313. Contamination and Legislative Measures for Sustainable Growth of Business of Tanneries in Pakistan

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Abstract

Leather industry is the third largest industry of Pakistan, which does annual business of approximately 35 million U.S. dollars. Existing industrial structure of leather is under fatigue to fulfill the rising demand of leather in international market. Tanning industry of Pakistan is contributing a lot to provide such goods and services, but, it has some limitations regarding degrading factors for environmental protection and health of living beings. In these contaminants, elements of Chromium had been observed as much toxic in their nature. This piece of writing had surveyed the state of pollution caused by Chromium elements in various cities of Pakistan along with presentation of a critical review of existing institutional coordination and legal binding of the target subject. It had found that inappropriate and ineffective measures taken by government agencies had made the issue much serious for environmental protection, health aspects of living organisms, degradation of agricultural soil, and potential sustainable development in the target business in Pakistan. It had highlighted some suitable tools of treatment of chromium contamination of water. Furthermore, the inefficient and outdated legislation had also contributed to grow the problem at such a level, which only can be reversed through carefully studied decisions, incorporating of international experiences and standards and commitment of all stakeholders with a comprehensive national approach to tackle these challenges cohesively.

Keywords: Leather, tannery's effluent, Chromium, environmental protection, health, legislation.

1. Introduction

Leather industry had observed an evolutionary need along with its own futuristic development in various parts of the world. Final product of leather industries is produced from tanning process of raw hides [1]. Its residue affects environment and other living creatures on earth. Therefore, developed and resourceful countries had applied state regulatory mechanism thorough legislation to make these industries accountable to take responsibility of its adverse effects. Resultantly, these environmental protection laws and relevant legislative interventions of the State had made the process much transparent, but it had affected the growth of tanning and business of leather in the host countries. Consequently, the target shareholders and stakeholders had been observed as dependent on those host countries, where such regulatory mechanism had either not grown at such a level to make the actors accountable or had not been able to develop institutional capacity to make the process transparent. Hence, on one hand, the host developed countries had to face a larger cost of tanning of leather to produce its workable final product. On the other hand, these countries had made safe their own host constituencies through regulatory measures, but their dependence on developing host countries had increased the demand of tanning of leather maximum, which had acted as a catalyst to increase the multidimensional momentum of insecurity for the host countries' environment and other living part of it [2].

According to State Bank of Islamic Republic of Pakistan, leather industry is the third biggest exporting industry of Pakistan, which does business of 35 million U.S. dollars per year [3], [4]. It has capacity for

tanning of about 50 million animal skins per year. City Kasur, Sialkot, Karachi, Faisalabad, and Mian Channun are larger constituencies of tanning factories in Pakistan. Although, the business growth in the target industries is fruitful for Pakistan, but it is paying a heavy price indirectly in the form of environmental degradation and potential threat of diseases in various creatures on its land [5]. Its city Sialkot has about 300 units of tanning factories, which have capacity to produce 65,000-kilogram leather in a day. Similarly, city Kasur has 250 units of tanning industries, which contribute significantly in its production at a large scale than the other cities. There are about 250 tanning units in Kasur and about 300 tanning units in Sialkot [6], [7], [8].

These tanneries had been observed as using several kinds of chemicals, in which chromium salts are much significant in their tanning processes [9]. Cr (III) Sulphate salt is used for chromium tanning, which is obtained from naturally occurring chromite salts. It creates cross linkages in the collagen, which mostly present in animal's skin. A significant amount of this salt (about 2-2.5%) of total mass of raw material is made part during tanning process to produce a good quality leather [10].

Pakistani tanneries use about 15,000 tons of Cr (III) Sulphate per year [11], which not only becomes part of solid and liquid waste of those factories, but also a significant part of it emits into air. Among all of these effluents, the liquid waste is much problematic. Although, it is a compulsive part of processes in tanneries, but at the same time it becomes among one of these limitation of such mechanisms, where tanneries discharge their effluents in open areas without decomposing their elements at such a level which must be estimated as less harmful for anything in this universe [8]. Resultantly, its carcinogenic, mutagenic and teratogenic characteristics causes nasal septum perforation, ulceration of skin, lungs cancer, malfunctioning of liver and kidney and growth depression. These affluent reaches to living organisms through various media, most probably form air and water [12], [13].

According to Pakistan Environmental Protection Agency's standards for maintaining the quality of drinking water in Pakistan, only 0.05 mg/L concentration of Chromium is permissible as less harmful. Although total concentration of Chromium in drinking water had been observed as much low naturally, but the water of host cities of tanneries, had been observed as victim of this element [14].

2. Contamination of Irrigation and Drinking Water

Elements of Chromium have capacity to enter into water bodies through seeping into groundwater [15]. If, this water is used for irrigation, then it this contamination becomes part of agricultural crops as bioaccumulation [16]. The potential threat of contamination of ground water in Pakistan is much high, because provision of limited and costly fresh water and groundwater resources had alarmed the situation through open use/mixing of it in the host products [17]. Although, a lot of examples can be described in this piece of writing, but the following information is conversant of host areas of tanneries in Pakistan, which had affected drinking and irrigation water significantly.

2.1. The Case of City Kasur

City Kasur is significant in this regards that its tanneries release 9000 m^3 per day of such kind of effluent in liquid form. It has been observed that about 2500 m^3 of this liquid becomes part of local irrigation water. Although, its tanneries are allowed to excrete 1mg/L amount of effluent, but it has been observed as containing 391 mg/L Chromium elements in it [15], [18]. Even, the ground water of host parts of Kasur had been estimated as having up to 2.12 mg/L Chromium, which significantly crosses World Health Organization's standards of permissible limit of presence of such elements [19]. In some host areas of city Kasur, it had been estimated as 0.05mg/Kg to 50 mg/Kg that is much dangerous for living organism to be inhaled at such level [15].

2.2. The Case of City Sialkot

The target amount of Chromium in liquid effluent from tanneries of Sialkot ranges from 4 µg/L to 15 µg/L. The target concentration of total Chromium in drinking water of the host area ranges from 0.057 µg/L to 1.60 µg/L. Resultantly, the host soil of the city contains more than 5 µg/L of Chromium in it, which is estimated as dangerous for all creatures in its area of contamination [20].

2.3. The Case of City Karachi

River Indus is the sole source of fresh water for constituencies of port city Karachi of Pakistan. Unplanned industrialization in the city has resulted contamination of its surface and ground water including approached water of River Sindh significantly [21]. The observed amount of Chromium in its ground and tap water has been estimated larger than the thresholds set by World Health Organization and Pakistan Environmental Protection Agency. Korangi Town of city Karachi had been declared as notorious for Chromium contamination in its drinking water [22].

2.4. The Case of City Faisalabad and Sargodha

City Faisalabad had been reported of containing up to 16000 mg/L Chromium in its host drinking water [7]. Similarly, in a study, city Sargodha also had been observed as having contamination of Chromium elements in its irrigation water. Consequently, the yield of those agricultural products had been observed as less than their input and also less than normal yields than their neighbouring areas of same variables except of not being contaminated in their nature. It is significant to be noted that Chromium elements not only pass into agricultural products, but also deposit into the host soil, which lead it toward degradation, deforestation, and ultimately towards desertification [23]. At Head Trimmu of River Chenab, a significant concentration of Chromium was reported in some major agricultural carps. The target water was estimated having contamination of 20.72 mg/L of Chromium in it. Whereas, its amount in sediments was reported as 76.39 µg/g [24].

3. Measures to Treat Chromium Contamination in Water

Target narrative had described that some host areas of Chromium in in irrigation and drinking water Pakistan is a serious public issue, which needs public policy to be addressed effectively. Although, it had been observed in Pakistan very late, but it does not mean that it has been emerged in some previous decades, but also had been observed from initial decades of 20th Century in other parts of the world too, which had been addressed through various public and private suitable actions [25]. The Government of Pakistan in collaboration with UNDP had set up a primary treatment plant of tannery's waste at city Kasur in 1996. This project had aimed to provide a system of collection of tannery's waste to process it in its primary phase (of the waste). It had to introduce various cleaning techniques of liquid effluent, which at least had to minimize the potential harm to the health and provided safety of the workers. Although, it was a greater project, but its limited functions had raised question marks to make the process effective and accountable [26].

National Cleaner Production Centre had played a significant role in Sialkot's tanneries, where recovery and management of Chrome elements in the waste had minimized their air pollution [27].

Waste management companies working under Local Government and Community Development in Province Punjab are also working on waste collection and its dumping and channelling of wastewater from such kinds of target industries [28]. Many private sector companies have also been observed as providing services for waste management and its treatment. In this regard, NEC Consultants had set up Combined Effluent Treatment Plants in cities of Faisalabad and Karachi (in Korangi) to tackle the issue on regular basis [29]. Besides of such developments, the momentum of the target problem had not been envision properly by its stakeholders to tackle the issue form its target dimensions [6].

The modern techniques of treatment of such wastes, such as; Bioremediation, Phytoremediation and Biosorption are some leading options to be initiated to tackle the challenge of treatment of such affluent [30], [31]. Dr. Shahid Hussain had taken an initiative of in the form of a project as titled; *Bioremediation of Chromium and Arsenic from Industrial Wastewater* at the University of Punjab, Lahore, in assistance and collaboration of USAID to make the affluent less harmful to the environment. The had aimed to use bacteria to detoxify the Cr (VI) and Arsenic in the liquid effluent of such industries [32].

Some plant species, such as; *Eichornia Crassipes, Typha Latifolia, Typha Angustifolia, Cyperus Esculentus* and *Scirpus Americanus* had known for Phytoremediation of heavy metals as present in the soil and in wetland of such wastewater had been formulated as geo-membrane in the bottom of the surface which prevent seepage of these elements (effluent) reach to ground water or accumulation in the soil permanently [33] [34], [35]. The target treatment had been estimated as cost effective, eco-friendly and requiring less

operational input than the other methods to be launched for the same purpose. It is the significance of potential of plantation of Phytoremediation, which depends upon hydrology conditions, type of sediment, plant species, growing season, substrate mode, depth of the water and feeding patterns to be grown effectively [36], [37].

Chromium Biosorption is yet another convenient procedure for simply picking up the metal on to biomass of certain bacteria, algae, fungi or plants or onto target biofilm. This method separates the metal from wastewater without converting or transforming it into any other compound, which sometime becomes even harder to get rid of [38], [39].

4. Legislation for Environmental Protection in Pakistan

It has been tried to realize to intelligentsia of Pakistan to have proper regulatory mechanism for the target issues [40]. Contemporary legislation and regulatory mechanism for environmental protection, institutional performance for waste monitoring and management, had been observed as insufficient to for acquired constituencies of host areas of problems. One in 1988, the Government of Pakistan in collaboration with International Union for Conservation of Nature (IUCN) had formulated a *National Conservation Strategy* (NCS) for tackling the challenges of *Environment and Urban Affairs* in supervision of the target Division as a greater development for three years' program (1988-91). Main objectives of NCS were aimed for resource conservation, sustainable development and efficient management of resource use in the target areas. NCS also had led to the creation of environment for development its unit in the Ministry of Planning and Development in Pakistan. Subsequently, it had led for setting up of provincial environmental departments in all administrative units of Pakistan [41], [42]. National Cleaner Production Centre (NCPC) was established in 1999 by joint collaboration with UNIDO, UNEP and EPAs for aimed to introduce cleaner industrial techniques and recycle industry effluents to reduce pollutant load of the effluent in the target areas [43].

The first environmental protection law in Pakistan was "*Pakistan Environmental Pollution Ordinance of 1983*". This law had led for the establishment of Pakistan Environmental Protection Council (PEPC), which had laid the foundation of Pakistan Environmental Protection Agency (PEPA) that had developed the National Environmental Quality Standards [18]. PEPA had been made responsible for enforcement and updating of NEQS, but it had been observed as less effective regarding of its programs and action plans [41]. PEPA had also developed SMRS (Self-Monitoring and Reporting System) which had made bound to the industries to submit their monthly, quarterly, annual reports about the amount of emission of effluent, quarterly or biannually [40], [41].

Provisions for environmental protection in the Penal Code of Pakistan (1860) had been observed as are outdated and insufficient to tackle the modern challenges. However, the Environmental Protection Act 1997 had introduced some strict measures for controlling the pollution and promotion of sustainable development in the country. It had announced punishments and strictly prohibited the emission or release of effluent in their excess limits, as set a threshold by NEQS, but the less institutional capacity had not made sure its implementation to its target constituencies [44], [41].

5. Conclusion

The commercial importance of tanning industry in Pakistan is undeniable. Along with its positive outcomes, its effluent cause contamination of water, soil and air, which collectively lead diseases in living beings, leading less yield in agricultural sector, and degradation of the soil on the cost of ineffective regulatory mechanism and outdated legislation, which had not competed with this area of interest of public institutions. Lack of incorporation of international experiences and lack of establishment of treatment plants of Chromium elements, had grew the problem at a large. Lack of institutional coordination and inferior sense of managing the Chromium elements in various kinds of wastes of tanning industries had been estimated as a big challenge in the future.

Recommendations

1. Government of Pakistan should revisit the existing legislative framework for monitoring the waste of tanneries in Pakistan;
2. It should have to launch exercises for institutional coordination to make the target industries more

accountable;

3. It should have to foreign missions of various stakeholders to visit abroad in target countries of producing leather to harmonize and build capacity of its public institutions and make its monitoring procedures in accordance with international standards;
4. Private sector must be encouraged to be a competitive stakeholder with a national approach to strengthened the target sector through following the already made procedures to control the target effluent; and
5. A strong transparency model had to be adopted for sustainable development in the industrial sector of the country.

References

[1] M. K. P. T. J. R. a. B. N. V. Suresh, "An Improved Product Process for Cleaner Chrome Tanning in Leather Processing," *Journal of Cleaner Production,* vol. 9, pp. 483-491, 2001.

[2] M. Iqbal, "The Leather Sector Environmental Report," Government of Pakistan, Islamabad, 1998.

[3] S. Kazmi, "Decline in leather Exports," Pakistan and Gulf Economist, 1994.

[4] GoP, "State Bank of Pakistan: Annual Report," Government of Pakistan, Karachi, 2002.

[5] PNEP, "Pakistan National Environment Plan Pakistan National Conservation Strategy," Government of Pakistan, Islamabad, 1991.

[6] IRIN, "Toxins from tanneries endanger Kasur's residents," IRIN News, 1 May 2007. [Online]. Available: http://www.irinnews.org/report/71896/pakistan-toxins-tanneries-endanger-kasurs-residents. [Accessed 06 October 2016].

[7] J. A. B. a. Q. M. Khan, "Pollution Levels Analysis in Tannery Effluents Collected from Three Different Cities of Punjab, Pakistan," *Pakistan Journal of Biological Sciences,* vol. 9, no. 3, pp. 418-421, 2006.

[8] A. H. N. S. A. M. a. I. S. Q. N. A. Kabashi, "Tanneries in Pakistan," *Journal of Chemical Technology,* vol. 1, p. 44, 2009.

[9] A. M. L. B. C. G. L. Z. G. T. V. B. a. A. G. L. P. Venier, "Genetic effects of chromium tannins," *Carcinogenesis,* vol. 6, pp. 1327-1335, 1985.

[10] P. T. a. U. B. N. J. R. Rao, "An Eco-Friendly Option for Less Chrome and Dye-Free Leather Processing: In its Generation of Natural Colors in Leather Tanned with Cr –Fe Complex," *Clean Technologies and Environmental Policy,* vol. 4, pp. 115-121, 2002.

[11] J. Landgrave, "A Pilot Plan for Removing Cr from Residual Water of Tanneries," *Environmental Health Perspectives,* vol. 1, pp. 63-65, 1995.

[12] T. L. M. a. M. J. McInerny, "Relationship of Hydrogen Bioavailability to Chromate Reduction in Aquifer Sediments," *Application of Environmental Microbiology,* vol. 67, no. 4, pp. 1517-1521, 2001.

[13] C. W. a. P. C. C. M. T. Frauchigar, "Effect of Acute Chromium Supplementation on Postprandial Metabolism in Healthy Young Men," *The Journal of American College of Nutrition,* vol. 23, no. 4, pp. 351-357, 2004.

[14] BGS, "Ground Water Quality: Pakistan," British Geological Survey, 2002.

[15] S. R. Tariq, "Correlation Studies on Trace Metal Levels in Effluents in Relation to Soil and Water in Proximity of Tanneries, Pakistan," Quaid-e-Azam University, Islamabad, 2006.

[16] F. Baruthio, "Toxc Effecs of Chromium and its Compounds," *Biological Trace Element Research,* vol. 32, pp. 17-24, 1992.

[17] M. S. A. M. R. J. O. M. a. R. E. M. S. Farid, "The impact of use of domestic wastewater from irrigation on groundwater quality," *Water Science and Technology,* vol. 27, pp. 147-157, 1993.

[18] GoP, "Pakistan Environmental Legislation and the National Environmental Quality Standards," Government of Pakistan, Islamabad, 1997.

[19] M. H. S. N. S. M. J. a. A. K. S. R. Taeiq, "Statistical Source Idnetification of Metals in Groundwater Exposed to Industrial Contamination," *Environmental Monitoring and Assessment,* vol. 138, pp. 159-165, 2008.

[20] U. R. A. A. A. K. K. S. N. a. R. R. Q. Mahmood, "Toxic chromium from tanneries pollute water resources and soil of Sialkot," *Journal of Chemical Society of Pakistan,* vol. 32, no. 5, pp. 644-649, 2010.

[21] S. S. Naqvi, "How Safe is the Water We Drink?," Dawn Daily, 2006. [Online].

[22] M. A. A. Z. H. a. N. M. N. Haq, "Drinking Water Contamination by Chromium and Lead in Industrial Lands of Karachi," *Journal of Pakistan Medical Association,* vol. 59, no. 5, pp. 270-274, 2009.

[23] A. E. M. A. Z. I. K. M. A. F. Q. A. F. S. G. A. R. B. a. E. E. V. K. Ahmad, "Lead , Cadmium and Chromium Contents of Canola Irrigated with Sewage Water," *Pakistan Journal of Botany,* vol. 43, no. 2, pp. 1403-1410, 2011.

[24] W. A. A. J. A. H. S. M. H. Z. S. a. S. S. H. B. H. Azmat, "Chromium Contamination in Water, Sediment and its Bioaccumulation in Indian Major Carps in River Chenab, Pakistan," *Punjab University Journal of Zoology,* vol.

31, no. 1, pp. 83-86, 2016.

[25] G. V. S. a. M. S. S. M. Badruddin, "In Proceedings of National Seminar on Environmental Management for Sustainable Socio-Economic Development," in *State of Environment in Pakistan*, Islamabad, 1996.

[26] UNIDP, "Kasur Tannery, Pollution Control (KTPC)," United Nations Industrial Development Organization and Government of Pakistan, Islamabad, 1996.

[27] PPI, "Sialkot industries re-open with a clean slate," Express Tribune, 03 August 2010. [Online]. Available: http://tribune.com.pk/story/33904/sialkot-industries-re-open-with-a-clean-slate/. [Accessed 06 October 2016].

[28] LGCD, "Local Government and Community Development," Government of Punjab, 28 September 2016. [Online]. Available: https://lgcd.punjab.gov.pk/. [Accessed 06 October 2016].

[29] NEC, "NEC Consultants (PVT) Limited: Projects," NEC Consultants in Envrionment and Energy, 206. [Online]. Available: http://www.nec.com.pk/Projects.aspx. [Accessed 06 October 2016].

[30] C. W. a. G. M. Gadd, "Biosorption of Radionuclides by Fungal Biomass," *Journal of Chemical Technology and Biotechnology,* vol. 44, pp. 331-343, 1990.

[31] D. G. C. a. R. J. N. M. J. Tobin, "Investigation of Mechanism of Metal Uptake by Denatured Rhizopus Orizus Biomass," *Enzyme and Microbial Technology,* vol. 23, pp. 591-595, 1990.

[32] L. K. S. H. a. M. F. Michael J. McInerney, "PAKISTAN-US SCIENCE AND TECHNOLOGY COOPERATION PROGRAM," The National Academies of Sciences . Engineering . Medicine, 30 November 2011. [Online]. Available: http://sites.nationalacademies.org/PGA/dsc/pakistan/PGA_053039. [Accessed 06 October 2016].

[33] H. B. S. V. D. Y. S. B. B. C. Keith, "36th Annual Mississippi Water Resource Conference," in *Rmoval of copper, chromium and arsenic by water hyacinths*, Mississippi , 2006.

[34] R. C. a. S. Yadav, "Phytoremediation of Cd, Cr, Cu, Mn, Fe, Ni, Pb and Zn from Aqueous Solution Using Phragmites Cummunis, Typha Angustifoliaand Cyperus Esculentus," *International Journal of Phytoremediation,* vol. 13, no. 6, pp. 580-591, 2011.

[35] M. S. S.-D. a. M. C. Barron-Cruz, "Lead, Chromium and Manganese Removal by in Vitro Root Cultures of Two Aquatic Macrophytes Species: Typha Latifolia L. and Scirpus Americanus Pers," *International Journal of Phytoremediation,* vol. 13, no. 6, pp. 538-551, 2011.

[36] J. B. Williams, "Phytoremediation in Wetland Ecosystems: Progress, Problems, and Potential," *Critical review in Plant sciences,* vol. 21, no. 6, pp. 607-635, 2002.

[37] J. Z. ,. H. H. N. W. G. Z. H. S. L. J. F. a. H. L. H. Wu, "A Review on the Sustainability of Constructed Wetlands for Wastewater Treatment: Design and Operation," *Bio-Resource Technology,* vol. 175, pp. 594-601, 2015.

[38] K. V. a. Y. Yun, "Baterial biosorbents and Biosorption," *Biotechnology Advances,* vol. 26, no. 3, pp. 266-291, 2008.

[39] R. N. C. a. J. H. Paran, "Biofilm concentration of chromium," *Environmental Technology,* vol. 12, no. 12, pp. 1079-1093, 2008.

[40] M. C. A. M. A. M. K. M. A. C. R. a. M. I. A. I. Ms. Zehra Aftab, "Industrial Policy and the Environment in Pakistan," UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION, 2000.

[41] B. Nazar, "The International Waste Trade and its Policy Implications for Pakistan," Sustainable Development Policy Institute , Islamabad, 1995.

[42] T. Banuri, "The Pakistan National Conservation Strategy: A Plan of Action for The 1990s," Sustainable Development Policy Institute, Islamabad, 1993.

[43] NCPC, "National Cleaner Production Center," National Cleaner Production Center, 24 November 2015. [Online]. Available: http://www.ncpc.com.pk/about_us.html. [Accessed 06 October 2016].

[44] M. A. Khwaja, "Environmental Impacts of Tanning and Leather Products Manufacturing Industry in NWFP (Pakistan)," Sustainable Development Policy Institute, Islamabad, 2000.