Appraisement And Categorization Of Compostable And Non-Compostable Plastic Bags Using HHXRF Spectrophotometer, A Study On Brands In Islamabad

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Article

Appraisement and Categorization of Compostable and Non-Compostable Plastic Bags Using HHXRF Spectrophotometer, A Study on Brands in Islamabad

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Abstract: The rapid development in industries manufacturing plastic bags is taking serious consideration to save the environment and human health, one way or the other. This study examines the composition of degradable and non-degradable plastic bags collected from the markets of different sectors of Islamabad. Hundred samples of both Degradable and non-degradable plastic bags were collected from the open market. The concentrations, proportion, and patterns of different heavy metals (additives) were used in the production of both degradable and non-degradable plastic bags by using the standard method with the help of Hands Held X-Ray Fluorescent (HHXRF) instrument. Samples results of the study showed Titanium, Calcium and Copper used in massive amounts, some of the toxic metals i.e., Arsenic, Lead, Cadmium, Chromium and Mercury were also detected. This study also reveals that degradable plastic bags might be more hazardous than non-degradable plastic bags because due to the Photolytic properties of additives used in degradable plastic bags when the chains of polymers break, the heavy metals are released in environment and become the part of it. So, concern department like Ministry of climate change and Pakistan Environmental Protection Agency should take serious step to control these serious issues.

Keywords: plastic pollution; plastic bags; Hands Held X-ray Fluorescent; degradable and non-degradable bags

1. Introduction

Since 1995, numerous geoscientific domains have adopted handheld or portable X-ray fluorescence spectroscopy (pXRF) as a common on-site analytical method. These include industrial minerals, process monitoring, environmental assessments and tidying up, and mineral exploration [1–7]. As plastics are useful in so many applications, they are being employed in consumer goods in increasing numbers. Consumer goods and packaging made of plastic are often strong, lightweight, cheaper, too. They are used in a wide variety of home products, including packaging, personal hygiene products, and keeping food, chemicals, and other random things in storage stuff like brooms and toys. Seven (7) distinct categories exist, with corresponding resin identification codes (1–7), a list of plastics. The various kinds of plastics are: (1) low-density polyethylene (LDPE), (2) Styrofoam (PS), (3) polyvinyl chloride (PVC), (4) high-density polyethylene (HDPE), (5) polyethylene terephthalate (PET), (6) Polypropylene (PP), (7) along with the some other. The codes for resin identification describe various categories of plastics. There are metal in these plastics components like Ti, Zn, Br, Cl and Cr [8].

This research article analyzes compostable (degradable) and non-compostable (non-degradable) waste of plastic present in market of Islamabad, Pakistan.

There are only two marked situations on which HHXRF study can be done.

- On-site, in which no sample preparation can be done or only a simplified way of sample mixing can be done, the result then orients for further investigation.
- Off-site or on-site, which have a complex sample preparation procedure using QA/QC measurements, almost done in laboratories.

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Around 46,000 pieces of plastic bags end up floating in each square mile of the world's oceans. And plastic bags are in the top 12 items of debris found in marine clean ups. During the 2011 International Coastal Cleanup, volunteers collected 120,450 pounds of bags in the United States, and in, around 5, 712 pounds of plastic bags were collected from Massachusetts alone.

The Environmental Literacy Council, 2009 stated that polyethylene isn't biodegradable. It can break down into synthetic granules under the exposure of ultraviolet radiation from the sun. But these granules aren't proven to break down completely. Therefore, they may damage wildlife and marine environments. Plastic bag litter has had a major impact on marine ecosystems. Marine animals such as turtles, seals, birds, and whales have been found to suffocate, become entangled in litter, and many have starved to death due to blockages in their digestive systems. In one case, in 2002, a mink whale that was stranded in Normandy was found to have 800g of plastic in its stomach. Owing to fact thar plastic waste with unsustainable use, disposal and production has now become a high level transboundary threat for human health, natural ecosystem and sustainability [9,10]. Bio-based materials are derived from renewable sources such as corn starch, cellulose, and polysaccharides. They have gained attention as resources that begin to report the evolving contest for the 21st century polymer manufacturing for an extensive collection of applications. Biodegradation includes the activities of a microorganism's extracellular enzymes in breaking down a polymer (by attacking ends of large molecules) into products or fragments that are small enough to be assimilated. Polymer fragments must be broken down into small adequate chain lengths for degradation to occur because enzymes are incapable of digesting larger macromolecules. In biodegradation of polymers, the first phase is a chain cleavage step concerning the conversion of a long polymer chain into smaller oligomeric fragments. Secondly, small size oligomeric polymer fragments are transformed into biomass such as raw materials, salts, CO_2 and methane [11].

2. Materials and Methods

2.1. Sampling and Categorization

Samples of plastic bags from different shops of various sectors have been collected. These samples were then brought to the laboratory of Environmental Protection Agency Islamabad for further processing. In laboratory of Environmental Protection Agency Islamabad these samples were classified in three main categories:

1. Plastic bags with stamp of D_2w / Recyclable material (Bio-Degradable Plastic Bags)
2. Plastic bags without the stamp of D_2w / Recyclable material (Non-Degradable Plastic Bags).
3. Paper Bags are classified on the base of color, quality, transparency, prints, texture, strength. For Each Category (Bio-degradable and Non-Degradable and Paper bags) fifty samples were selected for analysis with XRF, represented in Figure 1.

Figure 1. Samples Of Degradable and Non-Degradable Plastic Bags.

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2.2. Apparatus

The X-MET8000 range of handheld X-ray fluorescence (HHXRF) analyzers delivers the performance required for instant identification of Alloy grade. It also identifies accurate chemistry of different materials i.e. (solid and powder metals, polymers, solutions, soil, ores, minerals etc.,). The instrument is practical, Remote, used friendly and deliver trustable Results and features are described in Table 1.

Table 1. The Features of the XRF Spectrophotometer.

Sr. No.	Features	Elucidation
1.	Rugged	The instrument is splash and dust proof .It is tested to have a large heat sink for optimum stability.
2.	Connectors	Connectors (mains, USB, HDMI) safe under plastic cover.
3.	Covering	Impact resistant, industrial grade plastic covering.
4.	Battery	Up to 10 hours battery life, for constant workflow. Battery charge indicator on battery and on screen.
5.	Status Lights	Orange lights indicate when the instrument is ready to measure (in contact with a sample) Flashing red lights indicate when X-rays are being generated.
6.	Safety sensors	The instrument cannot take a measurement unless the instrument nose is covered by a sample.
7.	Optional window shield	Maximum ruggedness when testing sharp objects (e.g., turnings).Shield decreases the risks of detector damage
8.	Screen	4.3" color, touch screen, Easy to read in any kind of light including sunlight.
9.	User Interface	It has very large icons which are visible in any light .It can be used with gloves on. Customizable display to show what is important to you (i.e., grade ID, chemistry, pass/fail messages).

2.3. Procedure

The specimen is first folded into as many layers as possible before analysis and is placed on a disk made up of X-ray absorbing material (alloy), the XRF is then placed on the specimen. The folding of specimen is important because during analysis XRF releases X-rays which make a field around the specimen. The area of the field is equal to the area of the X ray absorbing disk on which specimen is placed for analysis. When the nose of XRF is touched with the specimen the orange light turns on indicating that the specimen is right, and the instrument is ready to analyze the specimen. Then the triggered is pressed for 3-5 seconds and the XRF starts analyzing the specimen shown in Figures 2 and 3. The process of analysis of XRF after pressing the trigger is 30 seconds, the countdown timer is displayed on the screen and the Red light turns on indicating the release of X-rays. When the countdown is over the results appear on the screen in the form of a table with three columns i.e., Parameters, values in ppm and values in +/- . These values are then noted and arranged according to the categories made for study.

Figure 2. Ms 8000 HH XRF.

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Figure 3. Analysis of plastic bag using HH XRF.

3. Results and Discussion

For the sake of assessment of both degradable and non-degradable plastic bags, fifty samples of each type (degradable and non-degradable) bags were segregated on behalf of their physical characteristics for examination. Following are the tables of the results of different heavy metals found in both degradable and non-degradable plastic bag samples.

Following are the elements and the patterns and trends of their presence in each category:

1. Alternative abundance of Copper (Cu) and Titanium (Ti).
2. Co-existence of Chromium (Cr) and Lead (Pb).
3. Presence of Calcium (Ca) in abundance in both kinds of samples.
4. Small amount of trace elements i.e., Arsenic (As), Mercury (Hg), Iron (Fe), Zinc (Zn) and Cadmium (Cd).
5. Metals which were analyzed but are not detected due to absence.
6. Alternative abundance of Copper (Cu) and Titanium (Ti).

Both copper and titanium are showing alternative abundance that means where Titanium is present in excessive amount the Copper is present in traces and where Copper is massive in quantity the Titanium is scarce. The pattern in which titanium and Copper is found in the samples of degradable and non-degradable plastic bags are shown in Figure 4. and Figure 5, respectively.

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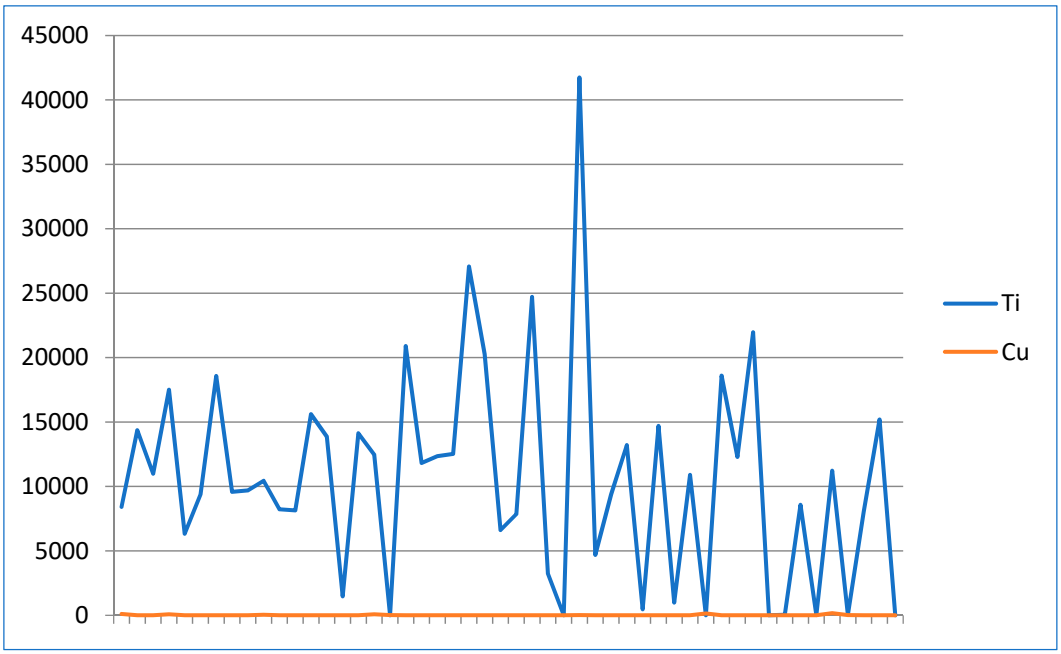

Figure 4. Cu and Ti in Degradable Plastic Bags.

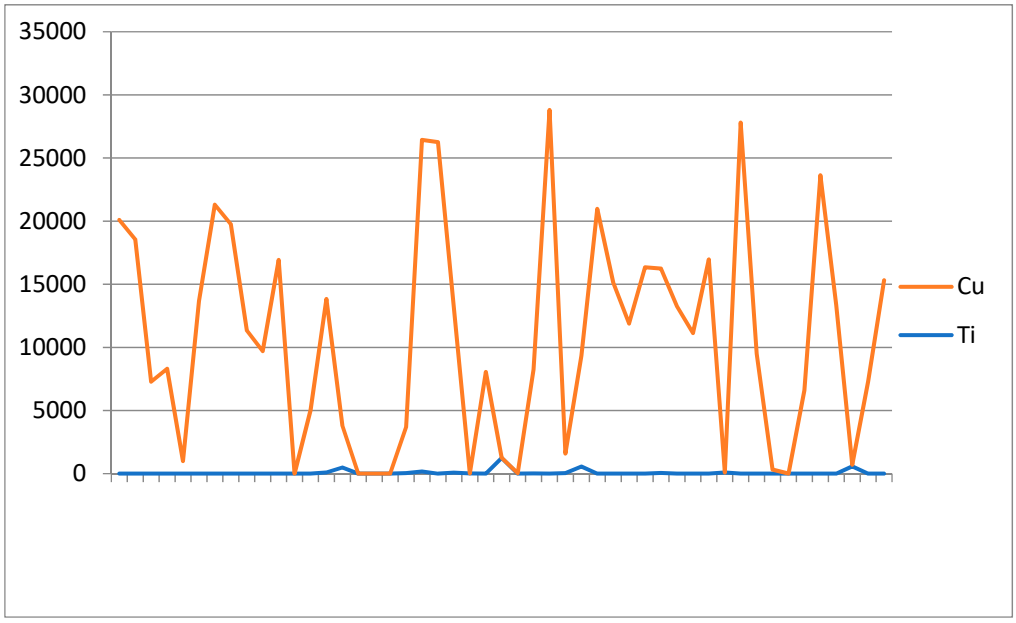

Figure 5. Cu and Ti in Non-Degradable Plastic Bags.

Table 2. Degradable Plastic Bags.

Serial No:	Sample Name	Names of Additives (ppm)									
		Ti	Cu	Ca	Fe	Zn	Hg	Cr	Pb	As	Cd
1	Kohi Noor Jewels	8421	108	7800	54	38	10	0	0	3	0
2	Stylo	14366	0	14002	26	110	0	0	0	2	0
3	Tehzeeb	10987	0	97014	0	79	14	1	0	5	0
4	Habibi	17504	82	26	38	56	0	0	0	3	0
5	Shaheen Chemist	6331	0	126360	94	217	0	1	0	0	0
6	Savor food	9382	0	126708	0	1728	0	1	0	0	0
7	Servis	18572	0	16944	50	215	0	0	0	0	31
8	La Madeleine Bakery	9578	0	121408	101	383	0	0	0	0	0

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9	MCC	9698	0	100515	93	211	0	0	0	0	0
10	Fresco	10436	40	109917	122	350	14	0	0	0	0
11	Save Mart	8231	0	146613	0	251	0	10	69	0	0
12	Local White torn	8147	0	167630	122	503	26	0	0	0	0
13	The body shop	15608	0	15643	29	227	10	0	0	4	0
14	Mother care	13866	0	71318	97	463	12	0	0	0	26
15	Jelly Factory	1467	0	33	0	48	27	0	0	2	0
16	Reader's Point	14129	0	133870	146	772	0	0	0	0	0
17	Cinnibon	12472	74	25524	35	94	11	0	0	3	0
18	Cambridge	0	16	22791	33	171	0	0	0	2	0
19	1 Step	20905	0	443	27	41	0	0	0	0	0
20	Local (dense) White	11823	0	92720	0	975	0	0	0	0	0
21	D-Watson	12359	0	131150	93	656	17	0	0	0	0
22	Vincci	12522	0	9217	25	304	0	0	0	2	0
23	Diner's	27074	0	2783	37	72	11	0	0	3	0
24	Giordano	20267	0	46318	0	35	12	0	0	0	0
25	Logo	6618	0	6825	107	0	0	90	239	0	0
26	Any Baby	7859	0	706	18	5	0	0	0	1	0
27	Baby Shop	24713	9	2437	24	64	0	0	0	3	0
28	Broast andbiryani	3238	0	136769	88	224	16	0	0	0	0
29	Nishanlinen	0	0	13671	34	92	0	0	0	2	0
30	Saeed Ghani	41741	19	21233	0	152	0	0	0	3	0
31	Rahat	4694	0	154485	113	80	0	7668	480	0	0
32	Lime Light	9388	0	25247	30	75	0	0	0	3	0
33	outfitters	13207	0	66675	79	40	15	0	0	0	7
34	Breakout	459	0	13775	25	58	13	1453	6967	0	0
35	Leena	14696	0	88750	72	27	12	0	0	0	0
36	Jamil Sweets	988	0	26055	223	59	0	435	2251	0	0
37	Ethnic	10904	0	30525	55	31	0	0	0	0	0
38	Generation's Store	0	138	918690	67	192	0	424	2041	0	0
39	ARQ's	18604	0	1751	0	21	11	0	0	0	0
40	Mango	12286	0	11526	501	389	0	0	0	2	0
41	J.	21962	10	532	215	61	0	0	0	3	0
42	Metro Cash & Carry	0	0	106429	72	39	12	0	0	0	0
43	NIKE	41	0	71	14	102	0	75	645	0	0
44	Gourmet	8571	0	102367	99	295	0	0	0	0	0
45	Subway	13	10	11	17	66	0	0	0	2	0
46	Domino's	11218	171	105535	0	66	0	0	0	0	0
47	Levi's	41	14	59	0	131	0	0	0	2	0
48	Haleem Ghar	8047	0	131003	80	687	0	1	0	0	0
49	K&N's	15197	0	7879	0	242	0	0	0	2	0
50	LEGENDS	0	0	59987	54	253	11	0	0	0	0
	Highest Value	41741	419	918690	501	1728	27	7668	6967	5	31
	Lowest Value	0	0	11	0	0	0	0	0	0	0

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Table 3. Non-Degradable Plastic Bags.

Serial No:	Sample Name	Names of Additives (ppm)									
		Cu	Ti	Ca	Fe	Zn	Hg	Cr	Pb	As	Cd
1	Cambridge	20085	8	50	0	65	0	0	0	3	0
2	borjan	16991	0	121128	103	43	0	0	0	0	0
3	Cougar	18552	0	22329	35	45	0	0	0	0	0
4	The Hart Pharmacy	7282	0	130753	0	559	14	0	0	0	0
5	Illusions	8312	0	7526	21	57	0	0	0	2	0
6	Hop Scotch	995	0	112310	107	60	0	0	0	0	0
7	Hush Puppies	13669	0	2025	17	59	0	0	0	2	0
8	minnie minors	21303	0	70	20	26	0	0	0	0	0
9	Sonali	19760	0	52546	47	192	0	0	0	0	0
10	edenrobe	11342	0	1084	18	45	0	0	0	3	0
1	Al-Latif Chemist	9701	0	126797	108	23	0	0	0	0	0
12	Shifa Medical	16930	0	121166	103	43	0	0	0	0	0
13	pink local	0	0	88322	94	482	0	0	0	0	0
14	red local	5032	0	29879	275	266	0	24	116	0	0
15	Grey local	13743	91	8244	83	116	0	40	150	0	0
16	Blue Local	3311	85	126899	155	609	0	0	0	0	0
17	green local	0	0	100016	104	0	16	0	0	0	0
18	yellow local	0	0	88119	110	481	15	0	0	4	0
19	Transparent Local	0	0	224	0	70	0	0	0	2	0
20	Black Local (rare)	3644	48	37092	919	407	0	1	106	0	0
21	Pepper land	26272	171	24	32	111	0	0	0	3	0
22	Vision optic	26256	0	302	0	39	0	0	0	4	0
23	Sargent Major	13085	86	25528	55	50	11	0	0	3	0
24	Threads & threads	0	15	2340	5127	60	0	0	0	3	0
25	food 24 hours	8061	0	109655	65	254	13	0	0	5	26
26	Amna fabrics	0	1786	17890	89	766	0	0	0	0	0
27	(Thank you) blue	0	1245	3314	26	230	0	12	0	3	0
28	(Thank you) yellow	32	0	778	0	75	33	1720	8003	0	0
29	(Thank you) white	8233	15	77285	62	173	0	0	0	0	0
30	Broz	28803	0	3006	43	201	3	0	0	0	0
31	Sputrnick	1550	43	3608	0	55	25	1073	5484	0	0
32	datchi	8776	558	37411	30	389	0	0	0	0	0
33	kashmir arts	20971	0	116099	0	324	0	1	0	0	0
34	kids master	15133	0	33	20	49	0	0	0	2	0
35	Nizam Watch	11879	0	83715	62	321	0	1	0	0	0
36	inc	16335	8	5615	26	41	0	0	0	3	0
37	Gul Ahmed	16191	51	46802	149	234	11	0	0	0	0
38	Al Jannat	13247	0	49412	74	96	14	0	0	4	0
39	Sattar Buksh	11134	5	1340	25	225	0	0	0	2	0
40	Stonage	16970	0	112544	0	69	14	0	0	0	0
41	Generations	0	98	42	11	81	0	0	0	2	0
42	Outfitters	27808	0	5500	35	63	0	0	0	0	79
43	Phulkari	9499	0	70085	88	203	13	0	0	0	0
44	Bakeman	322	0	144847	0	41	0	98	694	0	0
45	Explore	0	7	70	16	110	0	0	0	0	0
46	Kaish Cosmetics	6593	0	133463	119	252	19	0	0	0	0
47	Wazir Tailors	23636	0	1040	21	82	10	0	0	0	0
48	The merino tailor	13348	0	122992	79	369	19	0	0	0	0
49	Diner's	128	576	4539	14	363	0	0	0	2	0

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50	Albedo	15319	0	0	0	40	0	0	0	5	0
	Upper limit	28803	1786	144847	5127	766	33	1720	8003	5	79
	Lower limit	0	0	0	0	0	0	0	0	0	0

The following are the reasons of the behaviors and the patterns shown by Titanium and Copper observed by the analysis of the samples of both degradable and non-degradable plastic bags.

3.1. Titanium

Titanium was the abundant metal that was found to be present in Degradable plastic bags only; it was present in traces in Non-Degradable plastic bags. The highest value of titanium that is observed by analyzing Degradable Plastic bags samples was 41741 ppm while the least value observed was 0 ppm, similarly the highest value received by analyzing non degradable plastic bags was 1786 ppm and the least value was 0ppm the reason of its presence in Non-degradable plastic bags in abundance, because of the use of Titanium Dioxide powder in the manufacturing of degradable plastic bags which is Photolytic. The photocatalytic mechanism of the titanium dioxide is considered as follows. An electron and a hole generated inside the finely divided titanium dioxide particles convert water and oxygen present in the vicinity of the Surface of the titanium dioxide particles into hydroxyl radical or hydrogen peroxide, and by Virtue of the Strong oxidation-reduction function of hydroxyl radical or hydro gen peroxide, harmful Substances are converted into a harm less Substance Such as carbon dioxide gas, thereby attaining clarification. This photocatalytic action of finely divided titanium dioxide particles is said to permanently last if finely divided titanium dioxide particles, light, water and Oxygen are present. As application various attempts of incorporating Titanium Dioxide in medium have been made, The Titanium Dioxide powder is suitably shaped for handling articles such as fiber and plastic bags. However, the Strong photocatalytic action of titanium dioxide causes decomposition or degradation not only of harmful organic materials or environmental pollutants but also of the medium itself Such as textile fiber, plastic, and paper. This stands as an obstacle to the practical use of titanium dioxide photocatalyst. A coating material obtained by mixing finely divided titanium dioxide particles and a binder is drawing attention because of its good handling properties. As the organic polymer, there can be employed, for instance, thermoplastic polymers, thermosetting polymers, and natural resins. Since the organic polymer does not come in direct contact with the photocatalytic activated Surface of the titanium dioxide owing to the formation of the coating of a substantially water-insoluble organic Substance, the organic polymer itself serving as the medium is Scarcely Susceptible to decomposition and deterioration [12].

3.2. Copper

The range of copper for both Non degradable and degradable plastic bags was (0-28803) ppm and (0-419) ppm respectively, in Non-degradable copper was observed to be present in very large amount as a major content.

Thermoplastic composition which contains a copper phosphate salt such as copper phosphate, copper sulfate, cupric hydroxide phosphate and copper thiocyanate. The copper phosphate salt is preferably added in an amount ranging from about 0.1 to 5 parts by weight and the copper phosphate salt preferably has a particle size less than 10 μm [13].

Copper which is attached to organic matter and minerals after entering the atmosphere. As a result, it does not travel very far after release, and it hardly ever enters groundwater. In surface water copper can travel great distances, either suspended on sludge particles or as free ions. It does not break down in the environment and so can accumulate in plants and animals. On copper-rich soils only a limited number of plants have a chance of survival. That is why there is not much plant diversity near copper-disposing factories. Because upon plants copper is a serious threat to the production of farmlands. Copper can seriously influence the proceedings of certain farmlands, depending upon the acidity of the soil and the presence of organic matter. Despite this, copper-containing manures are still applied. Copper negatively influences the activity of microorganisms and earthworms so the decomposition of organic matter may seriously slow down because of this.

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When the soil of farmland was polluted with copper, animals will absorb concentrations that are damaging to their health. Mainly sheep suffer a great deal from copper poisoning, because the effects of copper are manifesting at low concentrations [14].

3.3. Co-existence of Chromium (Cr) and Lead (Pb):

It has been observed that either both Chromium and Lead were present together in the same samples or they both were absent. The reason for this behavior of these two metals was because both chromium and Lead were used together in the printing ink for designing logos and monograms. . The highest values of Chromium and Lead observed in degradable plastic bags were 7668 ppm and 6967 ppm respectively and the least values are 0 ppm for both. The highest values of Chromium and Lead observed in non-degradable plastic bags were 1720 ppm and 8003 ppm respectively while the lowest values of both are again 9 ppm.

Various amounts of heavy metals, such as chromium and lead impose a serious health hazard even in quite small amounts, and there has been considerable public anxiety and debate about these dangers. They can cause contamination of food and travel through water supplies and reach the atmosphere. This, in the past, has badly affected the Central Nervous System of Young children. Infants and young children should not be exposed unnecessarily to materials containing significant amounts of such heavy metals, and it is highly recommended that these should be replaced by non-hazardous substances in toys (Plastics) and printed papers (comics), as we see infants tend to chew and sometimes swallow such materials. Some people also say that these heavy metal compounds, normally used as pigments, are not necessarily dangerous, because the pigment particles may be insoluble or well protected by suitable coatings-as for instance in many plastic toys that use cadmium-based or lead-based pigments. Hence there is need for an extraction test simulating the conditions of the human stomach rather than an analysis for the total lead [15].

3.4. Chromium

Chromium has intense effects on the environment, especially hexavalent Chromium, has been commonly observed. Chromium is used on a large scale in many different industries, including metallurgical, electroplating, production of paints and pigments, tanning, wood preservation, Cr chemicals production, and pulp and paper production. Often wastes from such industries (e.g., sludge, fly ash, slag, etc.) are used as a fill material at numerous locations to reclaim marshlands, for tank dikes, and for backfill at sites following demolition. At many such sites, leaching and seepage of Cr (VI) from the soils into the groundwater poses a considerable health hazard. The tanning industry is an especially large contributor of Cr pollution to water resources.

In terms of nutrition, Cr (III) is an essential component of a balanced human and animal diet for preventing adverse effects in the metabolism of glucose and lipids. The high concentrations, Cr (VI) is also toxic to humans. Hexavalent Chromium (Cr VI) is a potent, extremely toxic carcinogen and may cause animals and humans death if taken in abundance. It reaches to the human beings majorly through air and is inhaled [16]. This chromium is a part of plastic bags which leaches out slowly and causes harmful effects on human beings and animals.

3.5. Lead

Lead is a toxic metal which can cause intense environmental contamination and significant public health problems. It can have severe harmful effects on the health of children. When exposed highly, Lead attacks the brain and central nervous system to cause coma, convulsions and even fatality. Children who survive severe lead poisoning may be left with mental retardation and disorders of behaviors. The low levels of exposure cause no obvious symptoms which was used to be considered safe, but now it is known to produce a spectrum of injury across multiple body systems. Lead can affect children's brain development resulting in reduced intelligence quotient (IQ), behavioral changes such as reduced attention span and increased antisocial behavior and reduced educational attainment. Lead exposure also causes anemia, hypertension, renal impairment,

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immunotoxicity and toxicity to the reproductive organs. The neurological and behavioral effects of lead are believed to be irreversible [17].

3.6. Presence of Calcium (Ca) in abundance in both kinds of samples

In the XRF analysis of plastic bags a large quantity of Calcium has been detected in results, the highest value of calcium in the list of degradable plastic bags is s 918690 ppm and the lowest value was 11 ppm, while in the list of non-degradable plastic bags the highest value of calcium is 144847 ppm whereas the lowest value was 0 ppm . The reason of the existence of this metal in a large quantity is because of the calcium carbonate $CaCO_3$ used in the plastic bags. Normally It is thought that inorganic fillers could further enhance the mechanical performance of plastic bags Various inorganic fillers such as talc, mica, clay, and calcium carbonate ($CaCO_3$) and fiber reinforcements such as glass fibers are commonly incorporated into thermoplastic polymers. Recently, natural fibers such as sisal, wood, and cellulose have also been used to reinforce thermoplastics. These composites generally exhibit superior stiffness, strength, and heat distortion temperatures with respect to unreinforced polymers. However, reinforcing materials such as glass fibers and carbon fibers are not biodegradable. Among the various reinforcing materials, $CaCO_3$ is attractive because of its low cost. Another advantage of $CaCO_3$ is derived from its hydrophilic behavior, that is, its water adsorption characteristics. It is anticipated that the incorporation of $CaCO_3$ can improve the water adsorption of a composite, thereby accelerating the biodegradation process of PPC polymers containing ester bonds. In this work, $CaCO_3$-reinforced PPC composites were prepared. Their static and dynamic mechanical properties, thermal characteristics, and microstructure were investigated. This could be the reason why the highest value of calcium in degradable plastic bags is nine times more as compared to the value of calcium in non-degradable plastic bags [18].

Small amount of trace elements i.e., Arsenic (As), Mercury (Hg), Iron (Fe), Zinc (Zn) and Cadmium (Cd):

A very small amount of Arsenic (As), Mercury (Hg), Iron (Fe), Zinc (Zn) and Cadmium (Cd) was also found which was disquieting because these metals are toxic and the plastic bags containing these metals are used for carrying eatables like bread, bakery products , vegetables, and fruits as well, it can be then entered into the food chain.

Arsenic (As):

Arsenic exists in solid, dissolved, and gaseous form. As both inorganic and organometallic species, arsenic can be converted into arsenic acids (3+ and 5+) and to methylated arsines (3-) under an aerobic condition by bacteria and other microorganisms Aquatic and terrestrial biota show a wide range of sensitivities to different arsenic species. Their sensitivity is modified by biological and biotic factors. Generally, inorganic arsenicals are more toxic than organo-arsenicals and arsenite is more toxic than arsenate. The mode of toxicity and mechanism of uptake of arsenate by organisms varies. This is why various species respond differently to arsenate and arsenite.

Compounds of arsenic cause acute and chronic effects in individuals, populations and communities at varying concentrations ranging from a few micrograms to milligrams per liter, depending on species, time of exposure and endpoints measured [19]. These effects include immortality, inhibition of growth, effect on photosynthesis and reproduction, and effects on behaviors. Arsenic-contaminated environments are characterized by limited species abundance and diversity. If levels of arsenate are high enough, only species which exhibit resistance may be present. The plastic bags through garbage trucks, wind and water runoff reach to the water bodies and causes the release of arsenic in the medium where they currently reach.

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Mercury (Hg):

Mercury is one of the most hazardous contaminants that may be present in the aquatic environment, but its ecological and toxicological effects are strongly dependent on the chemical species present. Species distribution and transformation processes in natural aquatic systems are controlled by various physical, chemical, and biological factors. Depending on the prevailing environmental conditions, inorganic mercury species may be converted to many times more toxic methylated forms such as methylmercury, a potent neurotoxin that is readily accumulated by aquatic biota. Despite a considerable amount of literature on the subject, the behavior of mercury and many of the transformation and distribution mechanisms operating in the natural aquatic environment are still poorly understood. Reported reviews examines the current state of knowledge on the physicochemical behavior of mercury in the aquatic environment, and in particular the environmental factors influencing its transformation into highly toxic methylated forms [20].

This mercury is released from the plastic bags when they slowly degrade and become a part of soil and water [21]. The range of mercury in both degradable and non-degradable plastic bag samples was about (0-27) ppm and (0-33) ppm.

Iron (Fe):

The range of iron found in both biodegradable and non-degradable plastic bags was (0-501) ppm and (0-5127) ppm respectively. Iron is used in printing inks known as gall inks. It is used in the form of Ferrous sulphate which is mixed with Gallic acid to form printing ink that is of black color [22]. It is then expected that the reason for the presence of iron metal in the samples is because of the inks used for printing.

Zinc (Zn):

Zinc is a metal that is used in different plastics for adding strength to them. It is added in the form of Zinc powder. The highest value of Zinc obtained from the analysis in both degradable and non-degradable plastic bags was 1728 ppm and 776 ppm respectively, while the least values in both kinds of samples were 0 ppm [23]. The concentration of Zinc powder ranges from 0 to 20% by volume. Generally, composites present poorer mechanical properties as compared to the unfilled polymer. The density and hardness of plastics are higher than that for the unfilled polymer. The thermal stability of the polyethylene charged with zinc powder is better than that for the unfilled polymer. The incorporation of zinc powder in polyethylene increases the thermal diffusivity and conductivity and decreases the specific heat [24].

Cadmium (Cd):

Cadmium is a toxic metal that exists naturally in the environment and as a pollutant releasing from industrial and agricultural sources. The main source of cadmium intake in the non-smoking population is food. Cadmium is efficiently retained in the kidney (half-time 10–30 years) and the concentration is proportional to that in urine (U-Cd). Cadmium is nephrotoxic in nature, initially causing kidney tubular damage. It also causes bone damage, either via a direct effect on bone tissue or indirectly because of renal dysfunction followed by glomerular damage with decreased glomerular filtration rate, and eventually to renal failure. Recent research has shown that is also carcinogenic. Roughly a considerable proportion of the non-smoking adult population has urinary cadmium concentrations of 0.5 μg/g creatinine or higher in non-exposed areas. For smokers this proportion is considerably higher. For that reason, steps should be taken to reduce exposure to a minimum, and the tolerable limits of daily intake should be set to keep ourselves safe [25]. The range of Cadmium in both degradable and non-degradable plastic bags is quite low , in all hundred samples only four samples were found to be cadmium positive [26]. Metals which were analyzed but are not detected due to absence:

The instrument (XRF) also scanned for other heavy metals including Mn, Au, Ni , Co, Ag, Pt, Br, Ta, V and Br but the results were 0 ppm in all samples only one non degradable plastic bag of Black color contained Bromine and the value was 282 ppm.

4. Conclusions

- Biodegradable plastic bags contained Enormous amount of Titanium which makes them degradable while Non degradable plastic bags contain an enormous amount of copper that may be makes them non degradable .
- The presence of chromium and Lead was due to the ink used for printing plastic bags.
- Trace amounts of several other heavy metals were also found mainly Arsenic (As), Mercury (Hg) and Cadmium (Cd), Chromium (Cr). this might be because of some additional printing material used for designing and writing.
- The Degradable plastic bags could be more harmful than non-degradable plastic bags because the non-degradable plastic bags cause immobilization of the heavy metals used for their formation and printing while the degradable plastic bags degrade by photolysis due to the presence of Titanium dioxide releasing other heavy metals into the environment.

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