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Glycerol as Green Solvent in Organic Synthesis

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Abstract: *Glycerol came out as favourably green solvent. Physio chemical properties are used for different applications. short analysis of organic reactions which engage glycerol as a green solvent are presented. Organic modification in glycerol medium arises with or without any catalytic material. Glycerol is also used as hydrogen donor to carry out hydrogenation reaction of organic compound. The supremacy off glycerol over other solvents turned out to be described in terms of its solubility, availability, non-toxicity and chemical reactivity.Organic synthesis is exothermic reaction in which both reactants and catalyst are dissolved in solutions. In this paper, glycerol. Is appeared as nontoxic, recyclable and eco-friendly liquid, which is manufactured from renewable sources. It has very high potential to serve as alternative green solvent in many organic reactions.*

Keywords: Microbiome, Plant Growth-Promoting Bacteria, etc.

I. INTRODUCTION

Glycerol also termed as glycerine. It is a simple Poly alcohol compound. Glycerol is usually colourless, order less and it is viscous liquid which is sweet tasting and non-toxic compound.[1] Glycerol backbone is found in lipids known as glycerides.As it contains antimicrobial and antiviral properties it is generally used in Food and Drug administration. which is approved for wounds and burns treatment.

Glycerol is commonly used as Sweetener in food industry and also used as humectant in pharmaceutical formulations. Duo to presence of three hydroxyl group glycerol easily get dissolved with water and it is hygroscopic in nature.[2] Boiling point of glycerol is 290 degree Celsius. Melting point of glycerol is 17.9 degree Celsius. Molecular weight is 92.094 g/mol Relative density is 1.261 g/Ml. It is insoluble in volatile oils and fixed oils. In water it is miscible.[3]

Glycerol has a unique combination of physical and chemical properties which include polarity, low toxicity, and flammability, high boiling point and ability to produce strong hydrogen bonds. It also has the ability to dissolve organic and inorganic compound and it is also easily available. Due to these characteristics in recent times green solvent is used in organic synthesis.[4]

Glycerol is generally produced as by-product of transesterification of triglyceride in the formation of natural fatty acid derivatives. The derivatives which are formed are used in many different areas from pharmaceuticals and food industry as an alternative fuel for example bio diesel.[5].

The severe damage for humanity and its environment of our planet is global warming. The primary cause of climate change are the emissions of greenhouse gas and this is because of the increase in population. Therefore, the need in food and industrial development is increasing day by day. In this way, solvents emerge. To replace some fossil energy sources with the renewable energies, which are more respectful to the environment.[6] According to the study of U.S. Department of Energy, Glycerol is the fastest growing industrial molecule. Glycerol act as a building block to produce bio-based molecule.

Nowadays, liquid phase organic synthesis reactions are highly demanding. Liquid phase reactions. Are better than solid or gas phase reaction. As they Have high conversion efficiency, better yield and improved product selectivity. Glycerol was discovered by. The chemist Carl W. Scheele in 1779, Which was obtained accidentally.[7] Is a new transparent and sweet-smelling liquid. The new liquid, which was found is completely soluble in alcohols and water. But this is insoluble in hydrocarbons. The IUPAC name for glycerol is Propane-1,2,3-triol.[8]

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II. LITERATURE REVIEW

The literature review comprises of the research done on the following topic.

Yan long GU and Francois Jerome (2010) The marriage mistake teen conducted a review on study of glycerol as a sustainable solvent for green chemistry.Firouzeh Nemati and Hossein Kiani (2013) Conducted a review on study of glycerol as a green solvent for efficient one-pot and catalyst free synthesis of 2,4,5-triaryl and 1,2,4,5-Tetra aryl imidazole derivatives.

Adi Wolfson, Christina Dlugy and Yoram Shotland (2007) conducted a review on study of glycerol as a green solvent for high product yield and selectivity. Navneet Kumar and vimal Chandra Srivastava(2019) Conducted a review on study of glycerol as a green solvent in organic reaction.

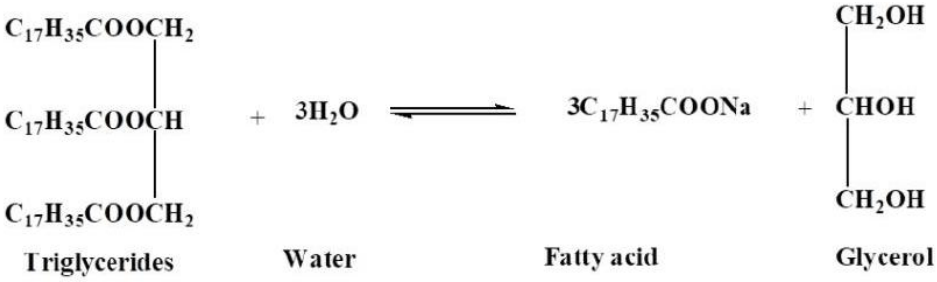
Zhanying Zhang, Darryn W Rackemann and Lan M O'Hara (2013) Conducted a review on study of glycerol carbonate as green solvent for pre-treatment of sugar cane bagasse. Alba E.Diaz Alvarez, Javier Francos, Pascale Crochet and Victoria Cadierno (2014) Conducted a review on study of recent advances in the use of glycerol as green solvent for synthetic organic chemistry.

Manish Pathak, Lubhan Singh, Amit Kumar, Gaurav Upadhya (2020) Conducted a review on study of green solvents and their importance in medicinal chemistry. M.N William (2003) conducted a review on study of green solvents for chemistry-perspective and practice. M.Pagliaro and M.Rossi (2000) conducted a review on study of Glycerol-properties and production.

S.Ahmed (2010) conducted a review on study of Hydrogen from glycerol. A.E Diaz-alvarez and V. Cadierni (2013) conducted a review on study of Glycerol-A promising green solvent and reducing agent for metal-catalysed transfer hydrogenation reactions and nanoparticles formulations.

2.1 Glycerol Synthesis

Glycerol can be easily found in lipids of plant oil and fats. They are the commonest sources for biodiesel production. With the help of oils and fats by doing certain chemical reaction we can obtain the crude alcohol as product. [9] Within the chemical reaction of triglycerides, alcohol is obtained as side product. Chemical reaction of alcohol could be a process during which a water molecule breaks triglycerides into free carbolic acid and alcohol.The obtained product could be a mixture of 2 phases wherever the less dense higher layer contains fatty acids. And also, the heavier bottom layer consists of crude alcohol and alternative impurities. Alcohol is obtained once the removal of impurities from this lower layer. [10]



We can obtain glycerol from triglycerideby the process of Saponification. Conversion of glycerol from triglyceride is also similar method to hydrolysis but here,Sodium hydroxide is used as solvent instead of water. In this process, the bond of triglyceride gets broken by sodium hydroxide to release glycerol and sodium salts. The product contains 3 soap molecules and one molecule of glycerol. [11]The glycerol can be easily separated from the product by using simple filtration. Where the glycerol is present in form of filtrate with other impurities.

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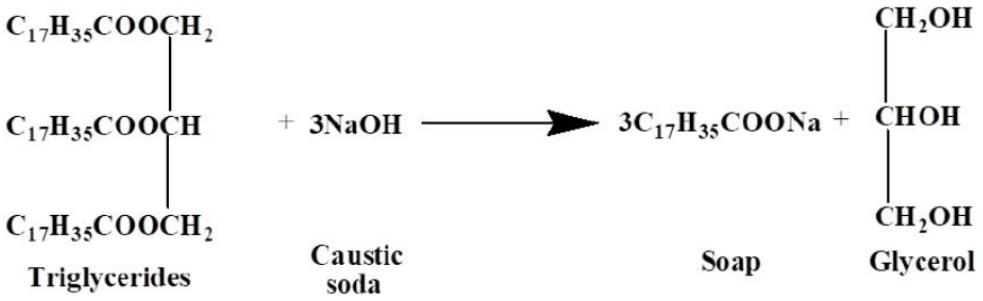
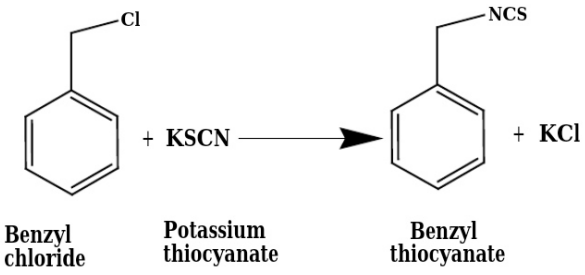


In the method of transesterification, the reaction between triglyceride and methanol is carried out in presence of catalyst. The reaction product is composed of methyl Ester and glycerol as a by-product. For the production of glycerol by transesterification process. Catalyst which are used. [12] Such as heterogeneous as well as homogeneous catalyst. The benefit of using heterogeneous catalyst. Over homogeneous catalyst is very easy to separate after the use of reaction. When we use the homogeneous catalyst Then it is very difficult to regenerate and reuse the catalysts.[13] And it often leads to the contamination of the product.

According to the literature, Homogeneous catalyst, such as sulphuric acid and hydrochloric acid. Are generally used in the process of Transesterification. In the method of production of glycerol by using homogeneous catalyst is very slow process and generally, Followed by loss of catalyst. To overcome such types of drawbacks, heterogeneous catalyst such as oxide of zirconium tin etc have been used. These types of metal oxide best catalyst do not React with the fatty acid and oils and they are also insensitive to water. The regeneration and reuse of heterogeneous catalyst is very simple process.[14]

2.2 Catalytic Method

The appeal of glycerol solvent for carrying out organic reaction has been explored by various investigators. In 2007, Wolfson and Coworkers announced the combination of benzyl thiocyanate by Responding benzyl chloride with potassium thiocyanate in glycerol.[15] The response appliance required the change of chloride by thiocyanate Batch. Glycerol not only permit dissolution of pair of the substrates ion period but also calculate in large consequences yields with a large change rate of 95%.The response was carried out at 80°C, and the periods need to performed the nucleophilic exchange producers was 5hour.Wolfson's batch also response the utilize Off glycerol as a solvent for reduction of benzaldehyde with sodium borohydride to give benzyl alcohol[16].



2.3 Non-Catalytic Method

Glycerol has been conjointly used as in experience solvent to facilitate organic process within the absence of any chemical change material. Perin and colleagues studied the employment of alcohol in activity thio-acetalisation of carbonyl compounds to offer corresponding thioacetals reaction at 90 degrees Celsius favoured the whole method and therefore the product yield was 96% [17]. Alcohol not solely fixed the reaction method and allowed straight forward product separation, however it can even be recycled and used for carrying additional thio-acetalisation reaction. In another report revealed by In gale Et Al, a novel, economical and catalyst free one-pot protocol was developed for the synthesis of nitriles from aldehydes in alcohol as

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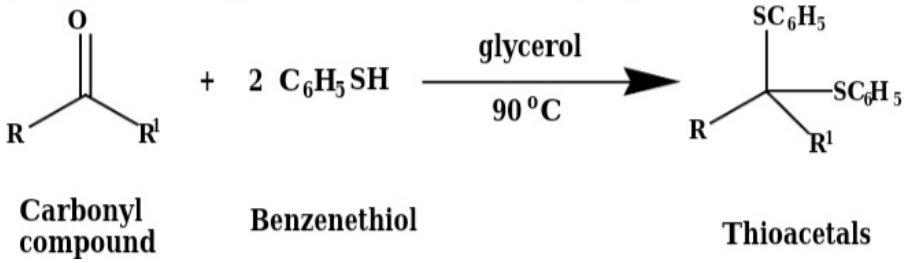
inexperienced medium. The synthesis was disbursed while not the employment of any catalyst. Different kinds of substituted aldehydes were chosen to check the effectiveness of the protocol to offer organic nitriles. Quite 80th product yield was achieved that showed the effectiveness of the strategy [18].



III. CONCLUSION

Organic reactions in presence of liquid solvents are of great importance in chemistry due to their applications in cosmetics, industries, and refineries. Water is the most promising and green solvent for such reaction, however, at the same time, it suffers from several drawbacks such as high polarity, hydrophilicity, and difficulty in product separation. Organic solvents are widely used in the field of synthetic organic chemistry; however, they have toxic nature, high cost, and carcinogenicity. Therefore, there is a high demand for some novel solvents that possess characteristics of a green solvent. In this context, glycerol, a by-product obtained in biodiesel industries has all the properties of a green solvent.

Several organic transformations such as Suzuki cross-coupling, Heck reaction, asymmetric hydrogenation, reduction, and transesterification have been carried out in glycerol medium with or without any metal catalyst. Glycerol-catalyst system not only gives the desired product with high yield but also favour the product selectivity. Glycerol can also promote hydrogenation reactions of organic compounds where the three hydroxyl groups of glycerol donate their hydrogen to bring the transformations. Loss of hydrogen from glycerol gives dihydroxyacetone as a side product. Glycerol derivatives have also been used as green solvents for organic synthesis. Apart from synthetic organic chemistry, glycerol has also found application in the synthesis of nanoparticles and other important reactions. Thus, it can be affirmed that glycerol and its derived solvents can be efficiently employed as green solvents without any adverse impact on the environment.

REFERENCES

[1] Yan lung chi in 2015 what is glycerol 23-26 in oxford dictionary,101-105 http://www.oxforddictionaries.com/definition/english/glycerol

[2] A. Wolfson, C. Dlugy, Y. Shotland, Glycerol as a green solvent for high product yields and selectivities, Environ. Chem. Lett. 5 (2007) 67–71. https://doi.org/10.1007/s10311-006-0

[3] A. Lubineau, J. Auge, Water as solvent in organic synthesis, in: P. Knochel (Ed.), Modern solvents in organic synthesis, Springer-Verlag Berlin Heidelberg, 2003,https://doi.org/10.1007/3-540-48664-x_

[4] R.D. Rogers, K.R. Seddon, Ionic liquids-solvents of the future, Science. 302 (2003) 792-793.

[5] C.A. Eckert, B.L. Knutson, P.G. Debenedetti, Supercritical fluids as solvents for chemical and materials processing, Nature 383 (1996) 313–318. https://doi.org/10.1038/383313a

[6] R. Bernini, E. Mincione, M. Barontini, F. Crisante, G. Fabrizi, A. Gambacorata, Dimethyl carbonate: an environmentally friendly solvent for hydrogen peroxide (H2O2)/ methyltrioxorhenium (CH3ReO3, MTO) catalytic oxidations, Tetrahedron 63 (2007) 6895-6900. https://doi.org/10.1016/j.tet.2007.04.03 9 Industrial Applications of Green Solvents – Volume II Materials Research Forum LLC Materials Research Foundations 54 (2019) 202-223 doi: https://doi.org/10.21741/9781644900314-

[7] P. Arockiam, V. Poirier, C. Fischmeister, C. Bruneau, P.H. Dixneuf, Diethyl carbonate as a solvent for ruthenium catalysed C-H bond functionalisation, Green Chem. 11 (2009) 1871-1875. https://doi.org/10.1039/b913115

[8] M.N. William, Green solvents for chemistry-perspectives and practice, Oxford University Press USA

IJARSCT
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International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
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Impact Factor: 6.252

(2003).

[9] M. Perrut, Supercritical fluid applications: industrial developments and economic issues, Ind. Eng. Chem. Res. 39 (2000) 4531-4535. https://doi.org/10.1039/c1cc10620a

[10] A.E. Diaz-Alvarez, J. Francos, B. Lastra-Barreira, P. Crochet, V. Cadierno, Glycerol and derived solvents: new sustainable reaction media for organic synthesis, Chem. Commun. 47 (2011) 6208–6227. https://doi.org/10.1039/c1cc10620

[11] V.G. Ricordi, C.S. Freitas, G. Perin, E.J. Lenardão, R.G. Jacob, L. Savegnago, D. Alves, Glycerol as a recyclable solvent for copper-catalyzed cross-coupling reactions of diaryldiselenides with aryl boronic acids, Green Chem. 14 (2012) 1030–103 https://doi.org/10.1039/c2gc16427

[12] L.C.C. Gonçalves, D.B. Lima, P.M.Y. Borba, G. Perin, D. Alves, R.G. Jacob, E.J. Lenardão, Glycerol / CuI / Zn as a recyclable catalytic system for synthesis of vinyl sulfides and tellurides, Tetrahedron 54 (2013) 3475–3480. https://doi.org/10.1016/j.tetlet.2013.04.1

[13] D.M.L. Cabrera, F.M. Líbero, D. Alves, G. Perin, J. Eder, R.G. Jacob, D.M.L. Cabrera, F.M. Líbero, D. Alves, G. Perin, D. Alves, G. Perin, J. Eder, R.G. Jacob, Glycerol as a recyclable solvent in a microwave-assisted synthesis of disulfides, Green Chem. Lett. Rev. 5 (2012) 329-336. https://doi.org/10.1080/17518253.2011.631942

[14] Y.H. Vo, T.V Le, H.D. Nguyen, T.A. To, H.Q. Ha, A.T. Nguyen, A.N.Q. Phan, N.T.S. Phan, Synthesis of quinazolinones and benzazoles utilizing recyclable sulfated metal-organic framework-808 catalyst in glycerol as green solvent, J. Ind. Eng. Chem. 64, 107-115. https://doi.org/10.1016/j.jiec.2018.03.006

[15] Y. Zhang, K. Na, O.M. Yaghi, J. Jiang, F. Gandara, Superacidity in sulfated metal-organic framework-808, J. Am. Chem. Soc. 136 (2014) 12844–12847. https://doi.org/10.1021/ja507119n

[16] G. Perin, L.G. Mello, C.S. Radatz, L. Savegnago, D. Alves, R.G. Jacob, E.J. Lenardão, Green, catalyst-free thioacetalization of carbonyl compounds using glycerol as recyclable solvent, Tetrahedron Lett. 51 (2010) 4354–4356. https://doi.org/10.1016/j.tetlet.2010.06.049

[17] A.P. Ingale, S.M. Patil, S. V Shinde, Catalyst-free, efficient and one pot protocol for synthesis of nitriles from aldehydes using glycerol as green solvent, Tetrahedron Lett. 58 (2017) 4845–4848. https://doi.org/10.1016/j.tetlet.2017.11.03

[18] K.P. Nandre, J.K. Salunke, J.P. Nandre, V.S. Patil, A.U. Borse, S. V Bhosale, Glycerol mediated synthesis of 5-substituted 1 H -tetrazole under catalyst free conditions, Chin. Chem. Lett. 23 (2012) 161–164. https://doi.org/10.1016/j.cclet.2011.11.019