Annals of Natural Sciences
(Peer-Reviewed/Referred International Journal)
Vol. 4(2), June 2018: 19-23
Journal's URL: http://www.crsdindia.com/ans.html
Email: crsdindia@gmail.com

e-ISSN: 2455-667X

Annals of Natural Sciences

ORIGINAL ARTICLE

Sustainable Development Strategies through Renewable Resources: An Overview

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ABSTRACT

There are prospective stresses throughout the world for replacing petroleum based raw materials with renewable resources. Now-a-days lot of attention has been paid by the scientific researcher to develop practicable materials from agricultural origins. Numerous products of significant importance have been developed from renewable resources in the past. These products reported to show multifarious applications in different areas. Among different renewable resources vegetable oil especially obtained from seeds of various plants play vital role due its unique properties. In present communication efforts have been made to overview the utilization of vegetable oils in the development of poly(ester), poly(ester-amide), epoxies and their different modifications in view to make these to more versatile.

Key words: *Vegetable oil, renewable source, epoxy, poly(ester), fatty acids.*

Received: 4th March 2018, Revised: 30th March 2018, Accepted: 10th April 2018
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How to cite this article:
Hasnat A. (2018): Sustainable Development Strategies through Renewable Resources: An Overview. Annals of Natural Sciences, Vol. 4[2]: June, 2018: 19-23.

INTRODUCTION

Now-a-days there have been increasing demands for the utilization of renewable resource especially derived from agriculture origin in search for the cost effective and alternative materials [1-4]. Uses of these materials are significant due to both sustainability and environmental issues. India is agriculture based country and bestowed with verity of plants and herbs. Utilizations of these resources in development of useful materials will benefits the stakeholders.

Numerous agricultural wastes have been utilized to architect the bio-based materials and documented in literature. Further efforts have been making to design new routes to excessive utilization these materials. Some common examples of renewable raw materials spotted by the academician now-a-days are seeds of different plants, empty fruit bunches, carbohydrate, proteins and many others [5, 6]. Among them vegetable oils, generally liquid at ordinary temperature have received potential application in different areas such as in cosmetic industries, reported to use as cosmetic base, significant application in pharmaceuticals. In addition to these they are extensively used in different industrial arenas. They are extensively used in development various polymeric recipes [7]. Vegetable oils especially obtained from the seeds of different plants are non-toxic, non-depletable, non-volatile and biodegradable. In present communication efforts have been made to overview the utilization of vegetable oils in the development of some useful products such as alkyds, poly(ester-amide)s, epoxies and their modifications.

VEGETABLE OIL

Vegetable oils are triglyceride of unsaturated and saturated fatty acids. Depending on nature and composition of fatty acids, vegetable oils show variable properties. There are numerous inbuilt functionalities such as double bonds, oxirane group, ester linkages, allylic and vinylic carbons. These functionalities provide avenues for chemical modifications and workable derivatizations [8-10]. The presence of different reactive sites in particular vegetable oil can be easily identified qualitatively and quantitatively both using different techniques. The unsaturation of triglyceride oil determined volumetrically with help of iodine value. Greater the iodine value greater the unsaturation. On the basis of the iodine value vegetable oils are categorized into non-drying, semidrying and drying. Saponification values, hydroxyl values of the vegetable oil also determine with the help of standard titration methods. These values can also be correlate with different spectral techniques [11, 12].

The vegetable oils have been playing significant role in our daily life from the ancient time in different form. Vegetable oils like soybean, castor, coconut, sunflower and many others have been extensively used in the synthesis of polyesters (alkyds), poly(ester-amide)s, poly(urethane)s, epoxies and many others. Now-a-days numerous non-edible and non-traditional vegetables oils are also utilized as starting materials in the syntheses of many worth full materials [13, 14]. Utilization of non-edible materials in the development of different practicable materials reduces the pressure on edible stack too [15, 16]. Additionally these acts solve the problems of waste disposal on the earth surface and prevent the rotting away of different seeds in the every session.

ALKYDS

Alkyd resins are the polyesters derived from triglyceride oils amongst oldest polymeric resins of the vegetable oils. Alkyd resins have received good position in the numerous industrial applications, because of their economy, ease of applications, production and good ability to protect the materials from environmental attacks [4,11,14]. Moreover, they are classified as a biologically degradable polymer due to presence repeating ester moieties. On the basis of oil proportion the alkyds are classified into different categories such as short oil alkyds, medium oil alkyds and long oil alkyds [4,12].

A short oil alkyd contains less than 40% of oil content. In many cases short chain alkyds are mixed with other compatible polymers. They air dried faster than oil alone. Short oil alkyds can also be applied using baking techniques. Short oil alkyds with high hydroxyl values frequently used with amino resins. In medium oil alkyds oil contents ranges between 40% to 60%. These are normally synthesized from drying oil and semi drying oils. Medium oil alkyds are used in both air drying and baking formulations. In long oil alkyds oil contents are more than 60%. These are generally synthesized from drying oils like linseed. Long alkyds are suitable for both external and internal applications. Length is the momentous factors, which control the properties and utility spectrum.

Drying and semi-drying oils, such as castor, sunflower, coconut, soybean and linseed oils are traditionally used in the preparation of oil-modified polyesters [17,18]. In addition to these many non-traditional vegetable oils such as rubber seed, orange seed, *Jatropha curcas, Albiziabenth, Pongamia glabra, Annona squamosa,* tomato seed oil, melon seed oils and many others are also reported for the syntheses of polyester resin [4,6,11,15,19-21]. Utilization of these vegetable oils in the formulation of valuable materials provides opportunity to increase the spectrum of raw materials and significant use of materials are going waste.

In view to make the alkyd resin more versatile, practically more useful, better resistance to environmental attacks and to improve the gloss several modification were carried out. The modifications were performed either through pre-polymerization or post-polymerization. Modifications with acrylic monomers especially those categorized as hard monomer extensively to confer the resistivity towards scratch [20,22]. Water soluble

alkyd resins were developed to reduce the application cost as well as to cut down the use of organic solvents. Alkyd resins with high acid values subsequently neutralized with amines were prepared for water soluble applications [20]. Modification by incorporation of amide linkages in poly(ester) resin, commonly known as poly(ester-amide) resins. A systematic scheme for the synthesis of poly(ester-amide) resin is depicted in figure 1. The Poly(ester-amide) resins reported for the improve performances over normal alkyds in terms of drying time, scratch resistance, water vapor resistance and resistance to various chemicals [23,24]. Consequently poly(ester-amide) resin known for high durability in many service conditions.

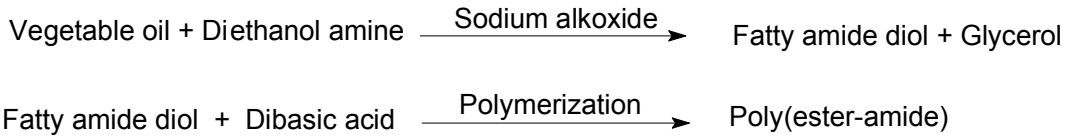

Fig. 1: A systematic scheme for synthesis of poly(ester-amide) resin

EPOXY

Vernonia seed oil contains naturally oxirane, a three member heterocyclic groups in its triglyceride structure and reported for many viable applications [8]. In view to overcome pressure on this vegetable oil, numerous other vegetable oils synthetically epoxidised by different chemical methods [25-27]. The vegetable oils are treated with peracids or peroxides in required ratios. The epoxy groups formed at the unsaturations of the fatty acid chains. Progress of reaction and extent of epoxidation is generally measured at regular interval of time by determination of epoxy equivalent analytically. The same can also be correlate with by measuring the iodine value [28]. A general reaction for conversion of unsaturation of vegetable oil into epoxy is depicted in figure 2.

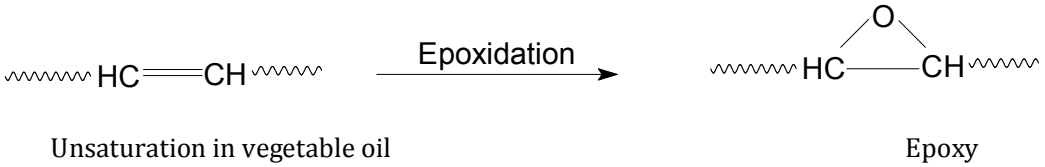

Fig. 2: A systematic scheme for epoxidation

Epoxidation of vegetable oil by enzymatic methods are reported and believed to be friendlier to the environment. Chemo-enzymatic epoxidation and optimization of soybean oil was reported [29]. Epoxidation of soybean oil using hydrogen per oxide as an oxygen donor carrier in presence of catalytic amount of formic acid has been reported. An excess of amount of hydrogen peroxide was necessary in the reaction to achieve high reaction conversion. The hydroxyl derivatives were also formed as a side product while pursuing the reaction, characteristic band for the hydroxyl group appear in the IR spectrum. The highest epoxy content was claimed 6.1 (wt) [30].

Epoxidized linseed oil was reported for polymerization with anhydrides in one-step in the presence of tertiary amines or imidazoles as catalysts. Epoxidized vegetable oils have also ability to undergo homo-polymerization by ring opening reaction in many cases [6,8]. The epoxidized products from oils and alkyl ester derivatives were investigated as cross-linking agents in the formulation of powder coatings [31]. UV curable organic/inorganic film based on epoxynorborene linseed oil was developed using in situ method of tetraethylorthosilane oilgomers and investigated their film properties. It has been reported that hybrid film properties were affected by the level of oligomer.

Epoxynorborene linseed oil a new type of epoxide originated from a renewable source replicating different synthetic epoxy resins in many valuable applications [32]. Modification of epoxidised soybean oil for lubricant formulation with improved oxidative stability and low pour point were reported. Epoxidised soybean oil reacted with different alcohols in presence sulfuric acid to obtain the ring-opened intermediate product [33].

CONCLUSION

In present studies effort have been made to overviewed the utilization of vegetable oil with special reference to their uses in the development of alkyds, epoxies and their modifications to make them more practicable and versatile. These products were derived by using indigenous resources have prospective in different domestics and industrial arena. Furthermore, utilization of materials from agricultural origins is renewable and beneficial to the farmers.

ACKNOWLEDGEMENT

Author is thankful to the Authorities of G.F. College, Shahjahanpur, UP, India, for providing necessary facilities to carry out this work.

REFERENCES

1. Lochab B., Varma I. K. and Bijwe J. (2012): Sustainable polymers derived from naturally occurring materials, Advances in Mater. Physics and Chem., 2: 221-225.
2. Lebarbe T., Maisonneuve L., Nguyen T.H.N., Gadenne B., Alfos C. and Cramail H. (2012): Methyl 10-undecenoate as a raw material for the synthesis of renewable semi-crystalline polyesters and poly(ester-amide)s, Polym. Chem., 3: 2842-2851.
3. Mahapatra S.S. and Karak N. (2004): Synthesis and characterization of polyesteramide resins from Nahar seed oil for surface coating application, Prog. Org. Coat., 51: 103-108.
4. Guner F.S., Yagci Y. and Erciyes A.T. (2006): Polymers from triglyceride oil, Prog. Polym. Sci., 31: 633-670.
5. Samarth N.B. and Mahanwar P.A. (2015): Modified vegetable oil based additives as a future polymeric material-review, Open J Organic Polym. Mater., 5: 1-22.
6. Sharmin E., Zafar F., Akram D., Alam M. and Ahmad S. (2015): Recent advances in vegetable oil based environment friendly coatings, A review, Industrial Crops and Products, 26: 215-229.
7. Lligadas G., Ronda J.C., Galia M. and Cadiz V. (2013): Renewable polymeric materials from vegetable oils: a perspective, Materials Today, 16: 337-343.
8. Narine S.S., Kong X. Vegetable oils in production of Polymers and plastics, Bailey's Industrial oil and Fat products, Sixth edition, Volume 6th, John Wiley& Sons Inc. 2005.
9. Babu R.P., Connor K.O. and Seoram R. (2013): Current progress on bio-based polymers and their future trends, Progress in Biomaterials, 28: 1-16.
10. Hasnat A., Ahamad S. and Ahmad S.A. (2017): Synthesis and characterization of poly (ester-amide) of adipic acid and fatty amide of Melia azedarach seed oil– An eco-friendly resource, Modern Organic Chem. Res., 2: 5-10.
11. Samarth N.B. and Mahanwar P.A. (2015): Modified vegetable oil based additives as a future polymeric material-review, Open J Organic Polym. Mater., 5: 1-22.
12. Islam M.R., Beg M.D.H. and Jamari S.S. (2014): Development of vegetable oil based polymers, J. Appl. Polym. Sci., 131: 40787-40799.
13. Gultekin M., Beker U., Guner F. S., Erciyes A.T., Yagci Y. (2000): Styrenation of castor oil and linseed oil by macromer method, Macromol. Mater. Eng., 283: 15-20.
14. Sharma V., Kundu P.P. (2006): Addition polymers from natural oils- a review, Prog. Polym. Sci., 31: 983-1008.
15. Datta N., Karak N., Dauli S.K. (2007): Stoving paint from Mesuaferrea L. seed oil based short oil polyester and MF resins blend, Prog. Org. Coat., 58, 40-45.
16. Kumar M.N.S., Maimunah Z.Y., Abdullah S.R.S. (2010): Synthesis of alkyd resin from non-edible Jatropha seed oil, J. polym. Env. 18: 539-544.
17. Akintayo C.O., Adebowale K.O. (2004): Synthesis and characterization of acrylated Albiziabenth medium oil alkyds, Prog. Org. Coat., 50: 207-212.
18. Hofland A. (2012): Alkyd resins from down to out to alive and kicking. Prog. Org. Coat., 73: 274-282.
19. Patel V.C., Varughese J., Krishnamoorthy P.A., Jain R.C., Singh A.K., Ramamoorty M. (2008): Synthesis of alkyd resin from Jatropha and Rapeseed oils and their applications in electrical insulation, J. Appl. Polym. Sci. 107: 1724-1729.

20. Aigbodion A.I., Okiemen F.E., Iukhuoria E.U., Bakare I.O., Obazee E.O. (2003): Rubber seed oil modified with maleic anhydride and fumaric acid and their alkyd resins as binder in water reducible coatings, J. Appl. Polym. Sci., 89: 3256-3259.

21. Ibrahim K.A., Abusbeih K.A., Trawneh I.A., Bourghli L. (2014): Preparation and characterization of alkyd resins of Jordan valley tomato oil J. Polym. Env., 22: 553-558.

22. Majumdar S., Kumar D., Nirvan Y.P.S. (1999): Acrylic grafted dehydrated castor oil alkyd, a binder for exterior paints, Paintindia, 60: 57-65.

23. Ahamad S., Ahmad S.A., Hasnat A. (2016): Synthesis and characterization of methyl methacrylate modified poly(ester-amide) resins from Melia azedarach seed oil as coating materials. Mater. Sci. Res. India, 13: 50-56.

24. Siyanbola T.O., James O.O., Gurunathan T., Sasidhar K., Ajanaku K.O., Ogunniran K.O., Adekoya J.A., Olasehinde G.I., Ajayi A.A., Olaofe O., Akintayo E.T. and Raju K.V.S.N. (2015): Synthesis and characterization and antimicrobial evaluation of polyesteramide resin from Moringa oleifera seed oil (MOSO) for surface coating application, Canad. J. Pure and Appl. Sci., 9: 3229-3240.

25. Petrovic Z.S. (2010): Polymers from biological oils. Contem. Mater., 1: 39-50.

26. Fiser S.S., Jankovic M. and Petrovic Z.S. (2001): Kinetics of *insitu* epoxidation of soybean oil in bulk catalyzed by ion exchange resin, J. Am. Oil Chem. Soc., 78: 725-731.

27. Saurabh T., Patnaik, M., Bhagt S.L., Renge V.C. (2011): Epoxidation of vegetable oils: A review, Int. J. Adv. Eng. Tech., 2: 491-501.

28. Lee H., Neville K. Hand book of epoxy resins, Mc Graw-Hill, New York, 1967.

29. Vlcek T. and Petrovic Z.S. (2006): Optimization of chemoenzymatic epoxidation of soybean oil. J. Am. Oil Chem. Soc., 83: 247-252.

30. Saremi K., Tabarsa T., Shakeri A. and Babanalbandi A. (2012): Epoxidation of soybean oil, Annals Biol. Res., 3: 4254-4258.

31. Hutchinson G.H. (2002): Traditional and new uses for vegetable oils for vegetable oils in the surface coatings and allied industries, Surface Coat. Int. Part B: Coat. Trans., 85: 1-8.

32. Zong Z., He J. and Soucek M.D. (2005): UV-curable organic-inorganic hybrid films based on epoxynorbornene linseed oils, Prog. Org. Coat., 53: 83-90.

33. Hwang H.S. and Erhan S.Z. (2001): Modification of epoxidized soybean oil for lubricant formulations with improved oxidative stability and low pour point, J. Am. Oil Chem. Soc. 78: 1179-1184.