Recovery and Utilization of Animal Fat from Sheepskin Degreasing Effluent

Mr. Vinodhkumar Marudhamuthu[1], Dr. Kanagaraj James[2], Dr. Swarna VinodhKanth[3], Mrs. Tamilselvi Alagumuthu[4], Dr. Asit Baran Mandal[5]

[1]Centre for Human and Organizational Resources Development, Central Leather Research Institute, Sardar Patel Road, Adyar, Chennai, India – 600020; Phone: 91-44-24437217; Fax: 91-44-24911589; Email: vinodh14579@gmail.com

[2]Leather Process Technology Department, Central Leather Research Institute, Sardar Patel Road, Adyar, Chennai, India – 600020; Phone: 91-44-24437110; Fax: 91-44-24911589; Email: jkraj68@yahoo.co.uk

[3] Centre for Human and Organizational Resources Development, Central Leather Research Institute, Sardar Patel Road, Adyar, Chennai, India – 600020; Phone: 91-44- 24437109; Fax: 91-44-24911589; Email: svkuvk71@yahoo.com

[4] Centre for Human and Organizational Resources Development, Central Leather Research Institute, Sardar Patel Road, Adyar, Chennai, India – 600020; Phone: 91-44- 24437109; Fax: 91-44-24911589; Email: selviala@yahoo.co.uk

[5]Chemical Laboratory, Central Leather Research Institute, Sardar Patel Road, Adyar, Chennai, India – 600020; Phone: 91-44- 2491 0897; Fax: 91-44-24912150; Email: abmandal@clri.res.in

Abstract

In leather manufacturing, woolskins with high fat content are subjected to the degreasing process. Aqueous and/or solvent degreasing is chosen judiciously based on the amount of fat present in the skins. But, the effluent is dumped as any other sectional stream emanating from leather processing. In spite of the potential to recover up to 40-50% fat from the wool sheep skins, this sectional stream is wasted. The aim of this work is to separate the fat from the rest of the effluent emulsion and effectively utilize it. A typical degreasing effluent, which is an emulsion, consists of surfactants, high content of fat, water and salt. A successive liquid – liquid extraction, allows the fat to be recovered. An FTIR study confirmed the presence of fat. The recovered fat was studied for their potential to be converted into useful products such as biodiesel and wax. The utilization is attributable to the presence of long chain fatty acids and fatty alcohols in the recovered fat.

Introduction

Woolskins are considered to have a very high content of fat, approximately 40-50% on dry skin weight (Marsal 1998). During leather making, this high content of fat is removed by degreasing process. The high content of fat, if not removed during the degreasing process, can confer undesirable characteristics to the finished leather (Marsal 1998). The degreasing effluent typically contains non-ionic surfactant, high content of fat, salt and water. In the current work, an attempt was made to recover fat from this emulsified mixture using liquid-liquid extraction. The extracted fat was explored to see its potential to produce Biodiesel and wax.

Biodiesel, as defined by experts, is a mixture of mono-alkyl esters of saturated or unsaturated higher fatty acids. The chemical reaction involved in the production of biodiesel is base catalyzed trans-esterification in which triglycerides are treated with alcohol to produce ethyl esters of fatty acids (Biodiesel) and glycerol as a byproduct. The feedstock in the current case is the fat obtained from the degreasing effluent. We attempted to produce biodiesel using effluent/byproducts as feedstock instead of relying on virgin materials as in conventional way of biodiesel production.

Secondly, we attempted to produce wax. Waxes generally refer to a class of compounds that are malleable near ambient temperatures. All waxes are organic compounds, both synthetic and naturally occurring. Wax has quite a lot of applications such as corrosion resistance, wear resistance to paints, tablet coatings, candles etc.

Materials and methods

Sheepskins were subjected to conventional leather process to collect the degreasing effluent.

Separation procedure

1. Dehydration

The effluent resulting from the degreasing process contained salt, water, natural fat and non ionic surfactant. In order to remove the water, a small amount of ethyl alcohol was added to the effluent (Marsal 1998). Then, the ethyl alcohol was evaporated using water bath.

2. Desalination

Once the water was removed, ethyl ether was added to the resulting effluent to precipitate the salt. The mixture was left to settle for 2 hours. The precipitated salt was separated by decantation of the supernatant solution (Marsal 1998). Ethyl ether was evaporated from the resulting effluent using water bath.

3. Liquid-liquid extraction

The resulting effluent from the desalination process was treated with petroleum ether in a separating funnel. Two layers were observed. Both the layers were collected separately and the same process was repeated simultaneously for 3 times to attain complete separation.

Biochemical tests

1. Saponification

Ethanol and 20% of NaOH were added to a small amount of fat and kept in a boiling water bath for 10 minutes. Equal volume of the resulting solution was taken in 3 test tubes. Calcium chloride, sodium chloride and conc. hydrochloric acid were added to the test tubes respectively.

2. Emulsification

With few drops of fat, 2% of sodium carbonate was added. A pinch of potassium hydrogen suphate powder was added to a few drops of fat in another test tube and the mixture was heated. The organic layer was collected and kept in a water bath for the removal of solvent (petroleum ether).

Fourier Transform Infrared spectroscopy (FTIR)

FTIR has been used to identify the functional group to confirm the presence of fat. The transmittance corresponding to wavelength was obtained and plotted.

Applications

1. Biodiesel

To the 20 ml of fat, 50 ml of methanol and 0.9 g of KOH were added and heated at 55°C for 8 hours. After the undisturbed heating, the solution was separated into 2 layers.

Confirmatory test for biodiesel

To 1.5ml of biodiesel, 28.5ml of methanol was added. The mixture was mixed well. Absence of puddle formation showed the presence of biodiesel in our case.

2. Wax

20 ml of water and 3g of NaCl were added to 10 ml of fat and kept in a boiling water bath for 15 minutes, later in a refrigerator for 1hour. The impurities settle down and the useable fats remain in the top which was separated by filtration.

Results and discussion

1. Biochemical test

Two biochemical tests, saponification and emulsification were carried out. In saponification, on heating with an alkali (NaOH or KOH), the triglycerides in oils get hydrolyzed to produce glycerol and sodium or potassium salts of fatty acids (soaps). Table I shows the results of saponification which confirms the presence of fat in organic layer. In emulsification test emulsion was formed when fat was treated with sodium carbonate. When a fat was heated strongly in the presence of a dehydrating agent such as potassium hydrogen sulphate, the glycerol portion of the molecule was dehydrated to form the unsaturated aldehyde, Acrolein, which has the peculiar odor of burnt grease. Table II shows the emulsification results that confirms the presence of fat in organic layer.

Table I Saponification

Test	Observation	Organic layer	Aqueous layer	Inference
Tube 1+2% CaCl_2	White precipitate was formed	Presence	Absence	Presence of fat in organic layer.
Tube 2+NaCl	White precipitate was formed	Presence	Absence	Presence of fat in organic layer.
Tube 3+ Conc.HCl	Wax like layer separates on surface	Presence	Absence	Presence of fat in organic layer.

Table II Emulsification

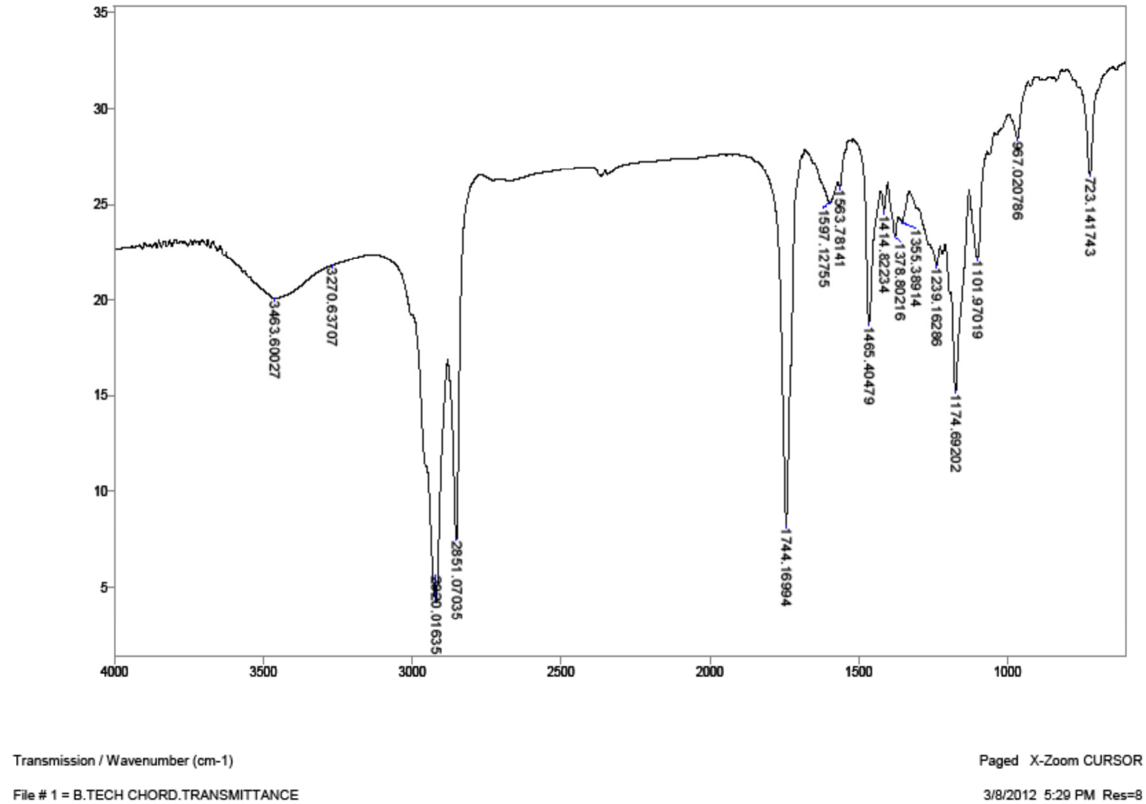
Test	Observation	Organic layer	Aqueous layer	Inference
2% of Na_2CO_3+ few drops of fat	Emulsion looking like a white solution	Presence	Absence	Presence of fat in organic layer.
Few drops of fat+ pinch of potassium hydrogen sulphate powder+ heat	Pungent odor	Presence	Absence	Presence of fat in organic layer.

From the table, it was confirmed that the fat present in the organic layer.

2. Fourier Transform Infrared spectroscopy

FTIR is used to identify the functional groups in a fat. Fat contains ester as their functional group. Figure (1) shows the presence of ester bond in the fat. The graph shows the peaks of various compounds. A peak formed at 1744.16994 shows the C=O stretch of ester bonds. Three peaks were formed at 1101.97019, 1174.69202, 1239.16286 shows the C-O stretch of esters, alcohols, ethers, carboxylic acids. The presence of fat was confirmed from FTIR spectrum.

Figure (1)
Transmittance Vs wavelength



3. Applications

Biodiesel

Biodiesel was produced successfully by trans-esterification reaction. The presence of biodiesel was confirmed by the absence of puddle formation while adding Methanol. The throughput was around 15 % in bench scale trials. The potential calls for a study on upscaling the experiment. The scope for improving the throughput is also high given the quantum of degreasing effluent let out annually by the sheep tanners globally.

Wax

The fat acquired was insolubile in water. They are not volatile and could be burnt without leaving any residue, i.e., ash. The collected wax was moulded to prepare candles.

Conclusion

Degreasing effluent contains high content of fat. The present work deals with the recovery of fat from the degreasing effluent and it was utilized to produce biodiesel and wax. Biodiesel fuel is gaining popularity due to growing environmental awareness and sky rocketing prices of gas in recent times. Biodiesel is an eco-friendly fuel. Biodiesel has fewer emissions than conventional diesel, is biodegradable, and is a renewable source of energy. It is non-toxic. In this work, the feedstock used to produce biodiesel is emancipated as a waste by sheepskins tanners. Hence, the cost of the biodiesel produced by using this feedstock will be cheaper than those that are available in the market. Wax produced from the fat was used to prepare candles. Thus this work shows that the fat from the degreasing effluent has immediate and valuable applications.

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