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The Studies of Environmental Load and Consequences of Leather Industrial Effluents in Bangladesh

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Abstract: Leather industrial effluent is restrained as one of the most ecologically uncomplimentary industrial processes. The study aims to review leather effluents in the industrial processes and their involvement in environmental contamination in Bangladesh. The article was organized to compile all present data from different journals, books, reports, and web sources on tannery effluents characterization in the country. A wide variability of synthetic dyes, dyestuffs, and toxic chemicals is used in the leather and tannery industrial sector. The result revealed that some physicochemical water parameters such as electrical conductivity (EC), total suspended solids (TSS), total dissolved solids (TDS), turbidity, chemical oxygen demand (COD), biological oxygen demand (BOD), etc. and one heavy metal, Cr of the leather industrial effluents of the country exceeded their standard limits. The effluents and solid wastes are affecting the soil systems, agriculture, aquatic environment, and public health since the development of the leather industries in the country. Now a day, its proper management and curative measures like the removal system have become the furthermost considerate responsibilities of Bangladesh. It is imperious to take instantaneous steps to diminish environmental contamination owing to discharge the of untreated leather industrial effluents.

Keywords: Hazards, Leather Effluents, Groundwater, Pollution, Surface Water, Tannery Industries.

1. INTRODUCTION

The leather industry in Bangladesh is an industry with a long tradition. The growth and progress of leather manufacturing in Bangladesh are due to low-cost plentiful workers and the existence of a huge livestock industry, which confirms a nonstop supply of raw substantial like hides and skins. The government of Bangladesh has also maintained this industry from the launch. The

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industry creates careers for low and semiskilled laborers, which is serious for lessening poverty. More than 200 tanneries are set up in Bangladesh. While most of these industries are positioned in the Hazaribagh area of Dhaka city and a small number of them are also situated in Chittagong. The tannery industries at Hazaribagh provide about 84% of the total treated hides and skins. The primary raw materials for this industry are cowhides and goat skin. The primary raw substance for any leather processing industry is resulting from slaughterhouses and waste from the meat industry. This raw material is treated and transformed into usable leather in tanneries. So, the tanning industry is considered one of the leather processing units in the whole leather industry [1]. Industrial effluent is concerned with environmental pollution. Industrial effluent discharge has been a growing concern as a result of the untreated release of toxic chemicals through effluents, which has potential threats to the environment and life. Industrial effluents are generated from different processes and the huge number of toxic materials released varies with its specific industrial processes. Industrial liquid wastes are customarily called effluents. Increasing industrialization and population develop the standard of living which results in a highly polluted atmosphere owing to drainage and waste stage from industrial plants [2]. The growth of industrialization plays a vital role in contaminating the environment and causing severe degradation in the water systems and atmosphere. The untreated industrial waste disposal into the environment affects both soil and aquifer water quality. Water used in industries generates waste that has potential hazards to our environment because of the introduction of different contaminants such as heavy metals and various toxic materials into the soil and water reservoirs [3]. Environmental pollution is becoming a global problem and a large number of industrial effluents are one of the major sources of water pollution. Industrial wastewater is being released into the common drainage or nearby soil or water bodies [4] and thus ultimately poses a serious threat to human beings and the routine functioning of the ecosystem [5,6]. The most problematic industries for the water sector are textile, leather-industries, paper, and pulp mills, fertilizer, industrial chemical production, and refineries. A complex mixture of harmful chemicals, both organic and inorganic is liquidated into the water bodies from all the manufacturing mills generally without treatment. The organic contaminants are both biodegradable and non-biodegradable. Biodegradable organic substances destroy water quality through disintegration by lessening dissolved oxygen. The non-biodegradable organic components persevere in the water bodies for a long time and pass into the food wave [7]. A figure has been made based on export earnings from the leather and leather products of the fiscal year 2013-2014 to 2018-2019 [8] and 2019-20 (www.worldfootwear.com). Inorganic contaminants are typically metallic salts and basic and acidic compounds. Leather industrial wastewater was found to contain high salinity, high organic loading higher levels of total dissolved solids (TDS), chromium (Cr), ammonia (NH_4^+), chloride (Cl^-), sulfates (SO_4^{2-}), and nitrate (NO_3^-) and specific heavy metals such as As, Cd, Cr, and Pb, etc. when samples were collected from the outlets of the leather industry [9,10]. The review article has been primed to gather the present status of leather industrial effluent and its environmental pollution concerns in Bangladesh.

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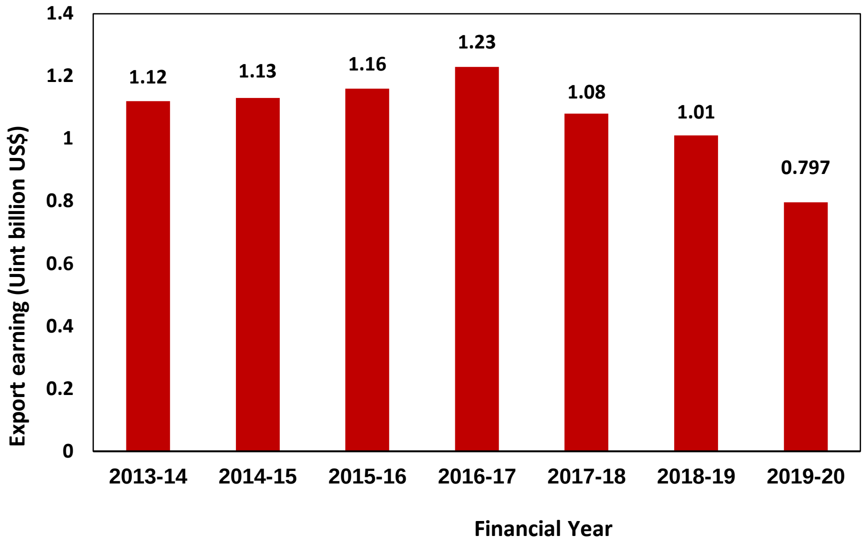

Fig. 1. Export earnings from the leather and leather products of Bangladesh

Tanning process

The production of leather comprises tanning which is a chemical procedure altering the derma, epidermis, and flesh into a firm non-putrescible substantial known as leather. The procedure includes reimbursement and washing the dirt, blood, flesh, etc. from raw hides and skin after beating before conserving them with different inorganic salt till they are transferred to the tannery. In the tannery, hide and skin is primarily scrubbed easily by hand or in some cases automatically to eradicate much salt as probable. This hide and skin will then be exposed to numerous processes. The tanning procedure is convoyed by toxins such as disintegrating organic substances, sulfide, hair, lime, and organic nitrogen with elevated BOD and COD [11]. Around 170 types of chemicals are utilized in the tanning process including sodium chloride (NaCl) salt, fat, sodium chlorite, sulphuric acid (H_2SO_4), lime (CaO), ammonium, sodium sulfate, chromium sulfate, non-ionic wetting agents, soda ash, ammonium sulfate, bactericides, calcium oxide, ammonium chloride, formic acid, formaldehyde, sodium bisulfate, sodium hypochlorite, sodium bicarbonate, vegetable tannins, polyurethane, systems, fat emulsion, and different organic and inorganic dyes [4,12,13].

Characterization of leather industrial effluents

The manufacturing of leather is the combination of various processes, which consist of several dyes and auxiliary chemicals such as acids, alkalis, fixing agents, etc. Maximum synthetic colorants are used for the dyeing of leather. Their dark color, low pH, high EC, high BOD, high COD, high loads of total suspended solids (TSS), and total dissolved solids (TDS) characterized usually leather industrial effluent. Some of the major parameters of leather industrial effluents are shortly discussed Average concentration of pollutants of leather industrial effluents in different industries of Bangladesh is given below in Table 1. The study represented that the nature of the leather industrial effluents is alkaline owing to the extreme use of lime and Na_2S in the leather industries of Bangladesh (Table 1). The EC of the effluent was observed in the range of 1100 - 42500 μS/cm which is greater than the standard value (1100 μS/cm) of ISW-BDS-ECR (1997). The excess EC indicates many ionic substances in

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the effluent. In general, BOD and COD values were found higher than discharge standards. The elevated levels of BOD (190 - 4464 mg/L) are hints of the contamination strength of the effluents. The higher COD (550 - 12840 mg/L) levels designate the toxic condition and the presence of biologically resilient organic ingredients [14]. The noteworthy increase in COD values related to BOD also designates that substantial levels of poison and trace elements may be present in the effluents [15]. The value of TDS (2910-21300 mg/L) and TSS (1250-6080 mg/L) were higher (Table 1) and indicative of a reflection of the oxygen amount mandatory to produce both organic and inorganic solids present in the tanning industrial effluents [16].

Table 1. Physicochemical parameters of leather industrial effluents in different industries of Bangladesh

Industry	Parameters							Reference
	pH	EC (μS/cm)	TSS (mg/L)	TDS (mg/L)	BOD (mg/L)	COD (mg/L)	Cr (mg/L)	
RMM	8.30	42500	1250	21300	4464	12840	10.35	Jahan et al. [17]
Mukti	7.50	6500	1250	2910	190	550	1.20	Rouf et al. [18]
Ruma	3.0	9000	1400	3300	400	1000	3.0	Rouf et al. [18]
Dhaka skin and hide	7.0	1300	1600	3700	700	1700	19	Rouf et al. [18]
Jamila	8.50	1100	1700	3740	550	1400	1.0	Rouf et al. [18]
Karim	7.5	19000	6080	14500	1200	10160	-	Chowdhury [19]
ISW-BDS-ECR	6.9	1000	500	2100	250	500	2.0	Chowdhury et al. [13]

Impact of the leather effluents on the environment
Environmental difficulties associated with the leather industry are characteristically those allied with water and soil pollution caused by the discharge of untreated leather industrial effluents. There are various sources of environmental toxins and many ways of mechanisms disturbing the ecosystems as given in Fig. 4. The leather dealing industry is one of the major next to pesticides and paints processing industries related to other industries. There are diverse sources of environmental contaminants and diverse ways of mechanisms disturbing the ecology as revealed in Fig. 2.

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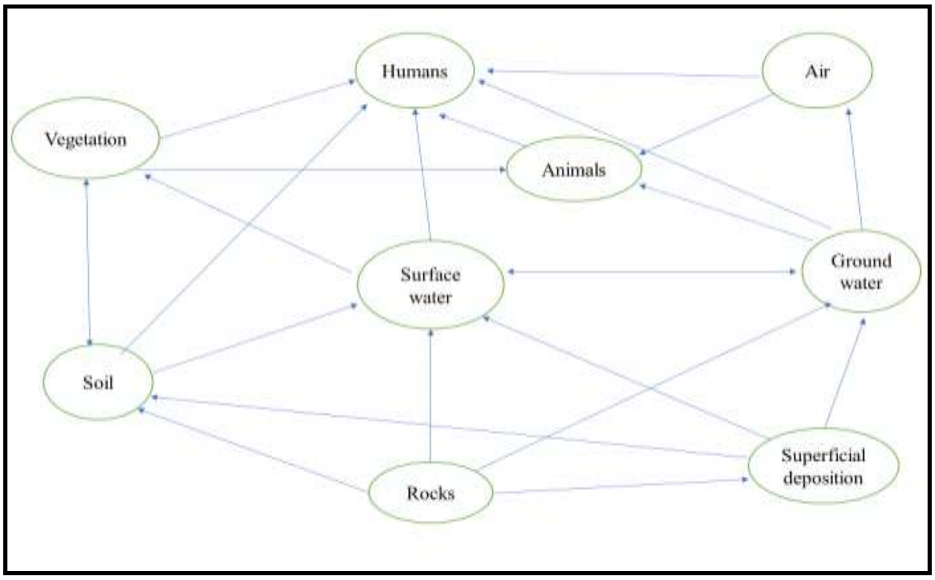

Fig. 2: The flow illustration of toxic materials discharged as waste from industries in the biospheres of plants, water, soil, air, animals, and humans in the environment [20].

Impact on Air

Throughout leather processing, numerous air contaminants including CO_2, CO, H_2S, SO_2, SO_3, NH_3, Cl_2, formic acid fume, and volatile organic substances are discharged into the air environment [21]. NH_3, H_2S, and Cl_2 are generated in liming, de-liming, and pickling operations of the leather finishing operations.

Impact on Soil

Soil is vital for furthermost the life of plants and animals as a growing substratum for their frequent progress and growth. In many cases, the nourishment of life in the soil medium is harmfully affected by the existence of toxic matters or impurities of the organic and inorganic forms of impurities consequences of dumping of industrial wastewater, particularly from leather industrial discharge (Fig. 3).

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Fig. 3. Open dumping of contaminated sludge at the Tannery Industrial Zone in Savar, Bangladesh
(Source: https://www.jugantor.com/todays-paper/city/330875)

Leather industries located at Savar, Hazaribag, and Chittagong, are the key sources of trace and toxic metal pollution in the farming soil in the neighboring zone specially Savar and have been used for cultivation. Ongoing use of sludge for cultivation can cause trace elements like Mn, Pb, Cd, Ni, Cr, and Zn to gather in superficial soils and it can discharge trace metals into groundwater or soil solution accessible for plant uptake owing to lessening of trace metal recollect capacity of the soil. The pollution of soils through trace metals or micronutrients in phytotoxic concentrations causes antagonistic effects not only on plants but also postures dangers to public health [22]. A huge amount of Cr remains in the soil by way of agricultural lands are cultivated with wastewater rich in leather industrial effluents, which contains a huge amount of $Cr_2(SO_4)_3$ [23]. Chromium is a vital element that is involved in the glucose metabolism in human and animal bodies but at high absorptions Cr(VI) is very harmful, mutagenic, carcinogenic, teratogenic, and in nature exists mostly as the dissoluble, enormously toxic anion [24-26]. Moreover, the Usage of NaCl as the raw substance in leather industrial effluents discharges a huge amount of Cl^- and NO_3^- [27] as the final product of the oxidation of nitrogen. Na_2CO_3, $NaHCO_3$, NaCl, and $CaCl_2$ in chrome tanning cause the alkalization of the soil ensuing to rise in the pH of the soil [28]. Soil is contaminated due to the unplanned leather industrial waste dumping at the Savar area (Fig. 5). Moreover, Cr(VI) is extremely mobile in most environments, mainly owing to its soluble nature in a water medium [29] and it negatively affects the environment owing to its distinguished solubility, mobility, and responsiveness. Soil and aquifer water neighboring zone is the most fictile to Cr(VI) contamination from spills, unlawful disposition, and unguarded stockpiles of new methods Cr products. Cr(VI) is enormously accessible to live creatures through numerous paths of entrance such as consumption, epidermal adjoin, breathing, and absorption (in the case of plants and root ages) [30]. Cr(VI) affects the enzyme amylase in the plant (which plays a significant role throughout seed germination during hydrolysis of reserve starch and release in the energy) [31]

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and shortens seed sprouting of plants [32,33]. Typically, chromium (Cr) is known to have chronic toxicity (above 0.05 mg/L) in consumption water [34].

Impact on water

Leather industrial effluents are of huge scale environmental anxiety because they reduce the color and the quality of the water reservoir into which they are discharged. Leather industrial effluents also comprise biodegradable organic matter (e.g., proteins and carbohydrates) which have the core problem of the despair of dissolved oxygen (DO) the content in stream waters instigated by the microbial breakdown [35]. This impact is mainly on the loss of dissolved oxygen (DO), which is damaging to aquatic animals and inspires anaerobic action, which leads to the release of poisonous gases [36,37]. Aquatics fauna is greatly affected by leather industrial effluents. Tannery effluents contain vegetable and non-vegetable tanning which employ oxygen (O_2) demand. The rise in the demand for O_2 leads to a decrease in the level of O_2 in the aquatic body which leads to the unsustainability of the aquatic ecosystem [38,39]. Around 80% of suspended solids (SS) are composed of organic substances in the form of protein, high BOD and COD were stated by investigators such as Seyoum et al. [40]; Haydar et al. [41]; Akan et al. [42]; Assefa and Ayalew [43]; etc. This high BOD content of the wastewater will impact the survival of gill-breathing animals of the receiving body since the rise in BOD is accountable for the decrease in dissolved oxygen (DO) which in turn has a negative influence on aquatic biota [42]. Elevated pH, high alkalinity, suspended substances, and sulfides are injurious to fish and other aquatic organisms. Sulfide present in wastewater can react with iron (Fe) and other heavy metals causing black precipitate thereby making water hazardous for fish and other aquatic biotas. Nitrogen and phosphorus in leather industrial effluents inspire algae blooms which in turn pose a high threat to fish and other aquatic life. Chlorides and other suspended matter may settle at the bottom of the water body thereby posing a threat to the bottom fauna [28,40,42,44-45,]. The contamination of the Buriganga River began throughout the Mughal Empire when the city's sewage was poured into the river. The water contamination of the Buriganga River is shown in Fig. 4. Numerous investigations on the Buriganga River have identified several sources of pollution, including sedimentation upstream, encroachment, solid waste disposal, sewage, and industrial effluents in the river water. As stated by the Department of Environment of Bangladesh, the tanneries discharge 22,000 m^3 of untreated liquid hazardous waste daily into the rivers, gutters, and canals that run together with the roads of Hazaribagh [46].

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Fig. 4: Contaminated water of Buriganga owing to the untreated discharge of leather industrial effluents
(Source: https://ourworld.unu.edu/en)

Waste from the leather industrial park of Hemayetpur at Saver in Dhaka is seriously polluting the water of six nearby rivers. Tannery effluents are causing a lot of stenches in the water of these rivers. It is becoming difficult for the people across the river to survive. The water of the Banshi, Dhaleshwari, Kaliganga, Buriganga, Turag, and Balu rivers is being polluted by the leather industrial park. The water of Banshi and Dhaleshwari is being polluted the most. As these two rivers are connected by four other rivers, their water is also getting polluted.

The watercolor of Banshi and Dhaleshwari is blackish due to the waste of garment factories and leather industrial effluents. 80% of the pollution of the Banshi and Dhaleshwari rivers is due to tannery waste. Water pollution in the Saver area is given below in Fig. 5. The latest test on May 28, 2021, by the Department of Environment (DoE) found that the biochemical oxygen demand (BOD) was as high as 17.6 mg/L compared to the permissible limit of 5 mg/L; dissolved oxygen was 1.75 mg/L compared to the minimum of 5mg/L (www. the daily star net.com). There are no fish in these rivers and the existence of aquatic plants is also endangered. The livelihoods of low-income people along the river have been disrupted. The stench of waste is also spreading in the air. The surrounding environment is endangered. Many people are suffering from skin diseases and respiratory problems by using contaminated water. It is becoming difficult for the people across the river to survive.

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Fig. 5: Untreated leather industrial effluent discharge into adjacent water bodies at Saver (Source: https://samakal.com/capital/article/1611252673).

Impact on Human Health

The most contamination-creating productions in Bangladesh are tanning ventures (leather industries). It is well thought-out a 'dirty industry' everywhere throughout the world because of its vast contaminating capacity. Among numerous organic and inorganic wastes free from tanneries, considerable metals are the most regarded factor, and the hazardous irresistible metals, chromium (Cr-VI) are the most remarkable. Poisonous with irresistible metal like chromium, applied as a part of Hazaribagh tanneries are released directly in the Buriganga and may cause cancer, genetic disorder, and birth deformities if it gets in the nourishment cycle**.** Leather effluents were discharged directly into the river from which over one lakh eighty thousand people get their consumption water**.** About fifteen thousand people who operated there and those who lived in the adjacent area were endlessly exposed to chemical materials in an unhealthy and tremendously hazardous environment [47,48]. Chromium can act exactly at the site of contact or be retained in or through human tissue. Leather industrial workers face various health problems such as skin and respiratory diseases outcome from frequent acquaintance with the harmful cocktail of chemicals when measuring as well as mixing them, totaling them to hides in containers, or using hides soaked in them. Some chemicals can be injured health in the short term, such as H_2SO_4 and Na_2S which can burn the eye membrane, human tissues, skin, and the respiratory tract. Other such as HCHO, azo colorants, and pentachlorophenol are established or possible human carcinogens, the health effects of which may only be apparent after introduction. Previous and existing tannery employees pronounced and exhibited a range of health conditions including early aged, itchy, faded, cracking, acid burned, and rash-covered skin, fingers rusted to stumps, aches, dizziness and nausea and disfigured or amputated limbs. Though Human Rights Watch is not alert of any epidemiological lessons on cancer amongst leather industrial employees in Bangladesh some unreliable evidence proposes that cancer rates are certainly raised among workers dealing with chemicals (www.hrw.org.). Disapprovingly susceptible contact dermatitis is the most noticeable response to the interaction of chromium with skin. About 0.5 million inhabitants of

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the capital of Bangladesh, Dhaka is at risk of serious health issues due to chemical contamination from tanneries near their homes, according to a report released by the Bangladesh Society for Environment and Human Development. The report stated that large numbers of the 8000 - 12000 workers at the tanneries suffer from dermatological, gastrointestinal, and other diseases that could be related to contamination and that 90% of them die before the age of 50 as compared to 60% at the country as a whole. A 2012 Human Rights Watch statement on the health effects of leather tanneries showed that inhabitants in Hazaribagh reported 30% more cases of skin illnesses, 20% more cases of jaundice, and 16% more cases of kidney-related disease associated with the people in an analogous neighborhood located farther away from the tanneries [49]. The local communal criticized that the Dhaleshwari River has become “unusable” and “toxic” since the tanneries arrived and regular dumping of untreated leather industrial effluents [50]. Due to the pollution of the Banshi and Dhaleshwari rivers, the livelihoods flow-income people along the riverside have been disrupted. The stench of waste is also spreading in the air. The surrounding environment is endangered. Many people are suffering from skin diseases and respiratory problems by using contaminated water. It is becoming difficult for the people across the river to survive at Saver [51-53].

2. CONCLUSION

The leather industry is one of the foremost manufacturers in Bangladesh. It offers employment and acts as a prime accountability in Bangladesh's economy. As these mills and factories use a massive quantity of chemical substances and various synthetic dyes for dealing with leather and leather products that are recognized as one of the utmost poisoning manufacturing in Bangladesh. The leather and tannery industries yield huge quantities of effluents, dirt slurry, and solid waste ingredients every day. A complex combination of unsafe chemicals in combination with organic and inorganic ingredients releases into the adjacent areas like Saver and Hazaribagh from all these industries. About 22000 m3/day of untreated leather industrial toxic effluents falls into the Buriganga from Hazaribagh leather and tannery industries. The pollutants are total dissolved solids (TDS), total suspended solids (TSS), colored compounds, higher BOD5, COD, heavy metals, especially total Cr, biodegradable proteins, carbohydrates, and slightly alkaline. Maximum of the parameters of the leather industrial effluents surpass the boundaries of their standard set by various organizations. The higher values of BOD (190 - 4464 mg/L, COD (550 - 12840 mg/L), TDS (2910 - 21300 mg/L), TSS (1250 - 6080 mg/L), EC (1100 - 42500 µS/cm) and heavy metal especially Cr (1 - 19 mg/L) indicate the robust noxiousness of the effluents. The leather industrial effluents cause discrepancies in the physicochemical and biological nature of the water atmosphere by the continuous change in turbidity, odor, noise, temperature, pH, etc. The leather industrial effluents are consisting of heavy metals especially total Cr which are capable of destroying the water, soil, and human health. This study revealed that the ecological stability of the rivers including Burigonga, Banshi, and Dhaleshwari deteriorated due to the discharging of untreated effluents. The leather effluent brutally disturbs crop yield in the adjacent agricultural lands of Savar. The study exposed that several leather and tannery industries have an ETP, but the efficacy of the EPT has not sufficient to continue the standard discharge limit. The study exhibited that the toxic

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leather industrial effluents are required to treat before liquidating into adjacent aquatic bodies to diminish pollution.

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