RESEARCH PAPER:

Accumulation nutrient and heavy metal content in wheat as influenced by irrigated with mix industrial effluents flowing in Khari river of Gujarat

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SUMMARY

A study was conducted to determine the chemical composition of wheat irrigated with effluents contaminated water flowing in Khari river of middle Gujarat region (India). Twenty - Twenty samples of wheat plant at harvest were collected from both contaminated and uncontaminated locations of the area of Nawagam-Vatava region of Gujarat (India) where effluent canal is passed. The plant samples of grain, straw and husk of wheat were used for analysis of total P, K, S, trace and heavy metals. The result indicated that P, K and S contents were higher in wheat grain, straw and husk samples of uncontaminated area except P content in wheat grain which was higher in uncontaminated area as compared to contaminated area. The micronutrients content were higher in wheat grain, straw and husk of contaminated area than in uncontaminated area. Further, it was noted that among the different micronutrients, Fe content in all the three components of wheat was very much higher than samples of uncontaminated area. Further, all the heavy metals were more concentrated in wheat grain, straw and husk parts in contaminated area. The Cr and Ni content in wheat grain, Cd, Co, Cr and Pb content in wheat straw and Co and Ni content in wheat husk were 123, 52, 57, 98, 141, 84, 61 and 142 per cent higher than wheat grain, straw and husk samples from uncontaminated area, respectively.

Key words : Wheat, Heavy metals, Industrial effluents

In different parts of the country, the menace of a rapidly increasing population, the want on growth of industries and increasing urbanization has created major problems with the disposal of sewage and industrial effluents. These industries generate huge quantity of solid and liquid wastes. They contain appreciable amounts of metals besides beneficial nutrients. Therefore, their continuous application to soil may lead to accumulation of heavy metals which are likely to pose serious threat on soil health and plant growth as they depress the yield and quality. In Nawagam area, villages ponds are receiving effluent water through Khari canal/ channel, which carries industrial effluents discharged from the industrial area of Naroda and Vatva. These effluents may or may not be biodegradable. It was also observed that there were approximately 1600 units of which, about 525 units generate effluents. Therefore, there are possibilities of the contamination of surface and ground water and soils of the area by chromium present in the wastewater released by the industry. Farmers in Nawagam area use effluent diluted with fresh canal water for irrigation purpose as and when required. In addition, water tube well of nearby effluent canal is contaminated and being used by the farmers for irrigating their fields where rice-wheat sequence is mainly practiced. This has caused serious problems concerning food chain and consequently, the health of organisms, including human being. Therefore, the survey work was carried out to investigate the heavy metal toxicity in wheat crop growing in Nawagam-Vatava area.

MATERIALS AND METHODS

The twenty-twenty plant samples of wheat were collected in the end of *Rabi* season from uncontaminated areas of villages like Shrijipura (2), Chitrasar (2), Dharoda (2), Kathwada (1), Chalindra (1), Bareja (2), Bherai (1), Bakodara jara (1), Vadala (4), Dhathal (1) and Nayaka (3) as well contaminated areas of villages like Chalinra (1), Pinglaj (2), Nawagam (3), Pansholi (2), Malarpur (1), Kanera (1), Girmatha (1), Lambha (1), Sarasa (1), Lali (2), Umiyapura (2), Bidaj (1) and Nayaka (2). The samples were washed with 0.3 N HCl, single and double distilled water in a sequence and air-dried. The samples were dried in paper bags at 70^0 C temperatures till

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constant weight in a hot air oven and preserved for further analysis. The plant samples of grain, straw and husk were washed successively with 0.1 M HCl and then with single and double distilled water. Samples were first air dried and then at 60^0–70^0 C temperature in a hot air oven. Dried samples were ground in a stainless steel blade Wiley mill and digested in diacid mixture (HNO_3: $HClO_4$ – 4:1). The volume was made with double distilled water and the extract was filtered through Whatman filter paper No.42. The acid extract was used for analysis of total P and K (Jackson, 1973), S (Chaudhary and Cornfield 1966), trace and heavy metals (Jackson, 1973) as per standard methods.

RESULTS AND DISCUSSION

The analysis of wheat grain, straw and husk samples revealed that the K and S content were higher in wheat grain of contaminated area with mean value of 0.48 and 0.27 per cent, respectively than that of uncontaminated area. The P content was higher in wheat grain of uncontaminated area with mean value of 0.71 per cent. The wheat straw and wheat husk collected form-contaminated areas showed higher amount of all primary and secondary nutrients. P, K and S ranged from 0.25-0.41 (0.30), 0.94-1.79 (1.41) and 0.21-0.43 (0.33) % in wheat straw and 0.21-0.35 (0.24), 0.60-0.92 (0.73) and 0.13-0.22 (0.16) % in wheat husk in samples of contaminated area (Table 1).

The micronutrients *viz.,* Fe, Mn, Zn and Cu content in wheat grain ranged from 352-1410 $\mu g\ g^1$, 23.7- 59.5 $\mu g\ g^1$, 45.1- 65.2 $\mu g\ g^1$ and 4.5- 12.2 $\mu g\ g^1$ with their corresponding mean of 706 $\mu g\ g^1$, 41.1 $\mu g\ g^1$, 55.4 $\mu g\ g^1$ and 6.2 $\mu g\ g^1$ which were higher than those noted in wheat grain samples collected from uncontaminated area. Similarly, micronutrients content in wheat straw and husk were higher in samples of contaminated area than samples of uncontaminated area. Further, it was noted that the Fe content ranged from 352-1410 (706 $\mu g\ g^1$), 204-842 (427 $\mu g\ g^1$) and 822-2332 (1305 $\mu g\ g^1$) in wheat grain, straw and husk, respectively, which were quite higher than those noted in samples of uncontaminated area (Table 2).

The heavy metal ranged from 0.03-0.80, 0.25-1.75, 0.30-3.90, 0.05-2.05 and 0.25-10.75 with there corresponding mean of 0.31, 0.83, 0.47, 0.79, 2.63 in wheat grain samples collected form uncontaminated area. Similar trend were also noted in wheat straw and wheat husk. It was noted further that Cr and Ni content in wheat grain, Cd, Co, Cr and Pb content in wheat straw and Co and Ni

Table 1: Nutrient content in wheat grain samples of Nawagam-Vatava region

	Wheat grain			Wheat straw			Wheat husk		
	P	K	S	P	K	S	P	K	S
	(%)								
Uncontaminated area									
Min	0.60	0.34	0.11	0.15	0.78	0.09	0.15	0.45	0.07
Max	0.85	0.47	0.19	0.32	1.43	0.22	0.26	0.88	0.15
Mean	0.71	0.42	0.15	0.21	1.02	0.15	0.18	0.55	0.12
Contaminated area									
Min	0.55	0.42	0.13	0.25	0.94	0.21	0.21	0.60	0.13
Max	0.70	0.61	0.32	0.41	1.79	0.43	0.35	0.92	0.22
Mean	0.62	0.48	0.27	0.30	1.41	0.33	0.24	0.73	0.16

Table 2: Micronutrients content in wheat grain samples of Nawagam- Vatava region

	Wheat grain				Wheat straw				Wheat husk			
	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
	$\mu g\ g^{-1}$											
Uncontaminated area												
Min	35.7	33.0	15.2	2.0	107.7	11.2	15.2	1.2	78	24.7	1.75	1.50
Max	64.2	45.0	44.0	5.5	462.7	35.5	38.0	3.5	138	40.2	24.7	6.00
Mean	48.0	38.8	22.9	4.3	256	21.0	27.8	2.3	104	32.2	11.2	3.53
Contaminated area												
Min	352	23.7	45.1	4.5	204	20.2	40.1	3.2	822	27.2	6.01	5.23
Max	1410	59.5	65.2	12.2	842	44.7	65.4	13.2	2332	46.5	20.5	11.2
Mean	706	41.1	55.4	6.2	427	39.7	52.6	5.9	1305	37.7	12.5	7.31

Table 3 : Heavy metals content in wheat grain samples of Nawagam- Vatava region

	Wheat grain					Wheat straw					Wheat husk				
	Cd	Co	Cr	Ni	Pb	Cd	Co	Cr	Ni	Pb	Cd	Co	Cr	Ni	Pb
	$\mu g\ g^{-1}$														
	Uncontaminated area														
Min	0.03	ND	0.03	0.05	0.75	0.43	0.25	0.23	0.60	1.25	0.18	ND	0.21	0.05	2.50
Max	0.50	1.75	1.35	2.12	7.00	2.43	2.00	2.20	2.83	9.00	0.43	1.50	3.15	1.88	9.25
Mean	0.31	0.83	0.47	0.79	2.63	1.54	1.11	0.91	2.00	2.99	0.35	0.70	1.84	0.89	3.66
	Contaminated area														
Min	0.03	0.25	0.03	0.30	0.25	0.28	0.25	0.03	1.60	2.25	0.23	0.25	0.25	0.68	1.25
Max	0.80	1.75	3.90	2.05	10.75	3.25	3.00	18.98	5.03	7.75	1.20	1.75	5.95	8.75	19.50
Mean	0.46	0.86	1.05	1.20	3.24	2.42	2.20	2.19	2.92	5.49	0.39	1.13	2.16	2.15	3.93

content in wheat husk were 123, 52, 57, 98, 141, 84, 61 and 142 per cent higher than wheat grain, straw and husk samples from uncontaminated area, respectively (Table 3).

The analysis of chemical composition for different elements in different components of wheat in contaminated as well as uncontaminated areas clearly revealed about the existence of heavy metals contamination in this important crops of the Nawagam-Vatava region. The contamination could be ascribed to the use of contaminated tube well water for irrigation purpose. The introduction of heavy metals through the irrigation in the soil becomes a source of contamination where the farmers grow this crop. Contamination of grain with heavy metals indicated that the heavy metals are translocated to the edible portion of wheat, which pose more threat to health of animal and human being if such contaminated edible portion is consumed over years. Maliwal *et al.* (2005) also reported higher contamination of different crops grown along the effluent channel in Vadodara region. Simlar results were also reported by several workers in different plants *viz.*, Wang *et al.* (2003) in rice and Sajid (2003) in wheat.

Conclusion:

In contaminated area of Nawagam-Vatava region, the heavy metal absorbance was higher by roots of the wheat crop as farmers are using Khari canal water as irrigation carrying mix industrial effluents and these heavy metal, translocated in edible portion of the wheat plant, are posing more threat to health of animal and human being if such contaminated edible portion is consumed over years. So, soil-plant and ground water contamination *vis-à-vis* human and animal health needs to be monitored regularly in heavy metals contaminated areas as well as crop/crops species need to be identified which can eliminate or reduce the heavy metals absorption.

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