UTILIZATION OF WASTE COOKING OIL (WCO) FOR SOAP PRODUCTION: FEASIBILITY STUDY

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ABSTRACT

In the quest for sustainable and eco-friendly alternatives to address the growing concerns of waste cooking oil (WCO) disposal, this scientific study investigates the efficiency of various adsorbers and filtration methods for the purification of WCO. Activated carbon, bentonite, celite and zeolite were utilized to eliminate the odor and impurities from WCO to obtain purified oil that meets the requirements for soap production. The influence of adsorber/filtration media on purification was investigated. To evaluate the quality of purified oil, the Free Fatty Acid test and Peroxide Test were performed. The results obtained after the analysis of unused oil, WCO and purified WCO were compared. It was shown that increased contact time between activated carbon and WCO sample resulted in better odor and color removal. Peroxide value and free fatty acid value for WCO purified by activated carbon and different filtration medium (celite, zeolite and bentonite) were comparable to the ones obtained for pure cooking oil.

INTRODUCTION

It has been estimated that more than 15 million tons of waste vegetable oils are generated annually in the world [1], with Canada's contribution of 135 thousand tons [2]. Used cooking oil is considered as a hazardous waste if not disposed properly. According to the Environmental Protection Agency [3], vegetable oils, animal fats and their constituents can cause similar devastating effects on the environment, flora, and fauna as petroleum oils. Therefore, finding an effective waste management strategy is an important task for both academia and industry.

During the last two decades, a significant effort has been demonstrated to recycle and reuse WCO. Due to its composition, WCO can be used as raw material for the manufacturing of added-value products in different industry branches. Through saponification process, purified WCO can be used for bar soap production [4].

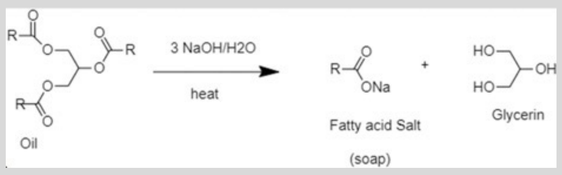
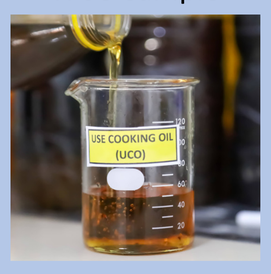


Figure 1 : Saponification reaction

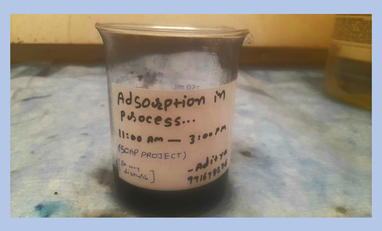
MATERIALS & METHOD

The materials utilized in this research included used canola oil from Bruin Café and environmentally friendly adsorbers: activated carbon powder, celite, bentonite and zeolite. Discolored and odorous cooking oil underwent purification treatment that included mixing 2g of activated carbon with 100 ml of oil. The mixture was stirred for 1h/3h/5h and then filtered using filter paper, along with celite, zeolite, and bentonite, to gauge purification levels. Between May and September 2023, research was undertaken at the Sheridan College Laboratory, Faculty of Applied Science and Technology.

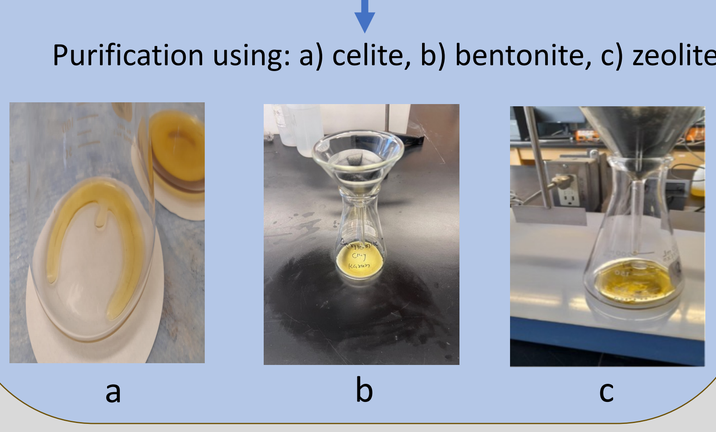
WCO sample



WCO sample + activated carbon



Purification using: a) celite, b) bentonite, c) zeolite



a b c

CONCLUSION

The possibility of purifying WCO to be used as a raw material for soap production was investigated. The efficiency of various adsorbance/filtration media was studied.

The pungent odor and dark brown color were removed using activated carbon. Increased WCO/activated carbon contact time resulted in better odor and color removal. Additional purification was achieved by filtering through celite/bentonite/zeolite.

%FFA and PV test values of WCO after purification indicate that the applied purification methods were effective in achieving required values characteristic for unused cooking oil.

ACKNOWLEDGEMENT

The research study was done under the supervision of Dr. Manju Sunil Varghese and Dr. Andjela Abu Rabi-Stankovic. Special thanks to Diana Wati, Lab Manager for providing lab space, Bruin Café for oil samples, and especially Nausheen Zehra for special support of providing materials and lab access.

RESULTS & DISCUSSION

Activated carbon was used to eliminate the odor and as a bleaching agent.

PEROXIDE VALUE TEST (PV)

To obtain PV, oil sample was dissolved in glacial acetic acid and ethanol solution. Upon addition of potassium iodide, the mixture was titrated with sodium thiosulphate solution, in the presence of starch as an indicator until the color changed from milky-white to blue. PV value was calculated using the formula [4]:

$$PV\left(\frac{meqO_2}{kg}\right) = \frac{V_{titrant} x N_{titrant} x 1000}{m_{sample(g)}}$$

%FFA VALUE TEST

The %FFA is determined by alkalimetry method. The procedure involved accurately weighing 5 grams of the cooking oil and adding 50 mL of isopropyl alcohol to the conical flask. Phenolphthalein indicator was added and then the analyte was titrated against 0.1 N NaOH solution until pink color appeared. The %FFA was calculated using the formula [4]:

$$\%FFA = \frac{V_{NaOH(ml)} x N_{NaOH} x 28.2}{m_{sample(g)}} x 100\%$$

Table 2: Comparison of PV and %FFA values

Sample type	% FFA value	PV value
Unpurified WCO	1.8	3.50
Pure unused oil	0.1-0.3	1-3
WCO purified through Celite	0.3	2.09
WCO purified through Zeolite	0.2	1.8
WCO purified through Bentonite	0.2	1.9

Unsaturated oils and fats become rancid by oxidation, forming peroxides. Thus, peroxide value (PV) is used for measuring the degree of oxidation of the fat/oil. The content of FFA determines the degradation during storage and can affect the emulsion properties of soap. Table 2 shows that the PV and %FFA values obtained for WCO samples treated with activated carbon and filtered through different filtration media are in the range obtained for pure/unused cooking oil.

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