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The Biodegradation Study of Polyurethane Foam Mixed with Local Additives

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Abstract
In this paper, three types of local additives including ash, powder of peel garlic and powder of cooked tea leaves are used. These additives are usually considered as a waste, so this research was based on the principle of using recycled waste to improve the properties of polyurethane foam. Three different weights ranged between 1 g to 17 g mixed with polyurethane were prepared for (1:1) weight ratio of polyol and isocyanate. All samples which mixed with these additives above had been cut to specific forms. The biodegradation of the polymers mixed with these additives had been studied by burial them in three types of soil such as: clayey, sandy and river soil. The burial process continued in the soils for 100 days. The biodegradation of samples had been calculated through measuring the difference in weight before and after the burial. The results showed that there was a kind of simple biodegradation resulted from the addition of these local cheap additives.

1- Introduction

Plastics hadwidely used because of its a high electrical insulation and chemically inert. Recent studies hadpaid attention to a degradation as one of a degradation methods which occurs during using it in outdoor, the agriculture areas, the coast of the seas and public parks. Plastic degrades and then dissociates in the presence of microorganisms such as bacteria and fungi, so it loses applied propertie[1- 5].

Biodegradation is affected by many factors including the chemical structure of the plastic, physical and chemical properties, humidity of the environment, nature of the surface, especially including hydrophobic and hydrophilic of water, the stereochemistry, molecular systematic and the type of soil whether (agricultural or coastal or swampy areas) [6- 7].

There are more than 200 species of bacteria that can attack the plastic in the soil. Studies hadshown that the plastic which used in agricultural field, faces several types of degradation such as optical and thermal degradation and this leads to surface oxidation of the plastic then degraded it [8-10].

Several studies on biodergradation hadbeen conducted using microbiology as an environmental way required for the disposal of plastic waste rather than burning or destroyed [11- 14]. Microbiology (bacteria, fungi) has been used as an environmental solution to dispose of tons of enormous waste resulted from human use as an example of recent studies in biodegradation in the field of degradation of polyester and polycarbonate [15-16]. In this study, three types of soil hadbeen made use to study the biodegradation of polyurethane mixed with three types of local additives including (ash, powder of peel garlic and powder of cooked tea leaves) to determine the effect of these additives on the biodegradation.

2- Experimental and Procedure :

2-1-Materials

1. Peel garlic powder consists of (sulfur compounds. Total carbohydrate content 26.58%. Total cellulose content in garlic skin 18.62 %. Total protein content in garlic skin approximately 0.4%).
2. Powder of cooked tea leaves which consist of (polyphenols, antioxidants and theophylline).

2-2- Measuring of Biodegradation

Fig.1 Pot burial samples

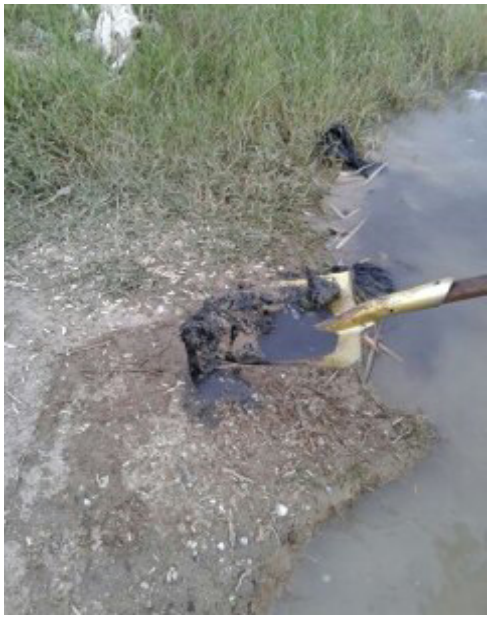


Fig.2 River soil

The samples of polyethylene, were mixed with the three local additives, (ash, peel garlic powder and tea leave powder) hadbeen prepared [(1)]. The samples were cut into circular discs, diameter of (4 cm) . These additives were used as a filler to this polymer, had been brought from a household rubbish, and then ground these additives by an electric mixer to get a powder of tea leaves and garlic peel while the ash had been processed by sieve (400≥μμ). After that, the additives, hadthe following weight ratios (1, 0.3, 0.5, 0.10, 0.17)gm, had been added into cups of plastic and mixed gradually with polyethylene with continuous mixing for fifteen minutes until becoming dried and hard as shown in the figures belowin figure (2).

Figure (2). The Prepration of Modified Polyurethane Foam

2-3-Preparation of pure polyurethane mixed with local additives

Fig. (3) Sample of polyurethane mixed with local additives

3- Results and Discusion

3-1- Study of the degradation of polyurethane mixed with local additives

The biodegradation of polyurethane mixed with ash, peel garlic powder and tea leave powder, as well as pure polyurethane, this characteristic had been studied through two things:

1- The morphology
2- Calculating changes in the weights of discs used before and after the burial in the soil

A-The biodegradation of polyurethane mixed with powder of peel garlic buried in sandy soil:

This bacterium had caused a clear change in the structure of the plastic and obvious scars on the surface in addition to the appearance of halos or rot like black spots.

1- In clay soils
   The scar on the surface of discs had been noticed.
2- In the soil of river banks
   It has been noticed scars on the surface of discs in addition to a change in the color were the edges of the disk to almost orange color.
   The change in the composition of the discs and the weight before and after the burial gives a clear evidence for a simple degradation of the polymer this is so-called biodegradation.

3-2- Biodegradation of polyurethane mixed with black tea leaves powder

Study the results of change in the discs shape of polyurethane mixed with the powder of black tea leaves in the soil of sand had shown large scars on the disk surface with a bit of dark circles. These scars can be seen on the surface of the discs buried in the soil of clay as well as polyurethane discs buried in the soil of the banks of the

river. These scars can be notice with a change in the color of the edges of the disk to orange.

3-3- Biodegradation of polyurethane mixed with ash

The discs of polyurethane mixed with ash in different types of soil had been shown appearance scars on its surface and there was no change in the color.

The decreases in the general weight that were recorded through a very sensitive balance illustrated that happened because of the fact that the bacteria were fed from it, because the plastic has units in its structure which competes with the carbohydrates or it has similar units includes carbon, hydrogen and oxygen.

Figures (4a-4e) illustrate the discs of polyurethane after extraction from the soil. Tables (1-10) show the weight changes of these discs before and after the burial in the soil.

Table (1) weight distribution before and after the biodegradation of pure polyurethane

Sample	WB	WA	WD
P1	2.892	2.999	0.107
P2	2.455	2.495	0.04
P3	2.307	7.392	7.389
P4	4.051	4.159	0.108
P5	2.582	2.619	0.037
P6	3.039	3.795	0.756
P7	2.048	2.093	0.045
P8	2.252	2.277	0.25
P9	1.914	2.149	0.235

Table 2 weight distribution values before and after the biodegradation for polyurethane mixed with peels garlic in the soil of sand

sand/ Garlic	WB	WA	WD
3 CL	3.523	3.551	0.028
4 CL	2.815	2.889	0.074
5 CL	3.011	3.074	0.063
1 CL	2.122	2.150	0.028
2 CL	3.384	3.511	0.127

Table (3) weight distribution before and after the biodegradation of polyurethane mixed with peels garlic in clay soil

clay/ Garlic	WB	WA	WD
1C2	1.409	1.445	0.036
2C2	2.859	2.831	-0.028
3C2	2.454	2.462	0.008
4C2	2.159	2.151	-0.008
5C2	1.884	1.888	0.004

Table (4) Weight distribution before and after the biodegradation of polyurethane mixed with peels garlic in the soil of water river banks

Garlic sewage	WB	WA	WD
1C3	1.556	1.406	1.554.5-
2C3	2.562	3.128	0.566
3C3	1.875	2.258	0.383
4C3	2.486	2.761	0.275
5C3	2.181	2.391	0.21

Table (5) Weight distribution values before and after the biodegradation of polyurethane mixed with ash in the soil of sand

Sand/ Ash	WB	WA	WD
1A1	2.975	2.033	0.924
2A1	5.129	4.294	-0.835
3A1	3.533	2.451	-1.082
4A1	6.323	6.474	0.081
5A1	2.964	2.043	-0.921

Table (6) Weight distribution values before and after the biodegradation of polyurethane mixed with ash in the soil of clay

Sand/ Ash	WB	WA	WD
1A2	1.161	0.048	-1.113
2A2	6.365	2.603	-3.762
3A2	3.116	1.993	-1.183
4A2	7.018	7.180	0.162
5A2	2.683	1.605	-1.078

Table (7) Weight distribution values before and after the biodegradation of polyurethane mixed with ash in the soil of the banks of the river

Sewages/ Sand	WB	WA	WD
1A3	1.596	0.631	-0.965
2A3	3.232	2.187	0.591
3A3	4.061	3.109	-0.952
4A3	3.213	1.614	-1.599
5A3	2.383	1.402	-0.981

Table (8) Weight distribution values before and after the biodegradation of polyurethane mixed with peels tea leaves in the soil of sand

Sand / Tea leaves	WB	WA	WD
1B1	3.972	4.041	0.069
2B1	3.030	3.237	0.207
3B1	4.424	4.622	0.198
4B1	2.252	2.494	0.242
5B1	1.419	1.538	0.119

Table (9) Weight distribution values before and after the biodegradation of polyurethane mixed with peels tea leaves in clay soil

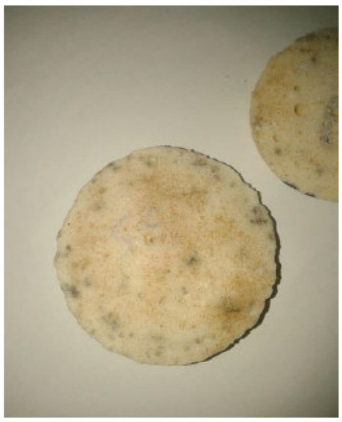
Clay/ Tea Leaves	WB	WA	WD
1B2	3.579	3.555	-0.024
2B2	2.66	2.637	-0.942
3B2	3.906	3.825	-0.081
4B2	1.782	1.829	0.047
5B2	2.092	2.088	-0.004

Table (10) Weight distribution values before and after the biodegradation of polyurethane mixed with peels tea leaves in the soil of the banks of the river

Clay/ Tea Leaves	WB	WA	WD
1B3	3.09	3.370	0.28
2B3	3.198	3.283	0.085
3B3	3.798	3.932	0.134
4B3	1.528	1.566	0.038
5B3	1.017	1.111	0.094

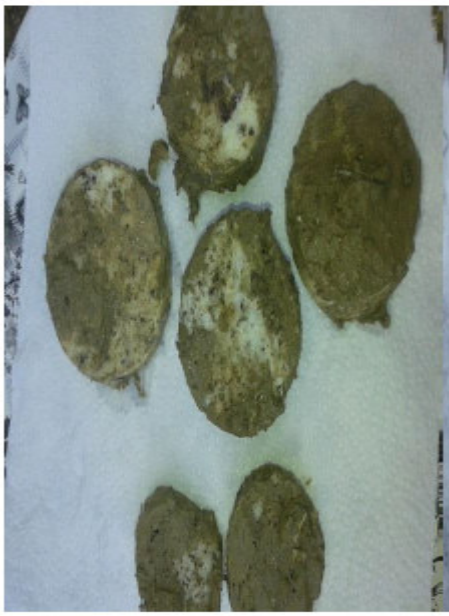
There was an increase in the weights of some discs after the burial due to the increase the proportion of molds and gatherings of microstructure on the surface of these discs. This indicates the beginning of the biodegradation process. The discs showed a mild decrease in weighting due to the decomposition of a part of the polymer or the surface of the polymer and its transformation to a low molecular weight polymer.

Fig(4a) Pu modified with peel garlic Burial in clay



Fig(4b) Pu modified with peel garlic Burial in sand

Fig(4c) Pu modifed with peel garlic Burial in river soil



Fig(4d) Pu modified with cooked tea Burial in river soil

Fig(4e) Pu modified with cooked tea Burial in clay

4-Conclusion

The obtained results revealed that both the addition of local additives and the soil type affcted the biodegradation ability of polyurethane foam.The biodegradation ratio was much related to both the type and the ratio of additive.The peel garlic had the faster effect on thebidegradation of polyurethane foam due to powder of cooked tea leaves and ash. The depth of burial tank also affected the biodegradation where much depth means more pressure, wide soil area and more moisture theprtically leading to much biodedradation.

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