total Drying Time (hr)	Conditions			
		Stage	Temperature (°C)	Delta T[a]	Time (hr)
40	18	Linear decrease of relative humidity from 95 to 60%			
60	10½	1	40	5.5°	2
		2	60	4.2°	8½
70	8½	1	40	5.5°	2
		2	70	4.0°	6½
80	6½	1	40	5.5°	2
		2	80	4.0°	4½

[a] Delta T is the difference between the wet bulb and dry bulb temperatures and gives an indication of the relative humidity.

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semolina and of the HRS wheat farina were equal (12.6%), but the HRW wheat farina protein content was considerably lower (10.4%, expressed on a 14% moisture basis).

The spaghetti color scores are shown in Table III. As expected, color decreased as the percentage of farina increased. This decrease was more pronounced in spaghetti containing more than 20% farina. Use of high drying temperatures also caused an increase in color scores, but these data indicated no difference in color among the samples in the three classes. This was justified because the trends observed using the average values were the same as those observed when individual values were used.

The average firmness value (6.4 g/cm) of all samples containing HRS wheat was significantly higher ($\alpha = 0.05$) than the average firmness value (5.7 g/cm) of all samples containing HRW wheat. This difference in firmness might be attributed to the difference in the protein quantity and quality of the HRS and HRW wheat farinas.

As the percentage of HRS wheat farina was increased, the spaghetti firmness values increased (Table IV). These results might be because of the difference in protein quality of the HRS wheat farina and the durum wheat semolina. This trend was not observed among the samples containing HRW wheat. The mixogram and farinogram results indicated that the mixing properties of the HRS and HRW wheat farinas are very similar. This suggests that the mixing properties do not necessarily indicate spaghetti firmness and supports data reported by Dexter and Matsuo (1978).

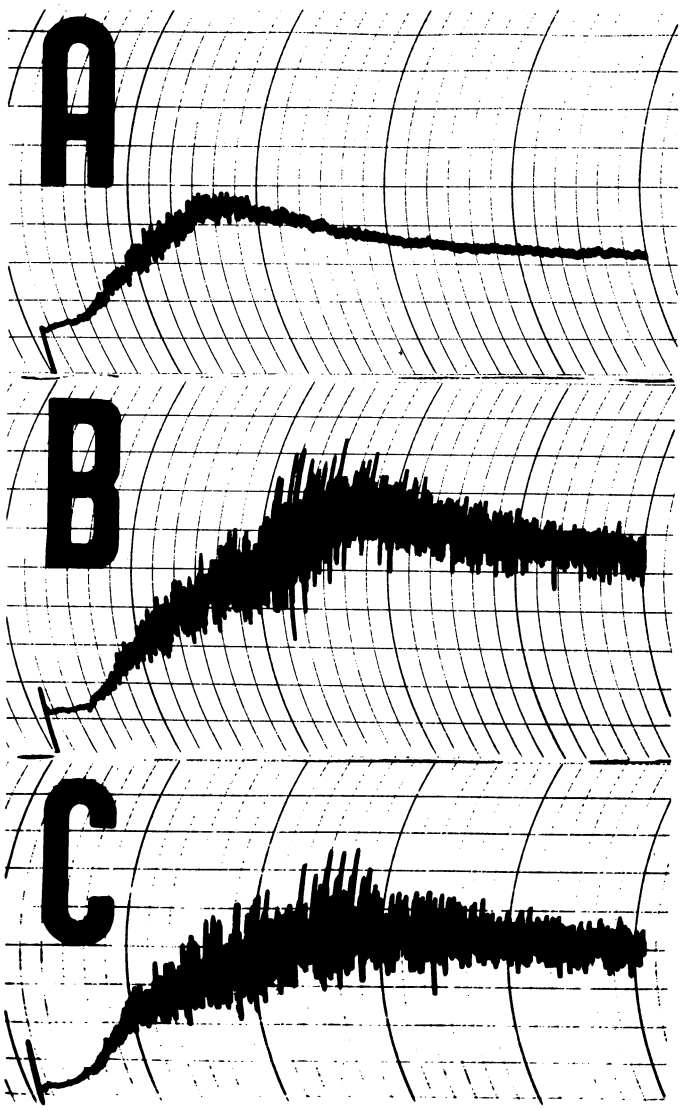

Fig. 1. Mixograms show mixing properties of **A**, durum wheat semolina; **B**, hard red spring wheat farina; and **C**, hard red winter wheat farina.

Drying at high temperatures improved spaghetti firmness (Table V). Manser (1980) reported similar findings and explained that the change was due to strengthening of the gluten framework.

The average cooking loss value for spaghetti containing HRS wheat (6.1%) was significantly ($\alpha = 0.05$) lower than those for spaghetti samples containing winter wheat farina (6.6%). The difference is probably due to the difference in protein content. The samples containing HRS wheat—samples that are higher in protein content—allow less starch to be leached out of the spaghetti strand, resulting in decreased cooking losses.

A decrease in cooking loss occurred as the percentage of farina was increased (Table VI). The decrease occurs because of the difference in protein quality of the semolina and farina samples, as indicated by the mixograms.

Increasing the drying temperature decreased the cooking loss values (Table VII). The decrease in cooking loss is probably due to the heat-strengthened protein network, which retains more starch.

TABLE III
Color Scores of Spaghetti[a]

Sample	Percentage	Spaghetti-Drying Temperature (°C) 40	60	70	80
Semolina	100	8.0	9.5	9.0	9.0
Hard red spring farina	5	9.0	9.0	9.5	9.0
	10	8.0	9.0	9.0	9.0
	20	8.5	9.0	9.0	9.0
	40	8.0	8.5	8.5	9.0
	60	7.5	8.0	8.0	8.0
	80	6.0	8.0	7.0	8.0
	100	5.0	6.0	6.0	6.0
Hard red winter farina	5	7.5	9.0	9.0	9.0
	10	7.5	9.0	9.0	9.0
	20	8.0	9.0	9.0	9.0
	40	8.0	8.5	8.5	8.5
	60	7.5	8.0	8.5	8.5
	80	7.5	7.5	8.0	8.0
	100	7.0	7.0	8.0	7.0

[a] Values based on a score of 1–12, where numbers 1 and 12 represent the poorest and best colors, respectively.

TABLE IV
Duncan's Multiple Range Test for Firmness Values of Spaghetti Containing Hard Red Spring Wheat[a]

Grouping[b]	Firmness Mean (g/cm)	Percent Farina in Blend[c]
D	5.9	0
C,D	6.0	5
C,D	6.1	10
B,C	6.4	20
A,B	6.6	40
B,C,D	6.3	60
A,B	6.7	80
A	6.9	100

[a] $\alpha = 0.05$. N = 96.
[b] Means with the same grouping letter are not significantly different.
[c] Variable.

TABLE V
Duncan's Multiple Range Test for Firmness[a]

Grouping[b]	Firmness Mean (g/cm)	Drying Temperature[c] (°C)
B	5.6	40
A	6.1	60
A	6.1	70
A	6.3	80

[a] $\alpha = 0.05$. N = 192.
[b] Means with the same grouping letter are not significantly different.
[c] Variable.

TABLE VI
Duncan's Multiple Range Test for Cooking Loss[a]

Grouping[b]	Cooking Loss Mean (%)	Percent Farina in Blend[c]
A	6.6	0
A	6.6	5
A	6.6	10
A	6.6	20
B	6.3	40
B,C	6.1	60
C	6.0	80
C	5.9	100

[a] $\alpha = 0.05$. N = 192.
[b] Means with the same grouping letter are not significantly different.
[c] Variable.

TABLE VII
Duncan's Multiple Range Test for Cooking Loss[a]

Grouping[b]	Cooking Loss Mean (%)	Drying Temperature[c] (°C)
A	6.7	40
B	6.3	60
B	6.3	70
C	6.0	80

[a] $\alpha = 0.05$. N = 192.
[b] Means with the same grouping letter are not significantly different.
[c] Variable.

The cooked-weight values of the spaghetti did not change significantly ($\alpha = 0.05$) as the percentage of farina was varied. No difference in cooked weight values was found between samples containing HRS wheat and samples containing HRW wheat. Spaghetti dried at high temperatures had lower cooked weight values than did the samples dried at the control temperature. Again, this is because of the heat-strengthened gluten network, which decreases the rate of water penetration into the strand of spaghetti.

The results of this study indicate that a good quality pasta product can be obtained by incorporating a certain percentage of farina with semolina. The quality of these products can be improved by using high temperatures for drying the product. Further studies using farina and semolina from different varieties and containing a range of protein quality and quantity would be beneficial.

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