

REVIEW ARTICLE

Leather Industry and Environment: Pakistan Scenario

*Ghulam Jilani Hashmi¹, Ghulam Dastageer², Muhammad Saqib Sajid³, Zubair Ali⁴, Muhammad Faheem Malik⁵ and Ihtisham Liaqat⁶

^{1,2,3,4,5,6} Department of Zoology, University of Gujrat, Hafiz Hayat Campus, Gujrat, Pakistan

*Correspondence: g.jilani1737@gmail.com

Abstract

Leather industry is the most dynamic export earning sector and ranked 2nd position of Pakistan economy. It contributes 5% GDP of the country and provides employment over than 500,000 people. Raw hides and skins are converted into finished leather through tanning process. Various chemicals are used during tanning that ultimately discharged in the environment in different forms causing air, soil and water pollution. Chromium is a major tanning agent which has adverse effect on the environment. Exposure rate of tannery workers to such hazardous pollutants is greater and they suffered in various complications. This review article shall reflect the status of leather industries of Pakistan in the world and also highlight the major environmental impacts due to this industry.

Key Words: Tanning, Leather Export, Leather Wastes, Tannery Pollution, Worker's Health

Introduction

Leather industry is the second largest export earning sector of Pakistan economy. It contributes 5% GDP of the country (Ghafoor et al, 2012) and provides employment over than 500,000 people (Siddiqui et al, 2016). It contributes around 700 million US\$ in Pakistan export in 2013 (Shahab et al, 2013) and 724 million US\$ in 2014-15 (Siddiqui et al, 2016). The major leather industries are established at Karachi, Sialkot, Kasur, Lahore, Gujranwala, Multan and Peshawar. Leather industry comprises into six sub-sectors leather tanning, footwear, garments, gloves, shoe uppers and leather goods (Ghafoor et al, 2012; Ghafoor et al, 2014). The material obtained by the conversion of the raw hide and skin of animals through a series of chemical processes is termed as leather. Various chemicals are used during the leather tanning process including lime, sodium sulphide, ammonium sulphate, sodium chloride, chrome salts, tannins, and bactericides (Chowdhury et al, 1996; Kankaria et al, 2011).

Although leather industry plays very important role in economy of the country but at the same time it also have adverse effect on the environment due to production of wastes. Tanning process produces a quite significant byproducts and wastes either in solid, liquid and gaseous forms which contributes pollution by chemical oxygen demand (COD), total dissolved solid (TDS), chlorides, sulphates and heavy metals (Sundar et al, 2011; Sumita et al, 2015). Exposure to these harmful chemicals in tannery workers causes a variety of complications including respiratory tract and eyes irritation, and a variety of cancers such as lung, buccal, pancreatic and bladder cancer. Chromium III is a major tanning agent used in the leather industry has an adverse and hazardous effect on environment as well as on living organisms (Song et al, 2000).

Tanning Chemicals

About 170 types of chemicals are used in leather tanning process including sodium chloride, fat, sulphuric acid, ammonium, sodium sulphate, lime, chromium sulphate, non-ionic wetting

agents, bactericides, soda ash, calcium oxide, ammonium sulphate, ammonium chloride, sodium bisulphate, sodium chlorite, sodium hypochlorite, formic acid, sodium bicarbonate, vegetable tannins, syntans, polyurethane, fat emulsion, formaldehydes and different dyes (Chowdhury et al, 1996; Kankaria et al, 2011).

Raw Material and Leather Processing

Raw material for leather production is usually obtained from the cow, buffalo, goat and sheep (Ghafoor et al, 2014). Tanning Process consist of Preparatory stage (Soaking, Liming, De-fleshing, De liming, Bating, Pickling). After preparatory phase Tanning stage gets start and there are different types of tannings that are usually applied including (Vegetable tanning, Aldehyde tanning, Synthetic tanning and Chrome tanning). Tanning stage is followed by Post tanning operations like Slamming, Splitting, Skiving, Neutralizing, Dyeing, Greasing, Drying and Finishing. Finally the leather surface is coated with dyes to remove scars or damages (Kesarwani et al, 2015).

Economic Importance of Leather Industry

The leather industry plays a vital role in the economy of the country and provides around 5% of the total GDP of Pakistan.

Sites of Leather Sectors

Various leather sectors are working throughout the country. There are over than 2500 registered and unregistered tanneries present in Pakistan. Sialkot, Karachi, Kasur, Korangi, Gujranwala, Multan, Lahore, Faisalabad, Sahiwal, Hyderabad and Peshawar are the main cities where leather industries are established. There are 784 leather units, 461 leather garment manufacturing units, 348 gloves, over 524 footwear units in the country (Siddiqui et al, 2001; Masood 2009; Siddiqui et al, 2016).

Pakistan's Status in World Market

Pakistan is very famous in international market for the high quality and wide variety of leather products. Pakistan stands at 21st position in world market contributing 6.17 % leather garments, 1.12% hides and skins, 10.76% leather gloves, 0.28% leather footwear and 0.21% leather goods (Ghafoor et al, 2014).

Leather Products

In 2014, Pakistan leather export to international market is 0.7 billion US\$ and the gloves product shares 0.3 billion US\$ that is highest among than other leather products. Pakistan stands at 1st position for gloves exportation in international market in 2014 (Siddiqui et al, 2016).

In 2014-15, footwear export shares 131.2 million US\$ in the Pakistan's economy (Federal Bureau of Statistics, Government of Pakistan 2015).

Importing Countries for Pakistan's Leather

Italy, Germany, France, USA, Portugal, Singapore, UK, Canada, Australia, Japan, Belgium, Spain, Korea, Netherlands, Norway, Sweden, Mexico, Chile, Poland, Russia, Denmark and South Africa are major importers of Pakistan's leather products (Shahab 2013; Ghafoor et al, 2014; Siddiqui et al, 2016).

Exporters of Raw Leather to Pakistan

Saud Arabia, China, Kenya, Sudan and Tanzania are the supplier of raw skin and hides to Pakistan (Haidri, 2010).

Environmental Impacts of Leather Industry

Air Pollutants

During leather processing, various air pollutants including H₂S, NH₃, SO₂, CO₂, Cl₂, fume of formic acid and volatile organic compounds are discharged into atmosphere (Das, 2000). H₂S, NH₃ and Cl₂ are produced in liming, de-liming and pickling operations of leather finishing process.

Impacts on Worker

H₂S is colorless gas having rotten egg smell. In tanneries, the workers do their jobs without wearing of nose masks, inhale H₂S. If level of H₂S is greater than 900ppm for a minute, it causes coma. Various complications such as olfactory fatigue, respiratory tract irritation and kerato- conjunctivitis are due to moderate exposure to H₂S (50-100 mg/l) while olfactory paralysis, pulmonary edema, severe lung and eye irritation exposure to high level (250- 500mg/l). NH₃ and its oxides are alkaline and corrosive in

nature cause the irritation and injury of skin, eyes and respiratory tract. Gaseous Cl_2 is toxic and cause the respiratory complications. The excess inhaling concentration of Cl_2 causes the loss of consciousness loss. The long term exposure to leather dusts, lead, NO_2 , SO_2 , H_2S in tannery worker cause high rate of morbidity and mortality (Gnanasekaran et al, 2010; Abul Hashem et al, 2015).

Solid Wastes

During leather processing, only 150 kg out of 1000kg of raw hide converted into finished leather while 850 kg generated as solid wastes in different forms.

Types of Solid Wastes

- Pre- fleshing waste
- Lime fleshing waste
- Shaving waste
- Buffing waste
- Leather trimming waste (Ramamoorthy et al, 1989).

Characterization and Environmental Impacts of Solid Wastes

There are different pollutants are present in these solid wastes such as nitrogen, sodium chloride, dichloromethane, sulphides, calcium, ferric, cadmium and chromium (Ozgunay et al, 2007).

Chromium and Cadmium Impact

There is a histopathological change in spleen and kidney of grass carp due to intoxication of chromium as well as the heart and gizzard of quail chick is observed. These changes included the splitting of longitudinal muscle, degeneration of cardiac muscle, necrosis, pigmentation and dislocation of nucleus of heart and gizzard. The presence of Cd in the tissues will cause the decrease level of Fe and Hb which ultimately result of hematopoiesis stimulation. Cd intoxication also causes the retarded growth of pheasant and have adverse effect on the testes function is observed (Samreen et al, 2006).

Utilization of Solid Wastes

Glue, protein flavor, gelatin and reconstituted collagen can be produced from chrome shaving wastes by treating with hydrogen

per oxide. Feed and fertilizers can also be obtained from wet blue trimming, shaving and buffing dust. Gels and adhesives can be produced from chrome shavings by treating under mild alkaline conditions. Nature of products depends on the original chromium waste composition as well as treatment method (Lollar, 1981; Taylor et al, 1990; Brown et al, 1994; Brown et al, 1996; Cot et al, 2003).

Water Pollution

Any change in thermal, physical and biological properties of water in such a manner that is hazardous for the life is termed as water pollution (Pickeninning, 1996). Ground water is safe drinking water having appropriate salt concentration that is primary need of human being. Leather industry is associated with highly water consuming and each ton of tanned skin needs up to 4000 liters of water. During tanning process a large number of chemicals are used that drains out into streams, ponds and rivers without treatment causes the ground water pollution. A single tannery can cause the ground water pollution in range of about 7-8km radius around it that has a devastating impact on aquatic life, birds, animals and human beings. The elements found in contaminated ground water are sodium, calcium, magnesium, chloride, sulphate ions and Cr6 causes water hardness that results in kidney stones, stomach problems and heart diseases. The elevated level of sodium and chloride ions gives sodium chloride in ground water causes the cardiac arrest, hypertension and asthma. Sulphate ions causes gastrointestinal and dehydration problems. Intake of Cr6 dissolved ground water causes the serious health problems such as ulcer, genetic mutations, respiratory problems, liver and kidney damages (Ramesh et al, 2014). The discharged waste water from leather industry also have ammonium nitrogen and germanium. The elevated level of nitrogen in drinking water causes a condition methemoglobinemia where transport of O_2 is interfered by nitrate in babies. The high intake concentrations of germanium ions can fix protein and result in lung cancer, nose membrane shrinkage and nose bleeding (Samreen et al, 2006).

Effluents Impact

The intake of polluted ground water near tannery areas can cause different hygienic

problems such as skin ailments, allergies, neoplasia, and gastrointestinal problems. High acidity in water by effluents and heavy metals binding to sulphhydryl group of amino acids can be result of intestinal, mucosal, corrosion and inhibition of essential enzymatic activities (Jerome et al, 1972; Beyersmann et al, 1987).

Tannery Pollutants

Sodium, calcium, magnesium, chlorine, sulphates, chromium, azodyes, cadmium, cobalt, copper, antimony, barium, lead, selenium, mercury, zinc, arsenic, polychlorinated biphenols (PCB), nickel, formaldehydes and resins are the major tannery pollutants discharged into environment causes the pollution (Tunay et al, 1994).

Worker's Health

The exposure rate of tannery workers to carcinogenic compounds including chromium salt, arsenic, benzene, formaldehyde, ethanol, toluene and acetone solvents is increased. Chromium chemicals are major compounds used in tanning process in the form of Baychrome and $\text{Cr}(\text{OH})\text{SO}_4$. In tanneries, Cr present in sulphate, inorganic and in protein bound form called leather dust (Bonasi et al, 1990; Seniori et al, 1990; Montanaro et al, 1997). Exposure to these compounds resulting in a variety of cancers i.e. lung, bladder, kidney, pancreatic, oral cavity and nasal cancers, soft tissue sarcoma and skin with dermatitis, ulcer and respiratory illness.

Skin Cancer

Exposure to leather dyes and fats causes the skin cancer in the tannery workers. The ratio of skin melanoma and skin cancer in tannery female workers is greater than males.

Buccal Cavity and Pharynx Cancer

This type of cancer observed in those workers who did their jobs in tanning and liming workshops.

Pancreatic Cancer

The exposure to formaldehyde in tannery workers is greater that results in development of pancreatic cancer (Veyalkin and Gerein, 2006).

Bladder Cancer

Aromatic amines and benzene based dyes are considered as carcinogens. The long time exposure to these dyes causes bladder cancer in tannery workers (Vineis et al, 1985).

Testicular Cancer

Long time exposure to the dimethylformamide (DMF) causes the testicular cancer in the workers of tannery finishing department. The ratio of testicular cancer is 7.2 % among tanners as compared to others (Levin, 1987; Calvert, 1990 and Marshall, 1990)

Soft Tissue Sarcoma

Chlorophenols used in pre-tanning and tanning process. The tanner workers are suffered in this type of rare cancer due to exposure of chlorophenols (Costantini, 1989).

Conclusion

Leather industry plays vital role in economy of the country and contributing 5% of total GDP. Pakistan exports different leather products in the world market and stands at 21st position. Leather is produced from raw skin and hides of animals through tanning process. A number of chemicals sodium chloride, ammonium chloride, sulphate, chromium etc. are used. During tanning operations, solid, liquid and gaseous wastes are generated along with toxic chemicals. Heavy metals like Cadmium and chromium are discharged in the environment cause various complications in the workers as well as plants and animals.

Recommendations

- i. Waste treatment technologies must be used in tanneries.
- ii. Strictly implement the National Sanitation Policy.
- iii. Enact the National Air Clean Act to save the atmosphere.
- iv. Enact Water Conservation Act to conserve the water sources.

References

Abul Hashem M, Shamas ul Arefin M, Abu Jor. 2015. Gaseous air pollutant sandits environ-

- mental effect emitted from the tanning industry at Hazaribagh, Bangladesh. *AJER* 4(5): 138-144.
- Beyersmann D, Koster A. 1987. Role of trivalent Chromium in chromium genotoxicity. *Toxicol. Environ. Chem* 19:11-22.
- Bonasi S, Merlo F, Puntoni R, Fernaris F, Bottura G. 1990. Epidemics of lung tumors in a Biella tannery. *Epidemiol Prev* 12:25-30.
- Brown EM, Taylor MM, Marmer WN. 1996. Production and potential uses of co-products from solid tannery waste. *J. Am. Leather Chem. Assoc* 91:270-275.
- Brown EM, Thompson CJ, Taylor MM. 1994. Molecular size and conformation of protein recovered from chrome shaving. *J. Am. Leather Chem. Assoc* 89:215-222.
- Calvert GM, Fajen JM, Hills BW, Halperin WE. 1990. Testicular cancer, Dimethylformamide and leather tanneries. *Lancet* 336:1253-1254.
- Chowdhury FJ, Inamul Haq SM, Aminul Islam M. 1996. Accumulation of various pollutants by some aquatic macrophytes found in the Bariganga River. *Proceedings of the 25th Bangladesh Science conference.*
- Costantini AS, Paci E, Miligi L, Buiatti E, Martelli C, Lenzi S. 1989. Cancer mortality among workers in the Tuscan tanning industry. *Br. J. Ind. Med* 46:384-388.
- Cot J, Marsal A, Manich A, Celma P, Choque R, Cabeza L, Labastida L, Lopez J, Salmeron J. 2003. Minimization of industrial waste: Adding value to collagen materials. *J. Soc. Leather Technol. Chem* 87:97-99.
- Das HK. 2000. Chemical toxicity and environmental hazards of tanneries in Bangladesh, Famco-Bangladesh Association of Scholars and Trainees (FBAST).
- Federal Bureau of Statistics. 2015. Government of Pakistan. www.fbs.gov.pk
- Ghafoor A, Zafar M. 2014. Determinants of leather exports from Pakistan: a time series analysis. *Transactions on Edu. Soc. Sci.* 5: 77-86.
- Ghafoor A, Aslam M, Rasool S. 2012. Determinants of leather goods exports: A case of Pakistan. *J. Buss. Econom.* 4:256-269.
- Gnanasekaran S, Subramani K, Thaminum A. 2010. Ambient air pollution from the leather tanneries in Vellore district in reference to Asthma. *J. Chem. Pharm. Res* 2:153-160.
- Haidri I. 2010. Leather and leather goods industry in Pakistan: Economic review. Economic and Industrial publication.
- Jerome G, Ferguson JF. 1972. The cycling of Mercury through the environment. *Water Res* 6:989-1008.
- Kankaria S, Andukur A, Hemamailin CG, Kisishnveni M. 2011. Impact of tannery effluents on ground water and agriculture with a remedial measure. A case study. *International Conference on Chemical Biological and Environmental Science, Bangkok.* 383-388.
- Kesarwani P, Jahan S, Kesarwani K. 2015. A review on leather processing. *Int. J. Appl. Res* 1:977-982.
- Levin SM, Baker DB, Landrigan PJ, Monaghan SV, Frumin E, Braithwaite M et al. 1987. Testicular cancer in leather tanners exposed to Dimethylformamide. *Lancet* 2:1153.
- Lollar RM. 1981. Potential uses of tanned collagen. *J. Am. Leather Chem. Assoc.* 76: 192-193.
- Marshall EG, Melius JM, London MA, Nasca PC, Burnett WS. 1990. Investigation of a testicular cancer cluster using a case control approach. *Int. J. Epidemiol* 19:269-273.
- Masood A. 2009. Leather exports need to find new markets. *Jang.com.pk.* 3rd Aug, 2009. Business and Finance review. *Business Magazine.*
- Montanaro F, Ceppi M, Demers PA, Puntoni R, Bonassi S. 1997. Mortality in a cohort of tannery workers. *Occup. Environ. Med.* J 54:588-591.
- Ozgunay H, Colak S, Mutlu MM, Akyuz F. 2007. Characterization of leather industry wastes. *Polish J. Environ. Stud* 16:867-873.
- Pickeninning KT, Owen LA. 1996. *An Introduction to Environmental Issues.* Rutledge, London and New York.
- Ramamoorthy G, Sehgal PK, Mahendra K. 1989. Improved uptake of basic chromium salts in tanning operations using keratin hydrolysate. *J. Soc. Leather Technol. Chem* 73:168-170.
- Ramesh K, Thirumangi V. 2014. Impacts of tanneries on quality of ground water in Pallavaram, Chennai metropolitan city. *IJERA.* 4:63-70.

- Samreen R, Saadia SA, Asma I. 2006. Histopathological changes observed in heart and gizzard of quail chicks *Coturnix japonica* administered by the different levels of chrome shavings. *Afr. J. Biotechnol* 5:1765-1769.
- Seniori CA, Merler E, Saracci R. 1990. Epidemiological studies on occupational cancer risk in tanning leather and shoe industries. *Med. Lav* 81:184-211.
- Shahab S. 2013. Comparative advantage of leather industry in Pakistan with selected Asian economies. *Int. J. Econ. Financial Issues* 3:133-139.
- Siddiqui A, Uroos A, Nadeem F. 2016. Sectoral competitiveness and value chain analysis: leather Gloves value chain analysis in Pakistan. Trade development authority of Pakistan.
- Siddiqui S. 2001. An overview of leather industry of Pakistan. *Pakistan leather trades J* 41:19
- Song Z, William CJ and Edyvean RGJ. 2000. Sedimentation of tannery wastewater. *Water Res* 34:2171-2176.
- Sumita D, Mukul D, Sakshi M, Subhash KK. 2015. Toxic hazards of leather industry and technologies to combat threat. *JCLEPRO*. 87:39-49.
- Sundar JV, Gananami A, Muralidharan C, Mandal AB. 2011. Recovery and utilization of proteinous wastes of leather making 10:151-163.
- Taylor MM, Diefendorf EJ, Na-GC. 1990. Enzymatic treatment of chrome shaving. *J. Am Leather Chem. Assoc* 76:395-401.
- Tunay O, Orhon D, Kabdasli I. 1994. Pretreatment requirements for leather tanning industry wastewaters. *Water Sci. Tech* 29:121-128.
- Veyalkin I, Gerein V. 2006. Retrospective cohort of cancer mortality at mink's leather tannery. *Industrial Health* 44:69-74.
- Vineis P, Magnani C. 1985. Occupation and bladder cancer in males: A case control study. *Int. J. Cancer* 35:599-606.