Indian Durum Wheats. I. Effect of Conditioning Treatments on the Milling Quality and Composition of Semolina

D. K. KATHURIA and J. S. SIDHU[1], Department of Food Science and Technology, Punjab Agricultural University, Ludhiana, India

Cereal Chem. 61(5): 460-462

ABSTRACT

The effect of hot conditioning on the milling quality of Indian durum and bread wheats was studied. The wheat variety DWL-5023 yielded the maximum amount of semolina with highest protein content, carotenoid pigments, and lowest lipoxygenase activity. The hot-water conditioning of the grain at 50° C for 30 min gave negligible loss of pigments in semolina. The color grade value and ash content of semolina decreased significantly with hot-water and steam-conditioning treatments.

Durum wheat has a hard, tough, horny endosperm, which facilitates a yield of good-quality semolina that is higher than that from aestivum wheats (Bolling and Zwingelberg 1974, 1975). Durum wheats have higher protein contents, higher levels of carotenoid pigments, lower lipoxygenase activity, and better resistance to rusts and Karnal bunt than do the common wheats. Each year in India, those diseases become more severe. Therefore, farmers in India want to grow more durum wheats than bread wheats. The carotenoid pigments of semolina are bleached by a coupled oxidation reaction by lipoxygenase (Faubion and Hoseney 1981). The yellow color is one of the major attributes of good-quality pasta products.

Steam conditioning improves the quality of semolina (Cleave 1956). A few workers (Andres 1979, Anonymous 1972) have reported the inactivation of lipoxygenase enzyme with heat treatments. Little information is available about how the quality of Indian durum wheats is affected by various heat-conditioning treatments. The present study was undertaken to investigate the effect of heat-conditioning on the milling quality and composition of semolina from Indian durum wheats.

MATERIALS AND METHODS

Representative samples of two Indian durum wheat varieties (DWL-5023 and DWL-5031) and one aestivum wheat variety (WL-711) were procured from the Department of Plant Breeding, Punjab Agricultural University, Ludhiana. The wheat samples were cleaned before different conditioning treatments were applied.

Conditioning Treatments

Weighed quantities (2 kg) of different varieties of wheat tied in muslin cloth were immersed in hot water (5 L) at 50° C for 10, 20, 30, and 40 min. The other three samples of wheat were steam-treated in an autoclave at 0-atmosphere, 1-atmosphere, and 2-atmospheres steam pressure for 5, 2, and 1 min, respectively. For zero-atmosphere steam treatment, the lid was not placed on the autoclave, and the wheat sample was given open steaming. The treated samples were then dried to about 11% moisture content in a forced-circulation cabinet drier.

Milling of Wheat

The treated wheat samples were conditioned to 18% moisture content for 4 hr with occasional shaking (Rahim et al 1976). Additional 0.5% water was added just before milling (Black and Bushuk 1967). The conditioned wheat samples were milled to

[1]Graduate student and associate professor, respectively.

TABLE I
Proximate Composition of Wheat Varieties

Variety	Moisture Content (%)	Total Ash (%)	Crude Protein (%)	Pigments (ppm β-carotene)	Lipoxygenase Activity (μl of O_2/g/min)
DWL-5023, durum	12.2	1.66	12.32	9.93	18.55
DWL-5031, durum	12.1	1.62	11.49	7.54	22.04
WL-711, common	12.1	1.45	9.32	4.23	37.45

TABLE II
Effect of Conditioning Treatments on the Milling Quality (14% moisture basis)[a]

	DWL-5023				DWL-5031				WL-711			
	Total Semolina	Fine Semolina	Break Flour	Bran	Total Semolina	Fine Semolina	Break Flour	Bran	Total Semolina	Fine Semolina	Break Flour	Bran
Control	78.00	47.06	4.31	17.58	76.20	46.20	5.71	17.95	66.70	42.95	9.39	23.80
10 min[b]	76.30	46.04	5.50	18.02	75.01	45.94	6.27	18.55	63.60	41.64	11.28	25.00
20 min[b]	76.10	46.00	5.52	18.20	74.90	45.88	6.31	18.71	63.00	41.50	11.60	25.31
30 min[b]	75.70	45.91	5.63	18.49	74.70	46.07	6.42	18.82	63.00	41.57	11.69	25.21
40 min[b]	75.00	45.90	5.72	18.69	74.00	45.90	6.95	18.89	63.00	41.50	11.69	25.21
0 atm												
5 min[c]	75.60	40.91	4.93	19.28	74.80	40.80	6.06	19.04	62.80	39.71	10.18	26.92
1 atm												
2 min[c]	75.00	46.10	5.23	19.49	75.95	45.10	6.71	19.27	62.30	40.70	12.31	25.21
2 atm												
1 min[c]	71.80	46.00	7.83	20.21	70.17	45.10	9.09	20.13	59.40	40.60	13.00	27.49

[a]The yields of total semolina, fine semolina, break flour, and bran are reported as percentage of clean wheat.
[b]Hot water conditioning (50° C).
[c]Steam conditioning.

TABLE III
Effect of Conditioning Treatments on the Moisture Contents (%)[a]

	Variety	Control	Steam Treatment 0 atm, 5 min	Steam Treatment 1 atm, 2 min	Steam Treatment 2 atm, 1 min
Semolina	DWL-5023	15.20	15.20	13.75	14.15
	DWL-5031	15.00	15.10	13.25	14.00
	WL-711	15.30	15.20	13.75	13.95
Bran	DWL-5023	15.80	16.50	17.10	17.20
	DWL-5031	15.85	16.40	17.30	17.20
	WL-711	15.82	16.20	16.85	17.07

[a]Critical difference for semolina: treatment = 0.22, variety = 0.13.

semolina on a Buhler Pneumatic laboratory mill (MLU 202). The clearance between the break rolls was adjusted to obtain maximum yield of good-quality semolina (−44W, +10xx). The total semolina was sifted again through 44- and 28-mesh sieves (Rahim et al 1976) to obtain coarse (−28, +44) and fine semolina (−44). Only the fine semolina was used for this investigation.

Analysis

Moisture, total ash, crude protein, color grade, and carotenoid pigments were determined using standard AACC methods (1972). The lipoxygenase activity was determined by the method of Sumner (1943), as modified by Rao et al (1976). The results were adjusted to 14% moisture basis. The chemicals used were of

TABLE IV
Effect of Conditioning Treatments on the Color Grade of Semolina[a]

Variety	Control	Hot Water Treatment at 50°C 10 min	20 min	30 min	40 min	Steam Treatment 0 atm, 5 min	1 atm, 2 min	2 atm, 1 min
DWL-5023	6.10	5.60	4.80	4.80	4.70	5.60	5.80	6.15
DWL-5031	6.00	5.30	4.80	4.70	4.65	5.30	5.55	6.05
WL-711	4.50	3.70	3.10	3.00	2.80	3.80	4.20	4.70

[a]Critical difference for semolina: treatment = 0.09, variety = 0.056.

TABLE V
Effect of Conditioning Treatments on the Crude Protein Content (%)[a]

	Variety	Control	Hot Water Treatment at 50°C 10 min	20 min	30 min	40 min	Steam Treatment 0 atm, 5 min	1 atm, 2 min	2 atm, 1 min
Semolina	DWL-5023	10.56	10.37	10.38	10.36	10.41	10.40	10.38	10.41
	DWL-5031	9.71	9.57	9.54	9.56	9.51	9.55	9.56	9.58
	WL-711	8.85	7.59	7.55	7.55	7.56	7.57	7.61	7.58
Bran	DWL-5023	14.51	14.49	14.48	14.47	14.49	14.50	14.50	14.49
	DWL-5031	14.44	14.41	14.38	14.38	14.42	14.42	14.41	14.42
	WL-711	11.29	11.28	11.28	11.29	11.27	11.26	11.28	11.27

[a]Critical difference for semolina: treatment = 0.09, variety = 0.06.

TABLE VI
Effect of Conditioning Treatments on the Total Carotenoid Pigments (ppm β-carotene)[a]

	Variety	Control	Hot Water Treatment at 50°C 10 min	20 min	30 min	40 min	Steam Treatment 0 atm, 5 min	1 atm, 2 min	2 atm, 1 min
Semolina	DWL-5023	4.73	4.54	4.54	4.55	4.46	3.86	4.52	4.36
	DWL-5031	3.95	3.81	3.81	3.80	3.78	3.35	3.81	3.61
	WL-711	1.58	1.48	1.47	1.46	1.47	1.37	1.54	1.49
Bran	DWL-5023	4.06	3.86	3.89	3.89	3.91	3.72	3.85	3.84
	DWL-5031	3.52	3.23	3.21	3.19	3.20	3.18	3.21	3.20
	WL-711	2.89	2.81	2.81	2.80	2.81	2.79	2.80	2.80

[a]Critical difference for semolina: treatment = 0.17, variety = 0.10.

TABLE VII
Effect of Conditioning Treatments on Lipoxygenase Activity (μl of O_2/g/min)[a]

	Variety	Control	Hot Water Treatment at 50°C 10 min	20 min	30 min	40 min	Steam Treatment 0 atm, 5 min	1 atm, 2 min	2 atm, 1 min
Semolina	DWL-5023	6.96	5.84	5.38	4.42	4.31	1.27	1.05	0.51
	DWL-5031	8.03	6.41	6.00	4.49	4.28	1.27	1.05	0.51
	WL-711	13.92	9.11	6.96	5.36	4.51	3.16	2.37	1.18
Bran	DWL-5023	30.25	23.75	21.04	19.29	17.75	11.23	7.48	6.29
	DWL-5031	35.75	24.33	20.98	18.27	17.67	11.74	8.23	6.72
	WL-711	49.45	33.37	29.25	23.45	22.98	18.87	12.47	9.42

[a]Critical difference for semolina: treatment = 2.04, variety = 1.25.

analytical grade. The experimental data were analyzed statistically by analysis of variance, and the critical difference at 5% confidence is reported.

RESULTS AND DISCUSSION

The durum wheats had higher ash, crude protein, and carotenoid pigments than did the bread wheat (Table I). Whereas the lipoxygenase activity was higher in the bread wheat than in the two durum wheat varieties, the varietal difference in lipoxygenase activity and pigment content depends upon both genetic and environmental factors (Lee et al 1976).

The effect of hot water and steam treatments on the yield of different milling fractions of wheat is shown in Table II. The yield of total and fine semolina from two durum wheats was higher than that of bread wheat, whereas yield of break flour and bran was highest from the bread wheat. The yield of semolina decreased considerably when the wheat was steamed at 2 atm for 1 min; the other heat treatments had little effect on the milling yield. The heat treatments did not affect the fine semolina yield except in steaming at 0-atm pressure for 5 min. The break flour and the bran yield increased with the heat treatments. The heat treatment mellows the grain and the endosperm, resulting in a higher yield of flour (Gehle 1935). The increased yield of break flour and bran by steaming has also been reported in the literature (Baldhiev and Nikolov 1972, Skyrabin et al 1975, Mozzone 1971).

The comparison between steaming treatments showed that the duration of steaming under pressure has a significant bearing on the moisture content of semolina (Table III). The increase in moisture content with hot-water treatment may be due to the inverse relationship between the rate of moisture equilibrium and the initial moisture content of the endosperm, as reported by Moss (1977). In contrast to the moisture content of semolina, the bran had a higher moisture content.

Total Ash

Depending upon variety, ash content of fine semolina as compared with whole grains was reduced by about 50% during milling. The total ash content of semolina in comparison with whole grains decreased significantly in the sample treated with hot water and steam. A slight amount of solubles were leached out during hot-water and steam conditioning, and this may explain the differences in ash content of these samples. The difference in ash content of bran obtained during milling of wheats conditioned by hot water and steam was negligible.

Color Grade of Semolina

The color-grade value of semolina decreased significantly with hot-water and steam treatments except at 2 atm for 1 min (Table IV). The decrease in color-grade value of semolina during warm milling was also reported by Sudgen (1954).

Crude Protein

When the conditioned wheat was milled, protein loss between wheat and semolina was 1.14–1.78%. The heat treatments resulted in better separation of bran and aleurone layers from the endosperm portions, giving a lower ash and protein content in the semolina. The protein content of bran was not affected significantly by the conditioning treatments (Table V).

Carotenoid Pigments

The carotenoid pigment content of treated samples, in comparison with the control, was not affected significantly by heat treatments except for hot-water treatments at 50° C for 40 min and steam treatments at 0 atm for 5 min and 2 atm for 1 min (Table VI).

Lipoxygenase Activity

The lipoxygenase activity of semolina and bran from conditioned wheat samples is presented in Table VII. The heat treatments decreased the lipoxygenase activity of semolina and bran significantly. As Table VII shows, most of the lipoxygenase activity is located in the bran layers. The steam conditioning proved to be more effective than hot-water conditioning for inactivating the lipoxygenase. These results are also corroborated by the work of Andres (1979).

LITERATURE CITED

AMERICAN ASSOCIATION OF CEREAL CHEMISTS. Approved Methods of the AACC. 1972. The Association, St. Paul, MN. Methods 44-15A, 08-12, 46-10, and 14-50.

ANDRES, C. 1979. Steam process inactivates enzymes in wheat flour, improves quality of food products. Food Process. 40(11):98.

ANONYMOUS. 1972. Effect of heat treatment of durum wheat on quality of semolina. Muehle 109(14):211.

BALDHIEV, D., and NIKOLOV, N. 1972. Effect of steam treatment on milling properties of grain. Nauchni Tr. Vissh. Inst. Khranit. Vkusova Promst. Plovdiv. 19(2):165.

BLACK, H. C., and BUSHUK, W. 1967. Modification of the Buhler Laboratory Mill for milling semolina. Cereal Sci. Today, 12:164.

BOLLING, H., and ZWINGELBERG, H. 1974. The problem of obtaining semolina from *Triticum aestivum* wheat. Getreide Mehl Brot 28(6):152.

BOLLING, H., and ZWINGELBERG, H. 1975. The problem of semolina production from *T. aestivum*. Dtsch. Molk. Ztg. 73(5):85.

CLEAVE, H. 1956. The treatment of wheat by the procedure using addition of steam. Bull. Ec. Meun. Belge. 17:65.

FAUBION, J. M., and HOSENEY, R. C. 1981. Lipoxygenase: Its biochemistry and role in breadmaking. Cereal Chem. 58:175.

GEHLE, H. 1935. Laboratory tests that lead to the improvement in the baking quality. Muehle 72:388.

LEE, J., KALTSIKE, P. J., and BUSHUK, W. 1976. The inheritance of lipoxidase activity and pigment content in durum wheat. Theor. Appl. Genet. 47(5):243.

MOSS, R. 1977. The influence of endosperm structure, protein content and grain moisture on the rate of water penetration into wheat during conditioning. J. Food Technol. 12(3):275.

MOZZONE, P. G. 1971. Wheat conditioning and preparing for milling: steam conditioning. Tec. Molitoria 22:29.

RAHIM, A., PRABHAVATI, C., RAO, P. H., and SHURPALEKAR, S. R. 1976. Suitability of Indian durum wheats for semolina milling and vermicelli preparation. J. Food Sci. Technol. 13(5):249.

RAO, P. H., RAHIM, A., PRABHAVATI, C., and SHURPALEKAR, S. R. 1976. Physico chemical, rheological and milling characteristics of Indian durum wheats. J. Food Sci. Technol. 13(6):317.

SKYRABIN, V., NEKLYUDOVA, V., CHEREPOUSKII, A., BETALIN, V., SAFRONOV, V., and CHEMYAGIN, Y. 1975. Wheat conditioning in Siberia. Mukomolno Elevat. Kombikormovaya Prom. 4:26.

SUDGEN, G. H. 1954. Warm wheat milling. Milling 128:94.

SUMNER, R. J. 1943. Lipoid oxidase studies. A method for determination of lipoxidase activity. Ind. Eng. Chem. Anal. 15:14.

[Received October 24, 1983. Revision received May 3, 1984. Accepted May 10, 1984]