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Volume 53 **No. 3** **July - Sept. 2021**

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From Editors Desk

Dear Readers,

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

Due to pressure from consumers Industries are looking for green and natural alternatives of conventional surfactants used in soaps, detergents, cosmetics, lubricants, coatings and several other industries. Scaling and commercializing sustainable surfactants has been an arduous challenge manufacturers attempted to surmount starting in the early 2000s. Researchers continue to pursue a solution since the ubiquity of surfactants for both home and industrial use implores sustainable sourcing.

Analysts predict continued growth in the global cleaning products market alone to reach $58.3 billion by 2024. Low-toxicity, natural alternatives to petroleum-based surfactants would guarantee the sustainable use of these compounds in household cleaning, as well as agriculture, bioremediation, and personal care applications, for decades to come. Pursuit of naturally sourced surfactants has taken many routes. One way to get environmentally friendly products is to take advantage of the surfactants present in the roots, seeds or leaves of plants. Biosurfactants, excreted from a microorganism, do not require as much chemical processing, but do undergo extensive purification to isolate the desired compound from a stew of biochemical products. Rhamnolipid biosurfactants have creeped into more household and personal care items, but so far cost of production has limited their wide-spread use.

Bio-based surfactants, made by replacing petroleum-sourced hydrophobic carbon chains with fatty acids from vegetable oils or animal fats, have proved to be the most economical way to produce a more sustainable ingredient. Coconut and palm kernel oils, containing up to 60% lauric acid (12:0), are currently the major feedstocks for the surfactant industry. High-oleic oils contain concentrations of between 60 and 90% oleic acid content from Varieties of high-oleic sunflower, safflower, and canola have been available for some time. Their unique chemistry makes it well-suited for surfactant development. used an epoxidation ring-opening reaction to produce

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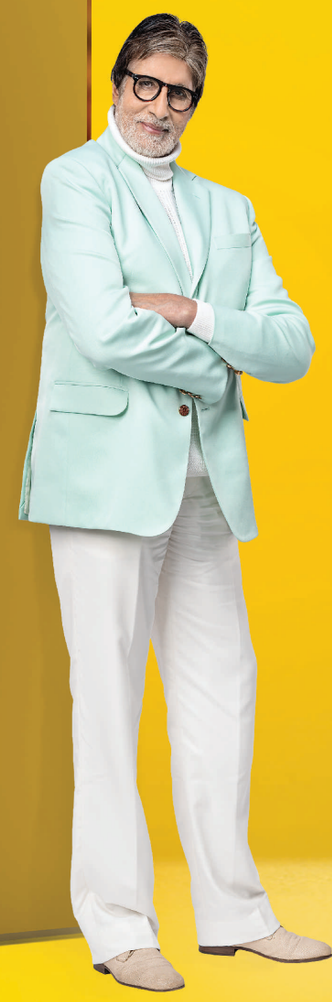

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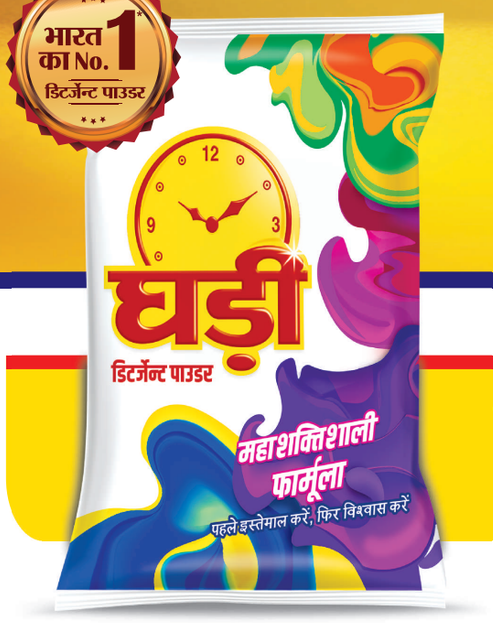

पहले इस्तेमाल करें फिर विश्वास करें

* As per Nielsen Retail Index data for MAT March 2021.
All India (Urban +Rural) market in Washing Powder Category.

surfactants with different hydrophilic-lipophilic balances. The single unsaturated bond in oleic acid simplifies the ring-opening epoxide reaction. Finally, surfactants made from high-oleic oil cost less to produce at commercial scale than other plant-based materials since epoxidizes can be formed at low temperatures using enzymes.Globally currently, only about 20% of the surfactants in cleaning applications are made from bio-based sources. Therefore, there is need to first target this growing market when developing high-oleic surfactants.

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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INDEX TO ADVERTISEMENTS / ANNOUNCEMENTS

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Studies on effective protection of soybean oil against oxidation by addition of food emulsifiers in conjugation with natural antioxidants

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ABSTRACT

Soybean oil is used widely in India for edible purposes due to the presence of the higher amount of polyunsaturated fatty acid (PUFA) and tocopherol, which acts as a natural anti-oxidant to prevent the oil from oxidation. Lipid oxidation is the main cause of food deterioration and makes the products unacceptable for human consumption. To prevent lipid oxidation, anti-oxidants that may be natural or synthetic are added to the oil to maintain the edible quality. Some of the most common natural anti-oxidants are sterols, tocopherols, sesame lignans, oryzanols, and squalene. In the present study the effect of adding some food emulsifiers viz lecithin and monoglyceride in presence of natural anti-oxidant, β-sitosterol was studied. The idea of adding food emulsifiers was to study whether they could form some micelle with the hydrophobic sterol molecules and thereby could prevent the oxidation of the oil. Refined soybean oil was taken for the study and stripped for the elimination of all added and natural anti-oxidants. Then β-sitosterol, lecithin, and monoglyceride in the different ratios were added and studied over a period of time with or without heating. Peroxide value, p-anisidine value, and surface tension of the experimental oil samples were measured from time to time to ascertain the quality deterioration of the oil samples. The results showed that the addition of β-sitosterol, lecithin and monoglyceride in 1:1.5:2 ratios effectively prevent the oxidation of soybean oil.

Keywords: Soybean oil. Polyunsaturated fatty acids, Lipid oxidation, Antioxidants, Association colloids.

INTRODUCTION

Soybean oil is the most widely used edible oil in India due to the presence of a higher amount of polyunsaturated fatty acid (PUFA). The presence of two essential fatty acids such as linoleic acid (18:2) and α-linolenic acid (18:3) makes the oil good for human consumption (1). Polyunsaturated fatty acids play an important role in human health by lowering the risk of cardiovascular disease as well as improving cognitive health (2). Besides PUFA the presence of tocopherol in soybean oil improves the oxidative stability of the oil. At the same time presence of a higher amount of PUFA in soybean oil makes the oil or the prepared food with soybean oil susceptible to oxidative deterioration (3).

To avoid lipid oxidation several antioxidants which may be natural such as sterols, tocopherols, Oryzanol, or synthetic such as butylated hydroxyl anisole (BHA), butylated hydroxyl toluene (BHT), tertiary-butyl hydroquinone (TBHQ) are often used in the oil to maintain their quality. Synthetic antioxidants are often used due to their processing stability, high antioxidant activity, low cost, and widespread availability. However, the safety of these synthetic antioxidants is questionable to potential toxicological concerns (4). It is, therefore, necessary to evaluate other relevant antioxidants which can improve the oxidative stability of PUFA rich oils.

In their study in 2014, Chaiyasit et. al (5) tried to establish that association colloids have an inhibitive role on lipid oxidation. They concluded that addition of natural antioxidants along with food emulsifiers could lead to the development of novel antioxidant technologies that not only protect the oil against oxidation and increase shelf-life but also allow food manufacturers to include more nutritionally beneficial fatty acids in their products. In the present study, we aimed to evaluate

the effect of adding some food emulsifiers viz. lecithin and monoglyceride in presence of natural anti-oxidant, β-sitosterol on the oxidative stability of soybean oil during storage and heating conditions. The idea of adding food emulsifiers was to study whether they could form some micelle with the hydrophobic sterol molecules and thereby could prevent the oxidation of the oil. This was a preliminary study on this topic and having the plan to continue further for the detailed study.

MATERIALS AND METHODS

Materials

The refined soybean oil sample was purchased from the local market of Kolkata, West Bengal, and maintained in dark at room temperature. All the reagents used in this study were of analytical grade and purchased from Merck India Ltd. (Mumbai, India).

Preparation of the stripped oil

Soybean oil without minor components such as tocopherol, free fatty acid, monoglyceride, and diglyceride was prepared by column chromatography according to the method described by Kittipongpittaya et al.. Briefly, a chromatographic column was packed in three layers of activated charcoal (5.6 gm) in the middle layer and silicic acid (22.5 gm each, washed with distilled and deionized water, and activated at 110 °C for 48 h).) in the top and bottom layer. Refined soybean oil was mixed with hexane and passed through the column with 270 ml of hexane for elution. The solvent was removed by a rotary evaporator at room temperature. The absence of tocopherol was confirmed by analyzing the oil by high-performance liquid chromatography according to AOCS Official Method Ce-8-89. Briefly, 0.5 g of oil was placed in a 5 ml volumetric flask and dissolved with hexane, and filtered through a 0.45μm PTFE membrane filter (6). 20 μl filtrate was injected into a waters 1525 HPLC system equipped with a c-18 fatty acid column (150 mm, 4.6 mm i.d., 5 μm particle size) and the mobile phase of n-hexane/isopropyl alcohol (99/1, v/v) at 1.0 ml/ min and 40°C column temperature.

Analysis of the fatty acid composition of the refined soybean oil

The fatty acid composition of refined soybean oil was analyzed by gas chromatography according to the AOCS method (7).

Chemical characterization of the refined soybean oil and the stripped oil

The chemical properties such as acid value, peroxide value, and unsaponifiable matter (% USM) content of the refined soybean oil and the stripped soybean oil were determined according to the AOCS official methods (8-10) respectively. The p-anisidine value of the sample was determined using a spectrophotometer (UV 1700, Shimadzu Corporation) according to the AOCS method Cd 18-90 (11).

Determination of optimal concentration by surface tension measurement

The prepared stripped soyabean oil sample was mixed with β–sitosterol, deoiled rice bran lecithin, and monoglyceride in different concentration ratios, and then the surface tension of the different solutions were measured by using Du Nouy Ring Tensiometer.

Preparation of the fortified soybean oil and their oxidation status

The surface tension of the stripped oil with different surface modifiers indicated that the surface tension of the stripped soybean oil was minimum when mixed with β-sitosterol, lecithin, monoglyceride in the ratio 1: 1.5: 2 (Table 1). Following the results obtained from the surface-tension study, the fortified soybean oil sample was prepared using the stripped soybean oil and β-sitosterol, lecithin, monoglyceride in the ratio 1: 1.5: 2. The peroxide value and the p-anisidine value of the prepared sample were measured according to the methods described earlier at an interval of seven days for more than one month. The oil was also heated for one hr at different temperatures such as 40°C, 50°C, 60°C, 70°C, 80°C, 90°C, 100°C, and the peroxide value, p-anisidine value, and surface tension were measured.

Determination of transition metal concentration Fe and Cu

The amount of transition metal present in the refined oil and fortified oil was determined by the AOCS official method (12) (999.11).

STATISTICAL ANALYSIS

All the data are presented as means with their standard errors. Statistical comparisons between groups were performed using one-way ANOVA.

RESULTS AND DISCUSSIONS

The fatty acid composition of the refined soybean oil as represented in Table 2 indicates that soybean oil contains nearly 85% unsaturated fatty acids which are mainly comprised of linoleic acid (55.06%), oleic acid (21.9%), and linolenic acid (7.81%). The presence of a higher amount of PUFA (nearly 63%) decreases the oxidative stability of the oil.

The concentration of transition metals iron (Fe) and copper (Cu) is given in Table 3. The concentration of Cu was nil in both stripped and fortified soybean oil. The Fe concentration was slightly greater in fortified soybean oil. This could be due to the contamination of Fe in the stripping operation of soybean oil in presence of charcoal. As there was Fe contamination in the fortified oil it was highly susceptible to secondary oxidation..

The chemical properties such as acid value, peroxide value, and USM content of the refined oil and the stripped oil were presented in Table 4. The acid value, and peroxide value of the refined oil and the stripped oil were found to be more or less similar but the USM content was much less in the stripped oil.

The oxidation studies of the fortified oil samples were conducted for 35 days. The lipid oxidation was measured through peroxide value and p-anisidine value and is represented in Table 5. A minor increase in the peroxide value of 2.01 to 2.7 meq/kg of oil up to 5 weeks was observed during storage whereas the p-anisidine value remained negative throughout the time of study which indicates a slight occurrence of primary oxidation but the fortification of the oil could successfully prevent the secondary oxidation of the oil. This study delivers very promising results for the fact that the addition of lecithin and monoglyceride may form association colloids with the hydrophobic sterol molecules within the system and therefore the oxidation of soybean oil can effectively be prevented.

The heating study of the oil sample as presented in Table 6 indicates that the peroxide value of the oil sample was maximum at 50°C and then gradually decreased with increasing temperature. This is because beyond 50°C the solubility of β-sitosterol enhances and therefore the full effect of the antioxidant protection of the sterol could be achieved above this temperature and as a result of this the peroxide value of the fortified oil gradually decreased above 50°C.whereas the p-anisidine value of the fortified soybean oil was negative at every temperature for 1 hr heating. So the fortified oil was capable to prevent secondary oxidation at every temperature for 1 hr heating in presence of the three additives. The surface tension of the fortified soybean oil increased gradually with an increase in temperature for 1 hr of heating. This may be due to the rupturing of micelles or the association colloids with increasing temperature.

CONCLUSION

The susceptibility of a PUFA rich oil towards lipid oxidation limits its uses in food products. The addition of synthetic anti-oxidants also has some limitations. The present study establishes that a combination of natural anti-oxidants viz. β-sitosterol, lecithin, and an emulsifier like monoglyceride in the ratio of 1:1.5:2 can successfully prevent lipid oxidation by the formation of association colloid. The formation of association colloids was reflected from both the temperature studies followed by the determination of surface tension and the oxidation studies. The presence of the emulsifiers like monoglyceride and lecithin has induced the formation of the association colloids, which played an important role in preventing the oxidation of soybean oil. Furthermore, β-sitosterol is also able to effectively prevent oxidation of the oil at high temperatures.

Table 1 : *Determination of Surface Tension Measurement*

Surface active component	Surface Tension at 27.6 ºC (mN/m)
Distilled Water	69.535±0.29
Chloroform	18.7±0.20
Stripped oil in chloroform	19.315±0.24
Stripped oil in chloroform with added monoglyceride (MG)	19.097±0.13
Stripped oil in chloroform with added β –sitosterol	19.202±0.16
Stripped oil in chloroform with added lecithin	19.155±0.19
Stripped oil in chloroform with added β – sitosterol, lecithin, and MG in a ratio of (1:1:1)	18.999±0.22
Stripped oil in chloroform with added β – sitosterol, lecithin, and MG in a ratio of (1:1.5:2)	18.926±0.021

Table 2: *Fatty Acid (% w/w) Composition of the Refined Soybean Oil*

Fatty acids → Samples ↓	16:0	18:0	18:1	18:2	18:3
Refined Soybean oil	11.43+0.12	3.80+0.07	21.90±0.33	55.06±0.10	7.81±0.11

Table 3: *Transition metal concentration*

Transition metals ↓	Concentration in stripped oil (ppm)	Concentration in fortified oil (ppm)
Cu	Nil	Nil
Fe	0.57±0.01	0.79±0.01

Table 4: *Chemical Properties of the Refined Soybean 0il and the stripped soybean oil*

Parameters → Samples ↓	Acid value	Peroxide value (meq /kg)	USM (% w/w)
Refined soybean oil	0.06±0.14	0.25±0.04	1.35±0.02
Stripped soybean oil	0.05±0.03	0.23±0.06	0.75±0.21

Table 5: *Oxidation studies of the fortified oil without heating*

Time → Parameters ↓	After 1st Week	After 2nd Week	After 3rd Week	After 4th Week	After 5th Week
Peroxide value (meq /kg)	2.01 ± 0.35	2.16 ± 0.70	2.27 ± 0.14	2.43 ± 0.64	2.7 ± 0.77
p-Anisidine Value	Negative	Negative	Negative	Negative	Negative

Table 6: *Oxidation studies of the fortified oil after heating for 1 hr at different temperatures*

Temperature → / Parameters ↓	40° C	50° C	60° C	70 °C	80° C	90° C	100° C
Peroxide Value (meq/kg)	4.08±0.15	11.30±0.01	9.17±0.56	3.14±0.42	2.68±0.34	2.67±0.36	2.66±0.09
p-Anisidine Value	Negative	Negative	Negative	Negative	Negative	Negative	Negative
Surface Tension (mN/m)	8.52± 0.13	9.67± 0.21	16.67±0.05	17.93±0.28	17.93±0.08	18.19±0.01	18.88±0.03

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Physico-chemical characteristics, acylglycerols and phytonutrients composition of fat from few selected Indian grown vegetable and fruit seeds as new source of edible oil

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ABSTRACT

This study was conducted to evaluate fat from five seeds of Indian grown vegetables and fruits as new source of edible oil. The fat extracted from ash gourd seeds (ASF), pumpkin seeds (PSF), tomato seeds (TSF), date fruit seeds (DSF), and jack fruit seeds (JSF), were analyzed for moisture, fat content, fatty acid composition and later only three seeds with a higher fat content were taken up for further studies. These had fat 0.89-54.5%; linoleic (9.4-72.8%), oleic (4.1-43.8%), palmitic (10.8-35.4%), lauric(0-18.6%), stearic(1.8-8.5%), linolenic(0.1-3.9%)+other acids; unsaponifiable matter 0.48-5.0%; free fatty acids 2.7– 8.4%, peroxide value 5.9–11.8 meq O_2/Kg, saponification value 196.4–236.1 mg KOH/g, iodine value 107.6–135.3 gI_2/100g, triacylglycerols 70.7-86.6%, diacylglycerols 10.6-17.9%, monoacylglycerols 0.1-2.9%, TAGs LLL_n (13.8-33.4%), POL (14.9-16.1%), PLL (10.8-23.2%), LLL (11.1-15.3%), OOL (3.9-13.5%), OOO (2.5-6.1%), POO (4.0-9.7%), POP (0.2-4.4%), PPP (0.1-0.7%), OOS (0.1-1.8%), SOP (0.2-3.0%), LL_nL_n (0.9-2.0%); phytonutrients viz., tocopherols (42-141.9mg%), phenolics (1.3-4.3mg%) and carotenoids (1.3-3.4mg%). These chemical constituents are normally present in all edible oils and hence could be new source of edible oil.

KEYWORDS: Ash gourd seed fat. Date seed fat. Fatty acids. Acylglycerols. physico-chemical characteristics. phytonutrients composition. Jack fruit seed fat. Pumpkin seed fat. Tomato seed fat.INTRODUCTION

Vegetable oil sources have become indispensable to mankind because of the need to meet the global nutritional demand. In spite of the innumerable sources four vegetable oils viz., soybean oil (31.6MT), palm oil (30.5MT), rapeseed oil (15.5MT), and sunflower oil (8.6MT) dominate the market in their annual consumption pattern[1]. The demand for vegetable oils is increasing every year which has posed the challenge to increase the production of oils from newer sources. This has necessitated to look for safe and sustainable sources from fruit and vegetable sources. Research

activities in the last two decades have been focusing on examination and characterization of chemical constituents from the fruit and vegetable seed sources for edible oils [1-5].

Processing of fruits and vegetables produces a solid waste, for example, seeds/stones, and peel/skin/stalk etc., and a liquid waste like juice, wash waters, etc. Tomato ((*Lycopersicon esculentum L.*), pumpkin (*Cucurbita maxima*) and ash gourd (*Benincasa hispida*) processing industries, accounts for 30% of waste which comprises tomato seeds, pumpkin seeds and ash gourd seeds respectively. Even at the domestic level, pumpkin and ash gourd seeds are discarded as waste along with their skin/stalk. Pumpkin seeds, also known as pepitas, are small, flat, green in colour and edible in nature. However, they are popular and are available in hulled or semi-hulled form in grocery stores at some places as they are a good source of protein, magnesium, copper, zinc, phytosterols, polyunsaturated fatty acids, carotenoids and tocopherols [1-4]. Some other examples which are by-products at the domestic level and can be used as a source of oil include date (*Phoenix dactylifera*) seeds and jack fruit (*Artocarpus heterophyllus*) seeds. After their processing, leftovers consisting of large amounts of date seeds are discarded as waste. Fat from two varieties of date fruit has been reported to contain about 10% fat and has similar fatty acids as those of commonly used vegetable oils [6]. Jack fruit seed fat has not been studied. The potential availability of processing waste containing seeds in the world and for India is presented in Table 1.

The aim of this study was to extract fat from the seeds of this waste and study their physico-chemical characteristics, acylglycerols and phytonutrients composition so that the fat could be used for edible purposes.

MATERIALS AND METHODS

Materials

The chemicals and reagents used in the study such as FAME standards, boron trifluoride (BF_3), gallic acid, Folin-Ciocalteu's (FC) reagent, β-carotene, and α-tocopherol were purchased from Sigma-Aldrich, Bangalore, India. All other chemicals and solvents used were of analytical grade (Hi-Media, Bangalore, India).

Sources of the vegetable seeds:

All the selected seeds of the vegetables viz., pumpkin, ashgourd, tomato and fruit seed of date were from M/s Maharashtra Hybrid **Seeds Company** Private Limited (**Mahyco**), Jalna – Aurangabad Road, Post Box no. 76, Dawalwadi,. and purchased from the local market of Mysore city, Karnataka, India. The seeds were initially screened to remove unwanted material and seed coat, if any and powdered using mixer grinder (Maharaja Whiteline Perfect W&R 500 Mixer grinder) for 20 min at high speed. The obtained seed powders were stored in airtight glass containers until further use. The seeds of jackfruit were obtained from fresh fruit and the seeds were carefully separated from the fruit, mashed and the wet seeds used as such.

Methods

Estimation of Moisture Content:

The estimation of moisture from the selected seed powders (5g) were done by using hot air oven method [7]. *The percentage moisture content was calculated based on the difference between initial and final weights of the samples.*

Extraction of Fat from Different Seeds:

The fat extraction was carried out using 5g or 100g of the seed powder with hexane as the solvent in 250mL or 2L capacity Soxhlet extraction apparatus for 8 h. The obtained hexane extract was evaporated and weighed to get the fat content [7].

Fatty Acid Composition:

Fatty acid methyl esters (FAME) of the five fat samples were prepared by trans-esterification,

according to the AOCS Official Method [7]. FAMEs were analyzed on a Shimadzu 20A gas chromatograph (Shimadzu Corporation, Japan), equipped with a flame ionization detector (FID) and a glass capillary column (100 m × 0.25 mm i.d.), coated with 0.20 μm SP2560 (Supelco Inc., Bellefonte, PA) as the stationary phase. The oven temperature was programmed from 140 to 240 °C at 4 °C/min with an initial hold at 140 °C for 5 min. The injector and FID were maintained at 260 °C. A reference standard FAME mix (Supelco Inc.) was analyzed under the same operating conditions to identify the fatty acids. The FAME peak areas were quantitated and expressed as relative area percentage of fatty acids.

Physicochemical Characteristics:

The characeteristics were determined only for three fats viz., ASF, PSF and TSF and are provided in Table 4. The fat content of date and jack fruit seeds were less than 10% and hence DSF and JSF were not analysed further and hence data not provided.

The colour of the extracted seed fats were determined by transmission measurement using a Lovibond tintometer in a 1" cell and expressed as 5R+Y Lovibond units where R = red components and Y = yellow components. Free fatty acid value (FFA), peroxide value (PV), iodine value (IV), saponification value (SV) and unsaponifiable matter (USM) were determined according to AOCS Official methods [7].

Acylglycerols Content of Oils:

The triacylglycerol (TAG), diacylglycerol (DAG) and monoacylglycerol (MAG) contents of the studied fat samples were estimated by using the standard column chromatographic method. A glass column (i.d. 1.8 cm, length 30 cm, Borosil Glass Works Ltd., Mumbai, India) was used in which a silica gel (100–120 μm mesh) bed was prepared from slurry of activated silica gel in petroleum ether. About 0.9 g of accurately weighed sample was dissolved in 5 mL of chloroform and quantitatively transferred to the column. TAG, DAG, and MAG were eluted with the standard solvent system. The solvent system comprises petroleum ether/diethyl ether (225:25 mL, v/v), petroleum ether/diethyl ether (175:75 mL, v/v) and diethyl ether (250 mL), and was used sequentially for the elution of TAG, DAG, and MAG respectively. The quantity of each fraction was determined gravimetrically after desolventisation [7].

Triacylglycerols Profile by HPLC:

HPLC Instrument (Model LC-10A, Shimadzu corporation, Kyoto, Japan) with a temperature control oven was fitted with a 15 cm × 4.6 mm id or 25 cm × 4.6 mm id C18 column and operated at a flow rate of 1 mL/min, using refractive index detector and a mobile phase of acetone-acetonitrile (65:35) mixture for a period of 10-30 min at 30 °C. Identification of TAG fractions was carried out using standard mixture of TAGs and theoretical carbon number [7].

Estimation of Phytonutrients in the Fats:

Total Phenolics Content:

The extraction of total phenolics from the samples was carried out according to Marina et al. [8]. The phenolics were extracted using methanol-water (80:20 v/v). About 5 g of the fat sample was mixed with 1 mL of 80% methanol and vortexed for 2 min (twice). The contents were centrifuged at 3500 rpm for 10 min at room temperature. The methanol-water layer was collected in another tube and this step was repeated four times. The extracts were pooled and made up to 4 mL with 80% methanol. The total phenolics content was determined using the Folin–Ciocalteu reagent. Different aliquots were mixed with 0.2 mL of Folin–Ciocalteu reagent and were kept for 3 min. About 1 mL of 15% Na_2CO_3 solution was added and made up to 7 mL with distilled water. The tubes were incubated for 45 min and centrifuged at 1500 rpm for 10 min at room temperature. The absorbance was read at

765 nm using an UV-Visible spectrophotometer (Shimadzu corporation, Kyoto, Japan, model UV – 1601). The total phenolics content was calculated using gallic acid as the standard and expressed as milligrams per 100g fat.

Carotenoids:

The fat sample (1 g) was weighed and diluted to 10 mL using hexane. 1 mL aliquot of this was further diluted to 10 mL with hexane and the absorbance was measured at 446 nm using a UV–Visible spectrophotometer (Model UV-1601, Shimadzu Corporation, Kyoto, Japan), followed by calculation using the diffusion coefficient of 383 and expressed as milligrams of β-carotene per 100g fat [9].

Tocopherols:

The tocopherol content of fat samples were determined by using high performance liquid chromatograph (Model Shimadzu Corp., Kyoto, Japan) fitted with silica column (CLC-SIL (M) 250mm x 4.6mm i.d.; Shimadzu) attached with a fluorescence detector. The mobile phase used was hexane-isopropanol (99.5:0.5, v/v) at a flow rate of 1 mL/min and excitation and emission wavelengths of 290 and 330 nm respectively. The individual tocopherol content was expressed as milligrams α-tocopherol equivalent per 100g fat [7].

Statistical Analysis:

All data were expressed as the mean ± standard deviation of quadruplicate analysis. Turkeys-Kramer Multiple Comparison Test was used to calculate significance differences using the statistical package, GraphPad Instat Demo [DATA-SET.ISD]. Statistical significance was declared at $p<0.05$ [10].

RESULTS AND DISCUSSION

Moisture Content

Moisture content of raw materials was determined and presented in Table 2. The moisture content of the studied seeds showed 4.7%, 5.1%, 6.2%, 7.6% and 54% for ash gourd seeds, pumpkin seeds, tomato seeds, date seeds and jack fruit seeds respectively. Jack fruit seeds were from fresh fruit and hence the moisture content was higher than all other seeds. Atasie et al. reported that the moisture content of the ground nut seeds was found to be 5.8% [11]. The moisture content of the seeds depends on various factors such as gravimetrical properties, handling, frictional characteristics, and the variety of seed.

Fat Content

Fat content of studied seeds is shown in Table 2. The ash gourd seeds, and pumpkin seeds contained fat in higher amounts (54.5% and 50.1%) and a lesser amount for the tomato seeds (23.6%). A lower fat content was recorded in the jack fruit seeds (0.9%) and date fruit seeds (9.0%). The above results agree with the reports of Evangelos et al, John Tsaknis et al, Besbes et al for TSF, PSF, DSF respectively [6,12,13]. In the present study, the ash gourd seeds, and pumpkin seeds contain a slightly higher fat content than sunflower and ground nut seeds. As there is huge demand of vegetable oil in the Indian market and elsewhere, the pumpkin and ash gourd seeds with more than 50% fat could be a suitable alternative.

Fatty Acid Composition

Table 3 shows fatty acid composition of studied vegetable seed fats wherein, the lauric acid (18.6%) and myristic acid (11.90%) were found to be higher in date seed fat (DSF) compared to other studied seed fats. The palmitic acid was found to be high in jackfruit seed fat (JSF) (35.4%), and low in PSF (10.8%). Stearic acid was found to be high in pumpkin seed fat (PSF) (8.5%) and low in JSF (1.8%). Oleic acid was found to be highest in DSF (43.8%), followed by PSF (35.9%). Linoleic acid was found to be highest in ash gourd seed fat (ASF) (72.8%) followed by tomato seed fat (TSF) (57.4%) and was found less in DSF (9.4%). JSF showed the linoleic acid content of 47.1% and linolenic acid of 3.9%. The fatty acid composition

of different seed fats showed that most of them were rich in linoleic acid oleic acid and palmitic acid. Prasanth Kumar et al. reported the fatty acid composition of the commercial vegetable oils, wherein they showed that sunflower oil and ground nut oil contained 59.3% and 32.6% of linoleic acid respectively [14]. In the studied seed fats also a good amount of unsaturated fatty acids similar to that of commercial vegetable oils are present. However, the DSF contains the high amount of medium chain fatty acids (20%) compared to the other studied fats whereas, unsaturated fatty acids were higher in TSF (82.2%) followed by ASF (78.1%) and PSF (77.7%). The S:M:P ratio of the PSF (1:1.8:1.1) was also very near to the ideal values. Evangelos et al (1998) studied tomato seed oil (Greek grown) and reported fatty acid composition, linoleic (54%), oleic (22%), palmitic (14%) and stearic (6%) acids. Pumpkin seed fat with fatty acids myristic 0.1, palmitic 12.7, stearic, 6.0, oleic 38.1, linoleic 42.1, linolenic 2.0% have been reported [13]. The fatty acid composition observed agrees with the literature reports of Evangelos et al, John Tsaknis et al and Eller et al [12-14].

Physico-chemical Characteristics

The characteristics of fat from only three seeds viz., ashgourd seeds, pumpkin seeds and tomato seeds are provided in Table 4 The jack fruit and date seeds contained less amount of fat and hence these were not studied further.

Colour

Colour is one of the important quality parameters of fat/oil. Table 4 shows that PSF was greenish brown in colour and had a high Lovibond unit of 88.0, TSF was yellowish red in colour and had the value of 23.5 Lovibond units, and ASF was light yellow in colour with 9.6 Lovibond units. A higher colour value for TSF and PSF has also been reported by others [12, 13, 15]. The colour of commercial vegetable oils available in India was reported earlier [14]. It varied from 1.0 to 32.1 Lovibond units. Pal et al. reported that crude oils are high in colour than the refined ones [16]. Hence the extracted crude fats in this study may show a little higher colour value compared with the commercial refined fats/oils.

Fatty Acids Value (FFA)

FFA is one of the basic analyses used to monitor the quality of vegetable oils. It is a measure of changes due to exposure to moisture in its parent glyceride molecule resulting in hydrolytic deterioration of oils. The FFA of studied seed fats showed that PSF (6.6%) and ASF (8.4%) have values higher than TSF (2.7%) (Table 4). In general, the FFA values of crude fats/oils are reported to be higher than the refined fats/oils

Peroxide Value (PV)

PV indicates the quality of an oil; up on oxidation the oils develop rancidity and that becomes a reason for their deterioration. Unsaturated fatty acids containing oils are prone to rancidity when compared to saturated ones like coconut oil. According to the Indian standards, PV should be less than 10 meq O_2/kg for expeller oil and 15 meq O_2/kg for cold pressed oil and less than 10 meq O_2/kg for international standard specification [17]. PV of studied samples were 5.9, 10.5 and 11.8 meq O_2/kg of TSF, PSF and ASF respectively. According to Indian Standard Specification the PV of studied fats were within limits for cold pressed oils category (Table 4). Evangelos et al and John Tsaknis et al also reported higher PV for TSF and PSF respectively [12, 13].

Iodine Value (IV)

Iodine value indicates the degree of unsaturation of oils which reflects the susceptibility of oil to oxidation. High iodine value indicates the presence of high degree of unsaturation in a fat/oil. The present experimental results showed that ASF (135.3 gI_2/100 g) has higher degree of unsaturation as compared to rest of the fats (110.5 and 107.6 gI_2

/100 g) indicating that ASF contains the highest amount of unsaturated fatty acids compared with the other studied fats and hence more prone to oxidation (Table 4). Similar values were reported by others for PSF and TSF [12,13]. Vegetable oils such as sunflower oil, soybean oil and sesame oil showed a higher IV as these contain higher amount of the unsaturated fatty acids [14].

Saponification Value (SV)

The saponification value indicates the average molecular weight carbon chains present in fats/oils. In the present study, the saponification value of TSF (236.5 mg KOH/g) was higher than PSF (215.6 mg KOH/g) and ASF (196.4 mg KOH/g) (Table 4). Evangelos et al (1997) have reported SV of 184 mg KOH/g) for TSF and for PSF a value of 201 mg KOH/g) has been reported by John Tsaknis et al [13]. Indian commercial SFO showed 176.8 mg KOH/g as SV and for other vegetable oils it ranged from 176.5 to 261 mg KOH/g which may be due to the oil source and various refining processes adopted therein [14]. The higher SV for these fats could be due to differences in source/climatic conditions.

Unsaponifiable Matter (USM)

The unsaponifiable matter (USM) comprises phytonutrients of the fat/oil. A high percentage of USM may reflect in a higher amount of phytonutrients present in the fat/oil. In the present study (Table 4), PSF contains the highest amounts of USM (5.0%) which indicates the presence of higher amounts of phytonutrients when compared to the other studied oils. On the other hand, TSF (0.5%) and ASF (0.48%) were found to have lower values than SFO (0.72%). Gopala Krishna et al have reported high USM content of 4.5% in rice bran oil. Probably a higher USM could be ascribed to the presence of phytosterols, hydrocarbons and tocopherols [17]. About 455 mg/100g of phytosterols has been reported in the literature for TSF [12]. The composition of phytosterols in PSF has also been reported [13].

Acylglycerols Composition

The acylglycerols composition of studied seed fats is shown in Table 4, wherein TSF shows the highest percentage of TAG (86.6%) while PSF and ASF showed 80.6% and 70.7% respectively. The DAG and MAG were considered as minor glyceride components in oils as these are generally present in less quantity. In commercially available oils, DAG content is lesser when compared to the studied seed oils which are crude oils. As per the results, ASF contains 19.6% of DAG followed by PSF (10.9%) and TSF (10.9%). Rice bran oil being a refined oil (RBO) contains a higher amount of 10.6% of DAG even after refining. Palm oil and rice bran oils can be considered as good sources of DAG containing vegetable oils [14]. DAG is one of the important molecules which acts as anti-obesity/low calorie fat. The MAG content was 0.1%, 1.4% and 2.9% in TSF, PSF and ASF respectively. The literature is scarce on this aspect.

Triacylglycerols (TAG) Composition by HPLC

TAG composition of the studied seed fats are shown in Table 5. The LLLn content was found to be high in ASF (33.4%) followed by PSF (13.8%) and TSF (16.8%). LLnLn was found higher in TSF (2.0%), and lower in ASF (0.9%). The LLL content was high in TSF (15.3%) followed by PSF (14.3%) and ASF (11.1%). The PLL value of ASF was 23.2% and 11.0% and 10.0% for PSF and TSF respectively. OOL content was high in PSF (13.5%) compared with the other studied oils. POL values for TSF, PSF and ASF was (16.0%), (16.1%) and (14.9%) respectively. PLP content was less in ASF (2.6%) and in TSF (3.3%) than PSF (4.7%). OOO content of PSF was 6.9%, comparatively higher than the other studied oils. POO values for TSF, PSF and ASF were 9.6%, 9.7% and 4.0% respectively. POP was higher in TSF (4.4%) than in ASF (1.9%), and PSF (0.2%). OOS was comparatively less in PSF (0.1%) than

for TSF (1.8%) and ASF (1.2%). Prasanth Kumar et al., reported the TAG composition of some Indian commercial vegetable oils and the major TAGs were for peanut oil/groundnut oil: LLO(12%), OOL(15.2%, POL/MOO(14%), OOO(10%), POO(14.1%), for rice bran oil: LLO(10%), OOL(12.8%), POL/MOO(14%), OOO(9.6%), POO(14.4%), for sunflower oil: LLL(21.7%), LLO(25.3%), OOL(11.2%), POL(9.9%), PLL(8.5%) which differed from the molecular species found for ASF, PSF and TSF [14]. However, the fatty acid composition of the studied vegetable seed oils was comparable to the composition of common vegetable oils but for a slightly higher PUFA content and unsaturated TAG molecular species. To our knowledge, the TAG composition of the studied seed fats has not been reported.

Phytonutrients Composition of Fats

Phenolics

The phenolic compounds are the ones which differ in the arrangement of hydroxy and methoxy groups on aromatic rings. Phenolics are a class of nutraceutical compounds present in vegetable oils which provide antioxidant activity to oils hence play a key role in stability of oils and in sensory attributes [19]. The polyphenol content of studied seed fats has been shown in Table 5 according to which, TSF showed higher polyphenol content (4.3 mg/100 g) compared to other studied fats of 1.3 mg/100 g and 2.5 mg/100 g of phenolics for PSF and ASF respectively. When compared with other vegetable oils the present studied seed fats could be a good source of phenolic compounds.

Carotenoids Content

The presence of carotenoids in oils provides yellow to orange-red colour to the vegetable oils. The carotenoids were high in palm oil when compared to other commercially available vegetable oils [20]. However, in the studied fats the carotenoid content was 3.3, 3.4 and 1.3 mg/100 g for TSF, PSF and ASF respectively (Table 5). Hence, all studied fats contain a good amount of carotenoids. Eller et al. reported carotenoids present in TSF (3 mg/100 g) which was comparable with the present study [15]. The carotenoid content in oils may vary according to the varietal and growing conditions of the vegetables [20].

Tocopherols Content

Tocopherols are minor phytonutrients commonly present in the seed fats and act as natural antioxidants. The tocopherol content of studied fats has been presented in Table 5 according to which, TSF (141.9 mg/100 g) contained high amount of tocopherols followed by ASF (107.6 mg/100 g) while the PSF (42 mg/100 g) contained a lower amount of tocopherols. TSF has been reported to contain 126 mg/100g with alpha T of 20.2mg/100g and delta T of 105.9 mg/100g [12]. For PSF a low value of 12.6mg/100g has been reported by John Tsaknis et al [13]. The tocopherols content was higher than those reported in the literature [15]. The reason could be that the tocopherol content depends on its variety, geographical conditions and type of processing. The crude oils generally contain a higher amount of tocopherols than the respective refined oils [14,22,23].

CONCLUSIONS

Vegetable seed by-products of food processing industries are a sustainable source to fulfill the demands of vegetable oils for the increasing population in India and other countries. The seed fat of studied vegetables and fruits have a potential of about 0.3 million metric tons in India and about 2.9 million metric tons in the world (taking an average of 15% as dry seed content and 30% as fat content) which may be made use of for production of edible oils. The characteristics of fat, fatty acids, triacylglycerols (triglycerides) and phytonutrients composition of these fats/oils showed that they were very much similar to the commonly used

edible oils. and hence these could be used as new source of oil for edible applications. In conclusion, vegetable seeds from pumpkin (50.1%), ash gourd (54.5%) and tomato (23.6%) could be an excellent edible oil source with a huge raw material availability potential. Date seed (9.0%) and jack fruit seeds (0.9%) contain comparatively low total oil content. Due to wastage of large amounts of date seeds, it may also be considered for oil extraction. The quality of the crude oils could be improved further by refining. The phytonutrients of the oils could be retained by careful processing to get maximum (therapeutic or otherwise) beneficial effect to the consumers.

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Table Captions

Table 1 Potential availability of the studied vegetables and fruits process waste containing seeds (2018-2020)

Table 2 Moisture and fat content of studied seeds

Table 3 Fatty acid composition of all fats from studied seeds

Table 4 Physico-chemical characteristics and acylglycerols composition of few fats from studied seeds

Table 5 TAG composition of few fats from studied seeds

Table 6 Phytonutrients composition of few fats from studied seeds

Table 1 : Potential availability of the studied vegetables and fruits process waste containing seeds (2018-2020) [24-27]

Vegetables and fruits	World	Process waste (30%)*	India	Process waste (30%)*
Ash gourd -	--	-	15,326 tons	4598 tons
Dates	9.07 million tons	2.72million tons	85,351 tons	25605 tons
Jack fruit	3,113 tons	934 tons	1,436 tons	431 tons
Pumpkin	26.523 million tons	7.96million tons	5.07 million tons	1.52million tons
Tomato	177.2 million tons	53.16 million tons	18.4 million tons	5.52 million tons
Total	-	638,40,934 (63.84million tons)	-	70,70,634tons (7.071 million tons)

Table 2 : Moisture and fat content of studied seeds

Seeds	Moisture (%)	Fat content (%)
Ash gourd	4.7 ± 0.35^{a}	54.5 ± 2.61^{d}
Dates	7.6 ± 0.42^{b}	9.0 ± 0.84^{b}
Jack fruit*	54.0 ± 1.41^{c}	0.9 ± 0.14^{a}
Pumpkin	5.1 ± 0.21^{a}	50.1 ± 1.13^{d}
Tomato	6.2 ± 0.14^{a}	23.6 ± 1.50^{c}

All values are on dry weight basis. All the values are mean ± SD of replicate analysis (n=4). *Jack fruit seeds were from fresh fruit which was mashed and analysed.

Table 3 : Fatty acid composition of all fats from studied seeds

Fatty acids (%)	ASF	DSF	JSF	PSF	TSF
C8:0	ND	ND	2.7 ± 0.1^{a}	ND	ND
C10:0	0.3 ± 0.0^{ab}	0.4 ± 0.0^{b}	0.9 ± 0.0^{c}	0.2 ± 0.0^{a}	0.2 ± 0.0^{a}
C12:0	ND	18.6 ± 0.2^{b}	2.1 ± 0.0^{a}	ND	ND
C14:0	ND	11.9 ± 0.1^{b}	0.1 ± 0.0^{a}	0.1 ± 0.0^{a}	ND
C16:0	12.9 ± 0.1^{c}	10.9 ± 0.1^{bc}	35.4 ± 0.4^{e}	10.8 ± 0.1^{b}	13.0 ± 0.1^{c}
C16:1	0.1 ± 0.0^{a}	ND	ND	0.10 ± 0.0^{a}	$0.1 \quad 0.0^{a}$
C18:0	5.1 ± 0.01^{d}	3.2 ± 0.01^{b}	1.8 ± 0.01^{a}	8.5 ± 0.1^{e}	3.7 ± 0.01^{bc}
C18:1	5.0 ± 0.01^{a}	43.8 ± 0.2^{e}	4.1 ± 0.0^{a}	35.9 ± 0.4^{d}	22.2 ± 0.2^{b}
C18:2	72.8 ± 0.8^{f}	9.4 ± 0.01^{a}	47.1 ± 0.2^{d}	41.6 ± 0.4^{c}	57.4 ± 0.2^{e}
C18:3	0.2 ± 0.0^{a}	0.1 ± 0.0^{a}	3.9 ± 0.01^{c}	0.1 ± 0.0^{a}	2.4 ± 0.01^{b}
C20:0	0.1 ± 0.0^{a}	0.4 ± 0.0^{b}	0.8 ± 0.0^{d}	0.5 ± 0.0^{c}	ND
C20:1	ND	0.4 ± 0.0^{b}	0.9 ± 0.0^{c}	ND	0.1 ± 0.0^{a}
C22:0	0.3 ± 0.0	ND	ND	ND	ND
Others	3.2 ± 0.02^{d}	0.9 ± 0.0^{b}	0.2 ± 0.0^{a}	2.2 ± 0.02^{c}	0.9 ± 0.0^{b}
MCFA	0.3 ± 0.0	20.0 ± 5.2	5.6 ± 1.2	0.2 ± 0.0	0.2 ± 0.0
SAFA	18.4 ± 1.0	26.4 ± 1.8	38.1 ± 2.4	19.9 ± 1.8	16.7 ± 1.4
MUFA	5.1 ± 0.6	44.2 ± 2.8	5.0 ± 0.9	36.0 ± 2.8	22.4 ± 1.8
PUFA	73.0 ± 4.6	9.5 ± 1.6	59.0 ± 2.2	41.7 ± 3.2	59.8 ± 3.2
S:M:P ratio	1:0.3:14.3	1:1.6:0.2	1:0.1:11.8	1:1.8:1.1	1:1.3:3.7

All the values are mean ± SD of replicates analysed (n=4). ASF = Ash gourd seed fat, DSF = Date seed fat, JSF = Jackfruit seed fat, PSF = Pumpkin seed fat, and TSF = Tomato seed fat. MUFA = Monounsaturated fatty acids, PUFA = Polyunsaturated fatty acids, C = Chain length, SAFA = Saturated fatty acids, U = Unsaturated, MCFA=medium chain fatty acids, S:M:P = saturated:monounsaturated:polyunsaturated

Table 4 : Physico-chemical characteristics and acylglycerols composition of few fats from studied seeds

Parameters	ASF	PSF	TSF
Colour	9.6 ± 0.3^{a}	88.0 ± 2.1^{c}	23.5 ± 0.9^{b}
FFA (% as oleic)	8.4 ± 0.3^{d}	6.6 ± 0.4^{c}	2.7 ± 0.3^{b}
PV (meq O_2/kg)	11.8 ± 0.6^{d}	10.5 ± 0.3^{c}	5.9 ± 0.4^{b}
SV (mg KOH/ g)	196.4 ± 1.9^{a}	215.6 ± 5.1^{b}	236.1 ± 7.3^{c}
USM (%)	0.48 ± 0.04^{a}	5.0 ± 0.4^{b}	0.5 ± 0.04^{a}
IV (gI_2 /100 g)	135.3 ± 4.7^{c}	107.6 ± 4.9^{a}	110.5 ± 5.1^{ab}
Acylglycerols composition			
TAG (%)	70.7 ± 0.8^{a}	80.6 ± 1.2^{b}	86.6 ± 0.2^{c}
DAG (%)	17.9 ± 0.4^{d}	11.5 ± 0.4^{c}	10.6 ± 0.3^{b}
MAG (%)	2.9 ± 1.2^{b}	1.4 ± 0.2^{ab}	0.1 ± 0.0^{a}

All the values are mean ± SD of replicate analysis (n=4). Data for DSF and JSF not determined.

Table 5 : TAG composition of few fats from studied seeds

TAG (%)	ASF	PSF	TSF
LLnLn	0.9 ± 0.05^{a}	1.6 ± 0.08^{b}	2.0 ± 0.02^{b}
LLLn	33.4 ± 1.1^{b}	13.8 ± 0.04^{a}	16.8 ± 0.07^{a}
LLL	11.1 ± 0.87^{a}	14.3 ± 0.03^{a}	15.3 ± 0.12^{a}
PLL	23.2 ± 0.47^{c}	11.0 ± 0.04^{a}	10.0 ± 0.45^{a}
OOL	3.9 ± 0.15^{a}	13.5 ± 0.01^{b}	12.0 ± 0.03^{b}
POL	14.9 ± 0.81^{a}	16.1 ± 0.09^{a}	16.0 ± 0.04^{a}
PLP/MOP	2.6 ± 0.03^{b}	4.7 ± 0.01^{c}	3.3 ± 0.54^{bc}
OOO	2.5 ± 0.09^{a}	6.9 ± 0.07^{b}	5.1 ± 0.09^{b}
POO	4.0 ± 0.37^{a}	9.7 ± 0.03^{b}	9.6 ± 0.01^{b}
POP	1.9 ± 0.21^{b}	0.2 ± 0.03^{a}	4.4 ± 0.05^{c}
PPP	0.1 ± 0.01^{a}	0.7 ± 0.02^{a}	0.3 ± 0.01^{a}
OOS	1.2 ± 0.06^{b}	0.1 ± 0.00^{a}	1.8 ± 0.03^{b}
SOP	0.2 ± 0.01^{a}	3.0 ± 0.02^{c}	1.1 ± 0.26^{ab}
Others	0.2 ± 0.01^{a}	4.4 ± 1.2^{d}	2.3 ± 1.0^{c}

All the values are mean ± SD of replicates analysed (n=4). M=Myristic, O=Oleic, L=Linoleic, Ln = linolenic, P=Palmitic, S=Stearic. Data for DSF and JSF not determined.

Table 6 : Phytonutrients composition of few fats from studied seeds

Phytonutrients (mg/100gm)	ASF	PSF	TSF
Phenolics	2.5 ± 0.3^{b}	1.3 ± 0.2^{a}	4.3 ± 0.3^{d}
Carotenoids	1.3 ± 0.3^{b}	3.4 ± 0.1^{b}	3.3 ± 0.1^{b}
a- Tocopherol	11.9 ± 0.8^{a}	41.5 ± 6.8^{b}	4.4 ± 0.2^{a}
β- Tocopherol	95.7 ± 2.6^{c}	0.5 ± 0.1^{a}	137.5 ± 4.8^{d}
Total Tocopherol s	107.6 ± 4.0^{b}	42.0 ± 0.1^{d}	141.9 ± 5.7^{c}

All the values are mean ± SD of replicates analysed (n=4). Data for DSF and JSF not determined.

Research Roundup Julyl-Sept. 2021

Water influence on the kinetics of transesterification using CaO catalyst to produce biodiesel

Ajala Anantapinitwatna *et al* investigated the water influence on biodiesel production via transesterification, and especially on their kinetic parameters [**Fuel, 296**, Article 120653, (2021)]. The initial rate of transesterification was increased with increasing amount of water (0–5 wt%). On the contrary, the initial rate was significantly reduced for the water concentration of 8–15 wt%. Moreover, when the biodiesel yield reached the maximum value of 30–40%, saponification as a side reaction became more significant with the presence of the emulsion phase, resulting in a remarkable decrease in biodiesel yield. The simple kinetic model including the rate constant and apparent activation energy revealed that transesterification containing 5 wt% water gave the higher rate constant compared to the case with the absence of water. However, the simple model could not describe the case with high water content. The water effect should be accounted for in the reaction rate in the adsorption term. The modified Langmuir-Hinshelwood kinetic model including the effects of water contamination was originally proposed. Our finding suggested that despite the small amount of water content in transesterification using CaO catalyst giving rise in the initial rate, the water contamination in feedstocks for biodiesel production should be avoided because of the notable presence of saponification.

Application of the GC-HRMS based method for monitoring of short- and medium-chain chlorinated paraffins in vegetable oils and fish

Jakub Tomasko *et al* developed methods for the determination of short- and medium-chain chlorinated paraffins (SCCPs; MCCPs) in vegetable oils and fish employing gas chromatography coupled with high-resolution mass spectrometry because of a lack of information on the presence of chlorinated paraffins in food consumed in Europe [**Food Chemistry, 355**, Article 129640, (2021)]. For isolation of CPs from fish, an ethyl acetate extraction followed by a clean-up of the extract by gel permeation chromatography was performed. The same purification step was used for the isolation of CPs from the vegetable oils. The concentration range for SCCPs was <10–389 ng/g lipid weight (lw, mean 36 ng/g lw for the oils and 28 ng/g lw for the fish) and that for MCCPs was <20–543 ng/g lw (mean 55 ng/g lw for the oils and 59 ng/g lw for the fish). There was found a high variability in concentrations of CPs influenced by area of origin.

Synthesis of biodiesel from coconut oil and characterization of its blends

Helen Lugo-Méndez *et al* produced biodiesel from coconut oil via homogeneous basic catalysis using sodium hydroxide as a catalyst, and its characteristics and applicability were analyzed [**Fuel, 295**, Article 120595, (2021)] The following physicochemical properties of coconut oil and biodiesel were determined: density, kinematic viscosity, refractive index, acidity index, saponification index, iodine index, cetane number, and higher calorific value. The following cold flow properties of coconut biodiesel were also identified: pour point, cloud point, and cold filter plugging point. Finally, the influence of the biodiesel content on the density, kinematic viscosity, and heating value of biodiesel blends was evaluated and predicted by a regression model.

Experimental assessment of performance, combustion and emission characteristics of diesel engine fuelled by combined non-edible blends with nanoparticles

Abdulaziz A. Al-Kheraif *et al* emphasised the utilization of Candle nut and Soap nut biodiesel as a substitute for conventional fuel and investigated the emission characteristics and performance of engine using the above biodiesel by incorporating nanoalumina at the concentration of 25 ppm [**Fuel, 295,** Article 120590, (2021)]. Initially the samples were blended with 50% Candle nut and 50% Soap nut and later it was mixed with the neat diesel at the concentration of 20%, 30% and 40% (B20, B30 and B40) respectively. The investigation has been made using the biodiesel and compared with the conventional fuel at various load conditions. The biodiesel blends were mixed with nano alumina using a ultrasonicator and the performance of the nanoparticles incorporated biodiesel blends was assessed using compression ignition engine. This study revealed that nanoparticles incorporated biodiesel blends enhance the engine performance significantly and the enhancement in performance is due to more surface area to volume ratio of Al_2O_3. The Nitrous oxide, carbon monoxide and hydrocarbon emissions were reduced considerably due to the incorporation of nano alumina at higher concentration. In addition, the nitrous oxide emission was higher as compared with pure diesel. The presence of oxygen molecules in nanoalumina reacts with carbon monoxide and forms carbon dioxide. The above process reduces the carbon monoxide emissions significantly in nanoparticles incorporated biodiesel blends. Out of various biodiesel mix, 30B samples showed better results in terms of reducing the nitrous oxide, carbon monoxide and hydro carbon emissions.

Preparation and characterization of basic graphene-based catalysts and their application in biodiesel synthesis

A series of N-doped graphene-based materials was prepared by **Justina Gaidukevič *et al*** from thermally reduced graphene oxide (TRGO) at elevated temperature (850 or 950 °C) under ammonia flow, and by impregnation of TRGO with melamine followed by subsequent thermal treatment [**Applied Surface Science, 554**, Article 149588, (2021)].The performed analyses revealed efficient doping of TRGO with N functionalities of different types, the content of which was found to be between 3.4 wt% and 12.3 wt%, depending on the modification route and conditions. The functionalization of TRGO with NH_3 was considerably less effective than that with melamine, however, the NH_3-treated carbons were significantly more basic in nature (basicity up to 0.77 mmol g^{-1}) due to the presence of quaternary N (NQ). It was also found that NQ was preferentially formed under more severe conditions, i.e., higher temperature and longer reaction time. The catalytic performance of the prepared samples was investigated in the transesterification of rapeseed oil with methanol under elevated pressure at 130 °C. The activity of carbons was strongly related to the content of NQ, and the highest yield of fatty acid methyl esters (of 65%) was obtained in the process performed with TRGO functionalized with ammonia at 950 °C for 8 h, which showed the highest number of quaternary nitrogen.

Application of adaptive neuro-fuzzy inference system and response surface methodology in biodiesel synthesis from jatropha–algae oil and its performance and emission analysis on diesel engine coupled with generator

Sunil Kumar *et al* present the results of methyl

esters preparation from Jatropha-Algae oil using transesterification process [**Energy, 226**, Article 120428, (2021)]. In this study, an adaptive neuro-fuzzy inference system (ANFIS) and the response surface methodology (RSM) based Box–Behnken techniques were used for modelling and analysis of different parameters viz molar ratio, temperature, reaction time, and catalyst concentration in biodiesel production process. Significant regression model with R^2value of 0.9867 was obtained under a molar ratio of 6–12, KOH of 0–2% w/w, time of 60–180 min and temperature of 35–55 °C using RSM. The ANFIS model was used to individually correlate the output variable (biodiesel yield) with four input variables with R^2 value of 0.9998. Finally, a study investigating the performance and emissions of a diesel engine fuelled with biodiesel blends (B0, B5, B10 and B20 vol%) has been performed concluding significant reduction of emission.

Dynamic monitoring oxidation process of nut oils through Raman technology combined with PLSR and RF-PLSR model

During preservation of nuts, nut oils are easily oxidized; hence, peroxide value (PV) is an important evaluation index. In this study, a novel method for the determination of the PV of nuts based on partial-least-square regression (PLSR) and Forest random PLSR (RF-PLSR) model was established by **Cheng Wang *et al***. Meanwhile, the Raman spectrum was processed by 24 spectral pretreatment methods to transform the whole Raman band, and the best band was selected by RF method [**LWT,146,** Article 111290, (2021)]. Among the whole bands, 36 wavenumbers were selected to establish the PLSR model. The R-square of the correction set (R^2c) and prediction set (R^2p) of the optimal Standard normal variate transformation + first Derivative-PLSR model and RF-PLSR were 0.9552, 0.8672, 0.8048, and 0.7927, while the root-mean-square error of calibration (RMSEC) and prediction (RMSEP) were 0.067, 0.1100, 0.1514, and 0.1547, respectively. These results showed that Raman spectroscopy combined with chemometrics could be used to establish a rapid, nondestructive, and precise method for the determination of oil oxidation index.

Deep eutectic solvents – Versatile chemicals in biodiesel production

Due to booming economies, a sharp increase in energy requirements is anticipated worldwide, primarily in the transportation sector. Biodiesel's aptness in substituting petro-diesel conveniently has pushed research toward more on economically and environmentally benign production technologies. Deep eutectic solvents (DESs), a sub-class of ionic liquids have gained wide popularity in various fields of biodiesel production because of process competence and environmental benevolence. This present study by **Kapil Mamtani *et al*** specifically summarizes the application of DESs as a catalyst, cosolvent and extracting solvent in biodiesel production [**Fuel, 18,** Article 120604, (2021)]. Sequentially, we first discuss the extraction of lipids, valuable compounds, feedstock pre-treatment, transesterification, and ester purification. Overall DESs in all roles show good performance and recyclability. Based on the findings of this study, we highlight areas where deep eutectic solvents require more research and identify future possibilities. It is suggested that a fully DESs-based biodiesel production scheme is possible.

Aerobic-liquor treatment improves the quality and deep-frying performance of refined palm oil

Deep-frying is a popular method for food preparation because it improves the taste and

sensory of food. Among the vegetable oils, palm oil is one of the commonly used oils for deep-frying application. During deep-frying, some of the oil would be absorbed by the food and subsequently be consumed together with the food. Hence, the quality and stability of the oil used for deep-frying are of critical food safety considerations. To address this issue, **Chien Lye Chew *et al*** produced refined palm oil from crude palm oil which has been treated with an aerobic liquor (AL) generated from a palm oil mill **[Food Control, 126**, Article 108072, (2021)]. The result shows that the refined palm oil produced from AL-treated CPO (aRPO) has improved quality, in particular the 3-monochloropropane-1,2 diol ester (3-MCPDE) and the glycidyl ester (GE) reduced by 58% and 46%, respectively. After 30 cycles of deep-frying, the used aRPO contained 68% lower FFA content, 13% lower polar content, and 43% lower 3-MCPDE content compared to the conventionally produced refined palm oil (RPO). Furthermore, the aRPO has a higher smoke-point and a higher resistance to darkening compared to the RPO. As a result, the fries prepared using aRPO have lower 3-MCPDE content and they have a better appearance and were less greasy when compared to the fries prepared using RPO. Overall, AL-treatment of CPO is a feasible method to improve the quality and deep-frying performance of refined palm oil and it could readily be adopted by the industry because it is simple and sustainable.

Selective decarboxylation of biobased fatty acids using a Ni-FSM-16 catalyst

A novel catalyst based on nickel supported on a folded sheet material (FSM) was synthesized by **Duangkamon Jiraroj *et al*** and fully characterized **[Applied Catalysis B: Environmental, 291,** Article 120050, (2021)] . The resulting Ni-FSM-16 catalyst showed a high reactivity and selectivity in decarboxylation of plant-based carboxylic acids to yield the corresponding linear alkenes and alkanes in up to 75 % yield and less than 5 % of undesired cracking products. In addition, lignin-derived vanillic acid was smoothly converted to guaiacol. A comparative investigation showed that both the support and the metal of the Ni-FSM-16 catalyst proved to be pivotal for the reactivity. Particularly, substituting Ni with Fe, Pd or Al or replacing the FSM-16 support with MCM-41 or SBA-15 led to lower reactivity and selectivity towards linear decarboxylated products. The superior catalytic performance of Ni-FSM-16 was driven by a higher and more even metal distribution, more acidic silanol-group and an electron-rich, thus softer Ni, that promote coordination by the carbon-carbon double-bond of the fatty acid.

The detection of glycidyl ester in edible palm-based cooking oil using FTIR-chemometrics and 1H NMR analysis

Glycidyl ester (GE) is a process contaminant formed during the palm oil refining process. In this study, 156 spectra of palm-based cooking oilwere recorded by **Kok Ming Goh *et al*** by Fourier transform infrared (FTIR) spectroscopy and resulting data were processed using chemometrics approach [**Food Control, 125**, Article 108018, (2021)]. The relationship between spectrum data and measured data of GE content was established using Cubist, Random Forest (RF), average neural network (avNNET), and artificial neural network (nnet) model. Then, a consensus regression model was established using a fusion of those four models. GE contents measured by gas chromatography-mass spectrometer (GC-MS) were between 1.338 and 18.362 mg/kg with mean value of 6.880 ± 3.767 mg/kg and median value of 6.480 mg/kg. In this study, FTIR spectrum served as data input and calibrated using measurements

from GC-MS. NMR was then applied to verify the present and structural information of GE. Prediction results of GE using the consensus model showed -high coefficient of determination (R^2) value of 0.79. The contribution (in percentage) of each member model from highest to the lowest was in order Cubist > RF > avNNET > nnet. Further confirmation of the presence of GE in samples were performed using ^{1}H NMR spectroscopy. Comprehensive analyses based on FTIR chemometrics and ^{1}H NMR spectroscopy successfully determined GE in palm-based cooking oil.

Fabrication and characterization of stable oleofoam based on medium-long chain diacylglycerol and β-sitosterol

Oleofoams have emerged as attractive low-calorie aeration systems, but saturated lipids or large amount of surfactants are commonly required. Herein, an innovative strategy was proposed by **Chaoying Qiu *et al*** to create oleofoams using medium-long chain diacylglycerol (MLCD) and β-sitosterol (St) **[Food Chemistry, 350**, Article 129275, (2021)]. The oleofoams prepared using MLCD and St in ratios of 15:5 and 12:8 exhibited smaller bubble size and much higher stability. MLCD crystals formed rigid Pickering shell, whereby air bubbles acted as "active fillers" leading to enhanced rigidity. Both Pickering and network stabilization for the MLCD-St oleofoam provided a steric hindrance against coalescence. The gelators interacted via hydrogen bonding, causing a condensing effect in improving the gel elasticity. The oleofoams and foam-based emulsions exhibited a favorable capacity in controlling volatile release where the maximum headspace concentrations and partition coefficients showed a significantly decrease. Overall, the oleofoams have shown great potential for development of low-calorie foods and delivery systems with enhanced textural and nutritional features.

Scalable workflow for green manufacturing: discovery of bacterial lipases for biodiesel production

Lipases are a group of enzymes capable of catalyzing the hydrolysis of triacylglycerides into free fatty acids during lipid metabolism. In the presence of short-chain alcohols, some of these enzymes can catalyze the transesterification of plant oils into biodiesel. Biodiesel has recently gained traction to be a green alternative to fossil fuel. Efficient production of biodiesel at an industrial scale is limited by the reusability of the enzyme and its tolerance toward high concentrations of organic solvents. **Jeng Yeong Chow *et al*** described a scalable workflow that integrates web-based tools and automation to identify a group of 114 orthologous bacterial lipases for expression, purification, and characterization using a high-throughput platform at our biofoundry ***[ACS Sustainable Chemistry & Engineering*, 9** 13450-13459, (2021)]. The activity profile of these enzymes revealed many targets with different substrate specificities and an optimal pH range. Most of these enzymes are thermostable and can tolerate up to 40% methanol (v/v). Among the 114 lipases that were targeted, 22 were found to be able to produce methyl oleate from triolein in the presence of methanol. Our study demonstrates the utility of the workflow to identify lipase candidates for the industrial production of biodiesel.

Synthesis of macrocyclic lactones and dilactones using olive oil

Macrocyclic lactones have redolent characteristics of muscones that originate from the rectal musk

organs of the musk deer. These lactones are the primary raw material in the flavor and fragrance industry and are also found within the cyclic frameworks of various bioactive molecules. Due to great demand, many efforts have been made for their synthesis; however, strategies generating a large number of macrocyclic analogues from renewable resources have not been fully realized and are urgently required. Here, **Rohit Rana *et al*** outlined a sustainable, straightforward, and eco-friendly approach to synthesize high-valued macrocyclic lactones utilizing olive oil under greener reaction conditions *[**ACS Omega**,* **6**, 25381-25388, (2021)]. The outlined method allows us to turn biomass into valuable 12- to 29-membered lactones and dilactones.

Super tough polylactic acid plasticized with epoxidized soybean oil methyl ester for flexible food packaging

Polylactic acid (PLA) is a key biopolymer with potential uses in numerous sectors, since it is biocompatible and both biobased and biodegradable. However, brittleness limits its industrial applications where plastic deformation at high impact rates or high elongation is required, for instance, flexible food packaging. In order to overcome this drawback and potentially expand the PLA market, **Arkadiusz Zych *et al*** developed flexible PLA materials plasticized with renewable and biodegradable epoxidized soybean oil methyl ester reaching elongations at break of almost 800% *[**ACS Applied Polymer Materials**,* **3**, 5087-5095, (2021)]. The use of amorphous PLA in combination with the lubricating effect of the plasticizer allowed the more sustainable extrusion at a low temperature of 140 °C, preventing the degradation of PLA and at the same time saving energy. Moreover, plasticized films produced, upon handling, significantly less acoustic noise than pure PLA, which is of great importance for food packaging applications. Morphology, thermomechanical and barrier properties, and migration levels were evaluated as a function of plasticizer content.

Curse and blessing–the role of water in the homogeneously ru-catalyzed epoxidation of technical grade methyl oleate

A homogeneous Ru-catalyst was investigated by **Johanna Vondran *et al*** toward its potential recycling in methyl oleate epoxidation under mild conditions using hydrogen peroxide as a green oxidant *[**ACS Sustainable Chemistry & Engineering,*** **9,** 11469-11478, (2021)]. The literature-known catalyst complex, *in situ* formed from ruthenium acetylacetonate and dipicolinic acid, offers excellent selectivity toward epoxidation of technical grade (91.5%) methyl oleate. The resulting product methyl 9,10-epoxy stearate exhibits versatile applications. It is used industrially as a biobased epoxide for plasticizers and lubricants, or it can be further processed into polyurethanes. In this work, we first report a concept for homogeneous catalyst recycling, including extraction of the epoxide into an organic phase. Particular emphasis was on the effect of water, as it would accumulate due to recycling of the aqueous catalyst phase and replenishment of hydrogen peroxide prior to each recycling run. Consequently, mass transfer limitations needed to be addressed. By a combined extraction-distillation technique, we report the first sufficient homogeneous catalyst recycling strategy for Ru-catalyzed epoxidation of methyl oleate. Removal of water and separation of epoxide allowed for a Σ TON of 1243 after seven recycling runs with 97% selectivity toward epoxide and a TTON of 1384 after 13 runs, respectively, while catalyst leaching into the product phase was negligibly small.

Moreover, pervaporation using a poly(vinyl alcohol) membrane was investigated as a promising technique for both removal of water and retention of the catalyst showing very promising results.

Palm-Oil-Based biodiesel in indonesia: a case study on a socioscientific issue that engages students to learn chemistry and its impact on society

Safwatun Nida *et al* present a case study examining the current controversial issue of palm oil production for manufacturing biodiesel in Indonesia ***[Journal of Chemical Education,* 98**, 2536-2548, (2021)]. The study looks at how this issue was used as a context to teach chemistry at the undergraduate level. The lesson unit promotes general educational skills, which students need to develop in order to become actively involved in societal discussions as scientifically literate and responsible citizens. The study presents students' views on socioscientific issues-based chemistry education centered around palm-oil-based biodiesel in Indonesia. Most of the students (N = 74) considered the socioscientific issues-based pedagogy to be motivating, relevant, and encouraging for both learning chemistry concepts and preparing them for participation in societal debate.

Semiquantitative solid-state nmr study of the adsorption of soybean oils on silica and its significance for rubber processing

Soybean oil (SBO) is a renewable material used as an alternative to conventional petroleum-derived oils in the processing of rubber composites. Upon chemical modifications, such as epoxidation, its performance in the processing of rubber can be significantly improved, as indicated by a considerable reduction of the mixing energy. Although it has been hypothesized that hydrogen bonding between functional groups (e.g., epoxy) of SBOs and silanols present on the silica surface plays a key role, there is still a lack of direct evidence supporting this hypothesis. **Chuanyu Yan *et al*** demonstrated that there is an overall correlation between the epoxy concentration of SBOs and the mixing energy, consistent with the long-held hypothesis ***[Langmuir***, **37**,10298-10307, (2021)]. In particular, a correlation between the SBO–silica adsorption affinity and the degree of epoxidation is revealed by a set of surface-selective solid-state nuclear magnetic resonance (ssNMR) experiments. In addition, the surface-selective ssNMR technique demonstrated in this work could also be used to evaluate the adsorption affinity of other oils and/or additives more broadly.

Storage stability and physicochemical properties of flaxseed oil microencapsulated with chinese quince seed gum

Hua-Min Liu *et al* evaluated the potential of using the seed gum of Chinese quince (CQSG) as a wall material for flaxseed oil microencapsulation *via* freeze-drying. The stability, distribution of different sized droplets, and viscosity of the different emulsions stabilized by CQSG with various flaxseed oil concentrations were measured ***[ACS Food Science & Technology*, 1**, 1254-1261, (2021)]. The systems with the core/wall material ratios (w/w) of 4/6 and 5/5 created more stable emulsions in that no phase separation was observed after 20 days of storage. The smaller average droplet sizes and higher ζ potentials of these systems as compared with those of other emulsion systems indicated that they had the best emulsifying properties. Freeze-drying microencapsulation using CQSG as a wall material clearly protected the flaxseed oil from oxidation as cores in the microcapsule powders. Scanning

electron microscopy (SEM) revealed that the freeze-dried microcapsules typically showed a crumpled, somewhat porous structure. The results showed that CQSG could be used as a wall material for microencapsulation and that flaxseed oil encapsulated with this material could be used in the food industry as a functional ingredient.

Thickening castor oil with a lignin-enriched fraction from sugarcane bagasse waste via epoxidation: a rheological and hydrodynamic approach

Thickening vegetable oils to different extents is of great interest in the design and development of new bio-based lubricant formulations, as achieving a wide range of rheological properties is crucial to the successful replacement of petroleum-based traditional counterparts. With this aim, the influence of epoxidation degree, modified by altering the reaction conditions, on the viscous flow properties of epoxidized castor oil was investigated together by **Esperanza Cortés-Triviño *et al*** with the incorporation of a lignin-enriched fraction from sugarcane bagasse waste to more extensively modify the rheological properties, thereby valorizing this waste fraction. Oil thickening was achieved by promoting the cross-linking between the epoxidized oil and the lignin-enriched fraction that enables the compatibilization of both components ***[ACS Sustainable Chemistry & Engineering*, 9**, 10503-10512, (2021)]. Castor oil epoxidation was assessed by means of standard volumetric titration methods and infrared spectroscopy. In addition, a fully rheological characterization of both epoxidized and lignin-thickened castor oils was carried out. A hydrodynamic approach was also followed, aiming to provide an estimation of the Mark–Houwink–Sakurada parameters and relate the intrinsic viscosity with the average molecular weight of the resulting epoxidized castor oil/lignocellulose macromolecular compounds. The chemical interaction between castor oil and the lignocellulosic material increased as the extent of epoxidation was increased, yielding a variety of rheological responses from Newtonian liquids of increasing viscosities (from around 1 to 500 Pa·s) to viscoelastic liquids.

Biohydrogenated diesel from palm oil deoxygenation over unsupported and γ-al$_2$o$_3$ supported Ni–Mo catalysts

Pojawan Aiamsiri *et al* investigated the performance of unsupported and γ-Al_2O_3 supported nickel–molybdenum (Ni–Mo) catalysts for palm oil deoxygenation to biohydrogenated diesel ***[Energy & Fuels*, 35**, 14793-14804, (2021)] . Three preparation methods of supported catalyst (one-step hydrothermal, physical mixing, and incipient wetness impregnation) were studied. In all experiments, the main products were *n*-alkanes (*n*-C_{14}, *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, and *n*-C_{18}). For palm oil deoxygenation over an unsupported $NiMoS_2$ catalyst, increasing the palm oil concentration enhanced the decarbonylation (DCO) and decarboxylation (DCO_2) pathways, while prolonging the reaction time led to an increased relative rate of hydrodeoxygenation (HDO) rather than DCO and DCO_2 reactions. The unsupported 0.2-$NiMoS_2$ catalyst (at a Ni/[Ni + Mo] molar ratio of 2) prepared by a hydrothermal method was the efficient catalyst, while the appropriate reaction conditions were 300 °C for 3 h at an initial hydrogen pressure of 40 bar, with a catalyst/palm oil ratio of 0.1, to give the highest $C_{14–18}$ alkane yield of 67.0 wt %. The selectivities for *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, and *n*-C_{18} alkanes were 19.6%, 20.2%, 26.8%, and 33.0%, respectively. A new supported $NiMoS_2$ catalyst prepared by a one-step hydrothermal

method was proposed. This technique merges the advantages of both an alumina (Al_2O_3) support and our previous hydrothermal method. The H-$NiMoS_2/\gamma$-Al_2O_3 supported catalyst with a 20 wt % Al_2O_3 loading (H-$NiMoS_2/\gamma$-Al_2O_3-0.2) prepared by the hydrothermal method presented a higher dispersion of Ni–Mo–S species than the unsupported catalyst, which results from the Al_2O_3 support. Without needing further presulfidation, the H-$NiMoS_2/\gamma$-Al_2O_3-0.2 catalyst showed good HDO activity under appropriate conditions, which gave a high $C_{14–18}$ yield of 55.4 wt % and a selectivities for *n*-C_{15}, *n*-C_{16}, *n*-C_{17}, and *n*-C_{18} of 14.1%, 25.3%, 19.7%, and 36.3%, respectively. The 0.2-$NiMoS_2$ and H-$NiMoS_2/\gamma$-Al_2O_3-0.2 catalysts could be reused for at least three cycles of deoxygenation while maintaining a good performance.

Super tough polylactic acid plasticized with epoxidized soybean oil methyl ester for flexible food packaging

Polylactic acid (PLA) is a key biopolymer with potential uses in numerous sectors, since it is biocompatible and both biobased and biodegradable. However, brittleness limits its industrial applications where plastic deformation at high impact rates or high elongation is required, for instance, flexible food packaging. In order to overcome this drawback and potentially expand the PLA market, **Arkadiusz Zych *et al*** developed flexible PLA materials plasticized with renewable and biodegradable epoxidized soybean oil methyl ester reaching elongations at break of almost 800% ***[ACS Applied Polymer Materials*, 3**, 5087-5095, (2021)]. The use of amorphous PLA in combination with the lubricating effect of the plasticizer allowed the more sustainable extrusion at a low temperature of 140 °C, preventing the degradation of PLA and at the same time saving energy. Moreover, plasticized films produced, upon handling, significantly less acoustic noise than pure PLA, which is of great importance for food packaging applications. Morphology, thermomechanical and barrier properties, and migration levels were evaluated as a function of plasticizer content.

NaOH-catalyzed methanolysis optimization of biodiesel synthesis from desert date seed kernel oil

Biodiesel synthesis from non-edible vegetable oil via catalytic transesterification is one of the effective ways to replace petroleum-based fuels in the area of renewable energy development and is beneficial to environmental security. Therefore, this research investigates the optimization of process parameters (temperature, methanol to oil ratio, and NaOH catalyst dose) by **Kedir D. Mekonnen and Zenamarkos B. Sendekie** for the conversion of biodiesel from non-edible desert date (*Balanites Aegyptiaca*) seed kernel oil using the Box–Behnken experimental design of response surface methodology statistical analysis ***[ACS Omega*, 6**, 24082-24091, (2021)]. Accordingly, the optimum values of reaction conditions, namely, a temperature of 60.5 °C, methanol to oil ratio of 6.7:1, and catalyst dose of 0.79 %wt, yielded 93.16% biodiesel. Fourier transform infrared spectroscopy analysis confirmed the cracking of a single glycerol backbone from the triglycerides and the substitution by methoxyl in the presence of a NaOH catalyst. The physicochemical properties of the biodiesel were investigated and compared with standards in terms of its density, viscosity, higher heating value, acid value, saponification value, cetane number, cloud point, pour point, and flash point, and the values are within the recommended standard limits of American

Standard for Testing Material (ASTM D6751) and European Committee for Standardization (EN14214). Thus, the results revealed that homogeneous base catalysis of non-edible oil under optimum reaction conditions provides high yield of biodiesel.

Prediction of temperature profiles for catalytic hydrotreating of vegetable oil with a robust dynamic reactor model

Modeling and simulation of a three-phase commercial-scale reactor for the catalytic hydrotreating of vegetable oil was reported by **Alexis Tirado *et al*** to analyze the effect of reactor characteristics and mode of operation on product yields and temperature profiles along the catalytic bed length and time-on-stream ***[Industrial & Engineering Chemistry Research,* 60**, 13812-13821, (2021)]. The model considers the variation of superficial gas velocity and effects of diffusion inside the catalytic particle to generate information in a more realistic large-scale environment. A series of simulations performed at different operating conditions show that the reaction heat released and hydrogen consumption are higher than those found for petroleum distillate hydrotreating, which enhances a sudden decrease in product yields. This information is vital to propose reactor design strategies, i.e., cooling systems, for a sharp temperature increase to optimize the performance of the entire process.

Data-Driven approach to decipher the role of triglyceride composition on the thermomechanical properties of thermosetting polymers using vegetable and microbial oils

Sustainable and renewable polymeric materials are gaining traction, and vegetable oils have been used directly or in modified forms to meet this demand. At the same time, microbial hosts (such as the oleaginous yeast *Yarrowia lipolytica*) are being touted as sustainable alternatives for petroleum and vegetable oils. However, the exact role of fatty acid composition and speciation on polymer performance remains unclear. Here, **Lauren T. Cordova *et al*** explored a data-driven approach to explicitly relate the underlying oil composition with the thermomechanical properties of the resulting polymeric material. In doing so, they identified the C16:0, C16:1, and C18:0 fatty acid contents of vegetable oils as critical parameters for predicting thermal stability at maximum heat loss (T_{max}). Machine learning-based approaches were applied to study the link between thermal properties and monomer composition ***[ACS Applied Polymer Materials*, 3**, 4485-4494, (2021). In the end, application of multiple linear regression modeling indicated strong dependence on the C16:1 content as evident by the parameter loading (loading of +428 for T_{max}). As a more sustainable source of oil, *Y. lipolytica* oil-based polymer properties were also dictated by the C16:0 and C18:0 fatty acid contents but with an opposite impact as compared with vegetable oils (T_{max} loadings of - 208 and +36 for *Y. lipolytica* oils, +19 and - 72 for vegetable oils, C16:0 and C18:0, respectively). Despite these differences, *Y. lipolytica* oil-based polymers showed similar strength and cross-linking density to vegetable oil polymers. This work is the first evaluation of polymer properties from a library of vegetable- and yeast-sourced oils and highlights a mechanistic understanding of thermal stability from both oil source (vegetable or microbial) and oil composition that can be used for future design.

Synthesis and catalytic evaluation of acidic carbons in the etherification of glycerol obtained from biodiesel production

María E. Chiosso *et al* studied the catalytic

behaviour of carbonaceous system (Ccs) functionalized with $-SO_3H$ groups in the etherification of refined (Gly) and crude glycerol (GlyC), with benzyl alcohol (BA) [**Catalysis Today, 372,** Pages 107-114, (2021)]. This Ccs was obtained by a synthetic method with low energetic cost in only 24 h. Its catalytic activity and selectivity were studied varying the catalyst percentage (2.5, 5 and 10 wt.%), the initial reactant molar ratio and temperature (between 80 and 120 °C). A very good catalytic performance was achieved (97 % conversion after 360 min of reaction), at 120 °C, Gly:BA = 3:1 and 10 wt.% of Ccs. The high activity can be attributed to high acid site density (6.4 mmol H^+/g), that also allowed us to working at lower reaction temperature (100 °C) and with less catalyst concentration (2.5 wt.%), without observing significant loss in BA conversion. Monoether (ME_1) was the major product of the reaction with 72 % selectivity. The material can be reused and still gives a notable conversion of BA (about 43 %) after three successive reuses. Finally, the Ccs was active and selective to the desired products in the etherification of crude glycerol (GlyC) derived of biodiesel industry. An important BA conversion (45 %) was obtained only reducing the water content of GlyC and without carrying out any other purification and/or neutralization treatment.

Corrosion behavior of carbon steel, stainless steel, aluminum and copper upon exposure to biodiesel blended with petrodiesel

Cristie Luis Kugelmeier *et al* evaluated the compatibility and corrosion behavior of carbon steel, stainless steel, aluminum and copper in contact with blends composed of biodiesel (consisting of soybean oil, beef tallow and swine lard) and petrodiesel. Static immersion tests (total, partial and crevice) and exposure in vapor phase were carried out for 2160 h at 50 °C [**Energy, 226,** Article 120344, (2021)]. Our main findings indicate that fuel blends influence the corrosion behavior, being observed a less corrosive attack on the materials, except for copper that presented an anomalous corrosion behavior, with a clear trend towards lower corrosion rates. Carbon steel and stainless steel in total, partial and crevice tests presented surface morphology with slightly changes, while carbon steel exposed in vapor phase showed corrosive attack. Copper presented the highest corrosion rates in partial (9.5273 μm/y), total (9.1484 μm/y) and crevice (6.6178 μm/y) tests in the B7 blend, respectively; and the lowest corrosion rates in total (0.0547 μm/y) for the B15 blend; in partial (0.4926 μm/y) and crevice (0.0182 μm/y) tests for the B30 blend. Among the materials evaluated, copper showed higher influence on biodiesel oxidative stability. Aluminum exhibited good compatibility and did not show any compound formed on its surface without presenting any corrosion.

Investigation of preheated Dhupa seed oil biodiesel as an alternative fuel on the performance, emission and combustion in a CI engine

Shankar Vitthal Kodate *et al* investigated the suitability of preheated *Vateria indica* methyl ester (VIME) as an alternative fuel for a diesel engine [**Energy, 231,** Article 120874, (2021)]. VIME is a renewable, non-toxic and sustainable alternative biodiesel obtained from Dhupa fat by transesterification. This study aims to evaluate the combustion, performance, and emission characteristics of four different blends such as B0 (0% VIME and 100% mineral diesel), B30, B50 and B100 at elevated fuel inlet temperatures ranging from 35 °C to 95 °C. The tests are carried out in a single cylinder diesel engine at optimum

loading condition and fixed speed. Results are obtained in terms of brake thermal efficiency (BTE), brake specific fuel consumption (BSFC), in-cylinder pressure, heat release rate and exhaust emissions (CO, HC, NO_X, CO_2 and soot). It is observed that the preheating of blends decreases the viscosity which enhances fuel spray characteristics, leading to higher engine performance, lower CO and HC emissions with a slight increase in NO_X and CO_2 emissions. BTE and peak in-cylinder pressure for B100 at 95 °C and 75% load are increased by 7.44%, 2.97% respectively compared to unheated B100 biodiesel. BSFC, CO, HC emissions at 75% load for B100 at 95 °C are reduced by 26.73%, 28.08%, 42.7% respectively compared to unheated B100.

The effects of grape, pomegranate, sesame seed powder and their oils on probiotic ice cream: Total phenolic contents, antioxidant activity and probiotic viability

Sevinc Akca and Asli Akpinar produced probiotic ice cream, containing *Lactobacillus rhamnosus* and *Bifidobacterium animalis* subps. *lactis* BB12 as the starter cultures, by adding vegetable seed pulp powder (sesame, pomegranate seed, and grape seed) and oils of these seeds to the ice cream mixtures and to examine the effects of these additions on pH, acidity, total phenolic content, flavonoid content, antioxidant capacity and the probiotic viability of *Lactobacillus rhamnosus* and *Bifidobacterium animalis* subps. *lactis* BB12 in ice cream samples stored at - 20 °C for 90 days [**Food Bioscience, 42,** Article 101203, (2021)]. Total phenolic content, flavonoid content, and antioxidant capacity were evaluated on the first and last day of the storage. Vegetable seed powders and oils did not affect the pH and acidity values of the ice cream samples. The pulp powders and oils used contributed to preserving the viability of probiotic bacteria during storage. Among the seed pulp powders, the grape seed had the highest phenolic content and antioxidant activity. Especially, ice creams containing grape seed powder, grape seed powder + seed oil, and pomegranate seed powder promoted the development of probiotic microorganisms in these ice cream samples due to the high phenolic components and antioxidant activity. The total phenolic content and antioxidant activity of seed powders and oils were parallel to the total phenolic content and antioxidant activity of ice creams produced using these powders and oils. It can be concluded that grape seed powder and its oil can be used as a natural ingredient to develop a novel ice cream with high nutritional antioxidant activity.

Neuro fuzzy estimation of the most influential parameters for Kusum biodiesel performance

In order to reduce cost of biodiesel production there is need to use non-edible oil. Kusum feed oil is non-edible oil, low cost and substantial available for biodiesel production. To improve Kusum biodiesel performance and emission parameters there is need to analyze input variables in more comprehensive way. It is suitable to establish computational models to obtain optimal parameters. The main goal of the paper by **Dalibor Petković *et al*** was to establish and adaptive neuro fuzzy inference system (ANFIS) to determine the impact of blending, fuel injection timing, fuel injection pressure and engine load on brake thermal efficiency**,** unburnt hydrocarbons and oxides of nitrogen [**Energy,229,** Article 120621, (2021)]. It was found that the fuel injection pressure and engine load is the most influential factors on the brake thermal efficiency**,** unburnt hydrocarbons and oxides of nitrogen. The results could be useful for optimization of the Kusum biodiesel performance and emission parameters.

Enzymatic interesterification effect on the physicochemical and technological properties of cupuassu seed fat and inaja pulp oil blends

Pedro Danilo de Oliveira *et al* evaluated the effect of enzymatic interesterification process in blends with different proportions (w:w) of cupuassu fat and inaja oil (80:20, 70:30, 60:40, 50:50 and 40:60) [**Food Research International, 145**, Article 110384, (2021)]. The interesterification reaction was carried out at 65 °C, agitation at 150 rpm, and enzyme concentration of 5% (w/w), for 6 h. Acidity index, melting point, consistency and solid fat content of the blends were characterized before and after the interesterification process. Fatty acid content was characterized in cupuassu fat and inaja oil and, nutritional quality indexes of atherogenicity (*AI*) and thrombogenicity (*TI*) were calculated. Enzymatic interesterification promoted a decrease in acidity (<0.6%) and changes in the blends' properties, making them suitable for food product preparation. All esterified blends (cupuassu seed fat:inaja pulp oil) presented suitable consistency properties, plasticity and spreadability to be used for the preparation of functional, table and soft table types of margarine and used in food preparation such as special fats.

Preparation of cancrinite-type zeolite from diatomaceous earth as transesterification catalysts for biodiesel production

Tấn-Hiấp Đấng *et al* prepared new type of solid catalyst from hydrothermal reaction of natural diatomaceous earth in NaOH solution was studied for biodiesel production through the transesterification of soybean and palm oil in excess methanol [**Renewable Energy, 174**, Pages 347-358, (2021)]. Explicitly, the natural diatomite was transformed into efficacious catalysts, sequentially, by dispersion and activation in NaOH solutions for 30 min at 30 °C, followed by hydrothermal treatments at 180 °C or 220 °C for 12 h, and finally by calcination at 500 °C for 6 h. Coincidently, the physicochemical characteristics of these *as*-prepared catalysts were shown to bear a good resemblance with those of zeolite CAN. Under suitable conditions, the conversion efficiencies of soybean and palm oils to biodiesel in presence of these zeolite CAN catalysts at 63 °C and 70 °C could be obtained as high as 98.0% and 98.4%, respectively. Furthermore, the activation energies of the transesterification reactions of soybean and palm oils in excess methanol were found as 64.1 kJ/mol and 122.5 kJ/mol, respectively.

Synthesis and structural characterization of energy crop peelu methyl esters, using hybrid metallic nano-particles. A step forward to bioenergy industry

Kifayat Ullah *et al* investigated the energy crop peelu non-edible oil was as a potential source for fatty acid methyl esters production, using hybrid metallic nano-particles [**Fuel, 300,** Article 119241, (2021)]. The energy crop peelu is an evergreen shrubby plant distributed throughout the tropical and subtropical regions of the world. Naturally, the plant has having a worthy fates masses, had proceeded an optimum results for quantitative and qualitative methyl esters production, using hybrid metallic nano-particles poly-N-isopropylacrylamide "PNIPAM-Cu, PNIPAM-Pd & PNIPAM-Cu@Pd". Whereas, the carboxyl functionalized P(NIPAM) microgels was synthesized via soap free emulsion polymerization, containing poly-N-isopropyl acrylamide and acrylic acid. The proposed thiol group was then introduced via carbodiimide mediated imide bond between the carboxyl group of carboxyl functionalized microgels and the

amine from amino-ethanethiol. The Copper, Palladium and Copper@Palladium nano-particles were mixed-up into thiol-functionalized Poly-N-isopropylacrylamide microgels through metals thiol linkage. The hybrid metallic nano-particles were characterized using Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), X-ray diffraction (XRD), X-ray Photoelectron Spectroscopy (XPS) & Fourier Transfer Infra-Red (FT-IR) for rectification. The experimentation protocol for methyl esters synthesis using various concentrations of hybrid metallic nano-particles in conversion was adjusted to 1:6 oil to methanol molar ratio, temperature 60 °C and reaction time 2 h and stirring 600 rpm, respectively. The optimum yield of methyl esters was reported 92.20 against 1.5gm PNIPAM-Cu@Pd nano-particle. The chemical and structural status of synthesized methyl esters were characterized by Gas Chromatography & Mass Spectroscopy (GC&MS), FT-IR & Nuclear Magnetic Resonance) NMR spectroscopes. The physico-chemical properties of peelu crop methyl esters were analyzed, checked and compared with the international American Standards for Testing Materials (ASTM) & European Union (EN) standards, accordingly.

Developing friendlier biodiesel production process via systematic inherent safety interventions

The efficacy of inherent safety interventions for shaping Friendlier Chemical Processes (FCP) has been demonstrated in simultaneously augmenting safety (S), health (H), and environmental (E) performance while operating economically. However, there is limited attention to linking inherent safety concept with HE and cost issues when modifying process design, and a hierarchical metric used for measuring the inherent friendliness is yet to be presented. To this end, **Xiaoming Gao *et al*** developed a Reconciled Friendly Process Metric (RFPM) for generating FCP via Systematic Inherent Safety (SIS) modifications [**Journal of Cleaner Production, 308,** Article 127291, (2021)]. Firstly, the prestigious inherent SHE and cost metrics were selected and adapted to measure friendliness features. Then, the metrics were reconciled by Analytic Hierarchy Process (AHP) and Fuzzy Comprehensive Evaluation (FCE), and finally, the RFPM was validated through biodiesel production process. The results show that the base design is estimated as under Moderate (M) condition, while the modified design is estimated as under Relatively Friendly (RF) condition, which implies that the modified design is inherently friendlier than the base design. This newly developed RFPM can be used as a tool for hierarchically indicating the friendliness of processing scenarios and making trade-offs among safety, health, environmental, and cost concerns during design stage.

The effect of interfacial interactions on the rheology of water in oil emulsions oleogelled by candelilla wax and saturated triacylglycerols

The effects of water-oil interfacial activity of candelilla wax (CW), glycerol monopalmitate (GMP), glycerol monooleate (GMO) and polyglycerol-polyricinoleate (PGPR) on the microstructure and rheology of W/O emulsions oleogelled with CW and fully hydrogenated soybean oil (FH) was investigated by **Diego Orlando García-González *et al***. The emulsifier with the highest interfacial activity was PGPR, followed by GMO, and GMP [**LWT, 146**, Article 111405, (2021)]. Polar compounds of CW (CW-PC) also displayed interfacial activity. Interfacial interactions of the continuous lipid crystal network with the CW-PC and PGPR in W/O emulsions

decreased the elastic modulus (G') as the aqueous phase (AP) increased, indicating the water droplets behaved as inactive filler due to a weak interaction with the continuous phase. In contrast, the CW-PC and the monoglycerides had a cooperative interaction on the interfacial tension reduction. W/O emulsions produced with monoglycerols maintained or increased their G' as the AP increased, denoting a strong interaction of water droplets and the continuous phase (i.e., active filler behavior). At constant content of AP and FH, G' of emulsions tended to decline as the PGPR content increased, while the opposite was observed with emulsions produced with GMO. Adding 10% FH to the emulsions magnified both the active and inactive filler effects produced by GMO and PGPR, respectively.

Silica lipid hybrid microparticles for the co-encapsulation of linseed oil and coenzyme Q10: Preparation and in vitro characterization

Juan Huang *et al* investigated the efficiency of silica lipid hybrid (SLH) microparticles in delivering linseed oil and coenzyme Q10 (CoQ10) [**LWT 148**, Article 111704, (2021)]. The SLH microparticles were co-loaded with the lipophilic ingredients using high pressure homogenization and freeze drying, then the solidified samples were characterized by flowability analysis, morphological analysis, X-ray diffraction (XRD), and Fourier transform infrared spectroscopy (FTIR). The release and simulated digestion behaviors of the synthesized microparticles were analyzed *in vitro*, and their accelerated oxidation stability was assessed. The obtained results indicate that the SLH microspheres prepared with over 8% silica solution are characterized by irregular granular morphology and have good fluidity. Based on XRD and FTIR analyses, SLH-encapsulated CoQ10 exists in molecular dispersion or dissolved states, and the preparation process induces no chemical changes in the components. The silica particles in the SLH formulation inhibit the *in vitro* release and simulated digestion of α-linolenic acid and CoQ10. Moreover, the oxidation stability of the SLH microparticles is synergistically enhanced by CoQ10 and linseed oil. Overall, the results indicate that SLH microparticles can be used in the food industry for the encapsulation and delivery of functional bioactive compounds.

Changes in volatile compound profiles of cold-pressed berry seed oils induced by roasting

Sylwia Mildner-Szkudlarz *et al* compared the volatile compounds of cold-pressed oils obtained from unroasted and roasted chokeberry, raspberry, blackcurrant, and strawberry seeds using comprehensive gas chromatography–mass spectrometry coupled to time of flight mass spectrometry (GC × GC-ToFMS) [**LWT, 148,** Article 111718, (2021)]. It is found that the seed type used and chemical composition affected the final aroma of berry oils. The volatile profiles of all berry oils from both unroasted and roasted seeds were dominated by nonheterocyclic chemical class (89% of the total volatiles) with esters predominant (32% of total nonheterocyclic compounds). Unroasted raspberry and blackcurrant cold-pressed seed oils had a less complex volatile profile, and showed similarities between them and differences to chokeberry and strawberry seed oils. Chokeberry seed oil was characterized by the highest levels in ethyl propanoate, methylbutyl acetate, benzaldehyde, (*E,E*)-2,4-decadienal, acetoin, 3-penten-2-one, benzyl alcohol and strawberry seed oil by methyl acetate, isobutyl acetate, methyl 2-methylbutanoate, ethyl 2-hydroxypropanoate, ethyl 2-methylbutanoate, ethyl 3-

methylbutanoate, (*E,E*)-2,4-heptadienal, 1-penten-3-one, and 3,7-dimethyl-1,6-octadien-3-ol. N-containing and furanic-containing compounds contributed about 5% and 4%–16%, respectively, of total amount of volatiles after seed roasting. Roasting was critical for increasing the concentration of compounds derived from lipid peroxidation, especially in blackcurrant seed oils. Profiling volatiles using SPME-GC × GC-ToFMS might be helpful in evaluating oils quality.

Fabrication and characterization of stable oleofoam based on medium-long chain diacylglycerol and β-sitosterol

Oleofoams have emerged as attractive low-calorie aeration systems, but saturated lipids or large amount of surfactants are commonly required. Herein, an innovative strategy was proposed by **Chaoying Qiu *et al*** to create oleofoams using medium-long chain diacylglycerol (MLCD) and β-sitosterol (St) [**Food Chemistry, 350**, Article 129275, (2021)]. The oleofoams prepared using MLCD and St in ratios of 15:5 and 12:8 exhibited smaller bubble size and much higher stability. MLCD crystals formed rigid Pickering shell, whereby air bubbles acted as "active fillers" leading to enhanced rigidity. Both Pickering and network stabilization for the MLCD-St oleofoam provided a steric hindrance against coalescence. The gelators interacted via hydrogen bonding, causing a condensing effect in improving the gel elasticity. The oleofoams and foam-based emulsions exhibited a favorable capacity in controlling volatile release where the maximum headspace concentrations and partition coefficients showed a significantly decrease. Overall, the oleofoams have shown great potential for development of low-calorie foods and delivery systems with enhanced textural and nutritional features.

Evaluation and improvement of storage stability of astaxanthin isomers in oils and fats

Astaxanthin *Z*-isomers potentially have greater bioavailability and biological activity than (all-*E*)-astaxanthin. However, the stability of the *Z*-isomers is lower than the all-*E*-isomer, which is a serious problem affecting its practical use. In this study, **Masaki Honda *et al*** investigated the impacts of different suspension media (oils and fats) and additives on astaxanthin isomer stability and identified suitable ones for astaxanthin stabilization. The evaluations showed that several vegetable oils and antioxidants significantly improved astaxanthin isomer stability, e.g., when soybean and sunflower oils were used as the suspension medium, astaxanthin isomers were hardly degraded; however the total *Z*-isomer ratio decreased from ~80% to ~50% during 6-week storage at 30 °C. Moreover, it was revealed that (9*Z*)-astaxanthin showed higher stability than the 13*Z*- and 15*Z*-isomers [**Food Chemistry, 352**, Article 129371, (2021)]. Hence, to maintain astaxanthin concentration and the *Z*-isomer ratio over long periods, it is important to use suitable suspension mediums and antioxidants, and select a *Z*-isomerization method that increases (9*Z*)-astaxanthin ratio.

Non-targeted detection of butter adulteration using pointwise UHPLC-ELSD and UHPLC-UV fingerprints with chemometrics

A non-targeted chemometric method was devised by **Huiyue Sun *et al*** to detect possible butter adulteration without prior knowledge of the adulterant and marker compounds [**Food Chemistry, 356**, Article 129604, (2021)]. Nine common edible oils including vegetable oils, animal fats and margarines were selected as potential adulterants to build a unified classification model. The samples were analyzed

using the high-performance liquid chromatography hyphenated with an evaporative light scattering detector (UHPLC-ELSD) and an ultraviolet detector (UHPLC-UV), with the pointwise chromatograms instead of individual peaks for modelling. Both models achieved over 95% correct classification in external validation at the adulteration levels as low as 5% (w/w). The root mean squared errors of prediction (RMSEP) of the regression model were 0.9865 and 1.9080 for UHPLC-ELSD and UHPLC-UV, respectively. Non-targeted chemometrics analyses based on pointwise chromatographic profiles could be valuable for detecting adulterated butter.

Roles of gelator type and gelation technology on texture and sensory properties of cookies prepared with oleogels

In this paper, different types of oleogels were prepared by **Shiyi Li *et al*** for five gelators including hydroxypropyl methyl cellulose (HPMC), monoacylglycerol (MAG), sodium stearyl lactate (SSL), rice bran wax (RBW) and beeswax (BW), and their applications in cookies were compared [**Food Chemistry, 356**, Article 129667, (2021)]. Texture, microstructure, and colour results showed that MAG, RBW and shortening based cookies had similar hardness, porous structure, and L*, a*, b*. MAG and RBW exhibited excellent rheological properties similar to shortening. Regarding the consumer sensory evaluation of cookies, RBW, MAG and shortening had similar scores of 3.9, 4.3 and 4.1, respectively. For wax-based oleogels, the higher the content of β' crystal and solid fat content (SFC), the lower the hardness of cookies, but the cookies hardness of emulsifier based oleogels do not depend on β' content and SFC. This paper confirmed the best gelators for cookies, and provided a reference for developing the oleogels to match the quality of shortening in cookies.

Mealworm (Tenebrio molitor) oil characterization and optimization of the free fatty acid pretreatment via acid-catalyzed esterification

Hao Sen Siow *et al* studied the physical and chemical properties of mealworm (*Tenebrio molitor*) oil. Mealworm powder has a high oil content of 37.54 ± 0.78% with a high free fatty acid (FFA) content of 10.84 ± 0.005% [**Fuel, 299**, Article 120905, (2021)]. The primary fatty acids of mealworm oil were oleic acid (30.37%), linoleic acid (25.07%) and palmitic acid (19.54%). The mealworm oil decomposed almost completely after 470 °C. An optimization study of acid-catalyzed esterification using response surface methodology (RSM) was conducted to reduce the high level of FFA content to a range below 1% to be suitably used for biodiesel production via alkali-catalyzed transesterification. The optimum parameters were 5.8% w/w sulfuric acid as catalyst, 24:1 methanol to oil ratio, 174 min reaction time at a temperature of 74 °C. The methyl esters conversion obtained using these optimum condition parameters was 92.74 ± 0.92% indicating FFA content was successfully lowered to less than 1%, which is favorable for alkali-catalyzed transesterification to take place and convert the triglycerides in the oil into biodiesel. The pretreated oil is then converted to biodiesel and the properties were found to meet the ASTM D6751 standards.

Acai seed ash as a novel basic heterogeneous catalyst for biodiesel synthesis: Optimization of the biodiesel production process

Erica Karine Lourenço Mares *et al* investigated the catalytic activity of acai seed ash (ASA) for the synthesis of biodiesel from the methyl

transesterification of soybean oil. Acai seeds were calcined at different temperatures (500–900 °C) and times (2–5 h) to determine the best catalyst synthesis conditions [**Fuel, 299,** Article 120887, (2021)]. The catalyst obtained by calcination at 800 °C for 4 h was characterized by thermogravimetric analysis (TG-DTG), X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FT-IR), scanning electron microscopy (SEM), energy dispersion X-ray spectroscopy (EDS), and alkalinity. Subsequently, response surface methodology based on a face-centered composite design (FCCD 2^4) was applied to examine the best conditions to conduct the transesterification reaction. The optimal conditions were: temperature of 100 °C, molar ratio alcohol:oil of 18:1, catalyst concentration of 12.0% (w/w), and reaction time of 1 h, yielding biodiesel with an ester content of 98.5 ± 0.21%. The catalyst characterization showed that its catalytic activity is due to the high metal oxide content and carbonates with basic surface sites, making them highly efficient towards biodiesel production. The reuse of the catalyst showed that its catalytic activity resulted in an ester content above 92.5% in the first two reaction cycles. After the regeneration process, the catalyst yielded biodiesel with an ester content above 80.0% during four more reaction cycles. The production of a catalyst from acai seeds has several advantages, namely being obtained from widely available biomass waste, being low cost, and being easily synthesized, making it a sustainable and efficient catalyst for biodiesel production.

Partial hydrogenation of fatty acid methyl esters under mild conditions using sodium borohydride as hydrogen donor

Zongwu Xin *et al* used sodium borohydride as hydrogen donor instead of potentially dangerous hydrogen gas, and Ni-La-B as catalyst, a new method of partial hydrogenation of fatty acid methyl esters (FAMEs) was introduced as a mild process to gain the upgraded biodiesel [**Fuel, 299,** Article 120877, (2021)]. The effects of important operating parameters, including catalyst loading, reaction temperature, time, hydrogen donor amount and water quantity, have been investigated. Under the optimum conditions (catalyst loading 10 wt%, reaction time 150 min, reaction temperature 85 °C, sodium borohydride amount 1.14 g, and water quantity 100 g), the conversion ratio of methyl linoleate (C18:2) reached 95.4%, the iodine value of hydrogenated FAMEs decreased from 151.9 to 76.1, and good hydrogenation effect was achieved . Based on the results, the possible mechanisms were presented involved in the partial hydrogenation of FAMEs using sodium borohydride as hydrogen donor. Overall, a mild hydrogen way to upgrade the biodiesel and a systematic investigation to understand the hydrogenation reaction using sodium borohydride as hydrogen donor have been presented in the present work.

An innovative nanocatalyst α-Fe2O3/AlOOH processed from gibbsite rubbish ore for efficient biodiesel production via utilizing cottonseed waste oil

A novel dispersed α-Fe_2O_3 on AlOOH (Fe^{2+}/Fe^{3+}/AlOOH) acid catalyst was synthesized by **Mohamed Mokhatr Mohamed *et al*** via utilizing a deposition hydrothermal route and thoroughly characterized using XRD, SAED-TEM, FTIR, N_2 sorptiometry and XPS measurements was employed for biodiesel production via *trans*-esterification of waste cooking cottonseed oil (WCO) [**Fuel, 297**, Article 120741, (2021)]. The resulting catalysts own high

surface texturing and acid sites loading characteristics especially 12% Fe^{2+}/Fe^{3+}/AlOOH that owns the highest surface area value (323 m^2 g^{-1}), uniform 4 nm mesopores, and high total acid sites loading of 0.45 mmol g^{-1}. The optimum conditions for the transesterification of waste cooking oil (WCO) of the latter catalyst were 60 °C, methanol:WCO molar ratio of 6:1, 3% catalyst mass ratio, and 180 min reaction time to achieve 95% FAME yield. This catalyst exhibited high reusability and enabled facile separation and production of high quality biodiesel comparable to the universal ASTM standards. XPS results indicated that the catalytic reaction is promoted on the 12% catalyst when Fe^{3+}/Fe^{2+} atomic ratios equal 4:1 is combined with AlOOH of appreciable OH bonds. Although 8% catalyst exposed 100% ratio of AlOOH as the 12% catalyst however, the strong interaction exhibited in the later catalyst besides boosting the ratio of Fe^{3+} that owns two surface active sites; in front of only one on the former, appears to enhance the FAME yield. The calculated activation energy of the reaction indicates a value of 51.54 KJ mol^{-1} and from the thermodynamic parameters (ΔH‡, ΔS‡ and ΔG‡) the reaction appears to be non-spontaneous and thus accommodated endothermicity beside an entropy decrease.

Catalyzed production of different grade biofuels using metal ions modified activated carbon of cellulosic wastes

Amal A. Altalhi *et al* converted waste cooking oil (WCO) into biofuel through a catalytic cracking process [**Fuel, 295**, Article 120646, (2021)]. The process of catalytic cracking was catalyzed using activated carbon loaded with iron and manganese ions. Cellulosic waste, as an eco-friendly, cheap, and renewable resource, was used to prepare the activated carbon. FTIR, XRD, TGA, differential thermal analysis, and N_2-adsorption/desorption investigations were applied to characterize the prepared catalysts. Characterization of the obtained biofuels was established according to ASTM standard specifications. The engine tests of the different blends of biofuels-traditional diesel were performed. The obtained data confirmed that the biofuel blend contained 10% biofuel (B10) decreased the brake-specific fuel consumption from 651 g/kw.h for regular diesel to 554 g/kw, and raised the thermal brake efficiency from 15% to 17.4%. Therefore, a biofuel-petroleum fuel blend at 10% of biofuel can be presented as a promising fuel blend for the petroleum diesel.

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