

NITRATE AND NITRITE CONTENTS OF VARIOUS WHEAT VARIETIES GROWN IN THE PUNJAB

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Nitrate and nitrite contents of 12 varieties of wheat (140 samples) and 80 samples of wheat flour from various regions of the Punjab were determined. Variety Punjab-81 from Sahiwal region contained the maximum amount of nitrates (226.2 – 343.0 ppm) while the nitrite contents of Maxi Pak-65 from Lahore region were the highest i.e. 6.9 – 31.2 ppm. Wheat flour from Sheikhpura area contained the highest levels of nitrates (2.1 – 24.0 ppm). Daily dietary intake of nitrates and nitrites from wheat flour varied from 104.5 – 238.4 ppm and 0.7 – 12.0 ppm respectively.

INTRODUCTION

The use of nitrogen fertilizers to cropland without knowing the real demand, maturity stage of the crops and other agronomic factors has become a common agricultural practice in Pakistan. The indiscriminate application of these fertilizers has been reported [1] to cause excessive translocation of nitrogen from soil to the edible portions of plants. Wheat receiving nitrogen fertilizers at the boot stage has been reported [2] to accumulate significantly high amounts of inorganic nitrogen in grains. Inorganic nitrogen (nitrates or nitrites) thus accumulated in wheat grains may produce health hazards in consumers.

Nitrates are found to be toxic when reduced to nitrites during the storage of cooked food [3], by the microflora present in the mouth and gastrointestinal tract of man [4] and in the stomach of infants [5] (due to lesser stomach acidity). Nitrites are ten times more toxic than nitrates [6] and are reported [7] to produce methemoglobinaemia in infants and pre-school children. They are also recognised [8] as the precursors of N-nitrosamines and N-nitrosamides which are carcinogenic, mutagenic and teratogenic [9].

Several workers [10-12] have studied the effects of nitrogen fertilizers on the yield, quality and growth characteristics of wheat but no work has so far been reported in Pakistan about the levels of nitrates and nitrites in wheat, keeping this point in mind, the present studies were undertaken to assess the nitrate and nitrite contents in different varieties of wheat grown in the Punjab and commercially available wheat flour (*atta*) consumed by the general public.

MATERIALS AND METHODS

Certified varieties of wheat (*Triticum aestivum* L.) cultivated in the Punjab were procured from Federal Seed Certification Department Lahore and Islamabad.

Samples of wheat flour produced from the Roller and General Flour Mills were collected at random from retail shops in different regions of the Punjab.

Analytical: Moisture contents were determined by A.O.A.C method [13]. Nitrate was determined by the nitroxylenol method as modified by Heisler *et al.*, [14] and nitrite was estimated colorimetrically according to the method of Nelson *et al.* [15].

RESULTS AND DISCUSSION

Table 1 summarises the nitrate and nitrite contents of wheat varieties cultivated in different regions of the Punjab. Variety Punjab-81 (from Sahiwal region) contained higher levels of nitrates (226.2-343.0 ppm) as compared to the rest of the varieties. Varieties like Lyp-73 (Bahawalpur), FD-83 (Khanewal), Noori (Faisalabad), Pak-81 (Sahiwal), and Pari-73 (Lahore) also contained nitrates in substantial amounts. Nitrate contents of these varieties ranged between 240.8-321.2, 229.9-288.3, 204.3-280.9, 182.3-266.4 and 94.9-251.8 ppm respectively.

Nitrites were detected only in seven out of twelve varieties and were found in the range of 0.0-31.2 ppm. Maximum amount of nitrites (6.9-31.2 ppm) was recorded in Maxipak-65 from Lahore region. Accumulation of nitrates and nitrites in these wheat varieties were found to be correlated with each other as indicated by the values of coefficient of correlation (r) which varied from 0.5-1.0 with

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Table 1. Nitrate and nitrite contents of various wheat varieties cultivated in different regions of the Punjab.

Regions	Wheat variety	Moisture** %	Nitrate range (ppm)*	Nitrite range (ppm)*	Coefficient of correlation
Lahore	Pari-73	11.0	94.9-251.8 (± 62.9)	0.0-2.6 (± 1.1)	0.7
	Maxipak-65	11.6	0.0-47.5 (± 17.6)	6.9-31.2 (± 8.9)	0.9
	Pak-81	10.8	91.2-124.1 (± 12.4)	— — —	—
	Punjab-81	11.7	14.6-142.3 (± 53.4)	2.3-4.1 (± 0.7)	0.7
	FD-83	11.4	105.8-175.2 (± 26.4)	— — —	—
Faisalabad	Yecora	11.1	167.8-226.2 (± 22.5)	— — —	—
	Noori	11.4	204.3-280.9 (± 30.7)	0.0-3.3 (± 1.4)	0.4
	Sandal	11.5	91.2-164.2 (± 26.6)	0.0-7.6 (± 2.9)	0.8
	Blue Silver	11.9	197.1-226.2 (± 10.7)	0.0-5.7 (± 2.1)	0.8
	Lyp-73	11.1	238.7-311.0 (± 31.1)	— — —	—
Islamabad	Lyp-73	11.3	153.2-182.3 (± 11.0)	0.0-1.3 (± 0.6)	0.5
	Pak-81	13.8	94.9-215.3 (± 46.1)	— — —	—
	Punjab-81	12.1	127.8-180.2 (± 19.4)	— — —	—
	Blue Silver	11.5	130.4-180.9 (± 19.0)	— — —	—
	KH-83	11.0	99.8-168.3 (± 25.4)	1.1-4.5 (± 1.3)	1.0
Bahawalpur	Bwp-79	11.4	142.3-211.7 (± 25.1)	1.8-3.6 (± 0.7)	1.0
	Blue Silver	11.6	149.6-189.7 (± 15.7)	0.0-4.9 (± 1.8)	0.7
	Punjab-81	11.9	127.1-182.5 (± 22.7)	0.0-1.5 (± 0.6)	0.6
	Pak-81	12.0	138.6-193.4 (± 20.1)	0.8-2.8 (± 0.7)	0.9
	Lyp-73	11.1	240.8-321.2 (± 36.7)	— — —	—
Multan	Blue Silver	11.6	142.3-197.1 (± 21.3)	1.3-2.6 (± 0.5)	1.0
	Punjab-81	11.2	85.2-180.3 (± 43.8)	1.0-2.5 (± 0.5)	1.0
	Pak-81	12.1	128.6-260.1 (± 54.3)	1.4-3.6 (± 0.8)	1.0
	KH-83	11.8	100.4-160.0 (± 23.1)	1.0-5.8 (± 1.8)	0.9
	Bwp-79	12.3	88.7-225.3 (± 57.8)	0.0-2.0 (± 0.7)	0.9
Khanewal	FD-83	12.1	229.9-288.3 (± 21.8)	0.0-1.8 (± 0.8)	0.4
	Punjab-81	11.6	98.5-193.4 (± 36.3)	0.0-2.5 (± 1.2)	0.8
	Pak-81	11.9	131.3-266.4 (± 52.7)	2.5-4.1 (± 0.6)	1.0
	Bwp-79	12.3	102.2-233.6 (± 48.3)	0.0-2.1 (± 0.9)	0.7
	KH-83	11.7	102.2-164.2 (± 25.8)	0.0-6.9 (± 2.5)	0.6
Sahiwal	Punjab-81	11.4	226.2-343.0 (± 45.8)	— — —	—
	Pak-81	11.3	182.5-266.4 (± 31.2)	— — —	—
	Blue Silver	11.6	156.9-229.9 (± 27.3)	0.8-2.1 (± 0.5)	0.9
	Lyp-73	12.1	150.1-200.7 (± 26.0)	0.8-2.5 (± 0.7)	1.0
	KH-83	11.2	147.9-180.6 (± 12.3)	2.1-5.8 (± 1.5)	1.0

*Calculated on dry weight basis. **Average of four samples. Figures in parentheses indicate standard deviation.

the exception of two varieties for which the value of (r) was less than 0.5.

Contrary to wheat grains almost all samples of wheat flour contained significantly high amounts of both nitrates and nitrites (Table 2). Wheat flour from Sheikhpura region contained the higher levels of nitrates (105.4-478.9 ppm) as well as those of nitrites (2.1-24.0 ppm) than wheat flour from other regions. The presence of nitrites in almost all the samples of wheat flour seem to be derived from nitrates

as a result of the thermal decomposition of nitrates into nitrites during milling. Nitrate has been reported [16] to be reduced to nitrite at elevated temperature. The existence of positive correlation (r), varied from 0.7-1.0) between nitrate and nitrite contents of wheat flour also supported this view.

Nitrate and nitrite contents of wheat (Table 1) and that of wheat flour (Table 2) were higher than those reported by other workers [17-18]. Richardson [19]

Table 2. Nitrate and nitrite contents* of wheat flour.

Region	Moisture**	Nitrate range (ppm)	Nitrite range (ppm)	Coefficient of correlation
Lahore	11.9	82.2-209.1 (± 43.9)	0.0-12.5 (± 4.0)	0.7
Sheikhupura	12.8	105.4-478.9 (± 129.8)	2.1-24.0 (± 7.2)	0.9
Rawalpindi	13.0	109.4-237.2 (± 38.3)	0.0-3.4 (± 1.2)	0.7
Multan	11.9	131.3-218.9 (± 26.2)	— — —	—
Sahiwal	12.5	76.6-313.8 (± 71.4)	0.0-3.9 (± 1.3)	0.7
Faisalabad	11.9	156.9-259.1 (± 27.8)	0.3-8.2 (± 2.2)	0.8
Kharian	13.5	142.3-226.2 (± 29.5)	3.4-7.4 (± 1.1)	0.9
Sialkot	11.9	116.7-248.2 (± 45.7)	0.0-1.5 (± 0.5)	0.7
Bahawalpur	12.2	142.3-218.9 (± 26.6)	1.3-3.3 (± 0.7)	1.0
Sargodha	11.8	142.3-244.5 (± 35.6)	0.8-2.6 (± 0.6)	1.0

*Calculated on dry weight basis. **Average of eight samples. Figures in parenthesis indicate standard deviations.

reported nitrate in the range of 27.0-40.0 ppm in wheat and 0.0-57.0 ppm in other cereal grains. Rooma [17] recorded 22.0-27.0 ppm nitrates and 0.12-0.17 ppm nitrites in wheat bread. The high nitrate and nitrite contents detected in wheat (Table 1) and wheat flour (Table 2) may be attributed to the application of variable amounts of nitrogen fertilizers by the farmers of various regions of the Punjab. Other agronomic factors such as chemical nature and time of fertilizer application, availability of water (during the growth period), and soil characteristics may also be the contributing factors towards high accumulation of inorganic nitrogen (nitrates and nitrites) in wheat grains. These factors have been reported [19-22] to have positive influence on the uptake, metabolism and accumulation of nitrogen in plants.

Table 3. Maximum daily intake* of nitrate and nitrite from wheat flour in various regions of the Punjab.

Regions	Intake of nitrite (ppm)	Intake of nitrite (ppm)
Lahore	104.5	6.2
Sheikhupura	239.4	12.0
Rawalpindi	118.6	1.7
Multan	109.0	
Sahiwal	156.9	1.9
Faisalabad	129.5	4.1
Kharian	113.1	3.7
Sialkot	124.1	0.7
Bahawalpur	109.4	1.6
Sargodha	122.2	1.3

*Calculated on the basis of consumption of 500 g. wheat flour per person per day.

Contribution from wheat and wheat flour to the total daily intake of nitrates and nitrites. Wheat flour constitutes the major bulk of common man's diet in Pakistan. Calculated on the average consumption of wheat flour (500 g/person/day) dietary intake of nitrates and nitrites from this source varied from 104.5-239.4 ppm and 0.7-12.0 ppm respectively (Table 3). This intake of nitrate from wheat flour was significantly high as total permissible daily intake of nitrates (from all sources) has been proposed [23] to be 218.8 ppm/person/day. Nitrite contents of wheat flour although were not too high but in view of the toxicity of nitrite (nitrite has been reported [6] to be ten times more toxic than nitrates) these levels of nitrites in flour may cause health hazards in infants, children, elderly people and expectant mothers.

It could be concluded from the above studies that wheat accumulates (in grains) nitrates and nitrites under the conditions of fertilization of cropland prevalent in Pakistan. It is thus essential that continued monitoring of detrimental nitrogenous compounds in foods of plant origin should be carried out regularly.

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