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Research Article

A STUDY ON THE SEPARATION OF LIPIDS WITH DUAL SOLVENT SYSTEM USING LIQUID EXTRACTION

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ABSTRACT

In the present study, the distribution of castor oil and soya bean oil between hexane and the dual solvent system of hexane and ethanol is measured. The dual solvent system comprises of hexane and ethanol in equal proportions which is a mixture of a non-polar and a polar solvent. The separation efficiency was determined as function of solvent-feed ratio, contact time and contact temperature. The efficiency of dual solvent system was found to be much better than that of the single solvent system. The synergism in separation was brought by the combined effect of the non-polar hexane and polar-aprotic ethanol.

Keywords: Dual solvent, separation of lipids, polar solvents.

INTRODUCTION

Lipids are a broad group of naturally-occurring molecules which includes fats, waxes, sterols, fat-soluble vitamins (such as vitamins A, D, E and K), monoglycerides, diglycerides, phospholipids, and others. Energy storage of cells membranes and acting as structural component are two of the main biological functions of lipids. The only one property all lipids have in common is their hydrophobic nature. They include a diverse range of compounds, like fatty acids and their derivatives, carotenoids, terpenes, steroids and bile acids (Fahy et.al, 2005) The most common lipid classes in nature consist of fatty acids linked by an ester bond to the trihydric alcohol – glycerol, or to other alcohols such as cholesterol, or by amide bonds to sphingoid bases, or on occasion to other amines. In addition, they may contain alkyl moieties other than fatty acids, phosphoric acid, organic bases, carbohydrates and many more components, which can be released by various hydrolytic procedures (Casimir, 2005).

Almostall the commercially important fats and oils of animal and plant origin consist almost exclusively of the simple lipid class triacylglycerols (triglycerides). They consist of a glycerol moiety with each hydroxyl group esterified to a fatty acid. In nature, they are synthesised by enzyme systems, which determine that a centre of asymmetry is created about carbon-2 of the glycerol backbone, so they exist in enantiomeric forms, i.e. with different fatty acids in each position (William Christie, 1989).As most applications of functional lipids require high purity, there is an increasing need for separations to purify these functional lipids. Various chromatographic methods, low temperature crystallization and zone melting are already in use (Gloria, 1996, Waltking and Wessels, 1981, Aichholz and Lorbee, 2000, Brown and Kolb,1955, Murray,1985, Kristefro et.al,1966)for the separation of lipids. Lliquid extraction is used due to its low cost and its ability to be used at low temperature so that thermal decomposition can be avoided.Castor Oil is a triglyceride (ester) of fatty acids where about 90% of the fatty acid content is ricinoleic acid (85 -95%) and oleic acid present in 2-6 %. It is an 18-carbon acid having a double bond in the 9-10 position and a hydroxyl group on the 12th carbon. This combination of hydroxyl group and unsaturation occurs only in Castor Oil**.**It is highly polar due to the hydroxyl groups and this allows the oil to be notonly compatible with but will plasticize a wide variety of natural and synthetic resins, waxes, polymers and elastomers (Ogunniy,2006).It has excellent emollient and lubricating properties as well as a marked ability to wet and disperse dyes, pigments and fillers. Since castor oil is not

edible, it could be substituted in many industrial application areas where edible oils are used. Soybean oil obtained from the extraction of oil from its seed is fairly rich in glycerides of the unsaturated linoleic acid (55-60 %) with few oleic fatty acids (25-30%), which do not oxidize readily because they contain natural antioxidants (Evans et.al, 1969). It is an 18-carbon acid having two double bonds .Soybean oil is not only used in food products but is also used as renewable raw material to produce a variety of non-food products including bio diesel, inks, plasticizers, crayons, paints and soy candles.Solvents are basically classified as polar and non-polar, the dielectric constant being used as the measure of polarity. Solvents with dielectric constant less than 15 are considered to be non-polar while those having above 15 are considered to be polar. Polar aprotic solvents share ion dissolving power with protic solvents but lack acidic hydrogen. Common characteristics of aprotic solvents are non display of hydrogen bonding, lack of acidic hydrogen and ability to stabilize. Protic solvents solvate anions strongly by hydrogen bonding. Aprotic solvents have large dipole moments and solvate positively charged species by their negative dipole. Hexane with a dielectric constant of 1.88 is non-polar and ethanol with a dielectric constant of 30 is highly polar.

2.0 Methodology

Feed (mixture of soya bean oil and castor oil with 20 % castor oil) was contacted with the selected solvent system with proper stirring for fixed time, allowed to settle and then separated using a separating funnel. The extract phase and the raffinate phases were separated, the solvent distilled off and the product analyzed using acid value determination using the method specified as per ASTM D974.The separation procedures were done by varying the solvent to feed ratio, contact time and contact temperature. In all the runs the stirring speed as castor oil concentrations were kept constant. In the case of dual solvent system, 1:1 ratio of hexane and ethanol were used.

3.0 Results and Discussion

3.1 Variation of solvent to feed ratio

For the study with varying solvent to feed ratio, the solute concentration was kept as 20, contact time 20 minutes and temperature 303 K. The solvent to feed ratio was varied from 0.2 to 5.As observed in figure 1, the separation of lipids increases with the solvent to feed ratio for both the solvent systems studied. In the case of the dual solvent system, the optimum separation efficiency of 75% was obtained with a solvent feed ratio of 2 whereas for the single solvent system using hexane, the optimum separation efficiency of 70% was obtained with a solvent feed ratio of 3.

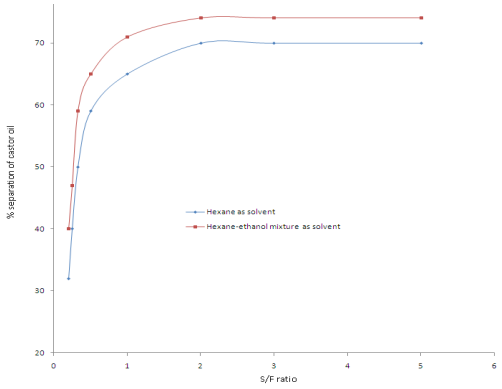

Fig. 1: Effect of solvent to feed ratio on separation

3.2 Variation of contact time

For the study with varying contact time, the solute concentration was kept as 20, solvent to feed ratio 2 and temperature 303 K. The contact time was varied from 20 minutes to 120 minutes. When the contact time was varied from 20 minutes to 120 minutes, the optimum separation efficiency of 72% was obtained with a contact time of 100 minutes for the single solvent system of hexane whereas for the dual solvent system, the optimum separation efficiency of 76% was obtained with a contact time of 80 minutes.

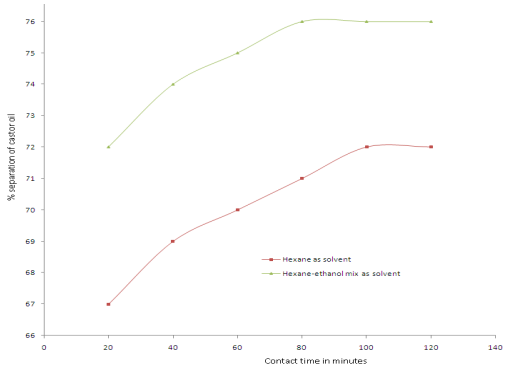

Fig. 2: Effect of contact time on separation

3.2 Variation of contact temperature

For the study with varying contact temperature, the solute concentration was kept as 20, solvent to feed ratio 2 and contact time 20 minutes. The contact temperature was varied from 297 K to 343 K. When the contact temperature was changed from 297 K to 343 K, the optimum separation efficiency of 76% was obtained with a contact temperature of 333K for the single

solvent system of hexane whereas for the dual solvent system, the optimum separation efficiency of 79% was obtained with a contact temperature of 333K.

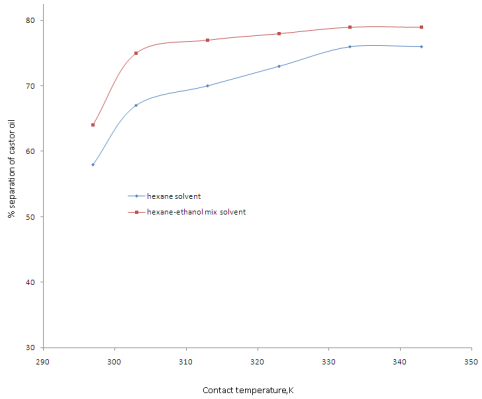

Fig. 3: Effect of contact temperature on separation

4.0 CONCLUSION

Liquid extraction is used as an alternative method for other chromatographic methods for the separation of lipids due to its low cost and its ability to be used at low temperature so that thermal decomposition can be avoided. As observed in all the studies done, the separation efficiency using dual solvent system is more than that with hexane alone as solvent. The dual solvent system which consists of a non-polar and polar solvent increases the separation by synergism. The maximum deviation was observed with change in solvent to feed ratio followed by change in contact temperature and contact time respectively.

REFERENCES

1. Aichholz R and Lorbeer E. Journal of Chromatography. 2000;23:75-88.
2. Brown JB and Kolb DK. Chemistry of Fats and Other Lipids, London, Pergamon Press. 1955;3:57
3. Buang Y, Cha JY, Nagao K, Wang YM, Inoue N and Yanagita T. J Nutr Sci Vitaminol. 2004;50:272-276.
4. Casimir C Akoh. Handbook of Functional Lipids. CRC Press. 2005.
5. Evans CD, McConnell DG, List GR and Scholfiel CR. Journal of the American Oil Chemists. 1969;46:8-12.
6. Fahy E, Subramaniam S and Brown HA. Journal of Lipid Research. 2005;46 (5):839–861.
7. Gloria Marquez –Ruiz. *J Chromatogr A.* 1996;**749:**55-60.
8. Murray KE. The Chemistry of Fats and Other Lipids, London. 1989;3:243.
9. Nichols BW, Morris LJ and James AT. British Medical Bulletin. 1996;22(2).
10. Ogunniyi DS. Bioresource Technology. 2006;97(9):1086–91.
11. Perry Robert H. HandBook of Chemical engineering, fifth edition.
12. Waltking AE and Wessels H. Chromatographic separation of polar. *J Assoc Off Anal Chem.* 1981;**64:1**329-1330
13. Yanagita T, Wang YM, Nagao K, Ujino Y and Inoue NC. J Agric Food Chem. 2005;53:9629-33.