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CHARACTERISTICS OF ENVIRONMENTAL FRIENDLY LABELED PLASTIC SHOPPING BAGS IN INDONESIA

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Abstract. Plastics are synthetic polymers, made from petroleum and its derivatives which are non biodegradable. Today, more people used plastic bags to support their activities ,which caused the supply of plastic shopping bags to increase in large number. Plastic bags, eventually, are usually used as garbage which would cause negative impact on the environment. Environmental friendly plastic bags are made from renewable raw materials, such as starch from cassava, corn or others. There are the ones entirely starch based such as Enviplast (biodegradable); the ones with partial mixture of starch with plastic ores such as Ecoplas (biodegradable), the ones plastic ores are formulated with additives Oxium (oxodegradble), and conventional made from plastic ores only. Distinguishing characteristics of samples plastic shopping bags which were taken from domestic and abroad supermarkets can be seen from the result of FTIR, SEM, and AAS analysis along with burial in soil. Density of domestic plastic bag (1.119 g/cm^3) are 49.55% smaller than samples abroad 2.258 g/cm^3 This means that in the country, a space to hold trash bags in the same weight needed almost 2x larger. Another discovery are some plastic shopping bags are labeled eco-friendly ,but had conventional plastic characteristisc .

INTRODUCTION

Modern convenient life has become very dependent on plastic shopping bags .The national consumption of plastic shopping bags have reached 300,000 tons/year, with growth 8%/year [5]. In Indonesia, retail was the leading sector of plastic bag users for their customers [6]. Aside for carrying groceries, apparently shopping bags were used as trash carriers prior to final disposing into landfill [1]. The raw materials of conventional plastic bags were synthetic polymer products, made from petrochemicals which were not biodegradable and need hundreds years to decompose [9]. The usage of conventional plastic shopping bags to be quite hard to maintain because it will eventually cause environmental issues in the future, and soon will be replaced with ecofriendly plastic shopping bags, such as fully biodegradable, degradable or oxodegradable plastic bags . Indonesian government has issued Law No.18/2008 concerning waste management. Keeping pace with that regulation, the reduction of plastic shopping bags usage has been initiated and replacement by some retailers. Oxodegradable plastic bags were decomposed or disintegrated faster than the conventional, because LDPE or HDPE resin were formulated with certain additives, which were more easily oxidized in the presence of ultraviolet light or heat [8]. This type of plastic bags were easily disintegrated into small micronized parts in intervals up to 2 (two) years. Biodegradable plastic shopping bags were produced and formulated from renewable compounds such as starch, so it can be easily degraded by soil microbes, and converted into carbon dioxide and water [3]. Many retailers labelled their plastic bags "environmentally friendly", "degradable", "save the earth", or "biodegradable". But mostly found in the market were plastic shopping bags without label (conventional). It is necessary to undergo analysis to distinguish characteristics of different kinds of ecofriendly labeled plastic shopping bags which were used and discarded daily.

RESEARCH METHODOLOGY

This study was a descriptive type of research using purposive sampling method [7]. Samples were taken from supermarkets in Tangerang, Indonesia such as Carrefour, Hypermart, and others. Analysis were carried out in Chemistry Lab. and Industrial Eng. Lab.of Pelita Harapan University, Polymer Lab. ITI, Polymer Centre Tech. Lab.-BPPT, and Center for Chemical and Packaging. Samples were analyzed physically such as length, width, thickness, and weight, allowing to calculate density. Furthermore, mechanical properties such elongation, tensile strength were tested, under heating and UV light, burial in soil test ,analysis by Fourier Transformed Infra Red (FTIR), metal analysis by AAS and Morphology analysis using SEM were done[2].

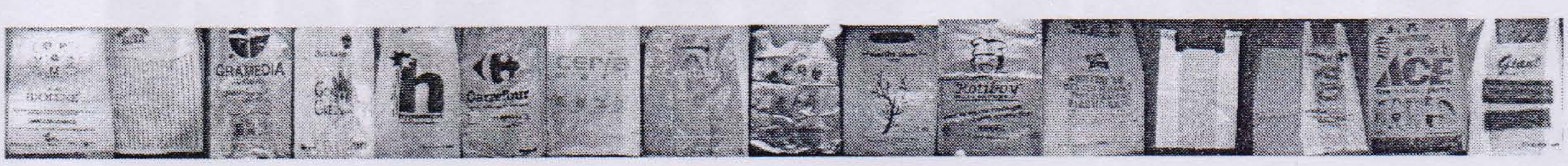
RESULT AND DISCUSSION

Plastic shopping bags samples on the market domestic (40 samples) and abroad (10 samples) were taken and categorized according to the label's printed on each plastic bags, to analyze the diffrence in term of density and weight of those plastic bags.

Table 1. Physical Data Different Types of Plastic Shopping Bags

No	Plastic shopping bags (Indonesia)	Length (cm)	Width (cm)	Thickness (cm)	Weight (gram)	Density (gram/cm³)	Colour	Remarks (Label)
	Domestic Market							
1	Green Laundry	90.0	45.0	0.003	24.5400	1.75	Dark white	biodegradable
2	[illegible]	25.5	15.1	0.002	3.6247	2.41	Dark white	biodegradable
3	Cima Mart	49.0	27.0	0.002	6.2670	2.37	Transparent	degradable
4	Hypermart	30.0	25.7	0.002	9.8192	2.74	White	degradable
5	Giant	48.0	29.5	0.002	9.2630	3.27	Transparent	degradable
6	Guardian	31.5	20.6	0.002	2.8622	1.76	White	degradable
7	Toys City	33.0	20.5	0.001	2.4475	2.43	Transparent	degradable
8	Indomaret(besar)	47.8	26.5	0.003	8.4579	2.00	White	degradable
9	Indomaret kecil	27.5	16.2	0.001	1.8610	2.78	White	degradable
10	Alfamart	29.5	15.0	0.001	1.9081	2.37	White	degradable
11	Hero	48.5	30.5	0.003	11.3678	2.19	White	degradable
12	Century	45.0	29.0	0.004	13.2536	2.66	Green	degradable
13	Gramedia	42.5	19.5	0.001	4.1352	3.27	White	degradable
14	Carrefour	32.0	15.0	0.001	2.0477	4.27	White	degradable
15	Kem-Chicks	46.5	28.0	0.002	1.9630	2.75	White	eco-friendly
16	Alfa Mart	32.5	24.0	0.001	2.8129	3.69	White	degradable
17	Farmers Market	37.0	20.5	0.002	2.4886	1.56	White	degradable
18	[illegible]	39.5	30.0	0.002	6.5636	1.73	White	degradable
19	Dr. Kong	32.0	23.0	0.007	10.6870	2.22	Green	degradable
20	[illegible]	49.5	29.5	0.003	3.1321	1.86	White	degradable
21	Food Mart (big size)	49.5	29.5	0.003	9.0631	1.89	White	degradable
22	Food Mart (small)	34.0	14.5	0.002	2.4973	2.03	White	EPI
23	[illegible]	45.5	27.0	0.003	6.1775	2.51	White	EPI
24	Rotiboy	38.8	37.0	0.003	11.9960	3.36	White	EPI
25	Watsons	36.0	23.5	0.003	4.2223	1.76	Green	EPI
26	Foodhall	48.0	24.5	0.003	7.6572	1.97	White	Green
27	[illegible]	25.5	30.2	0.002	7.3214	1.82	Gray	conventional
28	Mc Donald	45.8	26.0	0.002	6.0922	2.56	White	conventional
29	Sogo	39.8	25.0	0.003	3.9320	1.42	Red	conventional
30	Bread Talk	52.6	44.5	0.004	12.5408	2.16	Gray	conventional
31	[illegible]	40.0	25.5	0.002	7.0110	2.72	White	conventional
32	[illegible]	40.5	24.0	0.002	6.9776	2.38	White	conventional
33	Ace Hardware	47.5	32.7	0.003	15.9230	3.43	White	conventional
34	Black Plastic Bag	46.5	28.7	0.003	18.1126	2.16	Black	conventional
35	White Plastic Bag	48.2	24.5	0.004	7.0449	1.99	White	conventional
36	Pizza Hut	55.5	27.5	0.003	7.8946	1.52	White	conventional
37	[illegible]	32.0	22.5	0.003	5.2894	2.37	White	conventional
38	A & W	38.0	23.0	0.003	4.9073	2.00	White	conventional
39	[illegible]	24.8	14.8	0.002	4.5341	2.64	Black	conventional
40	[illegible]	32.5	30.0	0.004	13.4120	1.99	White	conventional
	Average			0.0026		1.119		

No	Plastic shopping Bags	Length (cm)	Width (cm)	Thickness (cm)	Weight (gram)	Density (gram/cm3)	Colour	Remarks (Label)
	International Market							
41	Carrefour, Italy	38.6	31.0	0.003	14.1020	2.38	Transparent	biodegradable
42	Biolene, Italy	38.0	30.5	0.002	8.2024	2.01	White	biodegradable
43	Muji, Japan	33.0	20.5	0.003	4.1465	1.86	White	conventional
44	Pharmacy Beijing	40.0	21.8	0.003	5.9199	2.27	White	conventional
45	Singapore	33.0	20.5	0.003	5.1180	2.52	Yellow	conventional
46	K-Link	35.2	15.0	0.003	4.3238	2.89	White	green save lives
47	Purple Plastic Bag, China	54.0	32.0	0.002	8.0293	2.32	Purple	conventional
48	Blank, China	32.0	32.2	0.002	10.7660	2.37	Transparent	conventional
49	Nex, USA	44.5	20.0	0.001	4.5837	2.29	Black	reduce, reuse,recycle
50	Xiamen, China	30.0	20.5	0.005	4.3399	1.47	White	conventional
	Average			0.0027		2.258		



There was no significant diffrence between "biodegradable" and "oxodegradable" plastic shopping bags labeled , when compared to the conventional plastic bags, in term of thickness and density. Thickness of 40 domestic samples plastic shopping bags are average 0.0026 cm and average density 2.258 gr/cm3, while 10 samples abroad have average thickness 0.0027cm and average density 1.119 gr/cm3. Those 50 samples have almost the same thickness, but the density of domestic plastic bags was smaller than about 50%. Usually plastic shopping bags are used as garbage, so it should be considered the volume and strength of the plastic shopping bag before being disposed off and degraded by UV light or heat or by microbes in the soil , in terms of the capacity of landfills and

environmental. Density samples of plastic shopping bags in domestic market was 49.55% from the samples abroad. This means that in the country, a place to hold in the same weight trash plastic shopping bags needed almost 2 times larger.

The Effect of Ultra Violet (UV) and Heating towards Weight, Tensile Strength and % Elongation from various type of plastic bags

Samples are being irradiated by UV light for 8 weeks to see a reduction in weight, tensile strength and % elongation and compared with heating samples 80^0C in oven for 2 hours. The result is as per below:

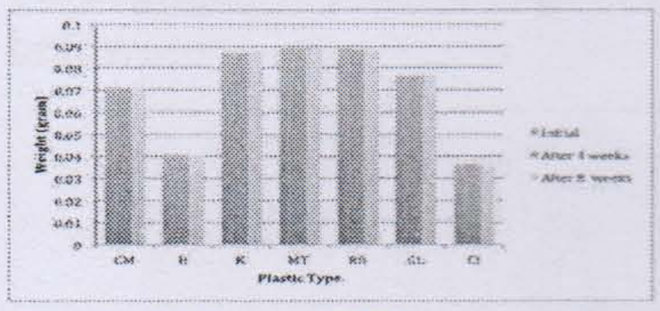


Fig 1 . Effect of UV vs weight

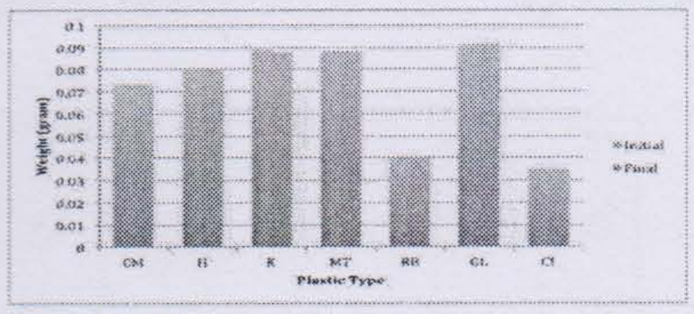


Fig 2 . Effect of heating vs weight

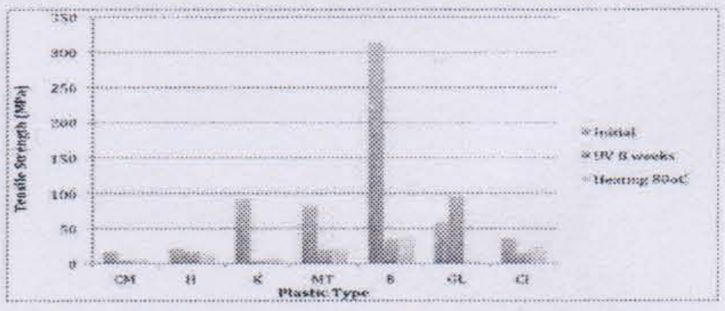


Fig 3 .Effect of UV and heating vs tensile strentgh

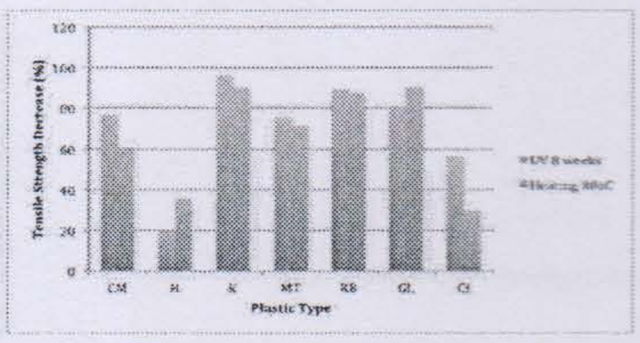


Fig 4. % decrease of tensile strength

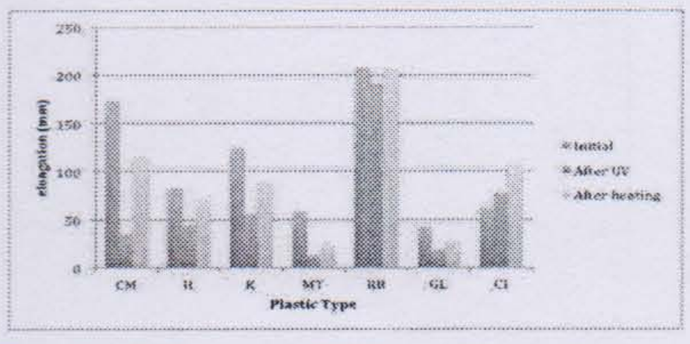


Fig 5 . Effect of UV and heating vs elongation

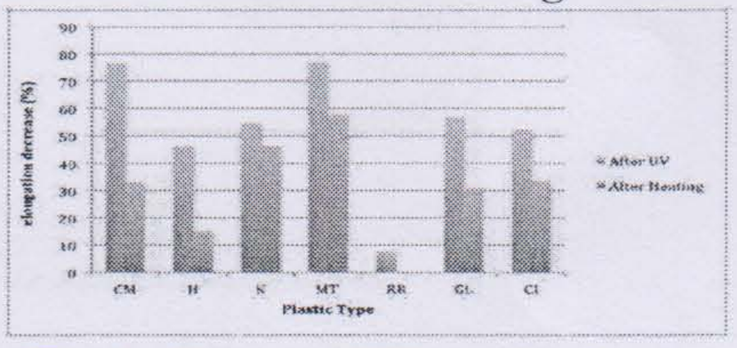


Fig 6 . Effect of UV and heating vs elongation decrease

note :

CM- biodegradable; H-oxodegradable; K-Conventional; MT-biodegradable; RB-EPI; GL-biodegradable; CI-oxodegradable

Burrying in Soil Analysis

Shopping bags characteristic can also be determined by the way of burying plastic bags in soil for period of time. The result of conventional plastic bags of 2 to 10 weeks can be seen in figure 9. Test sample remains intact, or without any degradation. Thisproves that the composition of the constituent plastic bag were not consumed by soil microbes. Degradation process of the other plastics bag (PB) type according to their label can be seen at the below pictures.

Fig 7. "CM" biodegradable

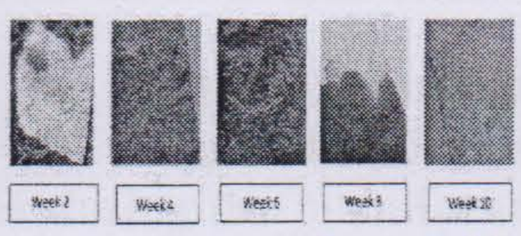


Fig 8. 'H" oxodegradable

Fig 9. Conventional

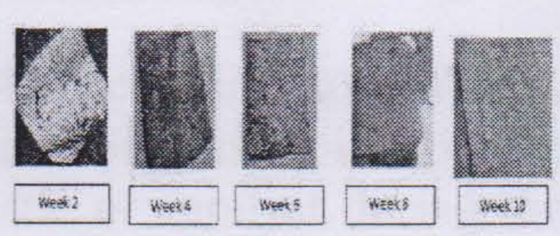


Fig 10. "MT"biodegradable

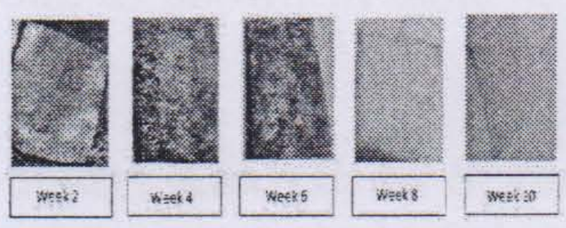


Fig 11. "RB" EPI

Fig 12. 'GL" bioodegradable

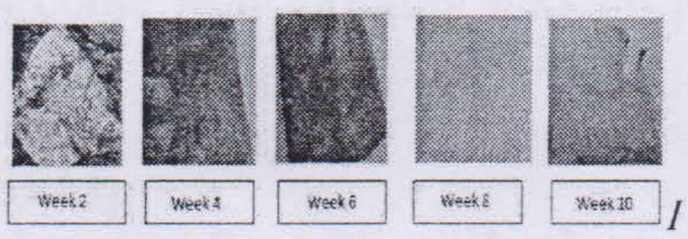


Fig 13. 'CI" oxodegradable

Fourier Analysis Functional Groups by Thermal Infra Red (FTIR)

FTIR results of plastic bags samples (conventional,oxodegradable and biodegradable) can be seen in Table 2 and Table 3 below. The FTIR result on the following sub section also mentioned that the function group were not typically showing starch spectrum. Table 2, it can be seen that some absorption(2850-2970 cm^{-1},1400-1600cm^{-1} and 675-1000 cm^{-1}), showed contains saturated and unsaturated hydrocarbons (alkenes and alkanes).

Table 2. Spectrum of sample conventional and oxodegradable labeled plastic bag

No	Absorption (cm^{-1})	Bonding	Group
1.	2850-2970	CH	Alkanes
2.	1400-1600	C=C	Alkenes
3.	675-1000	CH	Alkenes

Tabel 3. Spectrum of sample biodegradable labeled plastic bag

No	Absorption (cm^{-1})	Bonding	Group
1	3200-3600	OH	alcohol
2	2850-2970	CH	alkanes
3	1400-1600	C=C	alkenes
4	1050-1300	C-O	alcohol
5	1600-1800	C=O	Aldehyde/ketone
6	675-1000	CH	alkenes

Table 3 showed the absorption at 3367,71 cm^{-1} indicating typical OH groups in the structure of starch. Means that only sample "CM" represented containing starch and had characteristic of biodegradable plastic bag. A typical spectrum of each type of plastic bag can be seen in the picture below.

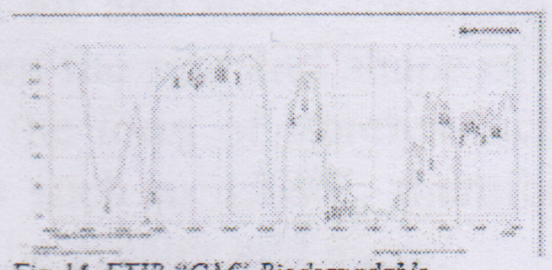


Fig 14. FTIR "CM" Biodegradable

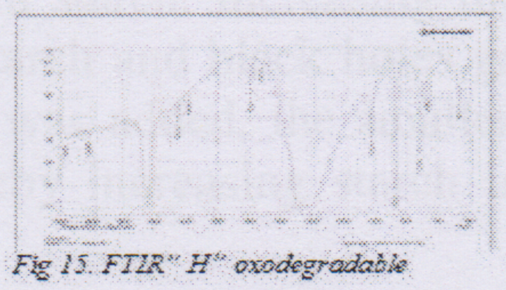


Fig 15. FTIR" H" oxodegradable

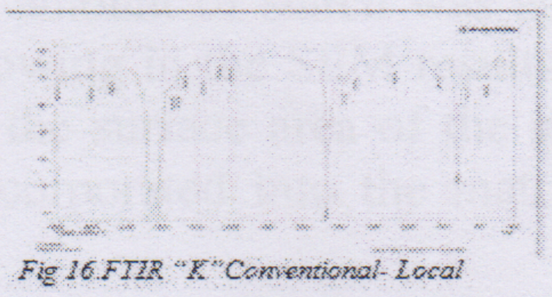


Fig 16.FTIR "K"Conventional- Local

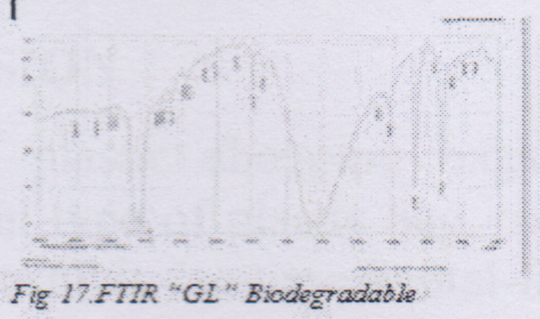


Fig 17.FTIR "GL" Biodegradable

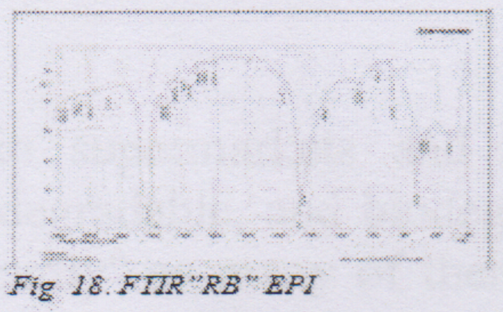


Fig 18. FTIR"RB" EPI

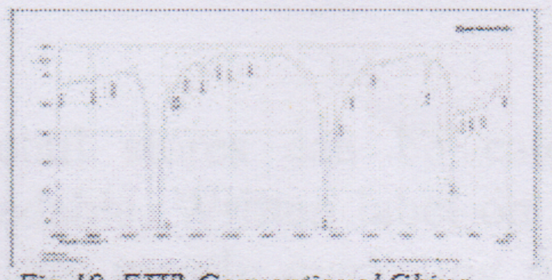


Fig 19. FTIR Conventional China

Metal analysis by Atomic Absorption Spectrophotometer (AAS)

Analysis of metal content Fe ,Co and Mn in various type of plastics bags, can be seen in Table 4.

Table 4 . Analysis result of metal in plastics bags

No	Types of Plastic (labeled)	Fe (mg/ kg)	Co (mg/kg)	Mn (mg/kg)
1	G L (biodegradable)	10.70	<3.3	
2	F H (oxium)	29.84	<3.3	
3	R B (EPI)	16.33	<3.3	
4	H (oxium)	18.78	<3.3	
5	C I (oxium)	29.80	<3.3	
6	K (conventional)	<2.3	<3.3	
7	V (biodegradable)	<2.3		<1.0
8	L (ecoplas)	<2.3		<1.0

Generally, metal content in a plastic were around 0.01% or 100 mg/kg [4]. According to Table 4, Fe, Mn and Co were less than 30 ppm. It can be seen that there is the possibility of metal in a plastic bag come from impurities during the manufacturing of raw material plastic or catalyst during the polymerization process. Biodegradable plastic bags should not contain metals such as Fe, but if it turns out, as shown in table 4, the possibility of these metals come from printing inks on plastic bags.

Morphology Analysis by Scanning Electron Microscopy (SEM)

The analysis were conducted to study morphology of 5 (five) types of sampling plastic shopping bags taken from domestic and abroad supermarket, which were thought had some different characteristics, according to their ecofriendly environmental label : (1)."**A**"Plastic bags from grocery in Australia labeled biodegradable and compostable. (2)."**MT**" plastic bag with ecoplas label- with % of cassava flour. (3)."**ST**" plastic bag with EPI label- go green 100% degradable.(4). Plastic bags of labels Oxium from "**FM**" with relatively oxodegradable (5). "**K**" Conventional plastic bags (white plastic) without any printing label as a control. Samples of plastic sheet with size 1cm x 0, 5cm directly on the coating with platinum for 60 seconds. Analyses were performed at accelerated voltage of 20kV with magnification 500 X (a), 100 X (b), 2500 X (c) and 5000 X (d).

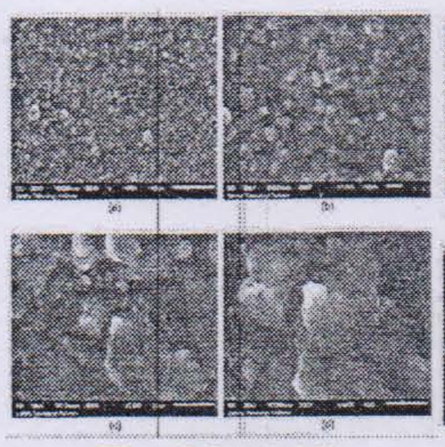


Fig 20. "A"

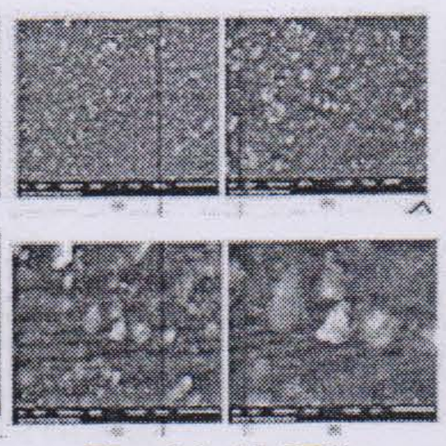


Fig 21."MT"

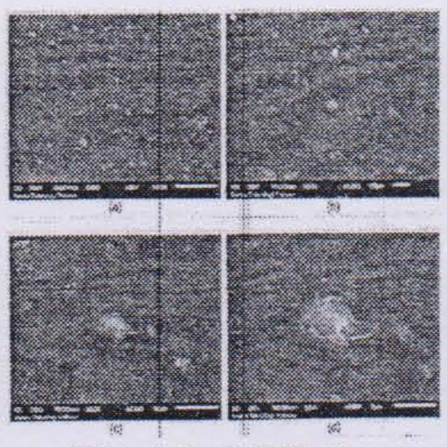


Fig 22. "ST "

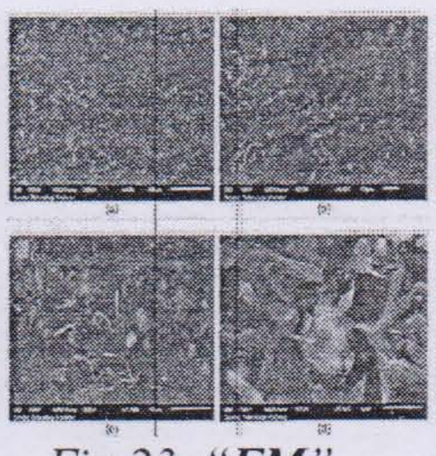


Fig 23. "FM"

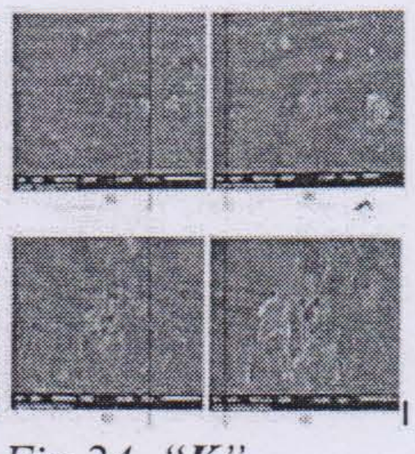


Fig 24. "K"

From he results, it can be seen that starch with scattered white as a continuous phase in a dark matrix that seen as the black holes in the matrix. The existence of this hole likely caused mindless presence of air and water contained in starch. Increasing the amount of starch was added for the mixture, then the size and shape of starch and black holes growing in the SEM results. Increasing the size of the form of starch which was added, the smaller the surface area of the starch-bound plastic ores such as LDPE, thereforeby increasing starch incorporated into the matrix, the hole formed by the greater and more.

CONCLUSION

Sample of plastic shopping bags in supermarkets and retail stores can be categorized as conventional type of plastic bag, oxodegradable, and biodegradable. Written label on plastic bags do not all exhibit "environmental-friendly" as many of them are merely marketing piracy. From many physical tests that were done, it can be concluded that heating and ultra violet lighting to various type of plastic bags caused a decline in tensile strength and elongation value in almost every type of plastic bags. Biodegradable type of plastic bag has the biggest decline elongation (79.67%) compared to oxodegradable (52.43%) and conventional (54.59%). From FTIR,it can be concluded that there are visible absorption on 3367,71 cm-1, this shows the typical character of OH group in starch structure only in biodegradable type of plastic bag. From ten weeks of burial test , it can be concluded that conventional plastic bag does not undergo changes/degradation. However, there was one sample of oxodegradable that started to degrade in week 10. The ones with biodegradable labels started to degrade since week 2, except for the "GL" plastic bag. From AAS metal analysis, all types of plastic do not contain significant level of Fe, Co, and Mn.. From SEM analysis result , there are morphological differences of several types of plastic shopping bags that have "ecofriendly" labels

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