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The Effects of Olive Pomace Ash on The Color Change of The Composite Material and Its Mechanical Properties

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ABSTRACT

The purpose of this study is to apply olive pomace ash (Prina ash), which is the remaining pulp after the pressing of olives, to a plastic material. Prina particles transformed into the ash were mixed in Polypropylene (PP) polymer with a weight ratio of 0%, 1% and 3% and then molded in the injection machine. Tensile-Stress Test, impact test, SEM images and color change measurements were carried out with produced samples. The effects of prina ash ratio on the color change and mechanical properties were investigated for the availability of Prina. As a result, it was determined that an increase in prina ash ratio caused an increase in both color change and mechanical properties of the material.

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INTRODUCTION

The wastes of the factories, which manufacture olive oil, one of the important product materials of our country, pollute the environment. Recycling of the wastes, which pollute the environment, is recently the goal of the environment friendly technologies. The pollutions consisting of various industrial wastes have increased nowadays and caused pretty important environmental problems. The wastes occurred in the olive oil factories generally in Mediterranean countries are one of the important pollutants of the agricultural industry. The olive oil factory waste includes organic substances such as nitrogenous compounds, toxic substances, sugars, organic acids and waste oil, which have commercial importance [1]. Olive pomace is a product consisting of the remaining seed, rind and pomace after the oil is extracted from the olive. The oil and moisture content of the obtained olive pomace changes depending on the applied procedure after the oil extraction process [2].

Olive pomace oil output obtained after getting the olive oil is directly linked to the olive oil production since it is a secondary oil. Even though the olive pomace and olive pomace oil depends on the olive growing technique, climate, soil, variety features and the technology used for the olive handling, the olive pomace obtained weigh around one and a half or two times more than the output of the olive oil produced at the olive oil factories. The olive pomace production in Turkey depends on the olive production and it is known that this value is 200000-250000 ton per year [3]. Even though the handling style of the olive oil factories changes the content of the olive pomace, oily olive pomace contains approximately 6-8% oil and 20-30% moisture [4].

The olive pomace can be used as fertilizer, as the feed for the bovine animals and even as the admixture material for the road construction when mixed with bitumen and it is used most commonly as the fuel due to its high-energy content [5].

There are many scientific studies on the use of prina. In these investigations, feeding of Lambs [6], obtaining Biosurfactant [1], drying [7], cement production [8] were studied.

In this study, the application of the olive pomace ash to the plastic material is intended. The olive pomace particles which were converted to the ash is mixed with Polypropylene (PP) polymer over the range of 0%, 1%

and 3% and Tensile-Strain Test, Hit-Test, SEM images and Color Change measurements are applied. The effects of the olive pomace rate change on the change at the resulting color values and the mechanical features are examined.

MATERIAL AND METHOD

The olive pomace used for the tests is obtained from a factory in Balıkesir city. The olive pomace material is shown in Fig. 1. The first moisture of the procured Olive Pomace material according to the wet base is determined as 50%.

Figure 1. Olive pomace example

The olive pomace is converted to the ash according to ASTM E1755-01 standards by using Nüve MF 106 (max. 1100 °C temperature, max.2 kW power and 6.3 l internal volume, Turkey) model ash furnace. The olive pomace, which is an olive waste, reached up to 250 °C with 10 °C/min in the ash furnace and it was kept here for 30 minutes. After this process, it is kept at 575°C by 10°C/min step for 3 hours. As a result, the ash process is carried out by cooling to 100°C. Petoplen MH 418 product belonging to PETKIM A.Ş. is used as the homopolymer material. The features of the product are as shown in the Table 1.

Olive pomace and PP materials were mixed at 40 rpm for 60 minutes by means of a mixer bunker before they are formed in the injection machine. Mixed test materials were produced by the help of the injection machine in the mold with 220-235 °C screw temperatures and in 38 sec.

Tensile features of the prepared samples were performed by applying the tensile tests by using the jaws of the equipment at a constant speed. Accepted plastic standard was given in [9] for the tests which the equipment force measurement range is between 500 N and 10 kN. Izod-Charpy testing setup was used for impact tests of the composite materials formed by using the ash additives. The plastic standard impact tests were performed according to [10]. The images of the prepared plastic samples were taken by using FEI brand Quanta FEG 256 model scanning electron microscope. In order to define the color changes of the samples, ASTM 6290-05e1 [10] standard is used.

Table 1. Petoplen MH 418 tensile values

Test Name	*Unit*	*Value*	*Method*
Tensile Strength at Yield Point	*kg/cm²*	*350*	*ASTM – 638*
Tensile Strength at Breaking Point	*kg/cm²*	*430*	*ASTM – 638*
Color B 10 D 65	*-*	*1.8*	*Hunter Lab. CQ*

Color Measurement

In this study, D25LT Hunter Lab (USA) model color measuring instrument is used. L*, a*, b* color scale numerical values are given at each reading of the colorimeter. The measurements are repeated for 10 times and the arithmetic mean of the results is taken. L* value represents the blackness and the whiteness which show the brightness. 0 value represents the blackness and 100 value represents the whiteness. A* color scale is known as the redness value. While the positiveness of the a* values represents the redness, the negativeness of the a* values represents the green color. B* color scale is known as the yellowness/blueness value. While the positiveness of the b* values represent the yellowness, the negativeness of the b* values represents the blueness. C value defines the color density (Eq.1) and H defines hue angle (Eq.2) [12]:

$$C = \sqrt{a*^2 + b*^2} \quad (1)$$

$$H = \arctan \frac{b*}{a*} \quad (2)$$

RESULTS AND DISCUSSION

The test specimens with mass of 1% and 3% ash as additive were produced in the temperature range of 220-235 ° C by means of plastic injection machine. The composite materials produced using pomace ash were removed by ejector pin and allowed to cool to room temperature and then made suitable for the tests. Test samples produced by means of plastic injection are listed according to their contribution rates and are given in Fig. 2.

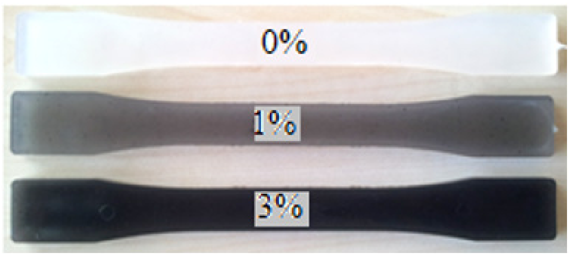

Figure 2. With and without ash added plastic material samples

Table 2. The color values of the plastic material sample

Ash content rate, %	L*	a*	b*	C	H
0	33.31±0.3	1.86±0.4	-0.20±0.2	1.87	353.74
1	5.75±0.4	-3.47±0.3	-9.89±0.4	10.48	250.67
3	0±0.1	-5.21±0.3	-10.39±0.3	11.62	243.34

±: standard deviation

The results obtained by the additive-free produced plastic sample (0%) and the results obtained by 1% and 3% added samples are compared. The color parameters of the resultant plastic samples are given in Table 2. It shows that the micro mixture in the material has an important effect by the increase in the ash rate. It is observed that the brightness value (L*) decreases and the sample turns to black color by the increase in the ash rate. It shows how good the brightness value (L*) is distributed as the micro dispersion for painting the polymer material with olive pomace.

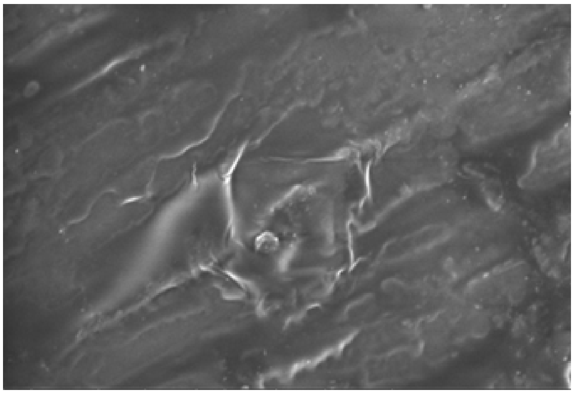

Figure 3. SEM images of the additive-free produced plastic material, 100000x

Interface band images of the polymer materials are shown in Fig. 3-5, which are taken by using Scanning Electron Microscope (SEM) at 100000x magnification rate. The color change results and SEM images give the effects of the distribution of the ash rate in the material and the interface connection. When SEM images taken from the experimental samples were examined, it was seen that the interfacial bonds formed high interaction with the additive material

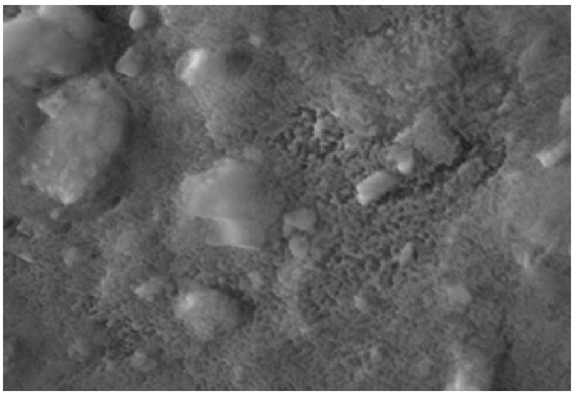

Figure 4. SEM images of the plastic material produced by adding 1% ash, 100000x

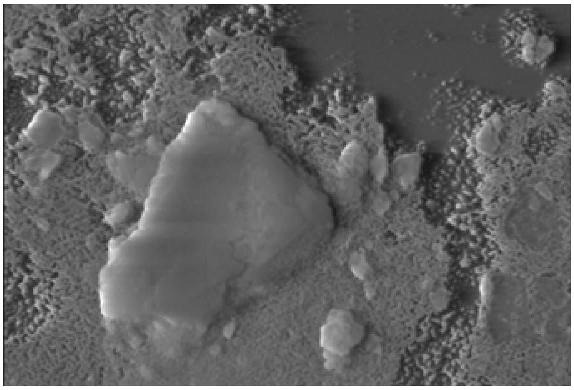

Figure 5. SEM images of the plastic material produced by adding 3% ash, 100000x

and produced a homogeneous distribution throughout the material. As the additive ratio increased, it was determined that the distribution and clusters within the matrix were more frequent and the surface area within the unit was larger. This situation caused the color intensity of the material to increase.

Table 3. Tensile test results

Content rates %	L*	a*	b*
0	1479.50±0.2	56.01±0.1	9.71±0.2
1	1490.58±0.3	60.53±0.1	9.39±0.1
3	1542.17±0.3	69.69±0.3	9.39±0.2

The tensile tests for three different samples with 50 mm/min tensile speed are carried out according to ISO 527-1 standard. The obtained results are given in Table 3 and tensile-force graphic is given in Fig. 6.

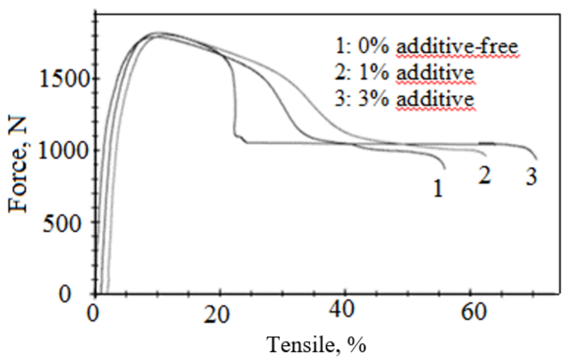

Figure 6. Tensile-Force Diagram applied on three different sample

As a result of the tensile test on the material, it is seen in Table 3 that there is an increase in E-module and the breaking elongation along with the increase in the olive pomace ash. It is thought that the reason for this increase is functioning of the olive pomace in the composite material as the reinforcement element. However, when the received results are examined, it is determined that the differences of the results of the tensile tests between the samples are at minimum level. The increase in the breaking elongation shows that the interface connection between the polymer, which functions as the matrix material and the ash olive pomace is strong.

The results of the experiments obtained from the tensile specimens, the density of the additive material in the composite and the effect of the interfacial bond formed by the additive on the modulus of elasticity of the material increased.

The results of the impact tests performed at different temperatures are given in Table 4. It is determined that the breaking difference between the test temperatures decreases as the content rate increases. This situation shows that the olive pomace additive partially ensures the interface connection between the plastic material and the heating insulation. Besides, it is obvious that the used olive pomace additive decreases the toughness of the plastic material.

Table 4. The results of the impact test applied to three different samples at different temperatures

Test temperature, °C	*The results of the impact test, J*		
	0%	*1% additive*	*3% additive*
-10	*1.34 ±0.01*	*1.28±0.01*	*1.04 ±0.01*
20	*6.56±0.01*	*4.71±0.01*	*3.07 ±0.01*

It is an original study since it has not been worked before. Therefore, no comparison was made with other studies.

CONCLUSION

The following results are obtained at the study:

(1) It has seen that the E module and the breaking elongation increase as the olive pomace ash increases. The reason for this is the increase of the distribution density of the additive material in the matrix and the increase of the surface area of the interfacial bond with the plastic matrix.

(2) The energy value increases as the temperature increases. This situation shows that the heat insulation can be obtained by using the olive pomace ash.

(3) When the color changes of the composite materials and the findings obtained from the SEM images are compared, it is observed that the olive pomace waste increases in PP content along with the color rate of the interface connection formations. In return for this, it is determined that the breaking surfaces of the material increase.

(4) The existence of the olive pomace particles, which increase the color change rate and the smooth distribution of the material, are found out from the image of the material and the results of the received color measurements. As a result of this, it has seen that the usage as the colorant in the material can be achieved easily.

(5) It has been determined that the dye properties of olive pomach reinforced materials can be reduced by decreasing the used masterbach ratio and reducing the ratio of waste material transferred to nature. The composite material produced can be used in the construction of simple household appliances.

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