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Investigation of the Carbonization Behavior of Olive Pomace

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Pomace is the solid residue obtained from the olive oil production process (during pressing or centrifugation). Pomace has a chemical content high in nitrogen, potassium, and low in phosphorus and carbon. This feature of pomace makes suitable the investigation of its usability in the reduction of metal oxides after carbonization. In this study, carbonization behavior of waste pomace was investigated for the searching of waste pomace instead of coke, which is one of the most important reducers in the reduction of metal oxides, or by mixing it with coke. For this purpose, the fixed carbon and sulfur content of the samples treated after the carbonization process were examined, and the most suitable carbonization test conditions were determined. In order to determine the optimum test parameters, the pomace that supplied from Marmarabirlik was placed in a metal crucible and carbonized in a muffle furnace at temperatures of 500, 600, 700 and 800 °C and for 1, 2, 4 and 6 hours. After carbonization XRF analysis was applied to the samples. When the analysis results are examined, the highest amount of carbon was recorded as 88.4% in the sample treated at 700 °C for 6 hours, and the lowest amount of sulfur was recorded as 0.003% in the sample treated at 800 °C for 6 hours.

Keywords: *Biomass, Pomace, Carbonization*

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1. Introduction

Pollutant emissions generated by the combustion of fossil fuels and given to the atmosphere create a greenhouse effect and cause climate change and adversely affect the environment. In particular, the use of poor quality local lignite with low calorific value and high ash and sulfur content increases air pollution. These negative effects increase the importance of using renewable energy sources. Today, developed or developing countries give priority to the use of different energy sources within their own possibilities [1].

The increasing pressure on natural resources, the rapid depletion of non-renewable resources and the problems created by waste piles have led to the acceleration of efforts to reduce the amount of waste and waste, to increase the efficiency of recyclable waste and waste, and to use resources effectively. Olive; It is one of the agricultural products with extremely important economic value in terms of oil production, fruit and waste. For many years, studies have been carried out on national and international platforms for the evaluation of wastes originating from olive processing and olive oil producing facilities. Studies especially focus on the purification of "black water" that comes out during oil extraction and the evaluation of "pomace" for various purposes [2].

Pomace is a waste of olive oil factories and is an important biomass seen in Mediterranean countries. It is a solid waste consisting of olive seeds and pulp remaining from olive oil production. It can be used as an important biomass fuel in terms of its content. 20-25 kg of olive oil and 40-45 kg of fresh pomace can be obtained from an average of 100 kg of olives. There are two types of pomace, depending on whether it is obtained from olive oil mills using traditional press or continuous centrifugation. These two types of pomace are distinguished from each other by the fact that they contain 25-30% and 45-55% moisture, respectively [3]. Olive pomace animal feed additive is used in growing horticultural crops, strengthening the soil, producing activated carbon and in many areas as fuel [4].

Carbonization is a process in which the basic pore structure is formed as a result of burning the cross-links between the carbons of the carbonaceous raw material in an oxygen-free environment and removing a significant part of the moisture and volatile matter in the raw material in an inert environment. Some of these pores are initially unusable due to the pyrolysis products formed, but can be reused by applying high temperature. Such factors affect the quality and activation of the final product. As a result of carbonization, the ash content of the product increases relatively according to the carbon content of the product and the properties of the mineral substance [5].

Carbonization solid product: Directly as fuel; Cooking, Heating, Tobacco drying, Mixture as fuel; Solid-water mixtures, Solid-fuel mixtures, Solid-vegetable oil based fuel mixtures are used as fuel by briquetting. For metallurgical purposes; It is used in Copper production, Brass production, Cast iron production, Steel production, Nickel production, Aluminum production, Armored plate production, Forged plate production. In the chemical industry; It is used in many areas such as activated carbon, carbon black, carbon disulfide, calcium carbide, silicon carbide, potassium cyanide, carbon monoxide, medicine, crayon, soil improvement and heat treatment. Properties that are important for usage areas can be listed as casting density, ash content, sulfur content, volatile matter content, porosity, surface area, calorific value, hardness and grindability [6].

This study constitutes the first stage of usability of waste pomace instead of coke, which is one of the most important reducers in the reduction of metal oxides, or by mixing it with coke. For this reason, the fixed carbon and sulfur content of the samples treated after the carbonization process was examined and the most suitable carbonization test conditions were determined.

2. Experimental

In the experimental studies, pomace obtained from MARMARABIRLIK facilities and containing 53.2% C and 0.006% S was used. Pomace was placed in a specially designed metal crucible and subjected to carbonization at varying temperatures and times. In Figure 1, the design of the specially designed metal crucible used in carbonization studies is given.

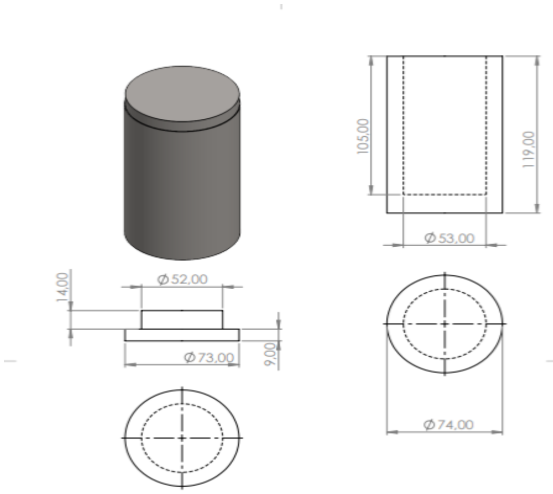

Figure 1. Metal Crucible Used in Carbonization Experiments (Measurements are in mm)

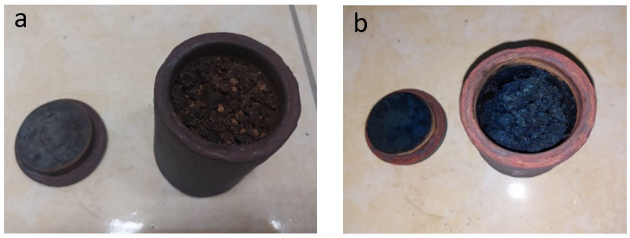

Figure 2. a) Image of pomace before carbonization b) Image of pomace after carbonization

The pomace was first dried at 80 ºC for 24 hours. Redwag MAC 110 brand moisture measuring device was used to determine the moisture content of the dried material. The moisture content of the material was determined as 1.45%. Then, the dried sample was weighed in certain weights and placed in a specially made metal crucible (Figure 1) and carbonized in the NUVE MF 201 brand muffle furnace at different temperatures and at different times. As a result of the experiments, it was observed that the material lost approximately 70-76% in weight. In order to determine the %C and %S amounts of the samples obtained from the carbonization processes, the C-S amounts were examined in the Rigaku Primus IV brand XRF device.

Figure 3. a)Moisture Device b)Muffle Furnace

3. Results and Discussion

The pomace obtained from Marmarabirlik facilities was subjected to carbonization process at 500, 600, 700 and 800 ºC temperatures and for 1, 2, 4 and 6 hours and the fixed carbon-sulfur content was investigated. Components such as fixed carbon and sulfur contained in the reducing element play a very important role in the reduction of metal oxides. Öztürk et al. (2020) stated that they use the carbonized tea plant wastes as a reducing element and they produce iron grains with an alternative method [7].

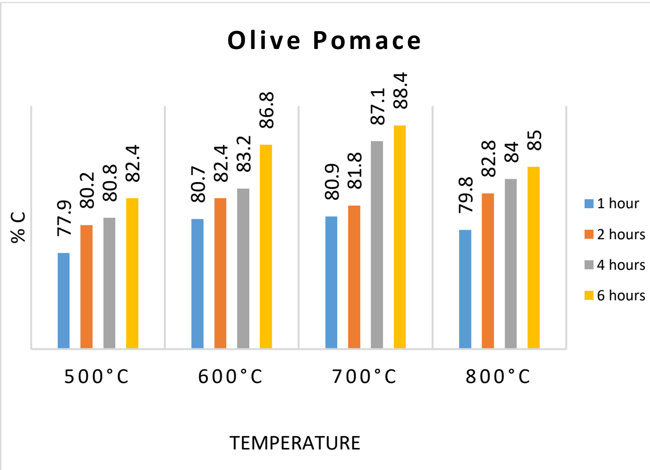

Figure 4. Carbon Content of Samples That Carbonized at 500-800 ºC Temperature for 1-6 Hours

In the processes performed at 500, 600, 700, 800 ºC temperatures, it was observed that the amount of carbon increased in parallel with time and temperature. The highest amount of carbon in the obtained samples was observed with 88.4% in the sample, which was subjected to carbonization process at 700 ºC for 6 hours. The lowest carbon content was observed in the sample treated at 500ºC for 1 hour. Before the carbonization process, the carbon content of the pomace is 53.2%. With the carbonization process at 700 º C temperature for 6 hours, an increase of 66% was observed in the amount of carbon.

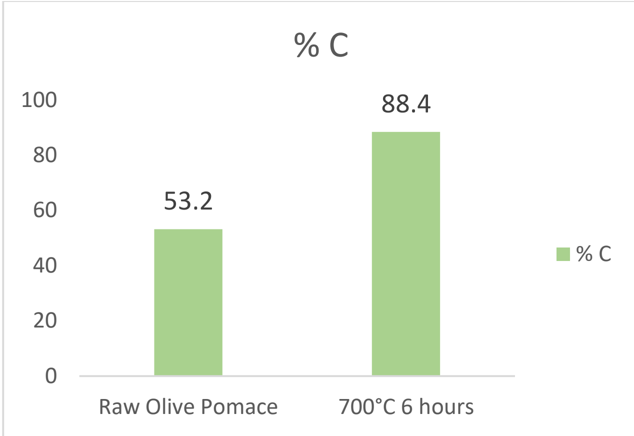

Figure 5: The Carbon Contents of Untreated and 700 ºC 6 hours Carbonized Pomace Samples

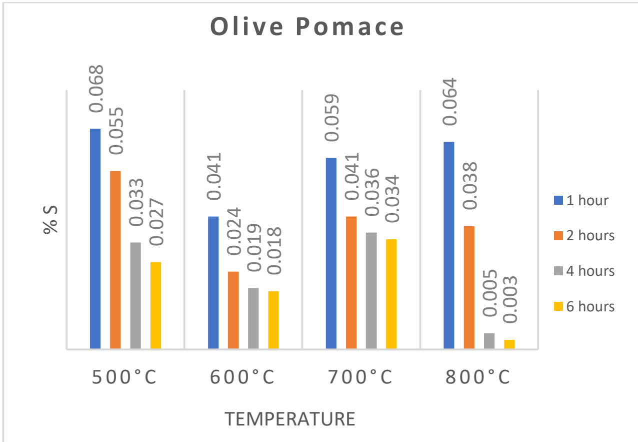

Figure 6. The Sulphur Contents of Carbonized Samples at 500-800 ºC Temperature for 1-6 Hours

In the processes carried out at 500, 600, 700, 800 º C, decreasing was observed in the amount of sulfur with the increase in time and temperature. The lowest amount of Sulphur that 0.003% in the samples subjected to carbonization process at a temperature of and 800 ºC for 6 hours. The highest sulfur content was observed in the sample treated with 0.068% to 500ºC for 1 hour. Before the carbonization process, the carbon content of the pomace is 0.006%. A 50% decrease in the amount of carbon was observed with the carbonization process at 800 º C temperature for 6 hours.

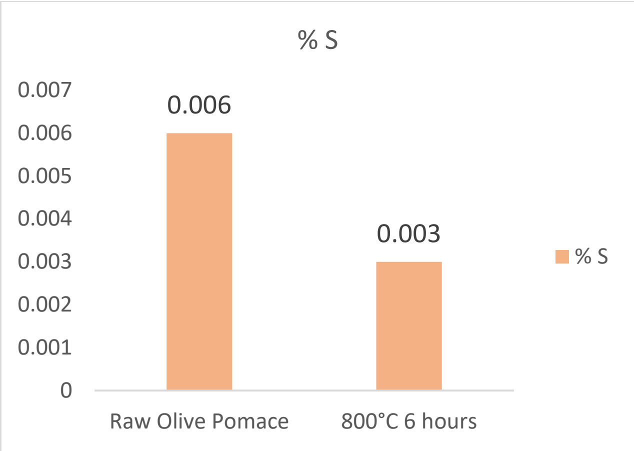

Figure 7. The Sulfur Contents of Untreated and 800 ºC 6 hours Carbonized Pomace

4. Conclusions

In this study, it is aimed to obtain the fixed carbon value required for the reduction of metal-oxide components after carbonization of pomace, which is characterized as waste, at different temperatures and times. The pomace obtained from Marmarabirlik facilities and containing 53.2% C and 0.006% S was carbonized and its fixed carbon and sulfur content were checked.

In the samples that were carbonized for 1, 2, 4 and 6 hours at 500, 600, 700 and 800 ºC temperatures, a decrease of approximately 42.37% in the sulfur ratio was observed in the 700 ^{O}C test samples where the highest carbon ratio was obtained. The greatest reduction in sulfur content was observed in the sample which was treated at a temperature 800 ºC for 6 hours with %50 reduction.

The carbon and sulfur content of the sample, which was treated at 700 ºC for 6 hours, was 88.4%, and the sulfur content was 0.034%, respectively. A mass loss of 75.1% was observed in the sample, which was treated at 700 ºC for 6 hours.

According to the results obtained in the carbonization of pomace, the optimum test temperature was determined as 700-800 ºC, and the optimum test time was 6 hours in order to obtain carbonized pomace with high carbon and low sulfur content.

Components such as fixed carbon and sulfur contained in the reducing element play a very important role in the reduction of metal oxides. The fixed carbon ratio in coke varies between 85% and 88%. The fixed carbon and sulphur contents of the samples obtained after the carbonization processes of pomace are considered promising.

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