

ANALYSIS OF WOOD ASH COMPOSITION AND ITS POTENTIAL APPLICATIONS IN PURIFYING VEGETABLE OILS



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Abstract *The composition of wood ash was analyzed to identify its main components. The research results indicated that wood ash contains high amounts of potassium (K), calcium (Ca), silicon (Si), and other beneficial minerals. This article discusses the analytical analysis of ash composition and its role in the cost-effective purification of vegetable oils.*

Keywords: *Wood ash, alkali, coagulant, precipitate, refining, acid number, color index, temperature.*

Introduction

Currently, the quality purification of vegetable oils is one of the important issues. Due to the high cost of traditional chemical reagents and the environmental problems they cause, there is a growing interest in inexpensive reagents derived from natural sources. Studying the composition of wood ash and exploring its potential applications in the oil purification process hold significant scientific and practical importance.

Methodology

During the research, the composition of wood ash was analyzed using the NEX CG X-ray fluorescence (XRF) spectrometer. This method offers high sensitivity in determining the elements within the material, providing quick and accurate results. The research consisted of the following stages:

1. **Sample Preparation** – Wood ash samples delivered to the laboratory were dried, ground, and placed into standard test containers.

2. **Analysis Process** – The chemical composition of the samples was measured using the X-ray fluorescence spectrometer. The mass percentage of each element was determined.
3. **Data Analysis** – The obtained results were statistically analyzed, and the roles of the constituent elements in the oil purification process were evaluated.
4. **Purification Process** – Vegetable oils were treated with 5% wood ash, and alkaline neutralization was performed. During the neutralization process, the initial temperature was 30°C, which was then increased to 55°C. After purification, the acid value of the oil was measured, and a decreasing trend was observed.

Acid Number Determination Method

The acid number of the oil was determined using a titrimetric method in accordance with the GOST 31756-2012 standard. In this method, the oil sample is dissolved in a mixture of ethanol and diethyl ether, and titrated with a KOH solution using phenolphthalein as an indicator. The color change observed at the titration endpoint allows for the calculation of the acid number.

Oil Color Measurement Method

The color characteristics of the oil were determined using Lovibond equipment. This method measures the optical density of the oil through red, yellow, and blue filters. Changes in color indicators under the influence of temperature were observed, and the effects of optimal temperature and time parameters on oil quality were evaluated.

Results and Discussion

Analyzed result

Sample Information

Sample name	Kul
File name	Kul
Application	Umumiy.
Date	2025/ 2/14 15:27
Analyzed by	
Counts	1
Comment	

Analyzed result (FP method, Scatter)

No.	Component	Result	Unit	Stat. Err.	LLD	LLQ
1	Cl	5.24	mass%	0.0041	0.0020	0.0060
2	Br	0.0029	mass%	<0.0001	<0.0001	0.0002
3	Mg	3.89	mass%	0.0372	0.0476	0.143
4	Al	1.71	mass%	0.0126	0.0145	0.0436
5	Si	6.23	mass%	0.0125	0.0068	0.0204
6	P	1.37	mass%	0.0041	0.0046	0.0138
7	S	2.33	mass%	0.0038	0.0038	0.0113
8	K	16.7	mass%	0.0298	0.0049	0.0146
9	Ca	10.9	mass%	0.0240	0.0183	0.0548
10	Ti	0.127	mass%	0.0017	0.0014	0.0043
11	Cr	(0.0016)	mass%	0.0002	0.0006	0.0017
12	Mn	0.0392	mass%	0.0010	0.0007	0.0022
13	Fe	1.05	mass%	0.0031	0.0010	0.0031
14	Ni	0.0032	mass%	0.0002	0.0003	0.0009
15	Cu	0.0076	mass%	0.0002	0.0002	0.0006
16	Zn	0.0844	mass%	0.0006	0.0002	0.0006
17	Ga	0.0008	mass%	<0.0001	0.0002	0.0005
18	As	(0.0005)	mass%	<0.0001	0.0002	0.0006
19	Rb	0.0067	mass%	<0.0001	<0.0001	0.0002
20	Sr	0.159	mass%	0.0004	0.0003	0.0008
21	Y	0.0012	mass%	<0.0001	0.0001	0.0003
22	Zr	0.172	mass%	0.0013	0.0005	0.0014
23	Ag	0.0012	mass%	0.0001	0.0002	0.0006
24	Su	0.0019	mass%	0.0001	0.0003	0.0009
25	Ba	0.0177	mass%	0.0007	0.0016	0.0048
26	Ta	(0.0015)	mass%	0.0005	0.0014	0.0041
27	Pb	0.0039	mass%	0.0001	0.0002	0.0006
28	Fr	(0.0005)	mass%	0.0001	0.0003	0.0010
29	Dy	(0.0097)	mass%	0.0018	0.0051	0.0152
30	U	0.0014	mass%	0.0001	0.0003	0.0008

Figure 1. Mass percentages of elements

Figure 1 presents the mass percentages of the constituent elements identified based on the spectrograms of ash samples. The quantitative composition of the identified elements is distributed as follows:

- **Major Elements:** Compounds such as Si, Ca, K, Mg, and Fe constitute the main portion of the ash composition.
- **Transition Metals:** Elements like Mn, Ti, V, Ni, and Zn are present in trace amounts, possibly depending on the raw material source of the ash.
- **Rare and Heavy Metals:** Elements such as Pb, As, U, and Ba were detected in trace amounts, which may be related to the nature of the material from which the ash was derived and the combustion conditions.

The composition was determined using X-ray fluorescence spectrograms obtained with the Rigaku NEX CG EDXRF Analyzer. This spectrogram displays the emission peaks of various elements, and the constituent elements were identified based on their intensity and energy levels.

The spectrogram includes characteristic spectra of the following elements:

- Light elements such as Mg-K α , Si-K α , P-K α , S-K α , Cl-K α , K-K α , and Ca-K α are located in the low-energy range.
- Transition metals like Ti-K α , V-K α , Cr-K α , Mn-K α , Fe-K α , Ni-K α , Cu-K α , and Zn-K α have spectra in the medium-energy range.
- Heavy elements such as Pb-La, As-K α , U-La, and Ba-K α are observed in the high-energy range.

This analysis was used to identify the main elements in the ash composition, which directly influence the physicochemical properties of the ash.

These analyses help in a thorough study of the ash composition and in evaluating its potential applications in industrial or environmental purposes. The results of Figures 1 and 2 serve as a basis for drawing additional conclusions in the subsequent stages of the research.

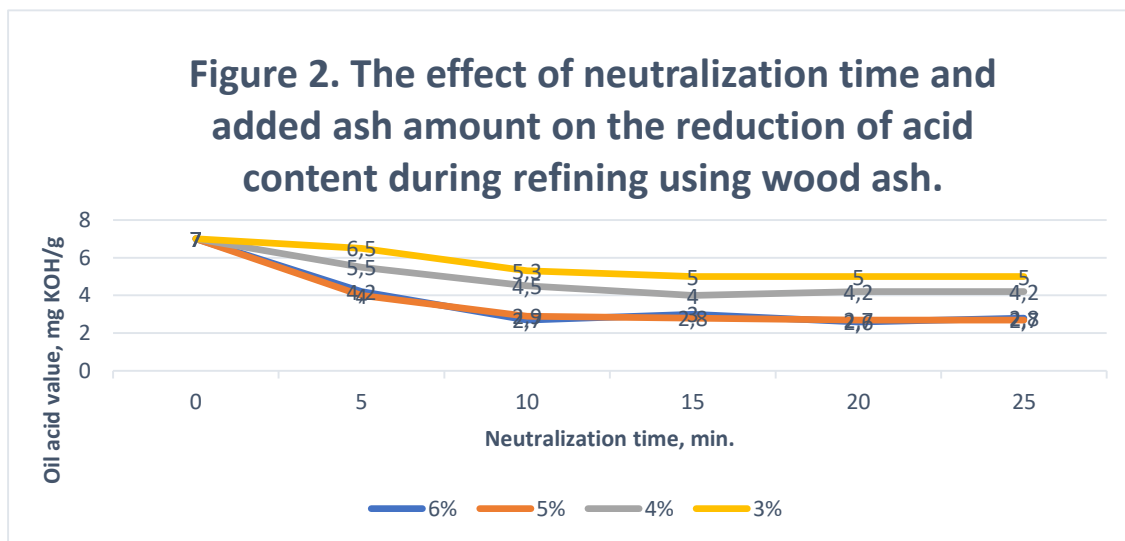
According to the analysis results, the main components of wood ash are as follows:

- Potassium (K) - 16.7%
- Calcium (Ca) - 10.9%
- Silicon (Si) - 6.23%
- Chlorine (Cl) - 5.24%
- Magnesium (Mg) - 3.89%
- Sulfur (S) - 2.33%
- Phosphorus (P) - 1.37%

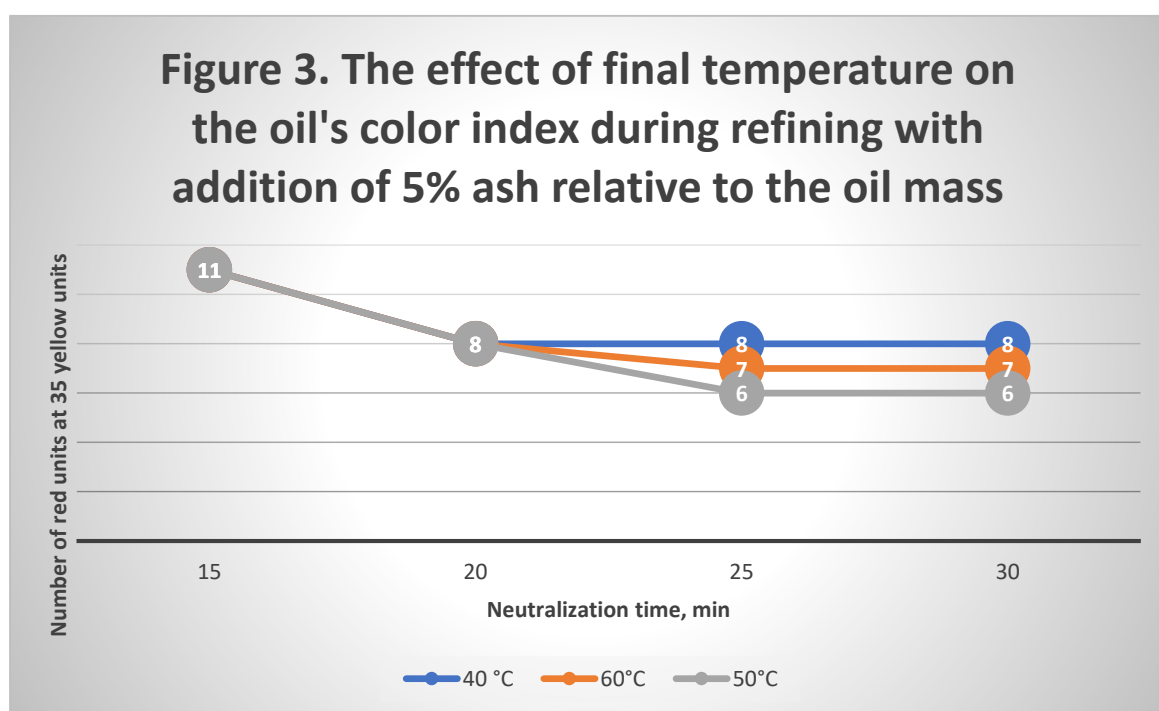
These elements are significant in the neutralization and adsorption processes of vegetable oils. Specifically:

- **Potassium (K) and Calcium (Ca):** Useful for neutralizing free fatty acids and reducing phospholipids in the oil composition.
- **Silicon (Si) and Aluminum Oxides (Al₂O₃):** Can be used as adsorbents in the decolorization and purification processes of oils from harmful impurities.

- **Sulfur (S) and Chlorine (Cl):** Help in reducing undesirable impurities in the oil composition.



As shown in **Figure 2**, the initial acid value of the oil was high, but significantly decreased upon application of wood ash during the neutralization process. A trend of decreasing acid value was observed with increasing neutralization time. Initially, the oil's acid value was 0.79 mg KOH/g, which dropped to 0.19 mg KOH/g after 20-



25 minutes, confirming the neutralizing properties of wood ash.

According to **Figure 3**, changes in oil color varied depending on temperature and neutralization time. The optimal temperature was determined to be 50°C and the optimal time 25 minutes. Under these conditions, the oil's color improved significantly.

Conclusion

The study revealed that wood ash contains components potentially beneficial for oil purification. The effectiveness of wood ash in reducing the acid value during the neutralization process was observed. Additionally, identifying optimal temperature and time parameters led to improvements in the oil's color and quality. Future laboratory tests are recommended to evaluate its application across various oil types.

Adabiyotlar

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