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From Editors Desk

Dear Readers,

It is my great pleasure and honor to bring forth the first issue of the Journal of Lipid Science & Technology (JLST) for the year 2021 to you.

The Journal intends to be the mainstream representation of Oil Technology. A meticulous attempt has been made to include the articles of 'classic' as well as 'modern' Technology. However, I must admit that there can be honest and healthy differences over what to count as a classic and as modern.

This issue of the Journal of Lipid Science and Technology of Oil Technologist Association of India (OTAI) comprises papers collected and reviewed by eminent scholars & researchers. The work reflects the research work of the scientists who have not only come up with innovative and groundbreaking ideas, but have also articulated them in an uncomplicated fashion.

The consumption pattern of fats and oils, both in terms of quantity and quality has changed over the years. However, there continues to be a lack of awareness amongst consumers about the health effects of both. Therefore, the need of the hour is to plan and implement public health awareness programmes to promote moderate consumption of fats & oils where the intake of omega 3 PUFA and MUFA is favored. Simultaneously, awareness needs to be fostered that the intake and usage of Saturated Fatty Acids (SFA) is lowered and Trans fatty Acids (TFA) is negligible.

Fats which are worse for health are the industrially-produced trans-fats. They are present in partially hydrogenated fats used extensively in bakery products and fried foods. Globally, the target to eliminate these fats from the food supply chain is by 2023. The Indian food regulator Food Safety and Standards Authority of India (FSSAI) has set out an aggressive target to achieve less than 2% industrially-produced trans-fat content by 2022.

The Editor-in-Chief wishes to thank all the contributors. I am also thankful to reviewers who have taken great pains to meticulously review the contributions. Hope this volume will serve the purpose of research & development for students and the members of OTAI.

I would be happy to receive any feedback regarding the JLST. Please feel free to email me your inputs and comments.

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All India (Urban +Rural) market in Washing Powder Category.

Coconut oil based low temperature hair oil formulations through Alcohol Esters- Bio-Process

**Mishra S C & Trivedi R K, Harcourt Butler Technical University,
Kanpur, U.P., India-208002**

ABSTRACT

Coconut oil when interesterified, gave product with reduced solidification point. But to get solidification point below 5^{0}C & good oxidative stability, the esterification of coconut oil with it's alcohol esters or inter-esterification with monounsaturated fatty acid group liquid oils were done. The re-esterification of the inter-esterified oil with alcohol esters was also done.

Based on the data of melting points of methyl esters of coconut oil & that of the products of interesterified coconut oils with liquid oils suggested us to go for trans-esterification of coconut oil.

Since Enzyme inter-esterification give no bye product, so for interesterification or esterification the immobilized enzyme TLIM (from Thermo-Myces Lanuginosus, Rosaceae family, make Novozymes, Denmark) was used as catalyst at 55^{0}C-60°C in 0.30-0.40% concentration with 3-4 hours reaction time. The Bio-process is efficient & simple to adopt.

Trans-esterification of coconut oil & castor oil with alcohols such as methyl alcohol, ethyl alcohol or butyl alcohols were experimented and desired solidification point obtained. The alkaline catalyst Sodium Methoxide 0.30 & 0.50%, with 6 moles of alcohol at 60-70^0 C, 3-4 hour reaction time was reaction conditions.

The alcohol esters so obtained when esterified by coconut oil gave better quality hair oil in terms of viscosity & also fulfilled the solidification point requirement. So, the coconut oil & alcohol esters were esterified and suitable ratio, produced the desired product with solidification point equal or below 5^{0}C.

The resulting solidification point of 2°C of Methyl esters & 0-2°C of Ethyl esters & , 0° C encouraged us to go to prepare alcohol esters and as the viscosity of the product was low, we thought to go for esterification of the Alcohol esters with the coconut oil. Thus coconut oil & Alcohol esters were interesterified and suitable ratio produced the desired product with solidification point equal or below 5^{0}C. The study was done with coconut oil and methanol, glycerol, glycol, ethanol & butanol and esterification with these esters and coconut oil to compare the results.

The esterification of ethyl and butyl esters with Coconut oil was also done to get the solidification point below 5° C.

Keywords- CCNO- coconut oil, CO- castor oil, MECCNO – methyl esters of coconut oil, GNO-groundnut oil, OLO olive oil, RBO- ricebran oil. IE-interesterified oil, S.P.- Solidification point. TLIM –Thermo Myces Lamuginosus immobilized enzyme.

INTRODUCTION:

The market research estimation that about 66% of the Indian market of hair oil is supplying coconut oil as a base oil in hair oil formulations and growth rate of 14% per annum became true (1). For winter season most of the popular manufacturers were found blending cosmetic grade light liquid paraffin, a refined mineral oil from about over 60 to over 90% (2). Innovations by some section of manufacturers led to supply the people coconut oil and sesame oil blends with some bio active materials obtained from natural essential oils for therapeutic and aromatherapy uses (3).

The need of this research was due to difficulty of coconut oil application in winter because of its solidification at about 20 degree °C and melting point of about 26 °C (4). The coconut oil having low & medium carbon numbers and molecular weight straight chain fatty acids in majority composition result in maximum penetration in scalp and thus does maximum protection of hair follicles from some surfactants used in shampoo such as low molecular weight sodium lauryl sulphate which can penetrate easily in to the hair structure and harm them (5,6). The coconut oil was found to be the better than oils like sunflower oil & mineral oil in successive order for hair nourishment and protection due to its chemical structure (5). By blending light liquid paraffin oil in majority to the coconut oil the performance of coconut oil got poor (5,6,7); and hair oil formulations without mineral oil are pleaded.

There are few important processes of fat modification – Fractionation, the Fractional distillation of distilled Coconut fatty acids and Re-esterification of lower molecular weight fatty acids, Inter-esterification (5), and dehydrogenation (8). Based on cost-benefit and ease of operation and multi choices the inter-esterification process is selected for study.

Review of the related work:

The oils which can penetrate in to the hairs more can fill the gap between cuticle cells and prevent the diffusion of the surfactant in to the hair follicle & coconut is the best (2).

The main characteristic of hair oil is hydrophobic nature of the oil. Saturated and monounsaturated fatty oils diffuse into the hair much better than polyunsaturated fatty oils (3). Also, the coconut & other oils are chosen by shelf life, melting points, nutrients (6) & prices. The oils selected for inter-esterification with coconut were coconut oill, modified coconut oil, castor oil (CO), rice bran oil (RBO), groundnut oil (GNO), sesame (SEME) and olive oil(OLO). Castor Oil is also regarded as the excellent hair oil (9), its MUFA content is highest (7). Castor oil is used as reliable laxative oil from the ancient time (10). To accommodate the demand of more concentrated steroid hormones, castor oil mixed with other suitable oils has been found to fulfil need owing to it's hydrophilic hydrophobic balance (11). Castor oil is also used as emollient (12). It has been that C**astor oil alone will not grow your beard** and what essential oils are best for **growing long, healthy beards (13)**.

Sesame, Groundnut, Rice Bran Oils are superb hair oils as per fatty acid composition and nutraceutical, Olive oil is also good oil as per fatty acid component and presence of nutrients, but it is costlier (5). Thus the above oil's use along with the Coconut oil is to be explored.

The coconut oil after hydrolysis give crude fatty acids & glycerine, former when distilled & the distilled fatty acids undergo fractional distillation provide C_8-C_{10}, C_{12}-C_{14} & C_{16}-C_{18}, fatty acid fractions. The C_8-C_{10} fatty acids when esterifies with glycerine synthesize medium chain triglycerides of low melting point form. The overall recovery of C8-10 fatty acid is about 15% (5).

The solvent fractionation of CCNO was carried out by Bhattacharya et al. in 2014 (14) with the Isopropanol by ranging the ratio of oil: solvent (1:3 to 1:5) at temperatures 25^0 C - 10^0 C. The melting points of coconut olein & stearin fractions were 20.6^0 C & 28.3^0 C & yields were 25.02% & 70.97% respectively (9).

Coconut oil and Acetone in ratio 1:2(V: V) mixture when cooled up to 7^0C in the chilled water bath with slow agitation to crystallize & separate by vacuum filtration produced solid and liquid fraction & latter was liquid at 8^0 C (15).

Laning S. J. in 1985 (16) reported decrease in drop point a factor related to melting point of coconut oil from 35.5 to 28.2 after chemical inter-esterification using alkali , 0.10% sodium meth oxide at 0.01% moisture and 0.05% FFA at 70^0C under vacuum due to increase in low molecular weight fatty acids among more triglyceride. The catalyst increases to 0.20-0.30% if FFA is more, i.e. up to 0.35%.

Reena M.B. et al. in 2008(9) conducted experiments by blending coconut oil, rice bran oil & sesame oil to achieve the ratio of SFA: MUFA: PUFA as 1:1:1. Its inter-esterification reaction was carried out using 1% lipozyme IMRM of the Rhizomucor Miehei family. Bio inter-esterification process was opted at 160 RPM for 72 hours at 37^0 C. After that, the oil was decanted & analyzed.Based upon the fatty acid composition of the interesterified blend of (CCNO+RBO) & (CCNO+SESO) & their standard methyl ester's melting points, the average estimated fatty acid's and methyl ester's melting points are expected to be -8.7 & $-12.^0$C. This also forms the basis of our selected process.

Nagaraju A. et al.(17), studied the fatty acid compositions of the (CCNO+OLO) &

(CCNO+GNO) by blending them in proportion to get SFA:MUFA: PUFA ratio of about 1:1:1 and of their interesterified products. Thus with (CCNO+GNO) the ratio of SFA:Mono: PUFA actual ratio was 31.0,38.0,31.0 and with (CCNO+OLO) they were 43.0:51.0:6.0. Based upon the fatty acid composition of the interesterified blend of (CCNO+OLO) & (CCNO+GNO) & their standard methyl ester's melting points, the average estimated fatty acid's and methyl ester's melting points are expected to be -6.6 & -11.^{0}C. This also forms the basis of our selection for the process.

Arita et al. in 2015(18) carried out directed interesterification of coconut oil in acetone solvent to fractionate its oil in 3 steps at 45^0 C, 35^0 C, 25^0 C successively & and finally got 10-15^0 C melting point Medium Chain Tri Glycerides in 24% quantity.

Thus interesterification process offers an optimum method to modify coconut oil for winter use. Based on the fatty acid composition of the coconut oil, oils with mono unsaturated fatty acid as major fatty acid component & nutraceuticals the oils selected for the interesterification process, were – Castor oil, sesame oil, groundnut oil, rice bran oil & olive oil. The sesame, ground nut, olive are widely used for hair oils & refined rice bran oil is also very good in quality.

The characteristics of Coconut oil used in our experiments as per standard BIS or AOCS methods (19-21) are:

Characteristic	FFA	I.V.	S.V.	HV	M.P.	S,P.	Fatty Acid Composition
CCNOil	1.0	9.7	263		25.6	22.0	C6-0.2 , C8-7.0, C10-6.3, C12-47.9, C14-18.2, C16-8.4, C18:0-2.40 , C18:1-7.50, C18:2-2.0

TABLE - 1

Material & Methods:

For esterification Lipozyme TLIM Immobilized Enzyme from Thermo-Myces Lanuginosus, Make Novozymes, Denmark was chosen. It is a fixed bed, 1-3 specific, but there is acyl migration from 2 to 3 or 1, hence most of the time it's randomized, the max temperature it can bear is 65^{0}C. The recommended parameters as per the supplier are: dose 0.30-0.40% at 55 ^{0}C & time 3-4 hours.

Oil chosen was Coconut Oil purchased from the Kanpur, U.P., India, market, manufactured, by Kamani Oils, Pvt. Ltd. Mumbai, India. Chemicals used were of ExcelR grade of Qualigens,Mumbai, India, S.D.Fine chemicals, Mumbai, India make & filter paper of Whattman, 42 no. of G E healthcare.

Laboratory's 3 digit accuracy scale was used for oils, chemicals weighing. Experiments were done in a 4 neck round bottom flask of Borosil glass. It's top B24 joint was fitted to the stuffing box & stirrer, the sides's B19 number joint was attached to thermometer pocket, to the vacuum pump connection through catch oil via stopcock, 4th neck was fitted by cork to use for sample / material addition purpose. The vacuum when not used for trans-esterification experiments then this pocket was connected to a vertical condenser.

In trans-esterification experiments the Coconut oil was mixed at 60^{0}C with 6 moles Methanol and 0,30% sodium methoxide using condenser for 3 hours (22). The product was cooled to 60^{0}C & neutralized with 0.15% phosphoric acid/ Citric acid PH checked to be between 6-6.5. Then excess methanol was distilled & condensed to recover at 70-80°C & then reactants settled to remove glycerine. Then product was washed with 6% hot deionized water at about 70° C twice & water removed by settling & tested for soap ppm (to be nil). The product was then heated under vacuum to

110ºC to dry & then cooled at to below 60º C.

In the next set of experiments methyl esters of coconut oil were made by chemical method. For chemical trans-esterification (23) the oil was dried at 110ºC under 758 mm vacuum, cooled to 60ºC, 20% methanol along-with 0.4% Sodium Methoxide catalyst used for the reaction carried out for 3 hours. After that the catalyst neutralized with stoichometrically proportion of Citric or Phosphoric acid & the excess methanol distilled. The mixture was cooled below the temperature of 60ºC, then settled to remove glycerol produced by draining. Then the product was washed with hot water, dried under vacuum to 110ºC & cooled to 60ºC. The Butyl & Ethyl esters of Coconut (EECCNO &BECCNO) were prepared by Chemical interesterification (17) method using Sodium methoxide as catalyst. The EECCNO & BECCNO were esterified with Coconut oil in optimum ratio using TLIM immobilized enzyme, to prepare product having solidification point (SP) below 5 ° C. The above results are shown in the table no. 5:

EXPERIMENTAL RESULTS TABLE NO. 2:

Composition A	**Composition B**	**Catalyst**	**Temp.**^{0} C	**Time**	**RPM**	**S.P.,** º C
CCNO	MeOH 6 mole	0.3% NaOCH3	60^{0} C	3 h	90	2º C
CO	MeOH 6 mole	0.3% NaOCH3	60^{0} C	3 h	90	-10º C
CCNO	BtOH 3 mole	0.3% NaOCH3	60^{0} C	3 h	90	-2^{0} C
CCNO 1mole	EE 6 mole	0.3% NaOCH3	60^{0} C	3 h	90	1° C
CCNO 50%	50% BECCNO	0.5%TLIM	$55\text{-}60^{0}$	3 h	90	5.1º C
CCNO 45%	55% BECCNO	0.5%TLIM	$55\text{-}60^{0}$	3 h	90	3.9º C
CCNO 40%	BECCNO 60%	0.5%TLIM	$55\text{-}60^{0}$	3 h	90	2.8º C
CCNO 35%	BECCNO 65%	0.5%TLIM	$55\text{-}60^{0}$	3 h	90	2.2º C
50% CCNO	50% EECCNO	0.5%TLIM	$55\text{-}60^{0}$	4 h	90	5.5º C
45% CCNO	55% EECCNO	0.5%TLIM	$55\text{-}60^{0}$	4 h	90	4ºC
40% CCNO	60% EECCNO	0.5%TLIM	$55\text{-}60^{0}$	4 h	90	3º C
40% CO	60% MECCNO	0.4% TLIM	$55\text{-}60^{0}$	4h	90	3.5
(CCNO60:CO 40)- IE, 60%, S.P.12º	MECCNO 40%, S.P.,2^{0} C	0.4% TLIM	$55\text{-}60^{0}$	3.5 h	90	3.0
100% CCNO	EtOH 25%	Eversa Transform 2.0	$38\text{-}40^{0}$	24 hr	90	2.0

Pie Charts Drawn Fig. 1 (BECCNO+CCNO) & (EECCNO+CCNO) 2 followed :

% BECCNO	% CCNO	S.P. °C
50	50	5.1
55	45	3.9
60	40	2.8
65	35	2.2

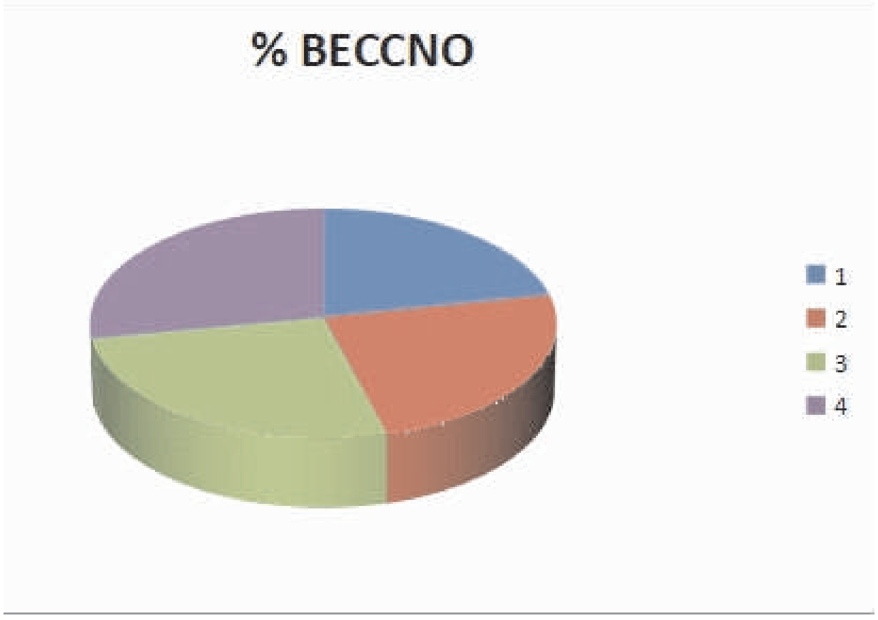
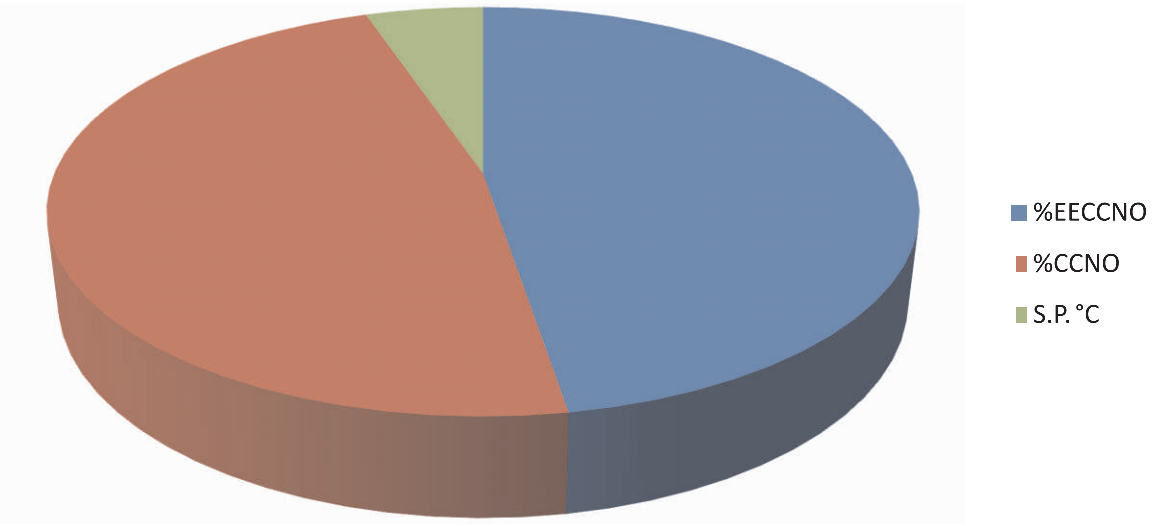


Fig 1
Pie Chart BECCNO & CCNO Inter esterification (IE): Linear Straight line type pattern (Linear Regression Model).T, It T

%EECCNO	%CCNO	S.P.°C
50	50	5.5
55	45	4
60	40	3



EECEECCNO & CCNO Esterification Experiments Pi Charts inference are:

Note : Pie chart points out towards Linear regression model.

It was also decided to test Viscosity of Products, physical tests & take view of colleague woman volunteer (25).

EXPERIMENTAL RESULTS TABLE NO. (Table 3):

S.no	Details of product	Viscosity at 30^0 C	Density at 30^{0}C	Color in 1" Cell
1	IE -40% CCNO + 60% ME CCNO	25.9 at 32^{0}C	0.905 at 32^{0}C	1Y,0.3R
2	MECCNO	3.82 at 34^{0}C	0.8795 at 32^{0}C	0.8Y, 0.3 R
3	EE-CCNO	6.1 at 30^{0}C	0.8728 at 30^{0}C	1.6Y,0.3R
4	CASTOR OIL (CO)	434.2 at 33^{0}C	0.965 at 33^0 C	3Y, 0.4R
5	COCONUT OIL (CCNO)	55.1 at 33^0 C	0.9196 at 33^{0}C	1Y, 0.3Y
6	BE-CCNO+(40CCNO+60MECCNO)50:50	14.2 at 33^0 C	0.946 at33^0 C	0.9Y, 0.3R
7	Garnier Ultra Doux; extract of almomd oil, CCNO & Mineral Oil based	38.488 at 32^{0}C	0.819 at 32^{0}C	Slight greenish
8	Kesh Kanti Sesame Oil & CCNO based	47.355 at 32^{0}C	0.883 at 32^{0}C	Greenish owing to Herbs extract addition
9	65% BECCNO+35%CCNO	16.45 at 20°C	0.912 at 20^{0}C	0.9Y, 0.4Y
10	605EECCNO+405CCNO	16.25 at 20°C	0.908 at 20^{0}C	0.8Y, 0.3R

Results& discussions:

The ethyl esters & butanol esters were prepared by chemical & enzymatic trans esterification process with sodium methoxide & Lipase Enzyme (Eversa Transform 2.0 of Novozymes) **as per parameters described in table 2 (12,27). The esterification of ethyl and butyl esters with Coconut oil was also done to get the** solidification point **below 5º C by enzymatic process and the results are shown in table no.2.** The composition of coconut oil & **ethyl esters & butanol esters** were optimized for esterification based on the desired solidification point, using bio-catalyst.

As also observed from the table no. 2, solidification point of coconut oil (CCNO) decreased by blending with the castor oil (CO) which is also a popular medicinal oil for hair growth & preventing hair loss. The solidification point further decreased after esterification of the blends. We aimed to bring the melting point below 5^0 C to use in winters without any solidification of the oil blend. As observed, the desired result was achieved at 15-20% CCNO & 80 - 85% CO composition approximately. But it was noticed that the % of CCNO is low in this composition. Thus CCNO was modified to make its methyl esters (MECCNO) by trans esterification process using chemical and enzymatic methods. And inter-esterification (CCNO+CO) product were esterified with MECCNO.

And as observed in table 2, the solidification point of CCNO dropped from 22 to 18^0 C by inter-esterification using immobilized enzyme & dropped to 20^0 C when modified to MECCNO. Then MECCNO when esterifies CCNO in 45:55, the solidification point of the interesterified products was $4\,^0$C.

The viscosity results show that inter esterfied (CCNO+MECCNO) or inter esterfied (CCNO+ EECCNO is better product than MECCNO or EECCNO (Table no. 3).

The viscosity values of the market leader's products were determined and compared. Human trial on woman volunteer (26,27) was also done who liked product with viscosity near coconut or monounsaturated based oils.

For Pie chart 1). BECCNO & CCNO , IE. 2). % EECCNO & CCNO IE data of sl. No. 3 to 6 & 7 to 9 (Table 2) were used & it was concluded that:

Pie Chart BECCNO & CCNO, EECCNO & CCNO inter esterification (IE): experiments follow Lineart Straight line type pattern

Conclusion:

The purpose of producing coconut oil based low temperature hair formulations is achieved by interesterification process of coconut and castor oil as per table no. 2. Other oils as mentioned above viz. SESO, RBO, GNO, OLO can be similarly interesterified with coconut oil to get the hair oil of below 5^0C S.P..

The intrinsic nutraceuticals shall give additional benefits. Transesterifed coconut oil with methyl alcohol when interesterified with coconut oil in proportions as shown also gave desired S.P. as per table no. 3.

Pie charts for CCNO & CO, CCNO & MECCNO experiments gives us the idea of the reactants required to get the desired results.

The viscosity of satisfactory SP products & that of the market products were tested and compared as per table 3. Only the viscosity of the IE(CCNO:CO)20:80 is higher & rest fall in the range of popular brands. Only one brand of Patanjali found to be having vegetable oils CCNO:TO in 20:80 ratio , rest were blended with LLP & later being the major component. Colours are also satisfactory.

Ethyl ester obtained by enzymatic process yielded S.P. 0 to 2^0C. The butyl esters from chemical esterification gave -2^0C product which are good starting material to esterify CCNO.

Esters of Ethyl alcohol (EECCNO), and butyl alcohol (BECCNO) were esterified with CCNO to see the optimum suitability for modification of the CCNO. Their results are satisfactory and is shown in table 2 and are optimized to get suitable 100% coconut oil based hair formulation.

TLIM catalyst is reusable up to 5 times as per the manufacturer or precisely as per the metal content to which they are inversely proportional.

Thus suitable hair oil formulations based on coconut fatty acids (100%), 79% Coconut oil fatty acids & 21% Castor oil based fatty acids are achieved.

REFERENCES :

1. Indian FMCG market research, by A.C.Neilson & Co, (2010).
2. Rele AS, Mohite R B, Effect of mineral oil, sunflower oil and coconut oil on prevention of hair damage, J Cosme Sci.; 54:175-92 (2003).
3. Robbins CR. Chemical and Physical Behaviour of Human Hair, 4th edition. Ney York: Springer; (2013).
4. www.consumeraffairs.nic.in access on 25/12/2017
5. Bailey's Industrial Oil and Fat Products,

Volume 3, Speciality Oils and Oil Products, Chapter 15, Modification of Fats and Oils by Chemical & Enzymatic methods, A Wiley Interscience Publication, John Wiley & Sons, New York, (2006-7), PP 555-584, 303, 431, 485, 537

6. Gode V, Bhalla N, ShirhattiV, Mhaskar S, Kamath Y, Quantitative measurement of penetration of coconut oil into human hair using radio labeled coconut oil. J. Cosmet. Sci.; 63:27-31 (2012).

7. W LIQUID CLEANERS FOR WORKER EXPOSED TO MINERAL OIL. L. N. Savidge and F. H. Tirer, From the Research Department, Port Sunlight, *Brit. J. Industr. Med.* 1951, 8, 26.

8. P. Fantl and G.J. Lincoln , Enzymatic dehydrogenation of fatty acid, Wiley on line library, From the Baker research institute, Alfred hospital Melbourne, accepted on 9 March 1949, worked under part time gant from National Health & Medical Council,

9. Malongil B. Reena, Sunki R. Y. Reddy and Belur R. Lokesh, Changes in Triacylglycerol species and thermal properties of blended and interesterified mixtures of coconut oil or palm oil with rice bran or sesame oil, Eur. J. L. S. T., 111, 346-357 (2009)

10. T.S,Gagiella, F. Capasso, N. Mascolo and S. Perilli Phytotherapy research, Vol. 12, S130-S138 (1998), John Wiley and Sons ltd.

11. C. Riffkin, R. Huber and C. H. Kresser, Castor oil as a vehicle for Parenteral administration of Steroid Harmones, Journal of Pharmaceutical Sciences, Vol. 16, No. 8, August 1964.

12. Zofchak, Albert; John Obeji & Michael Mosquera, "Use urethane polymers of castor oil for skin and personal care product compositions.

13. Posted by David Boiano on Oct 12th 2018, Beard and Company, U.S.A,

14. Mahua Ghosh & D. K. Bhattacharya, Isopropanol Fractionation of Coconut Oil into its Olein and Stearin Fractions, Volume 1, Issue 5, Print ISSN: 2395,602 x, Thermal Section, Science, and Technology, (2015).

15. www.sciencedirect.com, Agriculture, and Agricultural Science Procedia 3 248 – 254. The 2014 International Conference on Agro-industry (ICoA) : Competitive and sustainable Agroindustry for Human Welfare,

16. Laning S. J., Chemical Interesterification of Palm & Palm Kernel Oil, J.A.O.C.S.,volume 62,issue2, no. 2., (February 1985)

17. Anitha Nagaraju, B R Lokesh, Interesterified coconut oil blends with Groundnut or Olive oil exhibit greater hypocholesterolemic effect than their physical blends, Department of Lipid Science and Traditional Foods, Central Food Technological Research Institute, Mysore 570020, India, Available on www.scincedirect.com, Nutrition research, 27, (2007) 580-587

18. Coconut Oil Based Low Temperature Liquid Hair Oil Formulations with BUTYL Ester and ETHYL Ester Modifications, S.C.Mishra*& R K. Trivedi**, PhD Research Scholar, **H.O.D., Oil Technology Department, School of Chemical Technology, Harcourt Butler Technical University, Kanpur, U.P.,India-208002, Test Engineering and Management, *Volume 83, March - April 2020, Page no. 8245-8249, ISSN 0193-4120, Published by Mattingly Publishing Co., Inc*

19. Indian standard, method of sampling and test for oils and fats, part 1, sampling, physical and chemical tests(revised), IS :548(Part1)-1964(reaffirmed 2010).

20. Indian Standard, method of sampling and test for oils and fats, part III, analysis of gas liqid chromatography, IS : 548, Part (III), 1976 (Reaffirmed 2009)

21. Method of analysis, General Application Manual, book no. 1608754, file 1/1, Alfa Laval, copy right, Alfa Laval AB, Tumba, Sweden 1999: Oil and Protein Technology. 99-04-23

22. Vegetable Oil Technology, Operating Instructions, 200/24 hrs, Alfa Laval Dry Fractionation Process for RBD Palm Oil, prepared by Sheikh K.E. for Louis Dresfus commodities Ltd., Krishnapatnum, India, Job no. 7500119, REF:- P&ID FRJ00119-

101REV 0, commodities Ltd., Krishnapatnum, India, Job no. 7500119, REF:- P&ID FRJ00119- 101REV 0

23. Nasirullah, Murlidhara Hampapura Krishnegowda, Rizwan Shariff and Jayapal Hemavathi, Department of Lipid Science & Traditional Foods, Central Food Technological Institute, (CSIR), Mysore, Journal of Lipid Science and Technology, Vol, 42, No. 3, 98-103 (July-sep2010), ISSN 0973 – 6379, Published by Oil Technologist's Association of India

24. Arita Dewi Nugrahinia,et al a Department of Agro-industrial Technology Universitas Gadjah Mada, Jl Flora 1 Bulaksumur, Yogyakarta 55281, Indonesia (2015). Available at Available at www. sciencedirect. com, Agriculture and Agricultural Science Procedia 3 248 – 254.

25. Viscosity measurement by Ostwald Viscometer. Standard specific gravity measurement by Specific gravity bottle.

26. The research scholar (PHD, Oil Technology) Ms Surbhi Rajwan ihelp sought to physically use and inform the efficacy of hair oil suitability.

27. Coconut Oil Based Low Temperature Liquid Hair Oil,S C M ishra*&R K. Trivedi**, PhD Research Scholar, **H.O.D., Oil Technology Department,School of Chemical Technology, Harcourt Butler Technical University, Kanpur, U.P.,India-208002, Test Engineering & Management, Volume 82, Page Number 11504 - 11508, January-February 2020, ISSN 0193 - 4120.

Isolation and physico-chemical characterization of Red sanders (*Pterocarpus santalinus*) seed oil

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ABSTRACT:

The seeds of ***Red sanders (Pterocarpus santalinus)*** collected from the forest of southern region of India (Andhra Pradesh state) were analyzed for oil content along with physico-chemical properties. The seed kernel was found to contain oil (16.8%), moisture and volatiles (2.3 % v/w), protein (48.5 % on dry basis). The oil extracted from seed kernels was analyzed for various physico-chemical parameters such as free fatty acid (4.87%), iodine value (94.27 g/100gm), peroxide value (12.32 ppm), saponification value (173.83), density (0.91136 g/cm^3 at 30 ºC), specific gravity (0.91535 at 30 ºC), kinematic viscosity (42.14 Cst). The fatty acid composition was analyzed by gas chromatography and the prominent fatty acid was found to be linoleic acid (45.8 %) followed by oleic (17.5 %), palmitic (14.2 %) and stearic (8.1%) acids respectively. Neutral lipids were the dominant lipid fraction (98.4%) in the oil with linoleic as the most abundant fatty acid. The unsaponifiable matter in the oil was 1.915 % which was composed of phytosterols, phytol and triterpenoid.

KEYWORDS: ***Pterocarpus santalinus,*** seed oil; physico-chemical properties, fatty acid composition.

INTRODUCTION

Tree borne oil seeds are gaining importance as they are rich source of many natural bioactive compounds with huge potential [1]. In recent years, interest in search for new sources of food sources that will meet the health and nutritional needs of the world's population has been increasing [2]. With the growing population and the usage of oils for different applications, some of the countries have to depend more on imports to meet their domestic demands. Due to this scenario, the imports of vegetable oils are increasing rapidly and in recent times India alone imported more than 15 million tonnes of vegetable oils for the edible and industrial applications [3]. Many studies have been carried out aiming the utilization of wild plants as a source of unconventional oil for edible and non-edible application [4-7].

India's forest base is rich with wide range of plantations which can be explored for studying the lesser known and unknown and underutilized oilseeds of the forest origin. Literature reports on the lesser known and unconventional trees/plants indicate that the seeds from these types of species can be a good source of fats, nutrients and other components useful for human use [8]. ***Pterocarpus santalinus,*** **popularly known as Red sanders** belongs to this category as this tree has not been explored for study of its seed composition like oil content and physico-chemical properties. **Red sanders** belong to the family **Fabaceae** *and* are a light-demanding small to medium size trees growing to 8 metres tall with trunk having 50–150 cm diameter. ***Pterocarpus santalinus***, with the common names Red Sanders, Red **Sandalwood** and **Saunders wood** is endemic to the southern Eastern Ghats mountain range of South India. This tree is valued for the rich red colour of its wood which is believed as one of the most prized woods.

Pterocarpus santalinus was reported to be used in traditional herbal medicine as an antipyretic, anti-inflammatory, antihelmintic, tonic, haemorrhage, and dysentery, aphrodisiac, anti-hyperglycaemic and diaphoretic. [9]. The stem extracts were shown to exhibit anticancer activity against HeLa cell lines suggesting that *Pterocarpus santalinus* has potential applications in medicinal research [10]. The heartwood extract was isolated and studied for its composition where several compounds with anti-inflammatory and cytotoxic activities were reported [11]. Various parts of *this* tree have been studied for its composition, but no research data is available on the seed oil and its compositional study. Therefore, the present study was aimed to investigate the physico-chemical characteristics of seed oil of Red ***sanders which is exclusively available in India only.***

MATERIALS AND METHODS

Materials

Seeds of Red ***sanders*** were supplied by AP Forest Department, Hyderabad. Standard mixture of fatty acid methyl esters were purchased from Sigma-Aldrich Chemical Co. (St.Louis, MO, USA). All the chemicals and solvents were purchased from M/s. Sd Fine Chemical Co. Ltd. (Mumbai, India) and were of laboratory reagent grade.

Methods

Proximate Analysis:

*A*sh and crude-fibre contents of the seeds were determined following the standard AOAC methods [12]. Moisture and volatile matter were determined according to AOCS official methods [13].

Extraction of oil:

The dried seed were ground to powder and in an electrical grinder and oil was extracted in a Soxhlet apparatus using hexane as solvent. The oil content was determined as a percentage of the extracted oil to the sample weight (w/w). The extracted oil was stored at room temperature in a glass bottle under nitrogen blanket for further analysis.

Physico-chemical Analysis of Oil:

Free fatty acids, iodine value, saponification value, peroxide value, unsaponifiable matter and colour were measured following official methods of AOCS [13]. Density was determined using Anton Paar density meter (Type DMA4500M, Austria) at 30°C. The samples were analyzed in triplicate and the average of the three measurements is reported. Phosphorous content was estimated following IUPAC method [14]. Density, specific gravity and Kinematic viscosity (Cst) was measured following ASTM standard methods [15].

Fatty Acid Composition by Gas Chromatography:

The fatty acid composition of the extracted oil was determined by gas chromatography (GC). The oil was converted to fatty acid methyl esters using methanol-sulphuric acid (2% v/v) reagent. GC analysis of the fatty acid methyl esters (FAME) was performed using a Agilent 6890 gas chromatograph coupled to a flame ionization detector (FID) equipped with a DB 225 capillary column (30 m x 0.25 mm x 0.25 µm, (J&W Scientific, USA). The column temperature programme was 2 min at 160°C, 5°C/min to 230°C and 20 min at 230°C. The injector temperature was 230°C with a split ratio of 10:1. The carrier gas was N_2 at a flow rate of 1 mL/min. The detector temperature was 270°C with air and hydrogen flow rates of 300 mL/min and 30 mL/min, respectively. The fatty acids were identified by comparing the retention times with mixture of standard FAMEs, C4-C24. Each FAME sample was analyzed in duplicate and average value is reported.

Analysis of Unsaponifiable Matter by Gas Chromatography:

GC analysis of unsap matter was performed using Agilent 6890 Gas Chromatograph coupled to a flame ionization detector equipped with a HP-1 capillary column (30 m x 0.25 mm x 0.25 µm, 100% dimethyl polysiloxane stationary phase material; company, J&W Scientific, USA). The column temperature programme was 2 min at 150°C, 10°C/ min to 300°C and 20 min at 300°C. The injector temperature was 280°C with a split ratio of 50:1. The carrier gas was N_2 at a flow rate of 1 mL/min. The detector temperature was 300°C with air and hydrogen flow rates of 300 mL/min and 30 mL/min, respectively. The unsaponifiables were identified by comparing the retention times with those of mixture of standard compounds (Vitapherol, India). Each sample was analyzed in duplicate and the average value is reported.

Positional distribution of fatty acids in the triglyceride:

This was carried out by porcine pancreatic lipase mediated regio specific hydrolysis of ***kernel*** oil as described by Christie [16]. The oil (20 mg) was hydrolyzed in a mixture of tris buffer (1M; pH 8.0; 4 mL), calcium chloride solution (2.2%; 0.4 mL) and 0.05% bile salt solution catalyzed by pancreatic lipase (10 mg, porcine pancreatic lipase, crude type II) at 40°C for about 3 min with magnetic stirring. Later, ethanol (1 mL) was added followed by 1.5 mL of 6N HCl and the hydrolysis products were extracted by diethyl ether (2 x 10 mL) and the organic layer was washed with water until neutral and dried. Solvent was evaporated and the hydrolysis products were separated on TLC in a mobile phase consisting of hexane/ethyl acetate/acetic acid (70/30/1, v/v/v). The band corresponding to 2-monoglyceride was separately scraped and converted to fatty acid methyl esters using 2% sulphuric acid in methanol reagent and analyzed by GC to determine the fatty acid composition. All analyses were conducted in duplicate and average value was calculated. The mean composition of each fatty acid in positions 1 and 3 was calculated.

Separation of lipid classes:

The oil extracted was separated into individual lipid classes by column chromatography by elution with chloroform, acetone and methanol to separate neutral, glyco and phospholipids respectively. The lipid classes separated by column chromatography were determined for their fatty acid composition by gas chromatography.

RESULTS AND DISCUSSION

The kernels of *Pterocarpus santalinus* seeds were found to be tightly packed in the seed which were separated using mechanical tools. The shell and kernels were found to be in the ratio of 92 and 8% respectively. The proximate analysis of the seeds along with chemical composition is described in table 1.

Physico-chemical Properties of Oil: All the physico-chemical characteristics were analyzed following standard methodologies and the values obtained for *Pterocarpus* ***santalinus*** seed oil are shown in the table 2 .

Fatty Acid Composition

The fatty acid composition of the extracted oil was determined by GC and is illustrated in Table 3. Linoleic acid was found to be the major fatty acid (45.8%) followed by oleic, palmitic and stearic acids in lower amounts compared to linoleic acid. It was observed that the fatty acid composition is close to the fatty acid ranges of oil from Amaranthus except stearic acid which is slightly higher in *Pterocarpus* ***santalinus*** **kernel oil compared to Amaranthus seed oil** [17]. The fatty acid composition of *Red sanders* seed oil suggests that the oil can be a good source of linoleic acid and percentage of total unsaturated fatty acids in Red sanders seed oil was about 64.3%, while the percentages of saturated, monounsaturated and polyunsaturated fatty acids were 35.7, 17.5 and 46.4% respectively.

The regiospecific analysis of the oil showed that *sn*-2 position of the triglyceride was mainly composed of unsaturated fatty acids with linoleic acid being major fatty acid while *sn*-1 and 3 positions were composed of saturated fatty acids in higher amounts. It was also found that the kernel oil was composed of very long chain saturated fatty acids (C20 to C24) in considerable amounts. Presence of very long chain fatty acids like behenic and lignoceric acids in members of Fabaceae family seems to be a characteristic feature which was reported in several other species in the literature [18, 19]. The oil was further separated into lipid classes and it was observed that the oil was composed of 98.4% of neutral lipids and 1.6% of glycolipids. No phospholipids were detected in the oil of Red sanders which was also confirmed by the absence of phosphorous. The fatty acid composition of the neutral and glycolipids did not show much variation in composition in most of the fatty acids. However, the glycolipid fraction was composed of saturated fatty acids in slightly higher amounts compared to neutral lipids.

The unsaponifiable matter present in the Red sanders seed kernel oil was found to contain beta amyrin (33.8%) followed by phytol (28.5%) in as major components followed by some phytosterols in small amounts. It was interesting to observed p**hytol** in the seed oil of red sanders. Phytol was earlier reported in the unsaponifiable fraction of oil from Hemp seeds [20]. Phytol is reported to posses' antioxidant and anticancer properties and is found in foods such as spinach, beans, and raw vegetables [21]. Among the phytosterols present in the unsaponifiable matter, sitosterol (18.8%) was the major component followed by stigmasterol (8.9%) and campesterol (2.6%) in minor amounts.

CONCLUSIONS

In the present study, ***Pterocarpus santalinus*** seed was identified as a new source for oil from **Fabaceae** family. Complete analysis of the ***Pterocarpus santalinus*** seed and oil was carried out and this is the first report on the oil composition studies from this seed. The oil content in the kernel was about 16.5% with linoleic acid as a major fatty acid. The unsaponifiable matter showed the presence of phytol as one of the constituents along with other common phytosterols and terpenoids.

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REFERENCES

[1] P. Górnaś, M. Rudzińska, M. Raczyk, I. Mišina, A. Soliven and D. Segliņa, *Ind. Crops Prod.* **82**, 44 (2016).

[2] R. Yukui, W. Wenya, F. Rashid and L. Qing, ***Int. J. Food Prop.*** **12,** 774 (2009)).

[3] http://www.seaofindia.com/press-release

[4] M. Ram Mohan, J.R.C. Reddy, S.S. Kaki, R.B.N. Prasad and B.V.S.K. Rao, *Ind. Crops Prod.* **90**, 28, (2016).

[5] S.S. Kaki, J.R.C.Reddy, Y. Mohini, Y, T. Jabeen, B.V.S.K. Rao, B.V.P. Reddy and R.B.N. Prasad, *J. Lipid Sci. Technol*. **47**, 10 (2015).

[6] P. Górnas, A. Siger and D. Seglin, *Ind. Crops Prod.* **48**, 178 (2013).

[7] B. Anjaneyulu, S. S. Kaki, S. Kanjilal, J. R. C. Reddy, T. Ravinder, R. B. N. Prasad and B. V. S. K. Rao, *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, **39**, 811 (2017).

[8] C.H. Van Etten, W.F. Kwolek, J.E. Peters and A.S. Barclay, *J. Agric. Food. Chem.* **15**, 1077 (1967).

[9] K.K.I.U Arunakumara, B.C. Walpola, S. Subasinghe and M.H. Yoon, *J. Korean Soc. Appl. Biol. Chem*. **54**, 495 (2011)).

[10] H.J. Kwon, Y.K. Hong, K.H. Kim, C.H. Han, S.H. Cho, J.S. Choi and K. Byung-Woo, *Journal of Ethnopharmacology.* ***105,*** *229 (2006)*.

[11] S-F. Wu, F-R. Chang, S-Y. Wang, T-L. Hwang, C-L Lee, S-Li. Chen, C-C. Wu and Y-C. Wu, *J. Nat. Prod*. **74**, 989 (2011).

[12] AOAC. Official Methods of Analysis. 15th ed. Association of Official Analytical Chemists, Washington DC (1990).

[13] AOCS methods: Ca 2b-38; Ca 5-40; Cd 1-25; Cd 3-25; Ja 8-87; Ca 6a-40; Cc 13e-92; In official methods and recommended Practices of the American Oil Chemists' Society, 6th ed.; Firestone, D., Ed.; American oil Chemists' Society press: Champaigne, IL (2013)

[14] C. Pacquot and A. Hautfenne, International Union for Pure and Applied Chemistry (IUPAC). Standard Methods for the Analysis of Oils, Fats and Derivatives, 7th Ed. (The

Oxford, UK: Alden Press, Blackwell Publications 1987) p. 183.

[15] ASTM D 4052 ASTM. 2016. Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter. ASTM D 445 ASTM. 2010b. Standard Test Method for Kinematic Viscosity of Petroleum Products.

[16] W.W. Christie, Structural Analysis of Lipids by Means of Enzymatic Hydrolysis. In Lipid Analysis, 2nd Edition (Pergamon Press Ltd.: Oxford, United Kingdom, 1982) p. 155.

[17] **F.D**. Gunstone, Vegetable oils. In Bailey's Industrial Oil and Fat Products, Sixth Edition, Six Volume Set. Edited by Fereidoon Shahidi (John Wiley & Sons, Inc., Hoboken, New Jersey, 2005) p. 213.

[18] G.Knothe, Z.W.M.M. Phoo,.; M.E.G. de Castro and L.F. Razon, *Eur. J. Lipid Sci. Technol.* **117**, 567 (2015).

[19] S.S. Kaki, T. Jabeen, J.R.C. Reddy, M. Ram Mohan, E. Anjaneyulu, R.B.N. Prasad and B.V.S.K. Rao, *Grasas y Aceites.* **67**, e151 (2016).

[20] S. Montserrat-de la Paz, F. Marín-Aguilar, M.D. García-Giménez and M. A. Fernández-Arche, *J. Agric. Food Chem*. **62**, 1105 (2014).

[21] W.Vetter, M. Schröder and K. Lehnert, *J. Agric. Food Chem*. **60**, 6103 (2012).

Research Roundup Jan - Mar 2021

Nanoencapsulation of essential oils and their bioactive constituents: A novel strategy to control mycotoxin contamination in food system

Spoilage of food by mycotoxigenic fungi poses a serious risk to food securitythroughout the world. In view of the negative effects of synthetic preservatives, essential oils (EOs) and their bioactive constituents are gaining momentum as suitablesubstitute to ensure food safety by controlling mycotoxins. However, despite their proven preservative potential against mycotoxins, the use of EOs/bioactive constituents in real food system is still restricted due to instability caused by abiotic factors and negative impact on organoleptic attributes after direct application. Nanoencapsulation in this regard could be a promising approach to address these problems, since the process can increase the stability of EOs/bioactive constituents, barricades their loss and considerably prevent their interaction with food matrices, thus preserving their original organoleptic qualities. The aim of this review by **Anand Kumar Chaudhari*et al*** is to provide wider and up-to-date overview on recent advances in nanoencapsulation of EOs/bioactive constituents with the objective to control mycotoxin contamination infood system[**Food and Chemical Toxicology**, **149**, Article 112019, (2021)]. Further, the information on polymer characteristics, nanoencapsulation techniques, factors affecting the nanoencapsulation, applications ofnanoencapsulated formulations, and characterization along with the study on their release kinetics and impacts on organoleptic attributes of food are discussed. Finally,the safety aspects of nanoencapsulated formulations for their safe utilization are also explored.

Recent trends in the use of FTIR spectroscopy integrated with chemometrics for the detection of edible oil adulteration

Edible oils play an essential role in our routine life as cooking or frying oil as well as an ingredient used in food, medicine, and cosmetic commodities. Because of the highconsumption demands of edible oils, adulteration incidents have immensely raised. Thus, adulteration detection is very crucial for consumers, oil-producing industries,and regulatory authorities. The traditional analytical methods are usually time-taking, tedious, detrimental, lacking online monitoring, and need extensive samplepreparation. Whereas, the modern oil industry needs a competent and non-calamitous analytical approach for the rapid and precise quality control of edible oils. Fouriertransform infrared (FTIR) spectroscopy is an excellent technique for the detection of edible oil adulteration. It utilizes the fingerprint region of the obtained spectra todifferentiate and detect the different adulterants present in the edible oil. The spectra collected by the FTIR spectroscopy are complex and very much similar for different edible oils. To solve this complication, the multivariate branch of chemometrics coupled with FTIR spectral data has been employed to precisely distinguish between different edible oil adulterants. In chemometrics, different regression models, along with its various robust validation parameters, can detect even minute


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adulteration in edible oil with high precision and accuracy. This concise review by **Rahul Jamwal*et al*** presents the criticalaspects of major findings and brings together recent studies of the application of FTIRspectroscopy integrated with chemometric tools from several reliable sources[**Vibrational Spectroscopy**,**113**, Article 103222, (2021)].

Determination of 3-monochloropropanediol esters and glycidyl esters in fatty matrices by ultra-high performance liquid chromatography-tandem mass spectrometry

The development and validation of a method for the analysis of traces of 3-monochloropropanediol (3-MCPD) esters (19) and glycidyl esters (7) of fatty acids in vegetable oils, margarine, biscuits and croissants was performed by **José L. Hidalgo-Ruiz *et al***[**Journal of Chromatography A, 1639**, Article 461940, (2021)]. An extraction method based on the use of solvents (tert-butyl methyl ether (20% ethyl acetate, *v/v*))was carried out and cleaning of the extract with a mixture of sorbents (Si-SAX, PSA and Z-sep+) was optimized for the elimination of fatty interferents. The analysis of the targeted compounds was carried out by ultra-high-performance liquid chromatography coupled to tandem mass spectrometry, using a triple quadrupole analyzer (UHPLC-MS/MS-QqQ). The validation of the method provided trueness values between 72 and 118% and precision lower than 20%. The limits of quantification ranged from 0.01 to 0.1 mg kg^{-1}, which were below the current legal limits. Twenty samples of vegetable oils as well of 4 samples of margarine, biscuits and croissants were analyzed. Six out of the 24 samples (25%) exceeded the limits set by European legislation, and amaximum contamination of 3-MCPD esters at 2.52 mg kg^{-1} was obtained in a sample of corn oil (being 1-myristoyl-3-MCPD the compound detected at the highestconcentration). A maximum concentration of glycidyl esters at 7.84 mg kg^{-1} was determined in a soybean oil sample (glycidyl linoleate as the main compound). Onlyone sample of olive oil exceeded the maximum allowable limit for 3-MCPD esters witha value of 1.72 mg kg^{-1}, expressed as 3-MCPD.

Exergy analysis of glycerol steam reforming in a heat recovery reactor

A detailed exergy analysis was performed by **Felipe PinheiroFalcão Dias *et al***for the steam reforming process of glycerol by means of a series of experiments in a bench scale apparatus[**International Journal of Hydrogen Energy, 46**,Pages 8995-9007, (2021)]. The reforming was conducted in a fixed bed reactor, which operated in heat recovery mode by extracting the demanded energy from hot exhaust gases provided by a diesel engine. In order todetermine the role of the main operational parameters into the exergy efficiency of the studied process, the experiments were carried out with glycerol feed concentrations in water ranging from 10% up to 90% weight, whereas the outlet reactor temperaturewas varied from 600 °C up to 800 °C. Detailed exergy balances revealed a compromise between the exergy destruction within the reforming reactor and liquid separator versus the exergy losses associated to the tar and char outputs. This trade-off was favourable to the 50% and 70% glycerol feed concentration regimes andplateaus of about 74% exergy efficiency and 24 MJ/kg dry syngas exergy content were verified from 650 to 800 °C reactor temperatures.

Advanced Gel Permeation Chromatography system with increased loading capacity: Polycyclic aromatic hydrocarbons detection in olive oil as a case of study

Gel permeation chromatography (GPC) is herein used as size exclusion clean-up technique for highly sensitive and straightforward detection of Polycyclic Aromatic Hydrocarbons (PAHs) in olive oil samples. An advanced chromatographic system hasbeen developed by **Pietro Cotugno*et al***to isolate a series of PAHs with cancerogenic potential, including PAH4 (benzo(a)pyrene BaP, benzo(a)anthracene BaA, benzo(b)fluorantheneBbF and chrysene Chry) reported in the European Regulation [**Journal of Chromatography A, 1639**, Article 461920, (2021)]. The system avails of two glass chromatographic columns and a switching valve, that allow removal of interferinganalytes in olive oil without resorting to any preliminary extraction process. A seven-fold increase of the loaded sample amount versus conventional chromatographic systems (1 g vs 0.150 g) has been pursued, as well as improved PAHs detection and quantification limits (LOD-LOQ for PAH4: 0.21–0.70 ng/g for BaA, 0.26–0.86 ng/g forChry, 0.23–0.76 ng/g for BbF, 0.32–1.06 ng/g for BaP), in accordance with the continuous need of more and more reducing these limits in food analysis by the European Regulation. The protocol developed represents a highly innovative andefficient analytical method for organic pollutants in complex biological matrices as olive oil, that can have huge impact on technology for PAHs detection in food samples, being suitable for both industrial and small-scale laboratories.

Vegetable fixed oils obtained from soursop agro-industrial waste: Extraction, characterization and preliminary evaluation of the functionality as pharmaceutical ingredients

Jaqueline Rodrigues Cindra de Lima Souza*et al*designed to evaluate the feasibility of using oils extracted from seeds of soursop industrial waste for use as pharmaceutical ingredients [**Environmental Technology & Innovation, 21**, Article 101379, (2021)]. For that, soursop seeds were subjected to different processes of extraction of fixed oil, by chemical and mechanical routes. After characterization of fixed oils, the feasibility of using them as pharmaceutical excipients was explored by preparing creams in which the oils were used as emollient and/or antioxidant excipient. The oil extracted from soursop seedsin a Soxhlet device and ethyl ether solvent (SFO) showed a yield of 30.72 ± 0.09 % (w w^{-1}) and, in a domestic extruder (MFO), 23.86 ± 0.78 % (w w^{-1}). These oils showed physicochemical attributes that indicative of good preservation. The major fatty acidwas the oleic acid, with 42.94–43.73 % in relative area, followed by linoleic with 29.5%–30% in relative area. In the non-grease fraction, the SFO showed considerable levels of phenolics (194.5 ± 31.1 mg kg^{-1}) and tocopherols (608.2 ± 36.7 mg kg^{-1}), which gave it an antioxidant potential, confirmed by the 2,2-diphenyl-1-picrylhydrazyltest, with a concentration effective for 50% inhibition (IC50) of 2.8 mg mL^{-1}. Finally, the evaluation of the quality parameters of the creams, suggests that the use of fixed soursop oils to replace the synthetic ingredients usually incorporated (decyl oleate,liquid petrolatum and butylhydroxytoluene), originated formulations with adequate physical and chemical stability. These findings suggest that both oils obtained are possible candidates for use as emollients and antioxidant in pharmaceutical formulas.In addition, contributing to minimize the generation of waste from the fruit agribusinessand add economic value to a by-product generated in the production of fruit pulp

pH-sensitive castor oil/PEG-based polyurethane films for drug delivery

Apart from the frequent conventional use of polyurethanes (PUs), synthesizing bio-based polyurethanes from renewable sources is a new exciting way. The most intriguing issue in this respect is the use of bio-based PUs in biomedical applications. In the present study, PU films were synthesized by **FulyaGulmez*et al*** from castor oil (CO) and poly (ethyleneglycol) (PEG) in different CO:PEG ratios with a different molecular weight of PEG. Procaine was chosen as a model drug [**Journal of Drug Delivery Science and Technology, 61**, Article 102160, (2021)]. After the characterization of all films by FT-IR, DSC, and SEM methods, they were loaded with the drug in buffer solution at pH 9.1. The drug release behavior of the films in buffer solutions at pH 2.3, 5.8, and 6.4 was determined. Their swelling and degradation behaviors were also determined to explain their drug release mechanism. We found that decreasing the molecular weight of the PEG improved the drug release. Additionally, CO:PEG ratio and medium pH arecritical factors for the release behavior of the films. Almost 100% of the total drug was released at pH 2.3 in 24 h, which was approximately more than three-fold than that atpH 6.4. Zero-order, first-order, Higuchi, Korsmeyer-Peppas, and Kopcha kinetic models were used for the evaluation of the release data.

Technical feasibility of biodiesel production from virgin oil and waste cooking oil: Comparison between traditional and innovative process based on hydrodynamic cavitation

Biodiesel production calls for innovative solutions to turn into a competitive process with a reduced environmental impact. One of the process bottlenecks stands in theimmiscibility of oil and alcohol as raw materials, so mixing process largely impacts the overall process cost. This process step, if carried out by using hydrodynamic cavitation, has the possibility to become a benchmark for large scale applications. In this paper a process analysis of biodiesel production scheme is developed by **Valentina Innocenzi and Marina Prisciandaro**startingfrom two different feedstocks, virgin oil and waste cooking oil [**Waste Management, 122**, Pages 15-25, (2021)]. At the first the traditional process scheme has been simulated, in a second simulation, the reactor for the biodiesel production is interchanged with a hydrodynamic cavitation reactor. In the paper, the comparison between the traditional and innovative process by using lifecycle costing approach has been presented, thus providing indications for industrial technological implementation coming from a professional tool for process analysis. It is worth noting that the introduction of hydrodynamic cavitation reduces of about 40% the energy consumption with respect to the traditional process. As regards the totaltreatment costs, when using virgin oil as feedstock, they were in the range 820–830 €/t (innovative and traditional process, respectively); while starting from waste cooking oil the costs decreased of about 60%, down to 290–300 €/t (innovative and traditional process, respectively).

Optimization and characterization of chia seed (Salvia hispanica L.) oil extraction using supercritical carbon dioxide

Quality of chia seed (*Salvia hispanica* L.) oil obtained by supercritical carbon dioxide (SC- CO_2) is compared by **IzzreenIshak*et al***with Soxhlet extraction and commercial cold-pressed oil[**Journal of CO2 Utilization, 45** Article 101430, (2021)]. Response surface methodology (RSM) was conducted to determine the effect of different extraction parameters (pressure, temperature, and grinding time of chia seed) on chia seed oil yield. Linear and quadratic terms of pressure, temperature, anddifferent particle sizes (various grinding times) significantly affected the amount of chia seed oil. The optimal extraction conditions using SC- CO_2 to obtain the maximum yield of chia seed oil were as follows: chia seed particle size of 100−400 µm, 24 s of grinding time, extraction pressure of 335 bar and extraction temperature of 45 °C. However, the oil yield of chia seed extracted by SC- CO_2 was lower than Soxhlet. Imagescaptured by field emission scanning electron microscopy (FESEM) found a cracked surface in defatted chia seed powders with mostly oil released when high-pressure SC- CO_2 is applied. Based on the optimized conditions, chia seed oils obtained by SC- CO_2 and Soxhlet had comparable oxidation value, fatty acid composition, thermal properties, tocopherols, and antioxidant activity compared to commercial chia seedoil. However, oxidative stability test shows chia seed oil is less protected against oxidation due to the large amount of polyunsaturated fatty acids (PUFAs) more than85 %. The present study suggests that SC- CO_2 extraction is an effective method to produce chia seed oil with excellent sources of PUFAs and tocopherols.

Ageing properties of a polyoxymethylene copolymer exposed to (bio) diesel and hydrogenated vegetableoil (HVO) in demanding high temperature conditions

The increasing use of renewable biofuels in the transportation sector has driven attention on the incompatibility issues between biofuels and the polymeric materials used in the vehicle fuel system. Here, the ageing effects on a polyoxymethylene copolymer exposed to four types of fuels; petroleum diesel, biodiesel, a commercial mixture of these, and hydrogenated vegetable oil (HVO) at demanding high-temperature conditions, were investigated by **Xin-Feng Wei *et al***and compared with its performance in air. The degree of material degradation during ageing was highest in the presence of the non-polar fuels (HVO/petroleum diesel)[**Polymer Degradation and Stability, 185**, Article 109491, (2021)]. The samples aged in different fuels underwent the same increase in crystallinity due to annealing. Surface powdering was observed on the sample aged in the fuel mixture. The negative effects from acombination of plasticization and swelling, induced by the sorbed fuel, oxidation and surface cracks dominated the changes in mechanical properties, leading to reducedstiffness, strength and extensibility. The results indicate that care should be takenwhen choosing this polymer in contact with, especially, non-polar fuels at severe conditions.

The flow behavior of raw Jojoba oil in comparison with some traditional lube oils

To evaluate the possibility of utilizing the raw Jojoba oils for lubricating purposes in internal combustion engines, the flow behavior of raw Jojoba oil was investigated by **Mamdouh T. Ghannam and Mohamed Y. E. Selim**experimentally. Three customary lube oils of Diesel-, Petrol-, and Motorcycle-engines were employed in comparison with the raw Jojoba oil [**Industrial Crops and Products,161**, Article 113164, (2021)]. Rheometer type of Fann Model of 50SL with coaxial cylinders device was used for this investigation. This investigationreveals that the shear stress of the raw Jojoba oil increases gradually with shear rate in the range of 10–500 s^{-1} in a linear relationship. At constant shear rate, the shear stresses of the raw Jojoba oil decrease steadily with temperature range of 30- 90 C°. The well-known Herschel-Bulkley model can be used to describe sufficiently the flowbehavior of the raw Jojoba oil measurement data. The raw Jojoba oil shows flow behavior index equals almost one with slight apparent yield stress. The apparent flow viscosity of the raw Jojoba oil can be analyzed by Arrhenius relationship to show theeffect of the applied temperature. At higher operating temperature of 90 °C the raw Jojoba oil exhibits better performance and show higher viscosity values than all the examined lube oils within the range of 10–100 s^{-1} with viscosity index of 233 which is much higher than the commercial examined oils (range 130–140).

Solar energy-controlled shape selective synthesis of zinc oxide nanomaterials and its catalytic application in synthesis of glycerol carbonate

JayendraAhire and Bhalchandra M. Bhanagehave synthesized shape selective zinc oxide (ZnO) nanoflower using solar energy and naturally accessible aromatic amino acids like tryptophan, tyrosine and phenylalanine as a photo capping agents [**Journal of Solid State Chemistry, 295**, Article 121927, (2021)]. This synthesized material has been characterized by various characterization techniques such as XRD, FE-SEM, EDX, UV–Vis and FTIR. The ZnOnanoflower synthesized using solar energy and photocapping agents exhibited excellent catalytic activity after calcination for the synthesis of glycerol carbonate via urea glycerolysis as compared to the conventional process owing to its shape selective morphology. Further, high resolution XPS studies were performed to explore the valence states and effectiveness of surface engineering of the ZnO catalyst. Such a unique technique of ZnOnanoflowers synthesis representsa novel and environmentally benign route for synthesis of shape selective metal oxide nanoparticles as well as derived nanomaterial after calcination showed excellent activity and potential recyclability for the conversion of waste into valuable products.After calcination ZnO nanomaterials shows 67% yield in the synthesis of glycerol carbonate at 140 °C in 4 h, at the end a catalytic reaction mechanism was proposed.

Renewable fuels production from the hydrotreating over NiMo/γ-Al2O3 catalyst of castor oil methyl esters obtained by reactive extraction

In recent years, many studies have been published on the hydrotreating of non-edible vegetable oils, however, a limited number of them deal with the hydroprocessing of their corresponding fatty acid methyl esters for the productions of renewable fuels. In this study **Fabián S. Mederos-Nieto *et al*** outlined the production of renewable fuels from castor bean seeds (*Ricinus communis* L.) in two stages, the first one is to obtain the respective castor oil methyl esters by reactive extraction and the second one is to apply the hydrotreating process to these methyl esters by using a commercial NiMo/γ-Al_2O_3 catalyst in an isothermal batch reactor. A method was used to characterize the feedstock and the hydrotreating products from their TGA data by applying a proposed correlation equation for converting thermogravimetric measurements into simulated distillation results. Then, these estimated simulated distillation curves were used to obtain finally their characterization by composition based on real components [**Fuel, 285,** Article 119168, (2021)].

A chemical reaction network of four lumps along with its lumped kinetic model representing the hydrotreating of castor oil methyl esters was obtained from experiments conducted in a batch reactor operating under isothermal conditions at 395, 410, and 425 °C, 50 barg, and with reaction times from 2 to 4 h, and it was found that at severe operating conditions the yield and product selectivity of kerosene fraction increases, therefore, in order to obtain a higher production of renewable diesel fraction in this reaction system, the hydrotreating reaction time and temperature must be moderate.

Techno-economic analysis of used cooking oil to jet fuel production under uncertainty through three-, two-, and one-step conversion processes

The application of renewable jet fuel is an eco-friendly technique that can reduce greenhouse gas emissions. Based on existing commercial processes, this study by **Hsin-Wei Hsu *et al***aimed to evaluate the hydro-conversion processes for producing renewable jet fuel[**Journal of Cleaner Production, 289**, Article 125778, (2021)]. Three process scenarios were compared, in which the feedstock used cooking oil (UCO) is converted to hydroprocessed renewable jet fuel (HRJ) and its byproducts. Then, the investment feasibility of the three processes was evaluated through an economic analysis and predicted by an uncertainty analysis. The results show that if the main product (HRJ) is the profit target, one-step conversion is the best choice. However, if we consider the overall economic benefits, the three-step conversionmethod is more suitable with an average more 11.94% chance of profiting than the one-stage under uncertain analysis, which means it is a considerably competitive approach with lower risk and only 0.31 $/L of minimum selling price of jet fuel (MJSP), because it has the advantages of a wider range application and higher value of byproducts which reduce the risk of a single factor contribution. From the sensitivity analysis, jet fuel price is the key factor which contributes 75–82% for one- and two-stage processes, but UCO price in three-stage process reach nearly 50%. In addition, due to the economic scale, scaling up the plant capacity will lead higher economic benefits. Therefore, an efficient UCO recovery system and three-stage process are the keys for the industrial development aspect through the value-chain analysis under uncertainty.

Potato peel waste-derived carbon-based solid acid for the esterification of oleic acid to biodiesel

Bio-waste valorization to generate carbon-based solid acid catalysts for biodiesel production from the low-grade, highly acidic feedstocks has been a research hot spot over the last decade. In this study, an abundant bio-waste from the household kitchens, restaurants, and food processing industries, potato peel (PP), was adopted as a raw material by **Modather F. Hussein *et al*** for the production of a solid acid catalyst (SO_3H-PPAC)[**Environmental Technology & Innovation, 21,** Article 101355, (2021)]. Firstly, PP was mixed with $ZnCl_2$ and activated at 450 °C for 1 h to obtain a porous carbon material (PPAC), which was subsequently sulfonated via concentrated sulfuric acid treatment. Various physicochemical techniques, such as XRD, N2 physisorptionmeasurements, FTIR spectroscopy, and high-resolution transmission electron microscopy (HR-TEM), were used to study the structural properties of the prepared materials. The catalytic behavior of the catalyst was tested in the acid-catalyzed esterification of oleic acid with methanol for biodiesel production. The combination of the high surface area of 827.7 m^2/g and high concentration of acidic active sites of 1.6mmol/g led to a high oleic acid conversion efficiency of 97.2% at 5 wt.% SO_3H-PPAC, methanol/oleic acid molar ratio of 12:1 at 80 °C after 2.5 h. Moreover, the kinetic results unveiled that the esterification reaction obeyed the pseudo-first-order kinetic model, with an activation energy of 32.9 kJ/mol. Importantly, SO_3H-PPAC has satisfying recyclable features and could maintain 70 % of its initial catalytic performance in the 5th catalytic run.

A review on bio-lubricant production from non-edible oil-bearing biomass resources in Iran: Recent progress and perspectives

Lubricants are among the largest drivers of global oil demand in the world. The negative environmental impacts resulting from the entry of direct mineral lubricants necessitates the application of bio-lubricants as an excellent alternative to mineral lubricants. The main resources of bio-lubricants are edible/non-edible oils. The use of edible oils as the primary feedstock for bio-lubricant production in developing countries like Iran is being faced with several controversial challenges including the high dependence of the country to edible oils import, the high price of edible oils, the crisisof food shortage, and the negative impact of edible oils on energy security. The application of non-edible oils as a sustainable bio-lubricant resource plays a critical role in lubricant industries. This review by **Sara Almasi*et al*** provides an overview on bio-lubricant production with a description of various kinds of non-edible feedstocks [**Journal of Cleaner Production, 290**, Article 125830, (2021)]. A detailed description of different non-edible resources in Iran (e.i. castor, jatropha, microalgae, waste oil/fat, bitter almond, ailanthus, camelina, and waste fish oil) including the characterization, distribution, climate, and quality analysis are presented. Variouskinds of chemical modification methods focused on improving the quality of bio-lubricants have been also discussed. This review delivers a comprehensive overview of bio-lubricant synthesis by discussing applications, recent trends, and challenges in this field. The information provided in this study can be of assistance with the researchers and experts involved in the lubricant industry take an effective step to address the challenges ahead in the cleaner lubricants production by relying on sustainable oily resources.

Performance and emission of a diesel engine using different water/waste fish oil (WFO) biodiesel/diesel emulsion fuels: Optimization of fuel formulation via response surface methodology (RSM)

Ali Khanjani and Mohammad Amin Sobati used waste fish oil (WFO) to produce biodiesel, at first [**Fuel, 288**, Article 119662, (2021)]. Then, different formulations of water/WFO biodiesel/diesel emulsion fuels were prepared by ultrasound irradiation. Afterwards, the performance and exhaust emission of a single-cylinder diesel engine were investigated using different formulations of the emulsion fuel in the fixed engine speed (1800 rpm) under full load condition. The effect of water content (in the range of 3–7%), WFO biodiesel content (in the range of 3–7%), and surfactant content (in the range of 1–2%) was studied using response surface methodology (RSM). Based on multi-objective optimization considering theengine performance and emission factors, the best formulation of the emulsion fuel was found to be 3% WFO biodiesel, 6.13% water, and 1% surfactant. The engine performance and exhaust emission were compared for the best emulsion fuel and neat diesel fuel. Regarding the performance parameters, 6.33% decrease in the engine torque, 7.86% decrease in the engine brake power, and 9.52% increase in the brake specific fuel consumption (BSFC) were observed for the best emulsion fuel comparingthe neat diesel fuel. Considering the engine exhaust emission, 42.86% decrease inCO emission, 34.02% decrease in unburnt hydrocarbon emission, and 25.53% decrease in nitrogen oxide emission were observed for the best emulsion fuel in comparison with the neat diesel fuel. As the main finding, simultaneous reduction of CO, unburnt hydrocarbon, and nitrogen oxide emission was achieved for the best formulation of the water/WFO biodiesel/diesel emulsion fuel in comparison with the neat diesel fuel.

A study on biofuel produced by catalytic cracking of mustard and castor oil using porous Hβ and AlMCM-41 catalysts

Biofuel is the only novel solution to the increase in the greenhouse effect and bursting energy demand. The catalytic cracking of non-edible vegetable oils, namely castor and mustard was studied by **Ramya Ganesan *et al***to yield gasoline range (C5–C9) hydrocarbons [**Science of The Total Environment, 757**, Article 143781, (2021)]. Hβ (Microporous; pore size <2 nm) and AlMCM-41 (Mesoporous; pore size 2 nm–50 nm) materials with different Si/Al ratios were used as catalysts for cracking purposes. Characterization of these catalysts was done by X-ray diffraction, Surface areaanalyzer, nitrogen sorption studies, TPD and inductively coupled plasma techniques. Used mustard oil was cracked over AlMCM-41 catalysts in a fixed bed catalytic cracking unit at optimized reaction condition (400 °C, 4.6 h^{-1}) obtained over Hβ. The liquid and gaseous products were analyzed using gas chromatograph (Shimadzu GC-9A). Among the mesoporous catalysts AlMCM-41 (27) was able to convert 75% of mustard oil into 48% of bioliquid and 30.4% selectivity towards BG. Pongamia, neem,castor, fresh coconut and used coconut oil was also cracked using AlMCM-41 (27) catalyst. The major products of cracking reactions were Castor Bioliquid (CBL) comprising of bio gasoline (BG), bio kerosene (BK) and bio diesel (BD) with less yield of gaseous products. AlMCM-41 converted 98% of castor oil into 85% of CBL and itwas tested with ASTM 6751 standard procedures for its calorific value, viscosity and flash point. The sulphur emission from CBL run engine reached lower index. The results exhibited the commercial utility of the CBL in the near future.

Effect of cellulose nanocrystal supplementation on the stability of castor oil microemulsion

Microemulsion (ME) is widely used in food, pharmaceuticals, and medical applications. In the formulation of MEs, a substantial amount of surfactant is needed to stabilize the lipo-hydrophilic interface, which may have adverse effects on biological cells. Cellulose and its derivatives have been extensively utilized as solid emulsifying agents, known as pickering agents, which are added to improve the stability of emulsions. In this study, ME made from a mixture of 5 wt% castor oil, 85 wt% surfactant/co-surfactant and 10 wt% water was modified by**ChintyaGunarto*et al***by the addition of cellulosenanocrystal (CNC) in the aqueous fraction. The effect of CNC addition on the ME formation area, hydrodynamic diameter, and stability of resulting modified-MEs were investigated [**Journal of Molecular Liquids, 325**, Article 115181, (2021)]. While the addition of CNC did not contribute to the expansion of the ME formation area, the CNC supplementation has a significant influence on the hydrodynamic diameter and stability of ME. The results of this study demonstrate that the supplementation of CNC can reduce the usage of surfactant for ME formulation, with the use of CNC suspension containing 0.7 wt% CNC resulting in the most favorable hydrodynamic diameter and stability.

Process optimization, green chemistry balance and technoeconomic analysis of biodiesel production from castor oil using heterogeneous nanocatalyst

In the present work, **R. Naveenkumar and G. Baskar used** zinc doped calcium oxide as a nanocatalyst for biodiesel production from castor oil. The optimal conditions of biodiesel conversion and green chemistry balance were obtained with response surface methodology [**Bioresource Technology, 320**, Article 124347, (2021)]. Five green chemistry parameters like carbon efficiency, atom economy, reaction mass efficiency, stoichiometric factor and environmental factor were optimized. The sustainable biodiesel yield 84.9% and green chemistry balance 0.902 was achieved at methanol to oil molar ratio 10.5:1, temperature 57 °C, time 70 min, and catalyst concentration 2.15%. The synthesized biodiesel was characterized by GCMS and FTIR, and physic-chemical properties were determined. Based on experimental study annually 20.3 million kg capacity plant was simulated using SuperPro designer. The sensitivity analysis of oil purchase cost and biodiesel selling price on ROI, payback period, IRR and NPV were investigated. The optimization and technoeconomic analysis provided a sustainable platform for commercial based biodiesel production.

Characterization of non-volatile oxidation products formed from triolein in a model study at frying temperature

Frying allows cooking food while promoting their organoleptic properties, imparting crunchiness and flavor. The drawback is the oxidation of triacylglycerides (TAGs), leading to the formation of primary oxidized TAGs. Although they have been associated with chronic and degenerative diseases, they are precursors of pleasant flavors in fried foods. Nevertheless, there is a lack of knowledge about the oxidationspecies present in foods and their involvement in positive/negative health effects. In this work, high-resolution (HR) C_{30} reversed-phase (RP)–liquid chromatography (LC)–tandem HR mass spectrometry (MS/MS) was used to identify primary oxidation TAGs resulting from heating triolein (160 °C, 5 min). This allows simulating the initial heating process of frying oil usually used to prepare fried foods, such as chips, crisps, and snacks. Beyond hydroxy, dihydroxy, hydroperoxy, and hydroxy–hydroperoxyderivatives, already reported in phospholipids oxidized by Fenton reaction, new compounds were identified, by **SílviaPetronilho*et al*** such as dihydroxy–hydroperoxy–triolein derivatives and positional isomers (9/10- and 9/12-dihydroxy–triolein derivatives)[**Journal of Agricultural and Food Chemistry, 69**, 3466-3478, (2021)]. These compounds should be considered when proposing flavor formation pathways and/or mitigating lipid-derived reactive oxygen species occurring during food frying.

The Effect of Crystallization Conditions on the Structural Properties of Oleofoams Made of Cocoa Butter Crystals and High Oleic Sunflower Oil

Edible air-in-oil systems, also referred to as oleofoams, constitute a novel promising material for healthier, low-calorie fat replacers in confectionary products. Oleofoams can be formed by whipping oleogels, which are dispersions of fat crystals in anoil phase. Understanding how the properties of the fat crystals (*i.e.*, size, shape, and polymorphism) contained in oleogels affect the microstructure and stability ofoleofoams is essential for both the efficient design and manufacture of novel food products. In this work, cocoa butter, one of the main fat phases present in confectionary productions, which is responsible for pleasant texture and mouthfeel properties, was mixed by **Lorenzo Metilli*et al***with high oleic sunflower oil and crystallized to obtain anoleogel[**Crystal Growth & Design, 21**,1562-1575, (2021)]. This was subsequently whipped to yield a stable, highly aerated oleofoam. The effect of the crystallization conditions (oleogel composition and cooling rate) on the properties of the oleogels and related oleofoams was investigated with a multitechnique characterization approach, featuring polarized light microscopy,cryogenic scanning electron microscopy, X-ray diffraction, differential scanning calorimetry, and oscillatory rheology. Oleogel crystallization was performed in a lab-scale vessel and was monitored using light turbidimetry as an *in situ* technique. Results showed that the concentration of cocoa butter in sunflower oil was the parameter that affected most strongly the foamability and rheology of oleofoamsamples. The size and shape of cocoa butter crystals within the oleogel was found to have a less significant effect since crystals were broken or partially melted during the aeration process. Oleofoams whipped from oleogels containing 15 and 22% w/w cocoa butter displayed an overrun of 200%, corresponding to a calorific density reduction to one-third, and an increase in both the elastic and viscous moduli compared to their oleogel precursor. This was explained by a structuring effect causedby the aeration process, where cocoa butter β(V) crystal nanoplatelets (CNPs) in the oleogel rearranged to stabilize the air bubbles *via* a Pickering mechanism. Oleofoams prepared from 30% w/w cocoa butter oleogels, on the other hand, incorporated less air (overrun between 150 and 180%) and displayed a similar viscoelastic profile totheir unwhipped precursors potentially due to air incorporation being limited by the relatively high elastic modulus of the parent oleogels. Nevertheless, the calorificdensity of these samples was reduced by a factor of 1.6–2.5 compared to their full- fat analogues.

Carbon fibers derived from oleic acid-functionalized lignin via thermostabilization accelerated by uv irradiation

Lignin is a biorenewable precursor source suitable for the production of low-cost carbon fibers. In this work, softwood lignin was chemically modified with fatty acids to employ UV-triggered oxidative reactions occurring at long alk(en)yl chains as a pretreatment prior to thermostabilization. The chemical transformation of oleic acid-functionalized lignin (OAFL) under the UV irradiation was the free radical-based cross-linking reaction assisted by atmospheric oxygen, which successfully formedoxidatively cross-linked networks of lignin derivatives at the surface of the fiber. **Dohee Kang *et al***observed that OAFL showed more rapid oxidative cross-linking than stearic acid-functionalized lignin (SAFL) because the presence of carbon–carbon double bond in OAFL contributed to the formation of more stable allyl radicals in addition to alkyl radicals under the UV irradiation [**ACS Sustainable Chemistry & Engineering, 9**, 5204-5216, (2021)]. This UV pretreatment played a pivotal role in theconversion of flexible pristine OAFL fibers into infusible fibers during the subsequent thermostabilization step at the elevation rate of 2 °C/min without melt deformation. As the elevation rate of 2 °C/min is among the fastest thermostabilization process for lignin-derived carbon fibers, the duration of the thermostabilization of the OAFL-derived fibers in this study (2 h) is considerably less than previously reported ones.In addition, the UV irradiation process in this study requires less power (150 W) and exposure time (8 min), which can be appreciated by carbon fiber manufacturers aiming to reduce the fabrication cost. Therefore, the chemical functionalization with fatty acidsenvisages the possibility to produce carbon fibers from lignin precursors via a rapid stabilization step with spending less amount of time and energy.

Locally Sustainable Biodiesel Production from Waste Cooking Oil and Grease Using a Deep Eutectic Solvent: Characterization, Thermal Properties, and Blend Performance

As part of local sustainability efforts, biodiesel was synthesized via transesterification using a deep eutectic solvent (DES) without further washing from on-campus, dining facility waste cooking oil and grease. Before moving forward with repurposing used DES as a solvent in chemistry teaching labs, **Neelam Khan*et al*** determined the suitability of the biodiesel as an alternative fuel blended with diesel to power campus utility vehicles [**ACS Omega, 6**, 19204-9212, (2021)]. Biodiesel components were characterized by gas chromatography–mass spectrometry (GC–MS), Fourier transform infrared spectroscopy (FTIR), nuclear magnetic resonance spectroscopy (^{1}H NMR), viscometer, differential scanningcalorimetry (DSC), and evolved gas analysis during pyrolysis with a thermogravimetric analyzer coupled with FTIR (TGA-FTIR). The four major components of fatty acid methyl esters (FAMEs) in the biodiesel were methyl oleate, methyl linoleate, methyl palmitate, and methyl stearate. Kinematic viscosity over typical temperature ranges was within optimal values recommended by the American Biodiesel Standard (ASTM D6751), with a 30:70 biodiesel/diesel blend experimental viscosity of 3.43 cSt at 40 °Cand a calculated viscosity of 10.13 cSt at 0 °C. The pure biodiesel's cold-temperature onset of crystal formation is - 10.1 °C versus - 16.4 °C for a 30:70 biodiesel/diesel blend. Pyrolysis indicates good thermal stability, however, with an increased CO_2 evolution in the blended fuel at higher temperatures as compared to that in thepure biodiesel and the pure diesel. Combustion gas analysis indicates virtually complete combustion of the blended fuel to CO_2 and H_2O with only trace amounts of CO.Overall results indicate that the biodiesel synthesized using DES is a suitable fuel for campus utility vehicles in the local moderate temperature climate and affords increased local sustainability by using used DES repurposed in our chemistry teaching labs.

Viscoelastic Fluid Formed by Ultralong-Chain Erucic Acid–Base Ionic Liquid Surfactant Responds to Acid/Alkaline, CO_2, and Light

As a leftover of grease processing, the efficient utilization of erucic acid is still a challenge. An alternative strategy is to develop erucic acid-derived surfactants. However, erucic acid–based ionic liquid surfactants were barely involved. Here, a novel ionic liquid surfactant, benzyltrimethylammoniumerucate (ErBTA), was developed by **Zhe Yang *et al***a simple neutralization reaction, and its aggregations in the diluted andconcentrated solution were systematically studied by surface tension, conductivity, rheology, and cryo-TEM techniques [**Journal of Agricultural and Food Chemistry, 69**, 10, 3094-3102, (2021)]. The results showed that ErBTA has a very low metaling point (- 7.03 °C) and possesses excellent water solubility (Krafft temperature <4 °C). ErBTA alone starts to form micelles at a very low concentration (0.028 mmol/L)and then to form worm-based viscoelastic fluid at 4.07 mmol/L without any additives, exhibiting excellent self-assembly ability and thickening ability. This viscoelastic fluid formed by ErBTA can simultaneously respond to three stimuli: common acid/alkaline, CO_2 gas, and light, accompanied by an interesting gel–sol conversion, reflecting microstructure transition from wormlike micelles to spherical micelles. Although inessence CO_2 and light also act as pH regulators in the current system, they provide more sophisticated approaches to tune pH. Such a viscoelastic fluid with the characteristics of easy availability, renewability of raw materials, the simplicity of fabrication, good water-solubility, and excellent thickening ability may be an attractive candidate for clean fracturing in oil /gas recovery and fluid drag reduction.

Decarboxylation of oleic acid using pt@sapo-11 catalysts fabricated by *in situ* encapsulation

An *insitu* encapsulation process was used by **Meiqiu Hu *et al***to prepare ordered worm-like mesoporous Pt@SAPO-11 catalysts with different Pt loadings[**Energy & Fuels, 35**, 4148-4157, (2021)]. Transmission electron microscopy images showed that Pt nanoparticles encapsulated within the SAPO-11 support mesopores were uniformly distributed and highly dispersed and had a narrow particle size distribution of 2–7 nm. Scanning electron microscopy indicated thatincreasing the Pt loading from 0.6 to 1.6 wt % did not significantly change the crystalline morphology of the catalyst, although the crystallinity decreased slightly. Thespecific surface area and average pore diameter of the Pt@SAPO-11 were in the ranges of 72–116 m^2/g and 8.1–9.5 nm, respectively, which are determined by the Brunauer–Emmett–Teller method and Barrett–Joyner–Halenda method, respectively. The NH_3 thermal-programmed desorption established that increasing the Pt loadinggradually decreased the total NH_3 desorption and that a loading of 1.2 wt % producedthe highest concentration of medium-strong acid sites (6.2 cm^3/g STP). X-ray photoelectron spectroscopy and H_2 temperature-programmed reduction showed that a Pt loading of 1.2 wt % gave the strongest interaction between Pt nanoparticles and the SAPO-11 support. The Pt@SAPO-11 catalysts were used for the preparation ofC_8–C_{17} alkanes by decarboxylation of oleic acid. Employing a reaction temperature of 340 °C, a CO_2 atmosphere, a Pt loading on the catalyst of 1.2 wt %, and a reactiontime of 4 h, 100% oleic acid conversion was obtained together with an 80% yield of C_8–C_{17} alkanes.

Physico-chemical properties and sensory analysis of deodorized argan oil

Mechanically peeled argan nuts are expensive. The cosmetics industry preferentially uses colorless and odorless ingredients and almost systematically deodorizes cosmetic grade argan oil before incorporating it into cosmetics. Goat-regurgitatedargan nuts are underutilized because they lead to an oil that has an unpleasant taste and smell. The preparation of cosmetic argan oil from regurgitated nuts therefore seems to be an interesting avenue to explore even though deodorization might remove some of the oil essential nutrients, generate undesirable compounds, and possiblyincrease the final oil price. The deodorization of argan oil prepared from goat-regurgitated nuts by **SaïdGharby*et al***using the exact currently used method utilized for regular argan oil , led to colorless and odorless oil that a slightly decreased tocopherol, sterol, β-carotene, and free fatty acid content [**ACS Food Science & Technology ,1**, 275-281, (2021)]. A major reduction in primary oxidation products was observed with an increase of the level of stigmasta-3,5-diene. No significant change in the relative percentage of fatty acids was observed. Finally, deodorizationextents the preservation properties of argan oil. The use of regurgitated goat nuts can therefore be recommended to prepare cosmetic argan oil while allowing the development of the argan oil industry in a sustainable manner.

Single-droplet combustion of jet a-1, hydroprocessed vegetable oil, and their blends in a drop-tube furnace

The environmental impact and the dependence upon fossil fuels in the aeronautical sector have promoted the demand for alternative and greener fuels. Theimplementation of alternative fuels is one of the main challenges for this sector in the near future. A possible short-term solution might be the blending of biofuels with jetfuel, which would allow for the use of greener fuels and a reduction in the greenhouse gases and pollutant emissions without significant changes in the existing fleets of the companies, with the purpose to develop a "drop-in" fuel. In this context, this workexamines the combustion characteristics of single droplets of Jet A-1 (JF), hydroprocessed vegetable oil (NExBTL), and their mixtures in a drop-tube furnace (DTF). The objective of this work by**Gonçalo Pacheco*et al*** is to evaluate the influence of the mixture composition on the fuel characteristics. Droplets with diameters of 155 ± 5 µm, produced by acommercial droplet generator, were injected into the DTF, whose wall temperature and oxygen concentration were controlled[**Energy & Fuels, 35**, 7232-7241, (2021)]. Experiments were conducted for three temperatures (900, 1000, and 1100 °C). The combustion of droplets was evaluated through the images obtained with a high-speed camera coupled with a highmagnification lens and an edge detection algorithm. From the images allowed for the analysis of droplet combustion, data are reported for the temporal evolution of droplet sizes and burning rates. The results revealed that the mixtures followed the D^2 law, except the mixture with 75% JF for a DTF wall temperature of 1100 °C. The 75% JFmixture did not follow the D^2 law as a result of the occurrence of puffing and microexplosions, which enhanced the burning rates. Additionally, it was observed thatthe mixtures with a higher content of JF present brighter flames and higher burning rates.

Exploration of sunflower oil as a renewable biomass source to develop scalable and highly effective corrosion inhibitors in a 15% hcl medium at high temperatures

The feasibility study of utilizing sunflower oil as renewable biomass source to develop highly effective inhibitors for mild steel corrosion (MS) in the 15% HCl medium was done by weight loss, potentiodynamic polarization (PDP), dynamic electrochemicalimpedance spectroscopy (DEIS), and electrochemical impedance spectroscopy (EIS), supported with energy-dispersive X-ray (EDX), atomic force microscopy (AFM), and field-emission scanning electron microscope (FESEM) techniques. Moreover, a complementary theoretical investigation was carried out by **AbdolrezaFarhadian*et al*** to clarify the inhibition mechanism of inhibitors by density functional theory (DFT), density functional based tight-binding (DFTB), and molecular dynamics (MD) simulation approaches [**ACS Applied Materials & Interfaces, 13**, 3119-3138, (2021)]

. The obtained results confirm that sunflower-oil -based corrosion inhibitor (SFOCI) has a significant anticorrosion property toward the dissolution of MS in 15% HCl solution in the temperature range 20–80 °C. In addition, the results show that SFOCI could provide an inhibition efficiency of 98 and 93% at 60 and 80 °C, respectively. The inhibition mechanism of SFOCIs was mixed-type and their adsorption on the surface of MS was mainly chemisorption. The FESEM and EDX studies proved the presence of SFOCI molecules on the surface of MS. In addition, the adsorption energy of SFOCI indicated an intense interaction between the inhibitor and surface of Fe. The results of this study could open a new window for the design and development of scalable andeffective eco-friendly vegetable-oil-based corrosion inhibitors for highly corrosive solutions at high temperatures.

Myristicacid derived sophorolipid: efficient synthesis and enhanced antibacterial activity

Microbial glycolipids are one of the most interesting alternatives to chemical-basedsurfactants as they exhibit improved biodegradability and less toxicity. However, their potential has been limited because of specificity of the yeast toward fatty acids having a carbon 16 or carbon 18 chain. This study by **Isha Abhyankar*et al*** focuses on sophorolipid (SL) production by the yeast *Starmerellabombicola* using myristic acid, a medium-chain carbon-14fatty acid that has not been used as a substrate for SL production[**ACS Omega**, 6,1273-1279, (2021)]. The production was optimized for inoculum size and lipophilic substrate concentration. Furthermore, we also studied the effect of medium-chain fatty fat acid on yeast cell growth and optimized the process for excellent yield. The myristic acid SL (MASL) so synthesized consisted of mono- and diacetylated forms with preferential glycosylation at the methylend group, as determined by high-resolution mass spectrometry. Individual congeners of the crude mixture were separated using dry column chromatography and then structurally characterized by mass spectrometry. The synthesized MASL was also shown to have promising surface tension, lowering abilities with a low CMC of 14 mg/L.The SL derived from myristic acid exhibited superior antibacterial activity as compared to SL derived from oleic acid. MASL was also found to be more potent against Gram-positive organisms as compared to Gram-negative organisms. This work, therefore, demonstrates successful synthesis of myristic acid-derived SL and its superior antibacterial activity, establishing a promising future for this biosurfactant.

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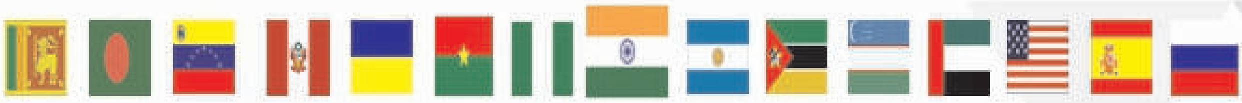

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