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From Editor's Desk



Ecological footprint is the measure of people's demand on nature. It gives a comparison of human consumption of natural resources and the ecological capacity of the planet earth to replenish them. Ecological footprint of a country refers to the area required to produce foods and fibers the people consume, to absorb the wastes it produces and to provide the necessary infra-structure. The measurement is expressed in global hectares and it refers to 1 hectare of biologically productive place having world's average productivity. The world's average ecological footprint was estimated to be 2.7 global hectares per person in 2007 whereas, the biological capacity of the earth is estimated to be 1.8 global hectares per person. This shows a deficit of 0.9 global hectares per person. The significant overshoot was observed in 1980's and since then it is ever increasing. A country that does not have sufficient resources and depends on net imports of ecological resources is termed as ecological debtors. On the other hand, the countries still having ecological reserves are called ecological creditors. The division of the world on the basis of this factor is going to dictate the geopolitical issues in near future. Though India's ecological footprint is below the world's average (0.91 global hectares per person), significantly lower biocapacity (0.51 global hectares per person) has made India a ecological debtor. Serious measures are to be taken by Governmental agencies, scientific organizations and industrial bodies. This problem can be handled through sustainable development. Round Table on Sustainable Palm Oil (RSPO) – a non-profit organization of all the stake holders was formed to monitor sustainable palm oil production and it has gained popularity worldwide. Similar initiatives should be taken in other relevant fields. Keeping in mind all these factors, OTAI has selected sustainability as the central theme of their 69th Annual Convention and it will be held at Agra during November 14-16, 2014. This should be a Grand Success with the participation of the members and other stake holders.

In recent times, oilseed proteins have generated huge interests for both edible and industrial uses. One research paper on sesame protein is published in this issue. In another communication, details of enzymatic hydrolysis of castor oil methyl esters using response surface methodology is described. Isopropyl alcohol is being projected as an alternative solvent to hexane for oils & fats extraction. Dehydration of isopropyl alcohol by using pervaporation is presented in the other research publication of this issue.

Happy reading!!



(PRADOSH PRASAD CHAKRABARTI)

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Production of Edible Quality Sesame Protein Concentrates by Ultrasonic Assisted Extraction and Characterisation of its Functional Properties

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ABSTRACT

Defatted sesame meal with 40-50% of protein content is very important as a protein source for human consumption due to the presence of sulfur-containing amino acids, mainly methionine. Sesame protein concentrate is produced from dehulled, defatted sesame meal and used as a starting material to produce protein concentrate by ultrasonic assisted extraction (SUC-3.6). Protein solubility at different pH values, emulsifying properties in terms of emulsion Capacity (EC), foaming properties in terms of foam capacity (FC) and foam stability (FS), and scanning electron micrograph of the SUC-3.6 were investigated and compared with traditional method. Sesame protein concentrate (by ultrasonication) have better functional properties than the Protein concentrate extracted by traditional method. Significant increase in protein solubility, EC, and FC were observed. These improved functional properties of different protein concentrates would make them useful products, especially in the food, pharmaceutical, and related industries.

KEYWORDS: *Sesame protein concentrate, Ultrasonic-assisted extraction, Functional properties*

INTRODUCTION

Animal proteins in major part of the world has become more and more costlier due to the huge gap between demand and supply. Deficiency in animal sources has generated interest in plant proteins as substitute of animal protein. Sesame seed (*Sesamum indicum*) is one of the most important oil seed cultivated in Tropical Africa, Central America and Eastern Asia¹. Sesame seeds and oil are used in the food industry and the oil has extensive uses in pharmaceutical and cosmetic industries too. The protein content of the whole sesame seed is usually between 19 to 25% and de-oiled sesame cake contains approximately 50% protein². Sesame proteins, while contributing

to the nutritional value of foods, can also be used as functional food additives due to their interesting functional properties which are reflected from their physico-chemical characteristics, composition and structure³⁻⁶. There is definitely some more scope to improve the functional properties of sesame proteins to ensure attractive products⁶.

One way to increase the functional properties of a protein is to target its origin with alternative mechanical forces for better concentration and functional properties⁷. Additionally, the effect of drying conditions on the functional properties of protein concentrates and isolates must be investigated. Drum drying, as opposed to spray and freeze drying, increases the emulsifying capacity of pea, fava bean and soybean proteins⁸. An increase in drying temperature from 50°C to 98°C, however, gradually reduces the solubility and emulsifying properties of proteins. Most of the variation in functional properties is related to modifications of protein structure that results from processing conditions. Several studies have been conducted on the preparation of protein concentrates and isolates. Alkali extraction and isoelectric precipitation which is the most common methods used because the reagents required for these processes are easily available. However, these methods have low extraction rates and result in poor quality protein.

The aim of the study was to compare extraction efficiency of sesame protein concentrate using ultrasonication and conventional method. Finally, the physical and functional properties of sesame protein concentrate samples obtained from both the methods were evaluated.

MATERIALS & METHODS

Materials

Chemicals and Instrument: Dehulled sesame seeds (1.5 kg) was procured from local market of Bhawanipur, Kolkata. Sesame seeds were kept in an air-tight dessicator containing CaCl₂ before use. The ultra

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sonicator used was from Vibronics, Mumbai, India. All other chemicals and reagents use were of analytical grades.

METHODS

Preparation of sesame meal: Dehulled sesame seed was pulverised with a mixer grinder (Bajaj, India) and defatted by soxhlet extraction method using hexane as solvent. Desolventisation of the defatted meal was done in an air oven at 60°C. The dry defatted meal was stored at 4°C in a hermetically sealed sample bottle until further processing.

Ultrasonic-assisted extraction of sesame protein: The defatted meal was again pulverized and sieved by 20 mesh screen size. A weighed quantity of the defatted meal was dispersed in phosphate buffer (pH 11.6) prior to ultrasonication. The extraction condition (solid/ liquid ratio, ultrasonic power and ultrasonic treatment time) were optimised. The solid/liquid ratio (1:10), ultrasonic power (300W) were kept same, whereas the ultrasonic treatment time was varied or 15, 30, 45 and 60 min to optimise the yield⁹. To prevent heat buildup, sample holders were placed in an ice bath during ultrasonication. The protein content was determined by the Kjeldhal method¹⁰. The slurry was centrifuged (Sigma, USA) at 12000 × g for 20 min at 4°C. The supernatant was acidified with 1 mol L⁻¹ HCl to pH 3.6. This pH was maintained for 15 min to allow protein aggregation and then the suspension was again centrifuged at 3000 × g for 20 min. Precipitated sesame protein SUC-3.6 was obtained by freeze-drying.

Traditional alkaline (pH 11) extraction and acidic precipitation (pH 3.6) methods without the use of ultrasonication served as control. After centrifugation the sesame protein precipitate (MS-3.6) was freeze-dried and then stored at 4°C.

Protein content analysis: The total protein content of the defatted sesame meal and sesame protein concentrate samples were determined by the Kjeldhal method¹⁰.

Analysis of Functional Properties

The functional properties evaluated were protein solubility, water holding capacity (WHC), fat absorption capacity (FAC), emulsifying capacity (EC), foaming capacity and foaming stability.

Protein solubility: Solubility, in terms of protein dispersibility index (PDI) and nitrogen solubility index (NSI) were determined according to standard method. PDI was determined upon stirring 20 g of the sample with 300 ml of distilled water in a mechanical stirrer (REMI Motors, Vasai, India) for 2 h¹⁰. Then the nitrogen content of supernatant was determined by Kjeldhal

method and multiplied by 6.25. Nitrogen solubility index was determined according to AOCS Method Ba 11-65¹⁰.

Fat Absorption Capacity and Water Holding Capacity: To determine oil and water absorption capacity, 1 g of protein sample was mixed with 5 mL of soybean oil and distilled water, respectively, and placed in 10 mL graduated centrifuge tubes. The dispersions were vortexed for 30s every 5 min and kept for 30 min at ambient temperature (28 ± 2°C), followed by centrifugation at 3000g for 10 min. The volume of the supernatant was recorded, and the oil or water retained by the protein samples was expressed as mL of oil or water per g of protein¹¹.

Emulsifying capacity: To determine the emulsifying capacity, 50 mL of 10 g kg⁻¹ protein solution in distilled water was stirred at constant temperature (20°C) in a 1 L laboratory stirrer (REMI Motors, Vasai, India). After adjusting the pH, 50 mL of sesame oil was added. The mixture was homogenised at 15000 rpm for 5 min and then centrifuged at 3000×g for 5 min. The heights of the emulsified layer and total liquid were recorded. The emulsifying capacity was determined in triplicate according to the method described by Chau and Cheung¹². EC was calculated using the following equation: EC (%) = (volume of emulsified layer/total liquid volume) × 100.

Foaming capacity and foam stability: Foaming capacity (FC) was determined using the method described by Makri et al.¹³. 1% protein solutions were prepared in deionized water and adjusted to pH 7.4 with 1(N) NaOH and 1(N) HCl. Volumes of 100 ml (V_L) of defatted sesame protein suspension was blended for 3 min using high-speed blender, poured into 250 ml graduated cylinders and the volume of foam (V_T) were immediately recorded at 0, 30 and 60 min. FC was calculated using the following equation:

$$FC (\%) = \frac{(V_L - V_T)}{V_T} \times 100$$

$$\text{Foam Stability (\%)} = \frac{(\text{volume after standing} - V_L)}{(V_T - V_L)} \times 100$$

Scanning electron microscopy (SEM): Scanning electron microscopic studies of the protein fractions were carried out (extracted by both ultrasonication and traditional method) using Scanning Electron Microscope (ZEISS EVO-MA 10, United States).

Statistical analysis: Results are expressed as mean ± standard deviation (SD) of three separate determinations. Average data of triplicate observations

were subjected to one-way analysis of variance (ANOVA) and the comparisons between the means were carried out using the Tukey test; $p < 0.05$ was considered as statistically significant in all the experiments.

RESULTS AND DISCUSSION

Extraction of sesame protein: The effect of ultrasonication on the yield of protein, total protein content, extraction efficiency of sesame protein and functional properties of sesame protein in comparison with traditional method of extraction of protein are discussed.

The effect of ultrasonic treatment time was evaluated with the ultrasonic temperature set at $0-4^{\circ}\text{C}$, the pH at 11.6, the ultrasonic power at 300W and the solid/liquid ratio at 1:10. The protein extraction efficiency increased steadily as the ultrasonic treatment time was increased from 15 to 60 min, but no further increase was observed at 90 min. Therefore the extraction efficiency was highest when the ultrasonic treatment time was set at 80 min. The sesame protein contents obtained with two different extraction methods are shown in Fig. 1. After extraction the sesame protein content increased significantly. The ultrasonic protein (SUC) had a higher protein content (79.12%) than the proteins (66.33%), extracted by traditional method (SMS). The amount of protein extracted by ultrasonication was higher than that obtained by the traditional method. This indicates that the ultrasonic-assisted method was effective for sesame protein extraction. High-power ultrasonication produces cavitation, which facilitates particle disintegration and reactions that enhance liquefaction.

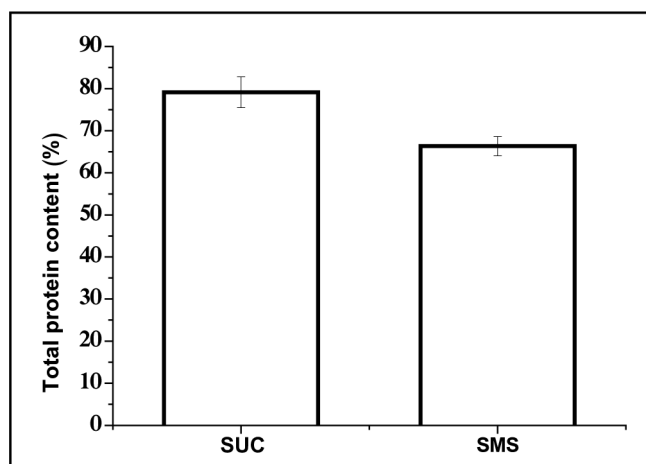


Fig. 1: Effect of Ultrasonication on Total Protein Content of Sesame Protein compared to Traditional Method of Extraction

Values are expressed as Mean \pm SD ($n=3$). Values not sharing a common superscript within a row are statistically significant ($p < 0.05$). *a- Experimental, b- Control

Effect of ultrasonication on functional properties: Protein dispersibility index and nitrogen solubility index of the extracted proteins were measured from pH range 3-7. Value of soluble protein in sesame protein extracted by ultrasonication was in pH 7 (66.25%) where as at pH 3 values were 38.19%. In case of traditional extraction method PDI value was respectively 52.72% and 33.07% at pH 7 and pH 3. The highest value of soluble protein was observed at pH 7. After extraction of protein by both ultrasonication assisted and acid-alkali precipitation, nitrogen solubility index (NSI) at pH 3.0 increased from 38.19% to 66.25% at PH 7 for SUC. This is probably that the high intensity ultrasound enhances protein solubility by changing protein conformation and structure in the way that hydrophilic parts of amino acids are opened towards water and the protein-water interaction increases, because the electrostatic forces are higher and more water interacts with the protein molecule¹⁴.

Fat Absorption Capacity and Water Holding Capacity: Result obtained from the present study for FAC and WHC showed that strong acid and alkali treatment for extraction reduced WHC (27.24%) and increased FAC (27.86%) while the ultrasonication assisted extraction increased WHC (33.43%) and decreased FAC (22.39%). During extracting, SMS 3.6 were likely denatured by strong acid and alkali exposing more hydrophobic sites, which could be explained by reduced water retention capacity of SMS 3.6. This probably had not occurred in case of ultrasonication. These results show that the SUC retained more water than oil, and was also more hydrophilic and less lipophilic than that of SMS (Table 1).

Emulsifying capacity: Food emulsions are thermodynamically unstable mixture of immiscible liquids (water and oil). Proteins are composed of charged amino acids, non-charged polar amino acids and nonpolar amino acids, which make protein as possible emulsifier, thus could be able to interact with both water and oil in food system. Emulsifying capacity (EC) of SUC-3.6 was higher than that of SMS-3.6 (Table 1). Ultrasonic extraction is primarily driven by cavitation and hence lowers the particle size of molecules. In case of ultrasonic assisted extraction, the sesame protein concentration increased, the thickness and intensity of the interfacial film in the emulsion were improved, leading to enhanced emulsification and emulsion stability.

Foaming capacity and foam stability: The foaming capacity of a protein depends mainly on its soluble fraction, but insoluble protein particles may also play a useful role by improving surface viscosity, thereby leading to the formation of stable foam. The formation

TABLE 1
Comparison between the Functional Properties of Extracted Proteins by Ultrasonication-assisted (SUC-3.6) and Traditional Method (SMS-3.6)

Type of Proteins	FAC (mL/g of protein)	WHC (mL/ g of protein)	Emulsifying Capacity (%)	Foaming Capacity (%)	Foam Stability (%)
SUC-3.6	22.39±0.76 ^a	33.43±0.74 ^a	89.35±1.36 ^a	96.21±1.92 ^a	69.34±5.41 ^a
SMS-3.6	27.86±0.94 ^b	27.24±0.1.43 ^b	68.5±3 ^b	87.83±1.39 ^b	45.62±6.03 ^b

Values are expressed as Mean ± SD (n=3). Values not sharing a common superscript within a row are statistically significant (p<0.05). *a- Experimental, b- Control

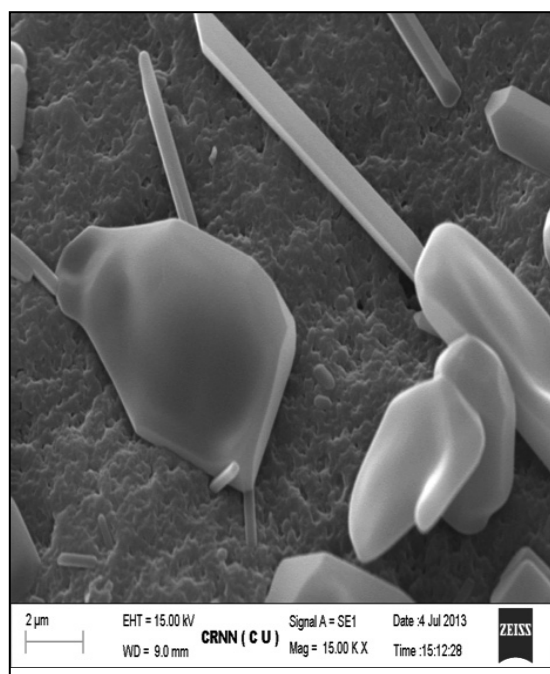
of foam is analogous to the formation of emulsion. In case of foam, water molecules surround air droplets, and air is the non-polar phase. Table 1 suggests that SUC-3.6 showed better foaming capacity and stability than the SMS-3.6. Therefore SUC-3.6 may be useful in food system that requires foaming such as cake & ice cream.

Scanning electron micrograph: Scanning electron microscopic studies of the protein fractions were carried out using Scanning Electron Microscope (ZEISS EVO-MA 10, United States). SEM images SUC-3.6 and SMS-3.6 are presented in Figure 2a & 2b respectively. SUC-3.6 contains mostly smaller particles of protein bodies which may be due to rupture of larger protein bodies during extraction by ultrasonication. The reduction in the size of SUC-3.6 was occurred due to the effect

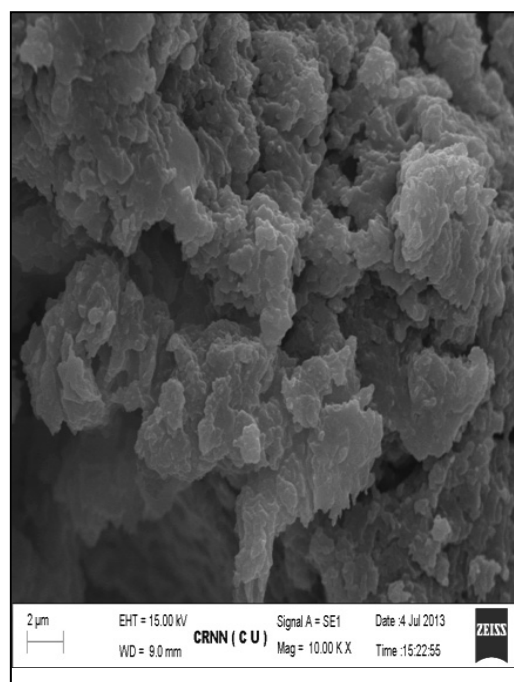
of ultrasonication compared to SMS-3.6. It has been reported that ultrasound in liquids generates a number of physical forces. Vibration, heating and physical agitation are forces that can be generated along with acoustic cavitation. In addition to these physical forces, acoustic cavitation generates micro jets, shear, shockwaves and acoustic streaming. Reduction in the size of SUC-3.6 in respect to SMS-3.6 could be the direct consequence of these physical factors.

CONCLUSION

Sesame protein fractions (SUC-3.6) obtained by ultrasonication were found to have better functional properties such as good emulsifying capacity, emulsion stability, foaming capacity, foam stability and higher protein solubility compared to that of sesame protein obtained by traditional alkali extraction and isoelectric



(a)



(b)

Fig. 2: SEM Images of (a) Sesame Protein Extracted by Ultrasonication and (b) Sesame Protein Extracted by Acid-Alkali Precipitation

TABLE 2

Solubility of Extracted Proteins by Ultrasonication-assisted (SUC-3.6) and Traditional Method (SMS-3.6)

Types of Protein	Nitrogen Solubility Index (NSI)%	
SUC-3.6	pH 3	38.19±2.64 ^a
	pH 4	42.67±1.92 ^a
	pH 5	51.29±1.33 ^a
	pH 7	66.25±2.95 ^a
SMS-3.6	pH 3	33.07±1.44 ^b
	pH 4	41.24±1.67 ^b
	pH 5	49.13±2.64 ^b
	pH 7	52.72±1.81 ^b

Values are expressed as Mean ± SD (n=3). Values not sharing a common superscript within a row are statistically significant (p<0.05).

*a- Experimental, b- Control

precipitation. It can be concluded that ultrasonication can be used to improve the quality & quantity of sesame protein from the deoiled sesame meal. The commercial exploitation of this process may enhance the use of sesame protein from deoiled seed meal.

ACKNOWLEDGEMENTS

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Optimization of Enzymatic Hydrolysis of Enriched Castor Oil Methyl Ester using Response Surface Methodology

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ABSTRACT

The major fatty acid present in castor oil is ricinoleic acid (85-90%). Ricinoleic acid is a potential raw material for various chemicals and finds several applications in coatings, lubricant formulations and pharmaceutical industries. Enzymatic hydrolysis is preferred over conventional hydrolysis to avoid estolide formation. Optimization of the enzymatic hydrolysis of enriched castor oil methyl ester (ECME) in presence of Novozym 435 was carried out by 2^3 factorial design and analysis of experiments. Reaction parameters such as temperature, buffer to ECME ratio and enzyme concentration were considered as determinant factors in the factorial design. Ricinoleic acid yield after six hours of reaction was taken as response. The reaction parameters ranged from reaction temperature (40 to 60°C), buffer to ECME ratio (1:1 to 6:1) and enzyme concentration (2% to 5%). The optimal conditions were found to be reaction time of 6 h, temperature 60°C, buffer to ECME ratio 2:1 and 4% enzyme concentration. The predicted results matched with the experimental values. Under optimum conditions, a maximum conversion of 98.5% was achieved based on acid value and saponification value.

KEYWORDS: *Enriched castor oil methyl ester, hydrolysis, ricinoleic acid, factorial design*

INTRODUCTION

Global castor seed production is around one million tons per year and India is the major producer and exporter of castor oil. The seed production is estimated to be over 8,30,000 tons per year on an average. Castor oil contains around 85-90% of ricinoleic acid and is the major feedstock for many useful industrial chemicals. Castor oil is mostly used in the form of dehydrated, hydrogenated, alkoxylated, sulphated and halogenated derivatives¹. Castor oil methyl esters with enriched ricinoleic content and more hydroxyl value² is an added advantage as the

enriched esters can be a potential raw material for different industrial applications with less impurities.

Enzymatic hydrolysis has received enormous attention during recent times. Enzymatic hydrolysis is preferred over conventional hydrolysis because of its mild operating conditions, higher conversions and environmental-friendly nature. The present study was taken up to prepare ricinoleic acid enzymatically using ECME with high purity and yield.

There is no literature on the hydrolysis of castor oil methyl esters or ECME for the preparation of ricinoleic acid however, scanty data is available on the hydrolysis of castor oil using different enzymes. Three different lipases such are *Porcain pancrease*, *Candida cylindracea*, and *Candida rugosa* were tested for the hydrolysis of castor oil by Yang *et al*³ for the mass production of ricinoleic acid. Rathod *et al*⁴ studied the hydrolysis of castor oil using *Aspergillus oryzae*, at room temperature with 3:1 oil to water ratio. Kulkarni *et al*⁵ also used the same enzyme, but adopted different contacting pattern for enzyme interaction by suspending the enzyme in isooctane at different time intervals and then determining the residual activity. The authors claimed that the rate of reaction was considerably improved by addition of a solvent. Goswami *et al*⁶ reviewed triacylglycerol acylhydrolase lipase for hydrolysis of vegetable oil and studied castor oil in particular. They statistically showed that interactions between any two parameters involving pH, enzyme concentration and buffer concentration become significant in presence of a nonionic surfactant named Span 80. Gamayurova *et al*⁷ proposed a method for hydrolysis without emulsifiers, simplifying the process of isolating the product, but with less yield of 47%. Also Goswami *et al*⁶ applied response surface methodology for hydrolysis of castor oil using *Candida rugosa* lipase.

The main objective of the present study is optimization of enzymatic hydrolysis of ECME employing Novozym 435. In the present study a factorial design of experiments was applied to study

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the effect of the variables on the process and the interaction among those variables, because it allows the simultaneous consideration of many variables at different levels and the interaction between those variables, using a smaller number of observations than conventional procedures.

MATERIALS AND METHODS

Materials

ECME used in the experiments was 100% pure methyl ricinoleate with hydroxyl value of 172.1, saponification value of 167.1. Immobilized Novozym 435 (*Candida antarctica* lipase B, specific activity 7000 PLU/g) provided by Novozymes A/S (Bagsvaerd, Denmark). All the chemicals used such as methanol, ethyl acetate, potassium hydroxide, and phenolphthalein indicator, were of analytical grade procured from M/s. Sd Fine Chem. Pvt. Ltd., Mumbai. Phosphate buffer of 7.5 pH was prepared in the laboratory.

Methods

The fatty acid composition of ECME was analyzed using Gas Chromatograph Agilent 6890 series equipped with flame ionization detector in accordance with AOCS official method Ce 1e-91. The stationary phase used was a capillary column, HP1 MS (i.d. 0.25mm, length 30m). The oven temperature was programmed from 150 to 300°C at 5°C per minute and nitrogen with a flow rate of 35 ml/min was used as carrier. The injector and detector temperatures were maintained at 280 and 300°C respectively. The area percentage was recorded using HP Chem Station Data System. ECME contained methyl ricinoleate (100%). Acid value and saponification value was determined as per AOCS standards Cd 3d-63 and Cd 3-25.

Experimental Procedure: 10 g of ECME was charged into a stirred reactor. To this, 20 ml of 2:1 phosphate buffer was added along with 4% of Novozym. The contents were stirred for 6 hr at 60°C. Samples were drawn at regular intervals, filtered, dried and analyzed for acid value to monitor the progress of the reaction.

The percentage hydrolysis was calculated using the following formula,

$$\% \text{ Hydrolysis} = \frac{\text{AV of Product} - \text{AV of ECME}}{\text{SV of ECME}} \times 100$$

where AV is the acid value and SV is the saponification value

Different sets of experiments were carried out using different operating conditions to arrive at optimum process conditions. The first set of experiments were carried out by varying time from 30 min to 6 hr, while maintaining other reaction parameters constant i.e., 4%

enzyme concentration, buffer to ECME ratio 2:1 and temperature 60°C. The second set of experiments were carried out at temperatures ranging from 40°C to 60°C, while maintaining other reaction parameters constant i.e., 4% enzyme concentration, buffer to ECME ratio 2:1, time period of 6 hr. The third set of experiments were carried out at enzyme concentrations ranging from 2% to 5% by keeping fixed buffer to ECME ratio of 2:1 and 60°C.

Statistical Analysis: A 2³ (two level three factor) factorial design of experiments (Design Expert V.4) was applied to determine the influence of the operational conditions of the enzymatic hydrolysis of ECME. The variables chosen were enzyme concentration, buffer to ECME ratio and temperature while the response was conversion of ECME to ricinoleic acid. Factor levels were chosen based on the operational limits of the experimental set up.

RESULTS AND DISCUSSION

Optimization of hydrolysis of ECME was carried out using Novozym 435 lipase by studying the effect of various parameters such as time, temperature (40 to 60°C), enzyme concentration (2% to 5%), buffer to ECME ratio(1:1 to 6:1). In addition, statistical analysis of data was carried out by using factorial design of experiments.

Effect of Reaction Time: The rate of hydrolysis of reaction depends on reaction time. Fig 1 shows a linear plot as a function of reaction time and conversion. It is apparent from the figure that reaction proceeds faster during initial 30 min reporting conversion of 71.7%. Conversion steadily increased with increase in time and reached a maximum value of 98.5% within 6 hr. However, there was no further change in conversion with increase in time indicating reaction equilibrium.

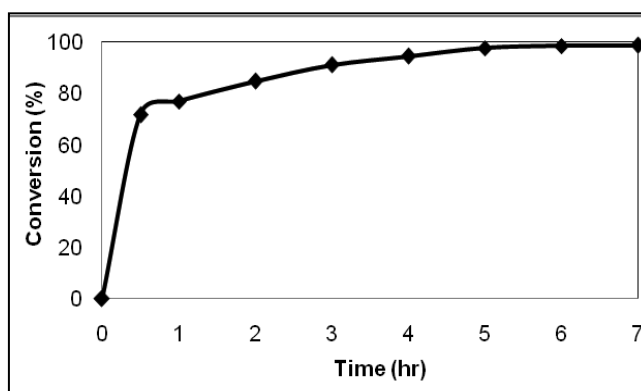


Fig. 1 : Conversion of ECME vs. Reaction Time
(Reaction temperature 60 °C, enzyme concentration 4%, buffer to ECME ratio 2:1 w/v)

Effect of Reaction Temperature: The effect of temperature was evaluated at different temperatures ranging from 40°C to 60°C, at 40°C the conversion was 80.2% and increase in the temperature to 50°C, increased reaction rate rapidly and the conversion reached up to 90.5% and further increase in temperature to 60°C resulted in maximum conversion of 98.5%. Temperature was not increased further as enzymes usually get deactivated at higher temperatures. The temperature profile of enzyme reaction is shown in Fig 2.

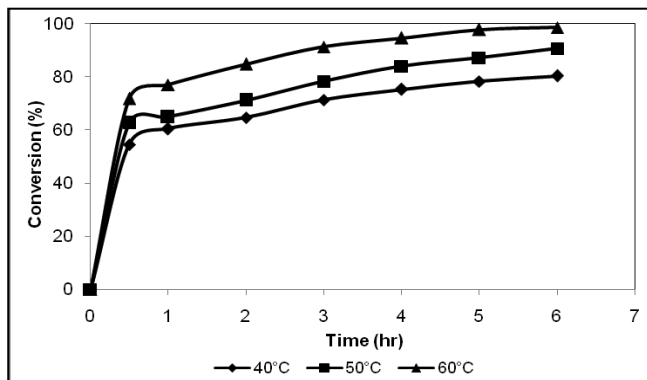


Fig. 2 : Conversion of ECME vs. reaction temperature (Reaction time 6 hr, enzyme concentration 4%, buffer to ECME ratio 2:1)

Effect of Enzyme Concentration: Generally lipase catalyzed reactions take place on the interface. The effect of amount of enzyme on hydrolysis of ECME was studied using 2% to 5% Novozym 435. Fig 3 represents the effect of enzyme concentration on conversion. When the enzyme concentration was 2% the conversion was 86.5%, increasing the enzyme concentration to 4% resulted in an increase in conversion to 98.5%.

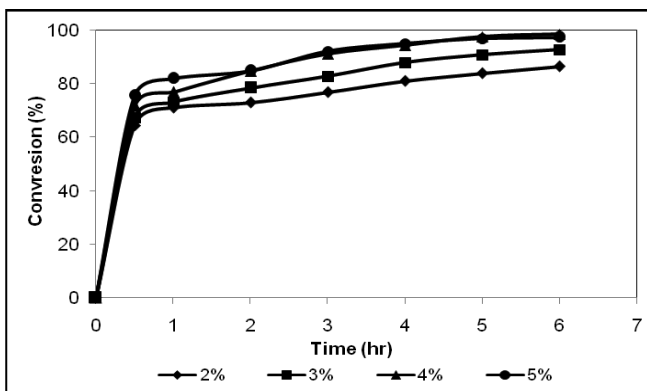


Fig. 3 : Conversion of ECME vs. enzyme concentration (Reaction time 6 hr, temperature 60°C, buffer to ECME ratio 2:1)

Effect of Buffer to ECME ratio: The effect of buffer concentration on the conversion of ECME was investigated from 1:1 to 6:1. Fig 4 shows that 1:1 buffer

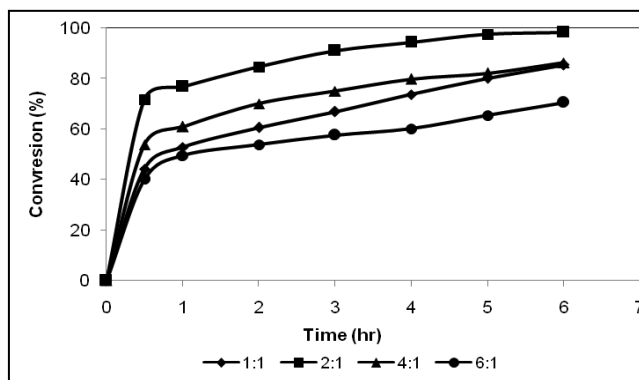


Fig. 4 : Conversion of ester vs. buffer to ECME ratio (Reaction time 6 hr, enzyme concentration 4% w/v, temperature 60°C)

to ECME ratio gave 85.5% conversion, increasing the ratio to 2:1 increased the conversion to 98.5% because lipase is an interfacial enzyme and gets activated when absorbed on to an oil-water interface⁹. As interfacial activity of fatty acid is greater than that of lipase; it shows higher affinity towards interface with respect to lipase.

Statistical Analysis: A 2³ (two level three factor) factorial design of experiments was used for this study. The variables chosen were enzyme concentration, amount of buffer and temperature while the response was conversion of ECME to ricinoleic acid. Factor levels were chosen based on the operational limits of the experimental set up. Temperature levels were varied from 40 to 60°C, enzyme concentration was 2 and 4% and buffer to ECME ratio was varied from 2:1 to 6:1. All the experiments were carried out for 6 hr. The factorial and conversion are shown in Table 1. The experiments were run in duplicates for experimental error estimation.

The ANOVA for the response surface model was determined and is given in Table 2. The results showed that the enzyme concentration, buffer to ECME ratio and temperature had positive influence on the reaction and the interaction among all the parameters were significant. The p-value obtained is less than 0.05 which indicates that there is a statistical relation between the response and the selected variables at 95% confidence level.

Second-order model was obtained to predict the responses analyzed as a function of the variables. The following expression was obtained for the system studied and the determination coefficient (R²) was found to be 0.995.

$$\text{Conversion} = -35.96 + 16.03 \cdot A + 1.96975 \cdot B + 0.59 \cdot C - 0.14394 \cdot A \cdot B + 1.8 \cdot A \cdot C - 0.073875 \cdot B \cdot C - 0.042906 \cdot A \cdot B \cdot C$$

TABLE 1
Design data for conversion of ECME

Standard Order	Run No	Enzyme Concentration (%) (A)	Temperature (deg C) (B)	Buffer to ECME ratio (C)	Conversion (%)
1	11	2	40	2	58.5
2	3	2	40	2	59.7
3	15	4	40	2	80.7
4	9	4	40	2	79.5
5	16	2	60	2	85.9
6	14	2	60	2	86.8
7	1	4	60	2	98.42
8	8	4	60	2	97.9
9	13	2	40	6	51.2
10	12	2	40	6	49.9
11	4	4	40	6	72.12
12	2	4	40	6	72.8
13	6	2	60	6	65.25
14	7	2	60	6	64.8
15	10	4	60	6	70.56
16	5	4	60	6	71.2

Table 2
Analysis for response surface linear model

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F
Model	3254.04	7	464.86	1106.01	< 0.0001
<i>A-Enzyme Concentration</i>	917.33	1	917.33	2182.53	< 0.0001
<i>B-Temperature</i>	846.96	1	846.96	2015.09	< 0.0001
<i>C- Buffer to ECME ratio</i>	1049.60	1	1049.60	2497.22	< 0.0001
<i>AB</i>	159.33	1	159.33	379.07	< 0.0001
<i>AC</i>	6.36	1	6.36	15.14	0.0046
<i>BC</i>	262.68	1	262.68	624.98	< 0.0001
<i>ABC</i>	11.78	1	11.78	28.03	0.0007
Pure Error	3.36	8	0.42		
Cor Total	3257.40	15			

Fig 5 shows the residual distribution, defined as the difference between calculated and observed values over the observed values for the response studied. A good fit was observed because the residual distribution does not follow a trend with regard to the predicted variables. The model depicts the influence of response over the experimental range studies which is proved by the relation between experimental values and predicted values as shown in Fig 6. The comparison of the experimental and calculated responses for the model shows the agreement between the observed and predicted values. Fig 7. depicts the normal probability plot of the residuals indicating a good validity for the linear regression model. Therefore, it is

emphasized that empirical model equation accurately explains the connectivity between the conversion and the reaction conditions for our system studied. Fig 8,9,10 reflects the 3D response surface graph of the regression equation and the contour plots are given in Fig 11,12,13.

CONCLUSION

ECME can be used as potential raw material due to its enriched ricinoleic acid content. In this study we have optimized process conditions like reaction time, enzyme concentration, amount of buffer and temperature for achieving maximum yields of ricinoleic acid using Novozym 435 as a catalyst using response

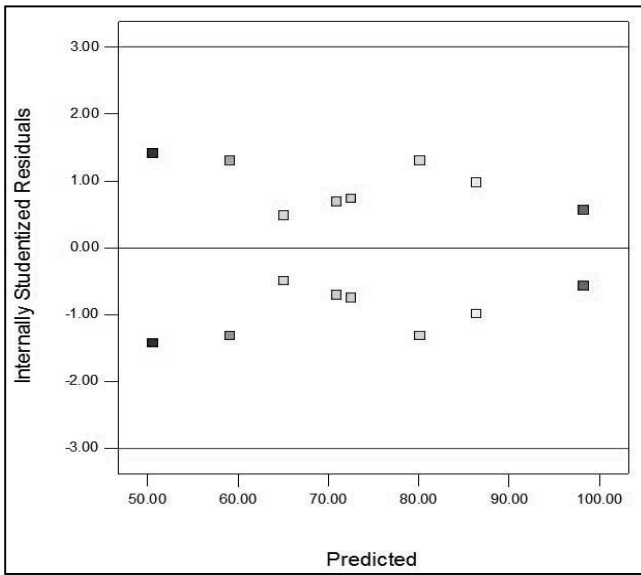


Fig. 5: Residual plots of conversion for the model

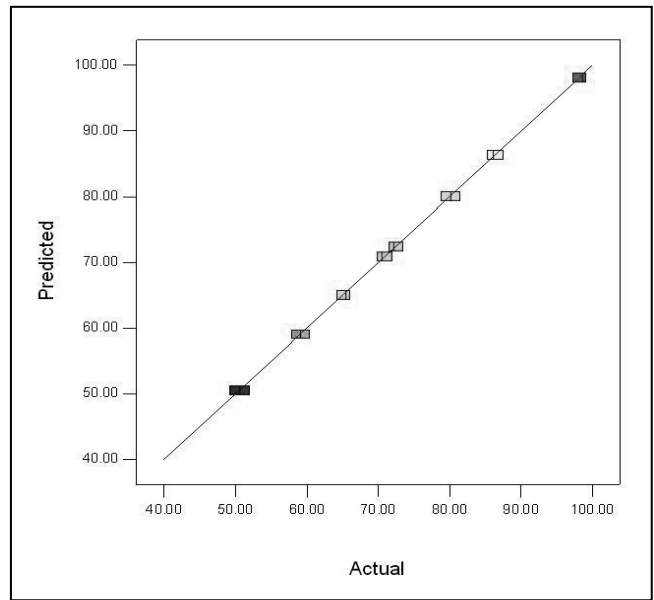


Fig. 6 : Predicted values vs. experimental values for the model

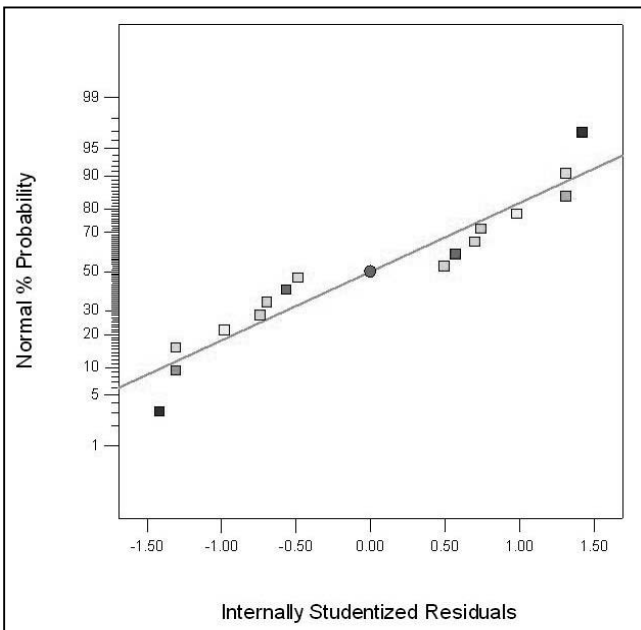


Fig. 7 : Normal probability plot of residuals

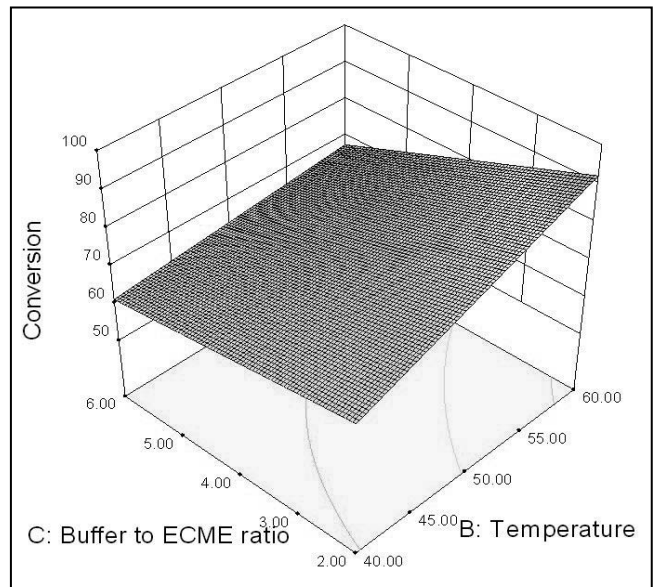


Fig. 8 : Response surface plot of conversion as a function of temperature and buffer to ECME ratio

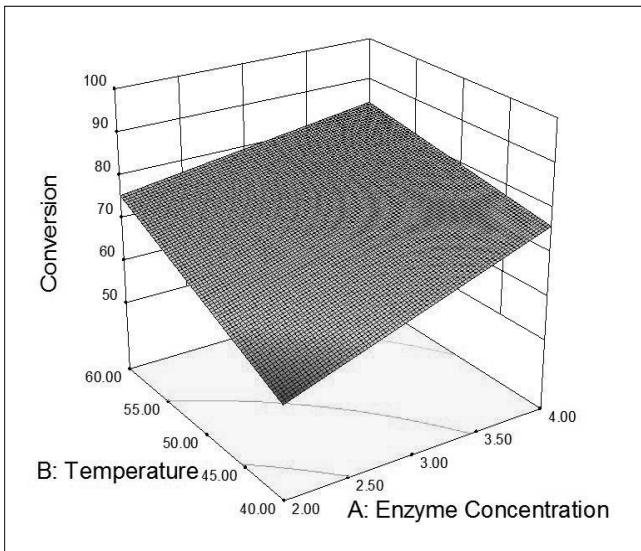


Fig. 9 : Response surface plot of conversion as a function of temperature and enzyme concentration

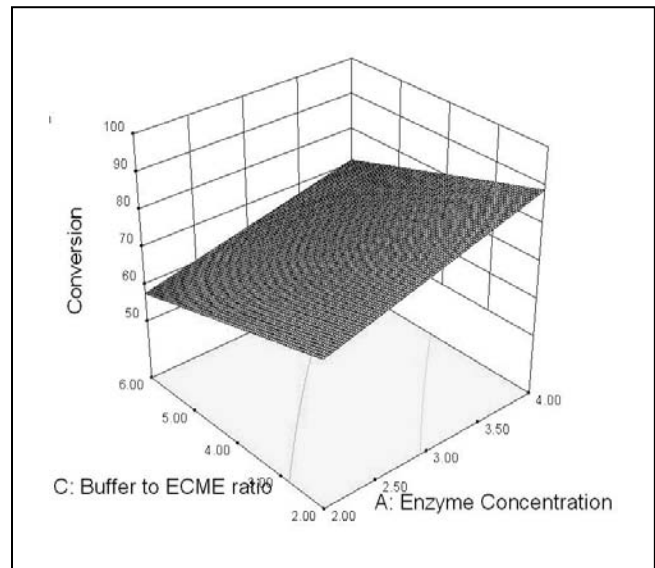


Fig. 10 : Response surface plot of conversion as a function of enzyme concentration and buffer to ECME ratio

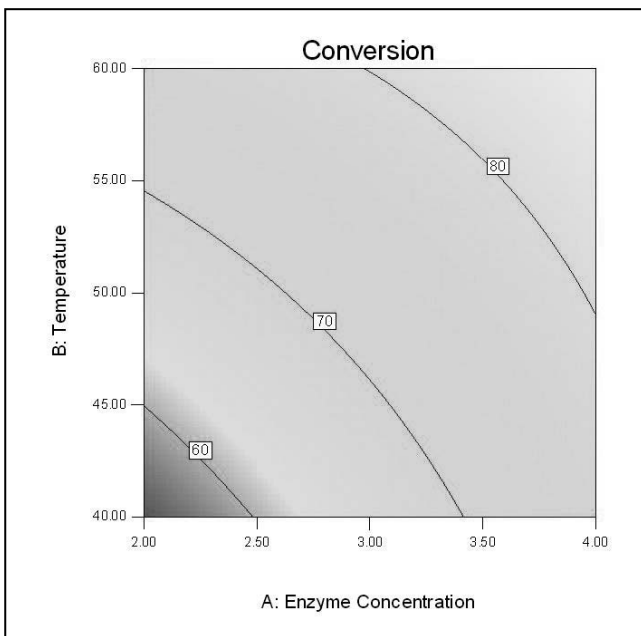


Fig. 11 : Contour plots of conversion as a function of temperature and enzyme concentration

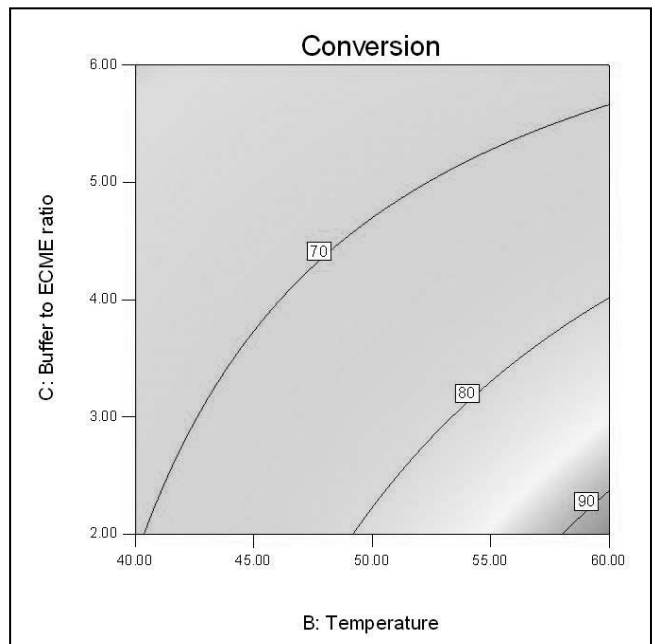


Fig. 12 : Contour plots of conversion as a function of temperature and buffer to ECME ratio

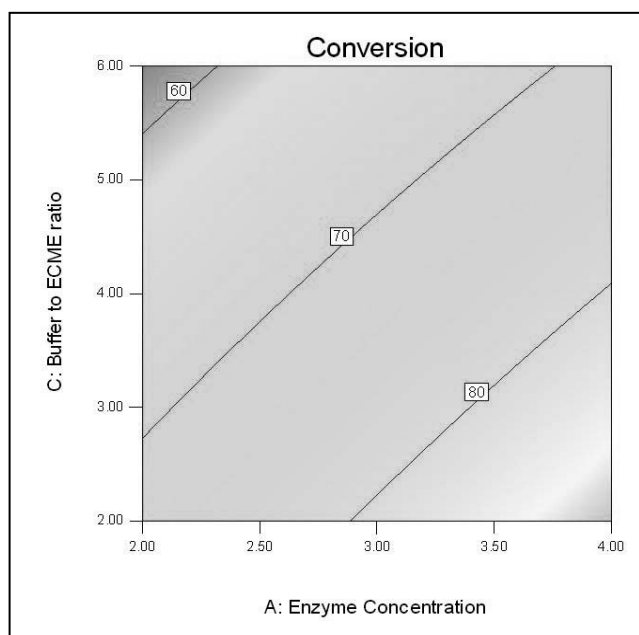


Fig. 13: Contour plots of conversion as a function of buffer to ECME ratio and enzyme concentration

surface methodology. The degree of hydrolysis of ECME was significantly affected by the hydrolysis conditions including reaction time, enzyme concentration, amount of buffer and temperature. A good agreement was observed between the experimental data and the predicted values. The optimized conditions for hydrolysis of ECME were found to be 4% enzyme concentration, buffer to ECME ratio 2:1 and 60 °C temperature for 6 hr, under optimum conditions a maximum conversion of 98.5% was obtained.

ACKNOWLEDGMENTS

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Pervaporative Dehydration of Isopropanol-Water Mixture

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ABSTRACT

Oils and fats are recovered from the oil-bearing materials by expression and solvent extraction. Hexane has been the main solvent used for vegetable oil extraction since the 1940s. Various alternative solvents were tried and most of solvents have been de-listed because of toxicity, safety and product flavor reasons. The lower alcohols like ethanol and isopropanol have gained much importance. However, the major disadvantage is the formation of azeotropes. In the present investigation, Pervaporative dehydration of isopropanol (IPA) -water mixture is studied. The main objectives of the present study were to prepare water selective pervaporative dense membrane for dehydration of IPA-water mixture and to study the characteristic properties like flux, selectivity, pervaporation separation index, stability, strength etc. of the prepared membrane. Poly Vinyl Alcohol (PVA)-Poly Acrylic Acid (PAA) interpenetrating polymer network (IPN) membranes were prepared by polymerizing Acrylic Acid (AA) in a 10 % PVA solution using benzyl-peroxide (BPO) as an initiator. The PVA- Poly Acrylamide (PAAM) IPN membranes are prepared by polymerizing AAM in a 10% PVA solution, using potassium per-sulfate (PPS) as an initiator. Glutaraldehyde (GAL), N-N methylenebisacrylamide (MBAA) is used as cross-linking agents for the PVA, PAAM polymers, respectively. Membranes of 10, 20, and 30% PAA & PAAM in PVA are prepared. Performance of the membranes were evaluated in terms of selectivity, rejection and pervaporation separation index (PSI) which gave the combined result of selectivity and flux. PVA-PAA IPN and PVA-PAAM IPN membranes found to have good mechanical strength and stability. The sorption characteristics were studied at temperature of 40, 50, 60 °C and water concentration upto 30 %. The sorption was increased with an increase in the concentration of water in the feed. The sorption was higher for PVA-PAA IPN membranes than that of PVA-PAAM membranes.

KEY WORDS: Isopropanol, Pervaporation, IPN membranes, membrane separation.

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INTRODUCTION

Food grade hexane is used in the extraction of vegetable oils. It is highly flammable and listed as hazardous material. Various other solvents were tried for extraction of vegetable oils and most of solvents did not gain popularity because of toxicity, safety and product flavor reasons. Lower alcohols like ethanol and isopropanol are exceptions. IPA has greater solvency for oil compared to ethanol. The main disadvantage with these alternative solvents lies in the fact that they have tendency to absorb moisture and form azeotrope. Thus reduces the solvency, and require high energy to break the azeotrope due to high latent heat of vaporization. The solubility depends upon the water content in the solvent. Isopropanol-water azeotrope (IPAWA) contains 12.3% moisture (by weight) as compared to 4% water in ethanol azeotrope.

In the last few decades considerable research work were performed in membrane based separation processes. Pervaporation (PV) as a membrane based separation technique has found many industrial applications – particularly in purification of alcohols. In the PV process, a liquid feed consisting of components A and B is in contact with one side of a membrane (feed side), which selectively permeates one of the feed components A. If the permeate side of the membrane is kept under a reduced pressure, (lower than the saturation pressure), the permeate, enriched with A, is removed as a vapor. This transport involves a phase change (liquid to vapor). The separation performance of PV is determined by the factors such as the physico-chemical nature of the membrane material, the species to be separated, the structure and the morphology of the membrane and the process conditions.

Kober¹ observed, that water evaporated out of a tightly closed colloidion bag, which is suspended in the air. He named this phenomenon as a pervaporation (PV). Heisler², for the first time reported quantitative work on PV of ethanol-water mixtures using a cellulose membrane. Binning³ and his co-workers developed a process for removal of water from organic chemicals using a cross-linked PVA membrane gained commercial interest. Till 1980, the low permeation flux

of membrane remained a barrier to the development of the PV process on industrial scale. Mulder⁴ reported results on the dehydration of ethanol by asymmetric membranes with a thin dense top layer in order to increase the permeability. PV offers the possibility of separating solutions, mixtures of components with close boiling points, or azeotropes that are difficult to separate by distillation or other means.

The major objectives of the present work were to prepare water selective pervaporative membrane for dehydration of isopropanol-water mixture and to study the characteristic properties like flux, selectivity, pervaporation separation index, stability, strength etc.

MATERIALS AND METHODS

Preparation of the PAA-PVA IPN Membranes: PVA having molecular weight of 1, 20,000 Dalton, degree of hydrolysis of 85–90 % of analytical grade is used. PVA-PAA IPN membranes are prepared by polymerizing AA in a 10 % PVA solution using benzylperoxide (BPO) as an initiator. Glutaraldehyde (GAL) and ethylene glycol dimethacrylate (EGDMA) were used as cross linking agents for the PVA and PAA networks, respectively. The reaction was carried out in a three-necked 500 ml round bottomed flask, with stirring. The specified quantities of AA, BPO and EGDMA were added to the PVA solution. The mixture with heated to 70°C and mixed for 12 hours to generate a PAA cross linked network in bulk of PVA and cooled to room temperature. Then, GAL and HCl were added and stirred for 30 min to produce cross linked PVA network. The dissolved air was removed using rotary vacuum pump. The mixture is cast on a flat glass plate and dried at ambient temperature. The obtained membranes were cured at 110°C. The films were peeled from the plate and washed with dilute sodium hydroxide solution in order to neutralize the free acid. The films were then washed with distilled water and dried at 110°C. Membranes of PVA-PAA IPN thus obtained were found to be transparent. The thickness of the dry membrane, measured with a micrometer, was in the range of 50-60 μm.

Preparation of the PVA-PAAM IPN Membranes: PVA-PAAM IPN membranes were prepared by polymerizing AAM in a 10% PVA solution, using potassium persulfate (PPS) as an initiator. Glutaraldehyde (GAL), N-N methylenebisacrylamide (MBAA) were used as crosslinking agents for the PVA and PAAM polymers, respectively. The same procedure was adopted for PVA-PAA IPN membranes and for the preparation of PVA-PAAM IPN membranes. Compositions of Casting Solutions (Dope) used to Prepare IPN membranes are given in Table -1.

Characterization: The performance is evaluated in terms of the flux 'J', rejection 'R', selectivity 'S_(A/B)', pervaporation separation index 'PSI' and sorption selectivity of the membrane 'S_s'.

Where

$$\text{Flux } J = \frac{\text{Weight of permeate}}{(\text{Area} \times \text{Time})}, \text{ gm / (m}^2 \times \text{hr)}.$$

$$\text{Sorption} = \frac{100 (\text{wt of swollen membrane} - \text{wt. of dry membrane})}{\text{Weight of dry membrane}}$$

$$\text{Rejection 'R';} = 100(C_{FA} - C_{PA})/C_{FA}$$

C_{FA} and C_{PA} are concentration of the component A in the feed and permeate respectively.

$$\text{Selectivity } S_{(A/B)} = (C_{PA}/C_{PB})/(C_{FA}/C_{FB})$$

C_{PA} and C_{PB} are the concentrations of components A and B in permeate and C_{FA} and C_{FB} are the concentrations of the components in the feed.

The separation index (enrichment factor)

$$\beta \text{ is defined as } \beta = C_{PA}/C_{FA}$$

Pervaporation separation index, PSI = J (β-1)

The membrane sorption selectivity

$$S_{ms} \text{ is defined as } S_{ms} = (C_{MA}/C_{MB})/(C_{FA}/C_{FB})$$

C_{MA} and C_{MB} are the concentrations of components A and B in membrane.

Table 1
Compositions of Casting Solutions (Dope) Used to Prepare IPN membranes

Membrane	Ratio	Total Water	PVA, g	PAA/ PAAM, g	BPO/ PPS,G	GLA 5% concentration ml	EGDMA/ MBAA, g	HCl 1 N, ml
PVA:PAA	90:10	100	9	1	0.01	5.0	0.07	0.5
PVA:PAA	80:20	100	8	2	0.02	4.5	0.14	0.5
PVA:PAA	70:30	100	7	3	0.03	4.0	0.21	0.5
PVA:PAAM	80:20	100	8	2	0.02	9.0	0.11	0.5

Separation study: The pervaporation apparatus consists of two stainless steel compartments. The upper compartment had a capacity of 450 ml, and the membrane area in contact with the feed solution was 23.77 cm². The membrane was supported by a sintered stainless steel disc. At the down stream side, a pressure less than 10 mm Hg was maintained by means of a vacuum pump, while the upstream side was kept at atmospheric pressure (Fig.1). About 400 ml of feed solution was taken into the upper compartment of pervaporation cell. The contents are well stirred so as to minimize concentration polarization on the membrane due to permeation of components through the membrane. The test membrane was allowed to equilibrate for 1 hr with the feed solution before the commencement of an experiment. The permeate was collected in cold trap that was immersed in liquid nitrogen. The water content in the feed and the permeate were estimated by Karl Fischer titration method.

RESULTS & DISCUSSIONS

Initially PVA-PAA & PVA-PAAM IPN membranes were prepared and characterized with different compositions of dopes. The membranes having better sorption characteristics were tested for IPA-Water separation.

Sorption Studies: The prepared membranes were swelled in the feed. The degree of sorption depends upon the water concentration in IPA-Water mixture. Table 2 shows the effect of temperatures and concentration of water in the feed on sorption of IPA-Water mixture. The sorption was increased with an increase in the concentration of water in the feed. The sorption was found to be higher for PVA-PAA IPN membranes than that of PVA-PAAM membranes.

Effect of Feed Water Concentration on Flux: It was observed that the permeation flux increased with an increase in the concentration of water in the feed. This was due to the higher sorbed water concentration and the consequent plasticization of membrane. Permeation flux increased with increase in weight percentage of PAA in the PVA-PAA IPN membrane. This may be due to high hydrophilic nature of PAA as compared to that of PVA. It was also observed that the permeation flux is higher for PVA-PAA IPN membrane as compared with PAAM-PVA IPN membrane. This is due to the higher hydrophilicity of carboxylic group as compared to amide group.

Table 2
Effect of Temperatures and Concentration on Sorption

Membrane	Water concentration %	Sorption		
		40 °C	50 °C	60 °C
PVA:PAA:: 90:10	5	1.37	1.36	1.31
	10	1.50	1.50	1.38
	20	1.59	1.55	1.43
	30	1.81	1.71	1.45
	40	1.79	1.76	1.50
PVA:PAA:: 80:20	5	1.45	1.43	1.35
	10	1.52	1.51	1.40
	20	1.60	1.57	1.47
	30	1.82	1.72	1.47
	40	1.81	1.76	1.52
PVA:PAA:: 70:30	5	1.52	1.46	1.39
	10	1.60	1.56	1.42
	20	1.65	1.59	1.47
	30	1.84	1.73	1.60
	40	1.88	1.81	1.67
PVA:PAAM:: 80:20	5	1.30	1.26	1.25
	10	1.45	--	--
	20	1.50	--	--
	30	1.65	--	--
	40	1.73	--	--

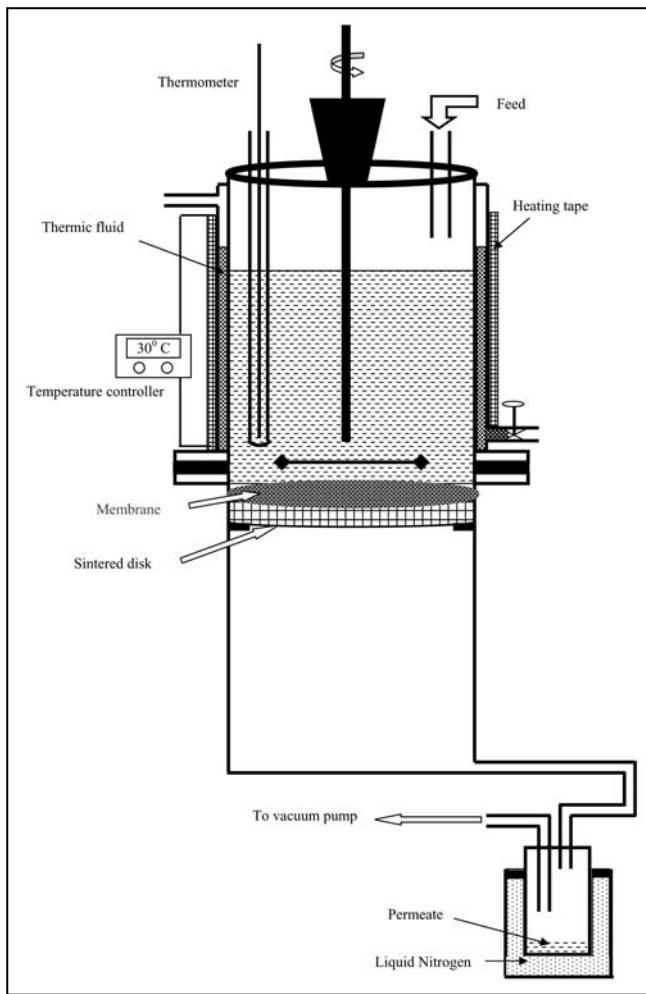


Fig. 1 : Pervaporation Test Cell

Effect of Feed Concentration on the Selectivity: Fig. 2 shows the variation of selectivity for water with feed water concentration for IPA-Water mixtures. It is observed that the selectivity decreases with an increase in feed water concentration. This could be attributed to a result of membrane plasticization. Polymer sorption increases with an increase in concentration of water in the IPA-Water mixture. This leads to an increase in the flexibility of the polymer chains. This increase in flexibility lowers the selectivity. It is observed that the PVA-PAAM IPN membrane has lower selectivity for water as compared with that of PVA-PAA IPN membrane. Fig. 3-5 shows the variation of weight percentage of water in the feed with weight percentage of water in permeates. Permeate water concentration decreased with increase of feed water concentration. The rejection and PSI decrease with increase of feed water concentration (Fig. 6&7).

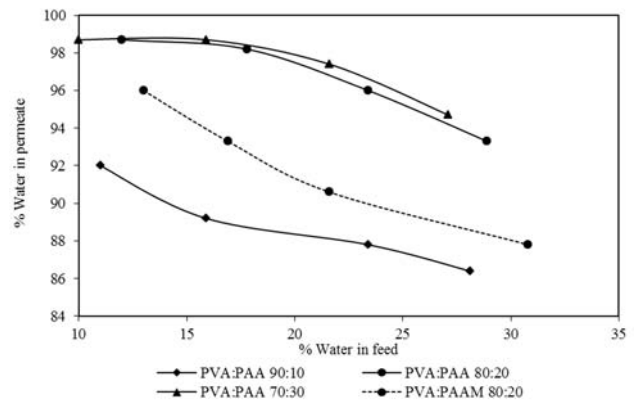


Fig. 3 : Effect of feed water concentration on permeate water concentration at 40°C

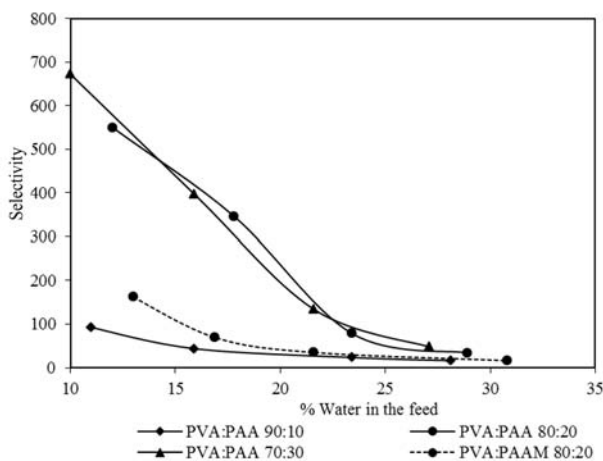


Fig. 2 : Selectivity at 40°C

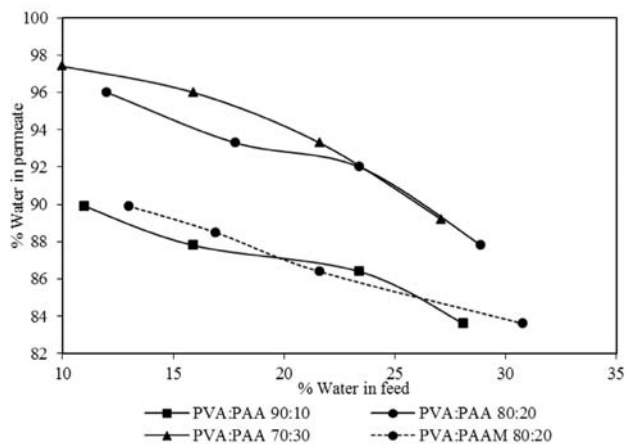


Fig. 4 : Effect of feed water concentration on permeate water concentration at 50°C

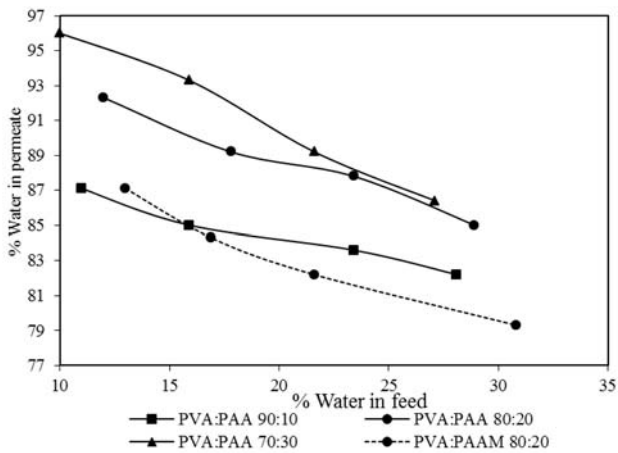


Fig. 5 : Effect of feed water concentration on permeate water concentration at 60°C

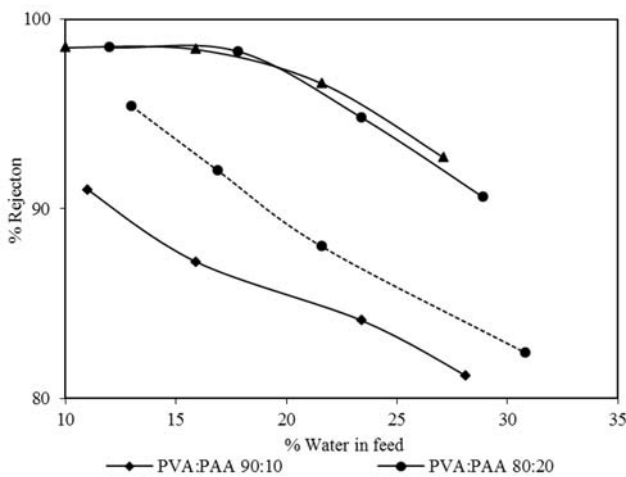


Fig. 6 : Effect of feed water concentration on rejection at 40°C

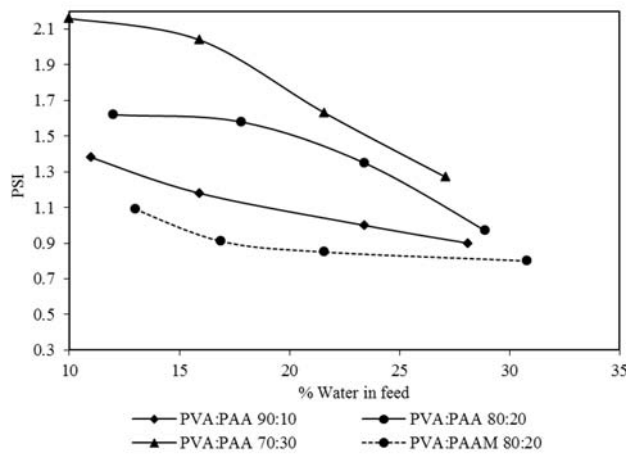


Fig. 7 : Pervaporation separation index at 40°C

Effect of Temperature: Fig. 8 & 9 shows the variation of selectivity and rejection with temperature for PVA-PAA IPN and PVA-PAAM IPN membranes for IPA-Water mixtures. It was observed that permeation selectivity of water decreases with an increase of operating temperature. However, the flux was increased (Fig. 10). The results indicate the diffusion coefficient increased with temperature. This is due to the increased thermal motions of the polymer chains and diffusivity at higher temperatures. Therefore, it can be concluded that with an increase in temperature the selectivity for water decreases. It was also found that the permeate water concentration decreased and the flux increased with temperature (Fig. 11-12). Rejection was found to be decreased where as permeation separation indices increased with increase in temperature (Fig.13).

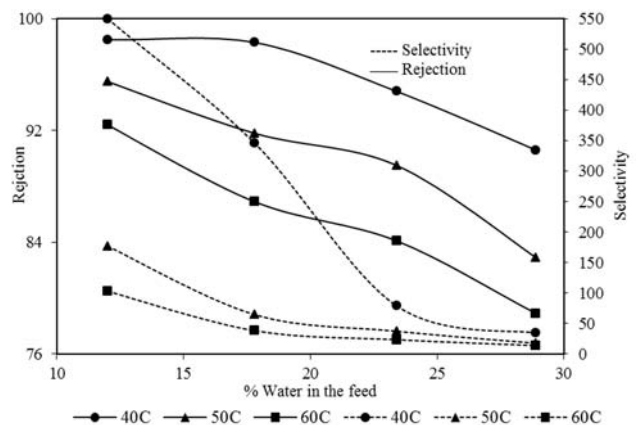


Fig. 8 : Effect of temperature on selectivity and rejection for PVA:PAA (80:20) membrane

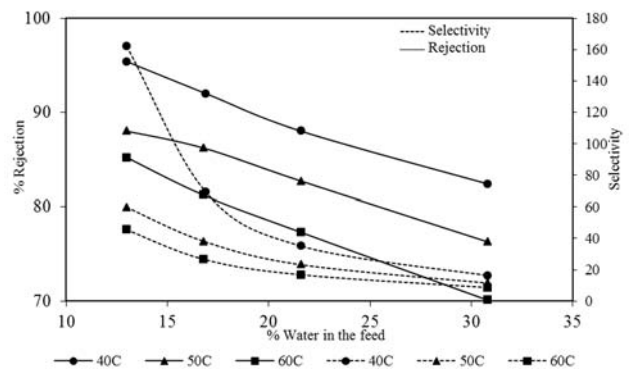


Fig. 9 : Effect of temperature on selectivity and rejection for PVA:PAAM (80:20) membrane

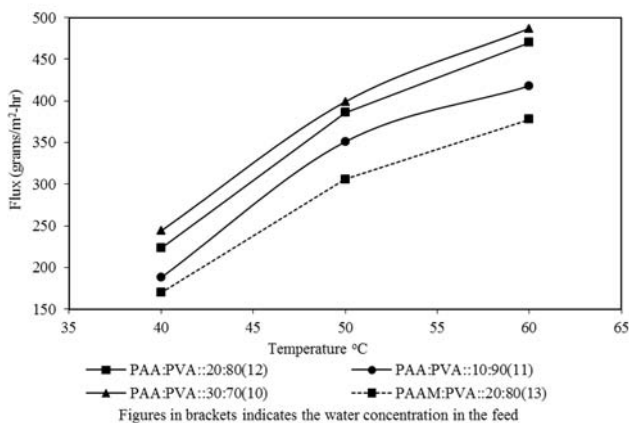


Fig.10: Flux at different temperatures @ 11% water in the feed

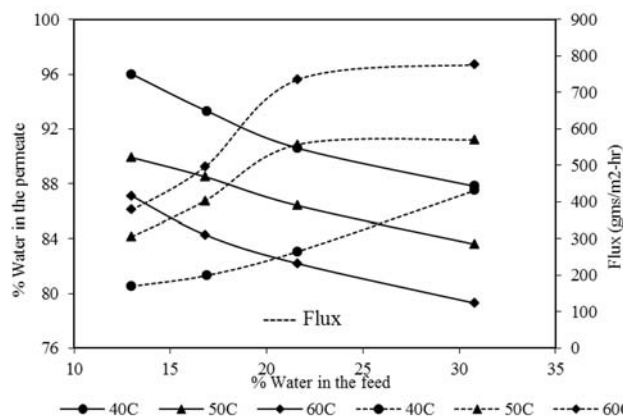


Fig.12: Effect of temperature on permeate water concentration and flux for PVA:PAA (80:20) membrane

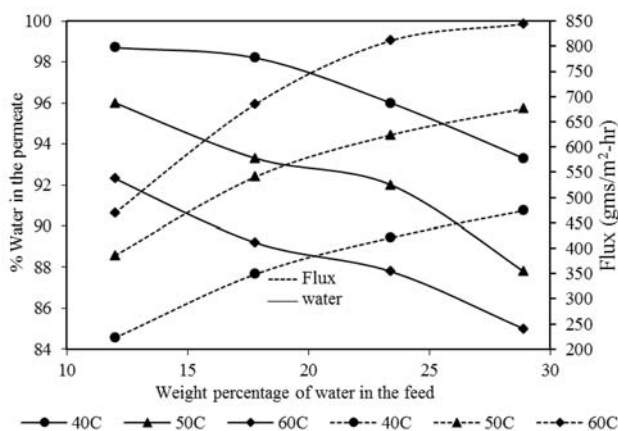


Fig.11: Effect of temperature on permeate water concentration and flux for PVA:PAA (80:20) membrane

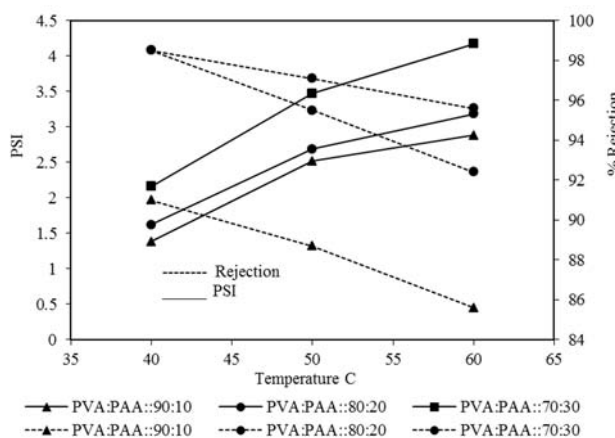


Fig.13: Effect of temperature on pervaporation separation index and rejection

In general the effect of temperature on flux was found to be positive due to increase of polymer thermal motion. The results indicated that permeation flux increased with increase in temperature. The effect of temperature on flux was high with increase of PAA content in the membrane. An optimum temperature which gives better flux with reasonable selectivity is to be set for pervaporative separations.

CONCLUSIONS

The PVA-PAA IPN membranes prepared in the laboratory were found to be compatible with IPA-Water mixture. It was used for breaking IPA-water azeotrope. It is observed that the permeation flux increased with an increase in the concentration of water in the feed. Permeation flux also increased with increase in weight percentage of PAA in the PVA-PAA IPN membrane. It was also noted that the permeation flux was higher for PVA-PAA IPN membrane as compared to PAAM-PVA IPN membrane.



The selectivity, rejection and PSI were found to be decreased with increase of feed water concentration. PVA-PAA IPN membrane had more selectivity for water as compared to that of PVA-PAAM IPN membrane. The selectivity increased with increase of PAA percentage in the PVA-PAA IPN membrane. The selectivity of water decreased with an increase in operating temperature. Permeation flux increased with increase in temperature. Based on these data a suitable membrane system can be devised for IPA-Water separation.

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RESEARCH ROUNDUP

Rapid determination of phospholipid content of vegetable oils by FTIR spectroscopy combined with partial least-square regression

A rapid mid-FTIR method was developed by **Xianghe Meng *et al*** to quantitatively determine the total phospholipid (PL) content of vegetable oils [**Food Chemistry**, **147**, 272-278, (2014)]. The method simply requires that the oil be diluted 4:1 (w/w) with hexane, its spectrum taken and ratioed against a hexane background. A calibration was devised using partial least squares by adding purified soybean PL at levels of 0.02–2.0% to phospholipid-free oils (soybean, rapeseed, sunflower) using the spectral region encompassing 1357–1000 cm^{-1} and validated using the AOCS 12–55. Using calibration and leave-one-out cross-validation predictive errors, a 200–20,000 ppm calibration was accurate to within ± 362 and 488 ppm, respectively, while for sub-calibrations ranging from 200 to 2000; 2000 to 8000 and 8000 to 20,000 ppm, they were ± 72 –172, ± 119 –220, and ± 242 –371 ppm, respectively. Although limited to 3 oil types in this study, the calibration is simple to devise and can be broadened to the universe of oil types of interest, the analytical protocol being straightforward and the analysis readily automatable.

Technological challenges for the production of biodiesel in arid lands

It is currently a much debated topic the potential economic benefits of biomass use for biodiesel production in arid lands. In this respect, the main focus has been directed to determine which different plant species are highly adapted and capable to produce significant amounts of triglycerides to be used in the biodiesel industry under arid conditions. However, very few studies have addressed the technological changes that will be needed to convert triglycerides into biofuels without making a large consumption of scarce water, as it is demanded by current technology. Beside, with current conventional transesterification technology, the production of glycerine as a byproduct is also a serious problem because of the large water requirements needed for its removal from biodiesel, before it can be used in motor engines. The main methods commonly employed to reduce the viscosity of vegetable oil in order to be used in diesel engines are its high dilution with petrodiesel (<10%), the breakdown and deoxygenation of the fatty acids from triglycerides through hydrotreating, and the cleavage of the triglycerides into its fatty acid components. In

the later case, the cleavage can be carried out with generating glycerine as a byproduct, or by integrating the glycerine in the biofuel using several methods recently developed. The present contribution by **D. Luna *et al*** aims to explain the current state of available technologies for the production of biofuels for diesel engines, with special emphasis on the possibilities of implementing the free or immobilized lipases for the development of new types of biofuels that integrate glycerine, and avoid waste production, that consume valuable and scarce water resources, thus achieving a feasible biofuels production in arid lands [**Journal of Arid Environments**, **102**, 127-138, (2014)].

Classification of edible vegetable oil using digital image and pattern recognition techniques

Karla Danielle Tavares Melo Milanez and Marcio Jose Coelho Pontes present a simple and non-expensive method based on digital image and pattern recognition techniques for the classification of edible vegetable oils with respect to the type (soybean, canola, sunflower and corn) and the conservation state (expired and non-expired shelf life) [**Microchemical Journal**, **113**, 10-16, (2014)]. For this purpose, vegetable oil sample images were obtained from a webcam and the frequency distribution of color indexes in the red–green–blue (RGB), hue (H), saturation (S), intensity (I), and grayscale channels were obtained. Linear discriminant analysis (LDA) was employed in order to build classification models on the basis of a reduced subset of variables. For the purpose of variable selection, two techniques were utilized, namely the successive projection algorithm (SPA) and stepwise (SW) formulation. For the study evolving the classification with respect to oil type, LDA/SPA and LDA/SW models achieved a correct classification rate (CCR) of 95% and 90% respectively. For the identification of expired and non-expired samples, LDA/SPA models were found to be the best method for classifying sunflower, soybean and canola oils, achieving a CCR in the overall data set of 97%, 94% and 93%, respectively, while the LDA/SW correctly classified at 100% for corn oil data. These results suggest that the proposed method is a promising alternative for the inspection of authenticity and the conservation state of edible vegetable oils. As advantages, the method does not use reagents to carry out the analysis and laborious procedures for chemical characterization of the samples are not required.

Combustion of vegetable oils under optimized conditions of atomization and granulometry in a modified fuel oil burner

The use of vegetable oils in burners represents an attractive alternative to the use of heating fuel oil (HFO) in heat production for domestic heating, small industrial units, drying of various products etc. In this work, a characterization of the combustion of cottonseed oil in a modified burner (type Riello 40N10) was performed by **Tizane Daho *et al*** to assess its ability to achieve proper combustion of vegetable oils in optimized conditions of atomization and granulometry [**Fuel**, **118**, 329-334, (2014)]. The quality of the combustion has been evaluated by the analysis of combustion products (CO, O₂, CO₂, NO, NO₂, SO₂) and organic compounds including PAHs. Results show that the modifications made on the burner type 40N10 can achieve suitable spray conditions and give particle size within the recommended values for burners. In the case of Riello 40N10 burner, a fuel pressure of 28 bars is adequate and the minimum temperature required for oil preheating is 125 °C. When these conditions are achieved, cottonseed oil combustion leads to the emission of non-condensable gases and the organic compounds species as well as their concentration close to those of HFO.

Measurements of activity coefficients at infinite dilution in vegetable oils and capric acid using the dilutor technique

Patricia C. Belting *et al* report experimental activity coefficients at infinite dilution, γ_i^∞ for methanol, ethanol and n-hexane in three refined vegetable oils (soybean, sunflower, and rapeseed oils) measured using the dilutor technique (inert gas stripping method) [**Fluid Phase Equilibria**, **361**, 215-222, (2014)]. The measurements were carried out in the temperature range between 313.15 and 353.15 K. Furthermore, activity coefficients at infinite dilution for various solutes (acetone, methanol, ethanol, n-hexane, cyclohexane and toluene) were measured in capric (decanoic) acid using the same technique in the temperature range from 313.13 to 353.30 K. The new data obtained for capric acid and soybean oil were compared with already published experimental data. Additionally, densities of the investigated vegetable oils were measured in the temperature range from 293.15 to 353.15 K. Using the experimental γ_i^∞ values obtained over the temperature range, the partial molar excess Gibbs energy ($\Delta H_i^{E,\infty}$), enthalpy ($\Delta H_i^{E,\infty}$) and entropy ($\Delta \Sigma_i^{E,\infty}$) at infinite dilution were determined. The relative error for the γ_i^∞ measurements carried out using the dilutor technique is approximately $\pm 2.5\%$. The measured γ_i^∞ data in the investigated refined vegetable oils were also compared with the results of the group contribution

methods original UNIFAC and modified UNIFAC (Dortmund) and an extension of the latter method to triacylglycerols was proposed.

Separation of steroids using vegetable oils in microemulsion electrokinetic capillary chromatography

The steroids, hydrocortisone, androstenedione, 17- α -hydroxyprogesterone, testosterone, 17- α -methyltestosterone, and progesterone were separated by **Heli Siren *et al*** with microemulsion electrokinetic chromatography (MEEKC) and detected with UV absorption [**Journal of Chromatography B**, **945-946**, 199-206, (2014)]. The microemulsion phases were prepared from both artificial and vegetable oils, from them the first was made of alkane and alcohol and the latter from colza, olive, linseed, and walnut oils. The electrolyte solutions were made to emulsions using sodium dodecyl sulfate and alkaline tetraborate. The solution mixtures made from ethyl acetate, sodium dodecyl sulfate, 1-butanol, acetonitrile, and sodium tetraborate were used as the reference solutions to evaluate the performance of the vegetable oil emulsions. Our study showed that the lipophilic organic phase in the microemulsion did provide resolution improvements but not selectivity changes. The results also correlate with real interactions of the steroids with the lipophilic organic microemulsion phase. The quality of the oils between the manufacturers did not have importance, which was noticed from the equal behavior of the steroids in the vegetable oil emulsions. Detection limits of the steroids in vegetable oil emulsions were at the level of 0.20–0.43 $\mu\text{g/L}$. Thus, they were 2–10 times higher than the concentrations in the partial filling micellar electrokinetic chromatography (PF-MEKC), which we have obtained earlier. The repeatability (RSD%) of the electrophoretic mobilities of the steroids was between 0.50 and 3.70. The RSD% values between the inter-day separations were below 1%, but when walnut and olive oils were used the values exceeded even 10%.

Experimental Analysis of a Micro Gas Turbine Fuelled with Vegetable Oils from Energy Crops

This paper by **Andrea Cavarzere *et al*** deals with the technical feasibility of the use of straight vegetable oil (SVO) as gas turbine fuels. First, this paper reports the results of the experimental characterization of different vegetable oils, derived from energy crops, and of blends of diesel and vegetable oil in different concentrations (from pure diesel to pure vegetable oil). The considered vegetable oils were obtained from different types of oilseeds (rapeseed, sunflower, soybean) and were cultivated under different agronomic scenarios [**Energy Procedia**, **45**, 91-100, (2014)]. The

SVO properties determined experimentally are SVO elemental composition, lower heating value, density, specific heat and viscosity, for which this paper provides a practical overview, coming both from experiments and literature data. Secondly, the paper experimentally evaluates the behavior of a Solar T-62T-32 micro gas turbine fed by vegetable oils. The vegetable oils are supplied to the micro gas turbine as blends of diesel and straight vegetable oils in different concentrations, up to pure vegetable oil. The paper describes the test rig used for the experimental activity and reports some experimental results, which highlight the effects of the different fuels on micro gas turbine performance and pollutant emissions.

Transforming duck tallow into biodiesel via non-catalytic transesterification

The transformation of the lipids extracted from duck tallow into biodiesel was achieved using activated alumina and CO₂ under ambient pressure (1 bar). Crude fatty acids (~98% assay) were also esterified to help **Eilhann E. Kwon et al** understand and validate the noncatalytic biodiesel conversion mechanisms. Its conversion efficiency was nearly 93.5(±0.5)%. The transformation of crude fatty acid into biodiesel proves that this newly developed technology for the production of biodiesel combines esterification of free fatty acids and transesterification of triglycerides into a single process that has a 98.5(±0.5)% conversion efficiency to biodiesel within 1 min at 350–500 °C [**Applied Energy**, **116**, 20-25 (2014)]. This paper addresses the simplest methodology for the production of biodiesel. Herein, it is confirmed that the main driving force of biodiesel conversion in the noncatalytic transesterification reaction is temperature rather than pressure. Noncatalytic biodiesel transformation can be achieved in the presence of a porous material via a thermochemical process in a continuous flow system. This noncatalytic biodiesel transformation was enhanced under the presence of carbon dioxide (CO₂).

Fatty acid from the renewable sources: A promising feedstock for the production of biofuels and biobased chemicals

With the depletion of the nonrenewable petrochemical resources and the increasing concerns of environmental pollution globally, biofuels and biobased chemicals produced from the renewable resources appear to be of great strategic significance. The present review by **Hui Liu et al** described the progress in the biosynthesis of fatty acid and its derivatives from renewable biomass and emphasized the importance of fatty acid serving as the platform chemical and feedstock for a variety of chemicals [**Biotechnology Advances**, **32**, 382-389, (2014)].

Due to the low efficient conversions of lignocellulosic biomass or carbon dioxide to fatty acid, we also put forward that rational strategies for the production of fatty acid and its derivatives should further derive from the consideration of whole bioprocess (pretreatment, saccharification, fermentation, separation), multiscale analysis and interdisciplinary combinations (omics, kinetics, metabolic engineering, synthetic biology, fermentation and so on

Evaluation of alternative solvents for improvement of oil extraction from rapeseeds

Ying Li et al designed to evaluate the performances of five alternative solvents (alcohols: ethanol, isopropanol and terpenes: D-limonene, α-pinene, p-cymene) compared to n-hexane in rapeseed oil extraction. The extracted oils were quantitatively and qualitatively analyzed to compare the solvents' performances in terms of kinetics, fatty acid compositions, lipid yields, and classes [**Comptes Rendus Chimie**, **17**, 242-251, (2014)]. Moreover, micronutrients in extracted oils were also respectively quantified by high-performance liquid chromatography (HPLC) and gas chromatography (GC). In addition, the interactions between alternative solvents and rapeseed oil have been theoretically studied with the Hansen solubility methodology to get a better comprehension of dissolving mechanisms. The results indicated that p-cymene could be the most promising solvent for n-hexane substitution with higher lipid yield and good selectivity, despite the micronutrient contents were relatively low.

Common mistakes about fatty acids identification by gas-liquid chromatography

A growing number of research articles currently present the occurrence of certain fatty acids (FAs) such as docosahexaenoic acid (DHA, 22:6n-3) and eicosapentaenoic acid (EPA, 20:5n-3), not only where they naturally occur (in the seedless plants), but also in higher plants, despite cautionary statements published about this topic more than 20 years ago. In these newer articles, the identification of FAs is being performed using gas-liquid chromatography (GLC). In the present commentary by **Jose Luis Guil-Guerrero et al** the general scheme of FA biosynthesis in plants is reviewed, with a renewed warning about the need to use confirmatory techniques such as GLC-mass spectrometry (GLC-MS) to identify any uncertain FAs detected in higher plants [**Journal of Food Composition and Analysis**, **33**, 153-154, (2014)].

Esterification of fatty acids by new ionic liquids as acid catalysts

Three new highly acidic ionic liquids based on 4-sulfobenzyl imidazolium hydrogensulfate and with

different length of the alkyl chain were screened by **Behzad Aghabarari *et al*** as catalysts for the esterification of oleic acid with methanol [**Journal of the Taiwan Institute of Chemical Engineers**, **45**, 431-435, (2014)]. The ionic liquids were characterized by FT-IR, ¹H NMR, ¹³C NMR and CHNS analyses. The reaction parameters, such as reaction temperature, molar ratio, catalyst loading, reaction time and stability were studied. The experimental results indicated that acidic ionic liquid with the longest alkyl chain performed the best activity, due to the less strict hindrance. Finally, the methyl oleate was produced with 95.0% yield at lower time (6 h) under the optimized reaction conditions. Furthermore, different alcohols and fatty acids were investigated and the results showed that the length of alkyl chain and degree of saturation of fatty acid affects the catalytic activity of the best catalyst.

Characterisation of lipid fraction of marine macroalgae by means of chromatography techniques coupled to mass spectrometry

In this work the characterisation of the lipid fraction of several species of marine macro algae gathered along the eastern coast of Sicily is reported by **Carla Ragonese *et al***. Two species of green marine algae (Chloropyceae), two species of red marine algae (Rhodophyceae) and four species of brown marine algae (Pheophyceae) were evaluated in terms of fatty acids, triacylglycerols, pigments and phospholipids profile [**Food Chemistry**, **145**, 932-940, (2014)]. Advanced analytical techniques were employed to fully characterise the lipid profile of these Mediterranean seaweeds, such as GC-MS coupled to a novel mass spectra database supported by the simultaneous use of linear retention index (LRI) for the identification of fatty acid profile; LC-MS was employed for the identification of triacylglycerols (TAGs), carotenoids and phospholipids; the determination of accurate mass was carried out on carotenoids and phospholipids. Quantitative data are reported on fatty acids and triacylglycerols as relative percentage of total fraction.

Thermal, oxidative and low temperature properties of methyl esters prepared from oils of different fatty acids composition: A comparative study

Thermo-oxidative stabilities of castor oil methyl esters (COME) and waste cooking oil methyl esters (WCOME) were estimated by **Venu Babu Borugadda and Vaibhav V. Goud** using thermo gravimetric analysis technique (TGA) [**Thermochimica Acta**, **577**, 33-40, (2014)]. Low temperature properties of the methyl esters were investigated using ASTM and differential scanning calorimetry (DSC) techniques and compared. Thermo-oxidative onset temperature study showed that process of WCOME decomposition initiated and

completed within a temperature range inferior to COME, because of higher percentage of polyunsaturated fatty acids in WCOME (44.41%) compared to COME (6.6%). Comparison of decomposition profile at 10 and 20 °C/min revealed that with increased heating rate degradation was found to be increased. WCOME in particular showed most unfavorable cold flow properties due to the presence of long chain saturated fatty acids (18 wt%). Comparison between ASTM and DSC method showed that DSC method could be a useful technique to estimate the low temperature properties, which also consume less time and sample amount.

Influence of blending vegetable oil methyl esters on biodiesel fuel properties: Oxidative stability and cold flow properties

Properties of biodiesel can be related to the chemical composition of the biomass source used in transesterification. Saturated fatty acids confer high oxidative stability, while unsaturated fatty acids improve the cold flow properties, which are also influenced by the chain length. In the present study, blends of biodiesel produced from different vegetable oils were evaluated in order to obtain the proper blend by **Marta Serrano *et al*** to fulfill the European Standard EN14214 in terms of oxidative stability and cold flow properties [**Energy**, **65**, 109-115, (2014)]. Citric acid was used to purify the methyl ester phase. Oxidative stability resulted highly dependent on polyunsaturated fatty esters while fatty ester chain length is a determining factor in cold flow performance of the blends. A preliminary study of the effectiveness of a commercial additive (a Poly alkyl methacrylate) in improving methyl ester flow at low temperatures was done, but no significant changes were found

Long-chain polyesters and polyamides from biochemically derived fatty acids

Nicolai Kolb *et al* describe the use of biochemically derived fatty acid derivatives (ω - and ω -1 hydroxy fatty acid methyl esters) as starting materials for renewable polyesters and polyamides [**European Polymer Journal**, **51**, 159-166, (2014)]. The required long-chain monomers were obtained by chemical derivatization of biochemically derived fatty acids. Thus, a long chain diester and a ω -amino fatty acid methyl ester were synthesized and used to prepare polyester PE 32-34:32-34 and polyamide PA 16. The polyester was prepared by transesterification using 5 mol% of the catalyst tin(II) 2-ethylhexanoate (Sn(Oct)₂), leading to an average molecular weight of $M_n = 7.4$ kDa and a melting point of 109 °C. PA 16 was prepared by amidation using TBD as catalyst and resulting in an average molecular weight of $M_n = 20.3$ kDa and a melting point of 166 °C.

Intensification of glycerolysis reaction of higher free fatty acid containing sustainable feedstock using microwave irradiation

Glycerolysis can be a useful alternative for the removal of free fatty acid content present in the sustainable feedstock but has limitation in terms of requirement of higher temperatures and higher processing time. In the present work, intensification of glycerolysis has been attempted by **Vitthal L. Gole and Parag R. Gogate** using microwave irradiations with comparative studies based on the use of the conventional heating approach [**Fuel Processing Technology, 118**,110-116, (2014)]. Effect of reaction parameters such as molar ratio (oil to glycerol), catalyst concentration and reaction temperature has been investigated. It has been observed that the optimum molar ratio of oil to glycerol as 1:2 and catalyst concentration of 0.1% for both approaches is similar but there is a significant decrease in the reaction time and optimum temperature. Reaction time was reduced from 240 to 25 min while the optimum temperature for maximum benefits reduced from 200 to 105 °C for the microwave based approach. Comparison based on kinetic analysis confirmed that the rate constant obtained for microwave assisted glycerolysis was six times higher than that obtained in the conventional approach. Energy consumption analysis also revealed the superiority of microwave based synthesis approach with much lower energy requirement for microwave (35.3 kJ/g) as compared to the conventional method (203.6 kJ/g).

Engineering production of C18 conjugated fatty acids in developing seeds of oil crops

Polyunsaturated fatty acids (PUFAs) with at least one pair of double bonds which are separated by only a single bond are known as conjugated fatty acids (CFAs). These types of fatty acids (FAs) are subject to a relatively high rate of oxidation and have subsequently found industrial applications in the production of organic coatings and polymers. From a dietary perspective, there is also a growing body of information which suggests that CFAs are useful in slowing the growth of certain types of cancer. This review by **Elzbieta Mietkiewska et al** emphasizes the production of oils containing C18 CFAs in the developing seeds of genetically engineered oleaginous plants [**Biocatalysis and Agricultural Biotechnology, 3**, 44-48, (2014)]. Designing effective strategies to increase the accumulation of CFAs in plant species which do not normally produce these FAs requires a detailed knowledge of FA biosynthesis and triacylglycerol assembly in both the species to be engineered and the species that normally produces the CFA. One of the major challenges in engineering oil crops to produce

CFAs, and other unusual FAs, is to effectively remove these FAs from phosphatidylcholine and make them available for incorporation into triacylglycerol.

Characterization of residual oils for biodiesel production

Residual oils were characterized by **Edmilson Antonio Canesin et al** according to their physicochemical properties, i.e. acidity, iodine value, peroxide value and saponification number, to evaluate the degradation level and viability for biodiesel production [**Electronic Journal of Biotechnology, 17**, 39-45, (2014)]. The methyl esters of fatty acids (FAME) from samples of residual bovine, chicken and soybean oils were quantified by using four transesterification methods, using acidic and basic catalysis and, gas chromatography with flame ionization detector (GC-FID). Methods that used acidic catalysis at a lower temperature were the most efficient. Methyl biodiesel samples were synthesized by basic catalysis (KOH) for all quantified oils and the physicochemical properties of the biofuel were evaluated, i.e. viscosity, flash and fire points, density, water content, iodine and acidity numbers. The obtained results suggesting that it is possible to take advantage of these residues for biodiesel production as the obtained products were approved according to the rules established by the National Association of Petroleum (ANP); the bovine samples were the exception regarding moisture and acidity.

Direct conversion of wet algae to crude biodiesel under supercritical ethanol conditions

Harvind K. Reddy et al present a single-step, environmentally friendly approach for the direct conversion of wet algae to crude biodiesel under supercritical ethanol conditions. Ethanol was used for the simultaneous extraction and transesterification of lipids in algae to produce fatty acid ethyl esters at supercritical conditions. In this work the effects of process parameters dry algae to ethanol (wt./vol.) ratio (1:6–1:15), reaction temperature (245–270 °C), and reaction time (2–30 min.) on the yield of fatty acid ethyl esters (FAEE) were studied [**Fuel, 115**, 720-726, (2014)]. 67% conversion was achieved at 265 °C and 20 min of reaction time. The calorific value of a purified biodiesel sample produced at optimum conditions was measured to be 43 MJ/kg, which is higher than that of fatty acid methyl esters produced from the same biomass. The purified fatty acid ethyl esters were analyzed using GC-MS and FTIR. TGA analysis of algal biomass and purified FAEE was presented along with TEM images of the biomass captured before and after supercritical ethanol transesterification. This green conversion process has the potential to provide an

energy-efficient and economical route for the production of renewable biodiesel production.

Optimization of oil yield of *Phaleria macrocarpa* seed using response surface methodology and its fatty acids constituents

Phaleria macrocarpa (Mahkota dewa) seed was examined by **J. Azmir *et al*** to determine the optimal conditions of oil yield by solvent extraction method using n-hexane as extracting solvent [**Industrial Crops and Products**, **52**, 405-412, (2014)]. Response surface methodology (RSM) was employed to describe explicitly the influence of extraction time, temperature and solvent-to-feed ratio on the yield of oil using central composite design (CCD). The linear, quadratic and interaction terms of the studied variables have significant ($P < 0.05$) effect on the oil yield. The temperature of 72 °C, extraction time of 8.4 h and solvent-to-feed ratio of 10.9 ml/g were the optimal conditions for seed oil extraction. The maximum oil yield was 55.32 g/100 g dry weight under these optimal conditions. Main chemical constituents of oil were determined by Gas chromatography–mass spectroscopy (GC–MS) and Fourier transform infrared spectroscopy (FTIR). Twelve components were identified by GC–MS analysis after formation of fatty acid methyl ester (FAME). Total saturated fatty acids were 19.38% whereas monounsaturated fatty acids and polyunsaturated fatty acids were 44.23% and 36.38%, respectively. Oleic acid, 18:1 (43.56%) and linoleic acid, 18:2 (36.25%) were the main fatty acid constituents of Mahkota dewa seed oil. The quantity of unsaturated fatty acids was higher than saturated fatty acids in *P. macrocarpa* seed oil

Towards a sustainable approach for development of biodiesel from plant and microalgae

The production of biodiesel can be accomplished using a variety of feedstock sources. Plant and microalgae based feedstocks are prominent and are studied extensively. Plant based feedstocks cultivated as monoculture on wastelands and trees in forests can cater towards partial fulfillment of feedstock requirements for biodiesel industry. Synthesis of biodiesel from microalgal oil has gathered immense interest and has potential to cater to the increasing feedstocks demands of the biodiesel industry. The major advantage offered by microalgal oil, as compared to plant based oils, is its potential for culture on non-arable land. Despite of the advantages of microalgal oil as a feedstock for biodiesel, there are constraints that have to be overcome in order to make it economical and sustainable. Sustainable approaches for both the plant and microalgae as feedstocks have been drawn. Despite there being several plant species, few have

been found to be desirable as feedstocks for biodiesel production based on their lipid profiles. Among the microalgae, there are thousands of species and several of these have been cultured for extracting the oil to explore their feasibility in utilization as biodiesel feedstocks. Though, several of the microalgal species have shown potential for high biomass growth and lipid productivity, only a few have been found to provide a high biodiesel yield and conversion. Due to the several steps involved in the extraction of oil which are energy intensive, the cost of biodiesel from microalgal oil is high as compared with that obtained from the plant oils. A sustainable approach for utilizing plant and microalgal oils as feedstocks for biodiesel have been discussed. The emerging cost effective methods in production of biodiesel have been described. The energy return and greenhouse gas emissions from biodiesel have been outlined by **Bhaskar Singh *et al***. Together, the plant oil and microalgal oil can offer potential source of feedstocks for the production of biodiesel [**Renewable and Sustainable Energy Reviews**, **29**, 216-245, (2014)].

Multiresponse optimisation on biodiesel obtained through a ternary mixture of vegetable oil and animal fat: Simplex-centroid mixture design application

The quality of biodiesel is a determining factor in its commercialisation, and parameters such as the Cold Filter Plugging Point (CFPP) and Induction Period (IP) determine its operability in engines on cold days and storage time, respectively. These factors are important in characterisation of the final product. A B100 biodiesel formulation was developed using a multiresponse optimisation, for which the CFPP and cost were minimised, and the IP and yield were maximised. The experiments were carried out by **Juliane Resges Orives *et al*** according to a simplex-centroid mixture design using soybean oil, beef tallow, and poultry fat [**Energy Conversion and Management**, **79**, 398-404, (2014)]. The optimum formulation consisted of 50% soybean oil, 20% beef tallow, and 30% poultry fat and had CFPP values of 1.92 °C, raw material costs of US\$ 903.87 ton⁻¹, an IP of 8.28 h, and a yield of 95.68%. Validation was performed in triplicate and the t-test indicated that there were no difference between the estimated and experimental values for none of the dependent variables, thus indicating efficiency of the joint optimisation in the biodiesel production process that met the criteria for CFPP and IP, as well as high yield and low cost.

Application of hydrotreated vegetable oil from triglyceride based biomass to CI engines – A review

This review by **Soo-Young No** was concentrated on the application of hydrotreated vegetable oils (HVO)

produced from the triglycerides based biomass such as vegetable oil, animal fat, waste cooking oil and algae to compression ignition (CI) engines [Fuel, 115, 88-96, (2014)].

Main problem in the application of HVO to CI engines is the poor low-temperature properties. The upgrading technology of cold flow properties of HVO reported in the literature can be categorized with four ways as isomerization, addition of flow improver, reaction temperature control and co-processing with petroleum derived raw materials. The advantages of hydrotreating over transesterification are lower processing cost, compatibility with infrastructure, NO_x emission reduction, and feedstock flexibility.

Combustion and emission characteristics of neat HVO, blends of HVO with petrodiesel and HVO with additives were widely investigated by many researchers. The use of HVO enables appreciable reductions in NO_x, PM, HC and CO emissions without any changes to the engine or its control in heavy-duty engines. HVO could play an important role in providing a sustainable source of transportation fuels during the coming decades. In addition, HVO obtained from inedible vegetable oil and application of it to CI engine will be the subjects of future research in the production and application of HVO. The technologies for the reduction of NO_x and PM in CI engines fuelled with HVO can be categorized with engine optimization and fuel optimization. The engine optimization technology is more effective than the fuel optimization technology.

Characterization of crystallization and melting profiles of blends of mango seed fat and palm oil mid-fraction as cocoa butter replacers using differential scanning calorimetry and pulse nuclear magnetic resonance

Mango seed fat (MSF) and palm oil mid-fraction (POMF) blends were stabilized prior to investigate crystallization and melting behavior, solid fat content (SFC) and triglyceride compositions by **M.H.A. Jahurul et al.** Ten blends at various ratios of MSF/POMF, 95/5 (blend 1), 90/10 (blend 2), 85/15 (blend 3), 80/20 (blend 4), 75/25 (blend 5), 70/30 (blend 6), 65/35 (blend 7), 60/40 (blend 8), 55/45 (blend 9), 50/50 (blend 10) were used in this study [Food Research International, 55, 103-109, (2014)]. Results showed that the major triglyceride ranges in all blends were from 11 to 38.8% 1,3-dipalmitoyl-2-oleoyl-glycerol (POP), from 22.1 to 36.9% 1,3-distearoyl-2-oleoyl-glycerol (SOS), and from 15.4 to 16.2% 1-palmitoyl-3-stearoyl-2-oleoyl-glycerol (POS), respectively. The melting behavior indicated a single curve with only one maximum and one small shoulder for the blends of 3 to 6. The blends having 70, 75, 80, and 85% of MSF showed similar crystallization

pattern with a single curve having one maximum peak heights at temperatures of 10.17, 10.58, 11.54, and 11.66 °C. The SFC of the blends no. 1 to 5 was found to be close to these SFC of commercial CB at 10 to 20 °C temperatures. A multiple regression equation was developed which showed strong correlations between triglycerides of blends 1 to 10 and their properties. The studies revealed that preparation of green quality cocoa butter replacers (CBRs) is possible using MSF and POMF.

Performance of the jatropha vegetable-base soluble cutting oil as a renewable source in the aluminum alloy 7050-T7451 milling

Carlos Alberto Schuch Bork et al aimed at collecting data on the performance of a new product – the jatropha vegetable-base soluble cutting oil in relation to other canola oils (vegetable), synthetic (jatropha ester), and the semisynthetic (mineral) traditionally used in the industry in high feed milling of the aluminum alloy 7050-T7451 for the production of aeronautical structures [CIRP Journal of Manufacturing Science and Technology, 7, 210-221, (2014)].

Thus, information on requisites, restrictions, and machinability criteria for the cutting oils were analyzed. It was observed that the jatropha cutting oil presented the best results in relation to requirements for lubrication, superficial mean roughness index Ra, and shape errors, which were measured in the milling part. It also offered an increase in the life-span of the cutting tool that exceeded in approximately 30% the other cutting oils analyzed here. The jatropha (vegetable) oil, in relation to its physicochemical properties, appeared to be the best one fit for being used in the machining of aluminum alloys 7050-T7451 because it did not interfere with any of the elements involved in the formation of intergranular corrosion and/or pitting, which are not allowed in the aeronautical production of parts. Jatropha (vegetable) cutting oil, besides being produced from a clean and renewable source, has the inherent characteristics that can help attain a sustainable manufacturing

Physical characteristics of spray-dried dairy powders containing different vegetable oils

The objective of this study by **Grace M. Kelly et al** was to investigate the physical characteristics of spray-dried dairy powders formulated with different oil types, spray-dried at different outlet temperatures [Journal of Food Engineering, 122, 122-129, (2014)]. A model fat-filled dairy formulation (target 40% w/w total solids, comprising protein, oil and lactose) containing lactose (23.9%), sodium caseinate

(5.11%) and sunflower (SO) or palm (PO) oil or a 50:50 mixture of SO/PO (in all cases 11.5% total oil) were heat-treated, homogenised and spray-dried at an outlet temperature of 80 or 90 °C. Increasing outlet temperature reduced water content, water activity and tapped bulk density, irrespective of oil type, and increased solvent-extractable free fat for all oil types. Onset of glass transition (T_g) and crystallisation (T_{cr}) decreased at the lower outlet temperature. Oil type had no effect on powder moisture, water activity (a_w), powder bulk density, particle size, fat globule size of emulsion or fat globule size of reconstituted fat-filled dairy powders.

Characteristics and vegetable oils degumming of recombinant phospholipase B

Phospholipase B from *Pseudomonas fluorescens* BIT-18 can cleave acyl chains at the sn-1 and sn-2 positions of a phospholipid and has been successfully used to degum vegetable oils in the previous work. This study by **Shen Huang et al** focused on the heterologous overexpression of phospholipase B (Pf-PLB-P) in *Pichia pastoris* to investigate its characteristics and application in degumming vegetable oils [**Chemical Engineering Journal**, **237**, 23-28, (2014)]. After optimizing the fermentation conditions, the maximum achieved enzyme activity was 65 U/ml, which was twice the enzyme activity of wild-strain *P. fluorescens* BIT-18. Purified Pf-PLB-P was obtained by ammonium sulfate precipitation, anion-exchange chromatography, and gel filtration. The kinetic constants K_m and V_{max} were determined to be 4.75 mM and 98.67 mmol/(L min), respectively. Pf-PLB-P enzyme activity was detected at 25–55 °C and pH 4.5–9.5, and the temperature range was observed to be slightly broadened than that of the wild type. Based on these characteristics, Pf-PLB-P was also successfully used to degum soybean and peanut oils, whose phosphorus contents decreased from 125.1 mg/kg to 4.96 mg/kg and 96 mg/kg to 3.54 mg/kg, respectively. These results indicate that Pf-PLB-P produced by *P. pastoris* has potential industrial use.

Effect of antioxidants on oxidation stability of biodiesel derived from vegetable and animal based feedstocks

The increase of energy demand coped with utilization of fossil resources have engendered serious environmental impact. The progressively stringent worldwide emission legislation and increasing greenhouse gas emission require significant research effort on alternative fuels. Therefore, biodiesels are becoming important increasingly due to its ease in adaptation, environmental benefits and prospect in energy security. Biodiesel derived from vegetable oils,

waste cooking oils and animal fats are long chain fatty acid alkyl esters, which contains unsaturated portions that are susceptible to oxidation. Biodiesel oxidation is a complex process having a number of mechanisms involved. Autoxidation radical chain reactions are the primary cause of biodiesel degradation that leads to formation of hydroperoxide, which, after that decompose to form an array of secondary oxidation products like aldehydes, ketones, carboxylic acids, oligomers, gum, sediment etc. Antioxidants are often used to inhibit biodiesel oxidative degradation. The present review by **I.M. Rizwanul Fattah et al** attempts to cover the inhibition action of natural and synthetic antioxidants, methods used to analyze biodiesel oxidation and their effect on biodiesel derived from various feedstocks [**Renewable and Sustainable Energy Reviews**, **30**, 356-370, (2014)]. Phenolic antioxidants are more effective compared to amine antioxidants. Pyrogallol is found to be the most effective antioxidant to improve the oxidation stability in case of almost all biodiesels reviewed.

Phase equilibria of free fatty acids enriched vegetable oils and carbon dioxide: Experimental data, distribution coefficients and separation factors

In present work, the oils were treated by saponification procedure to release fatty acids from triglycerides to obtain free fatty acids (FFA) enriched oils and glycerol by **Petra Kotnik et al**. Phase equilibria data for systems FFA enriched rapeseed oil- CO_2 , FFA enriched corn germ oil- CO_2 and FFA enriched borage oil- CO_2 were determined at temperatures 35, 45, 65 and 85 °C, and in pressure range from 100 to 550 Bar [**The Journal of Supercritical Fluids**, **87**, 65-72, (2014)]. Experiments using FFA enriched oils were performed using high-pressure variable-volume view cell, where phase inversions were also observed at temperatures 35 and 45 °C. Samples from liquid and vapor phases were analyzed by gas chromatography for the content of free fatty acids, and based on obtained data; the distribution coefficients and the separation factors between FFA and glycerol were calculated.

Optimization of biodiesel production from soybean oil in a microreactor

Transesterification of soybean oil with methanol in the presence of potassium hydroxide, as a catalyst, in a microreactor has been investigated by **Masoud Rahimi et al**. The transesterification reaction was performed at specific condition in circular tubes with hydraulic diameter of (0.8 mm) [**Energy Conversion and Management**, **79**, 599-605, (2014)]. In order to further improve the biodiesel production, the experimental design was performed using Box-Behnken method.

The results were analyzed using response surface methodology. The influence of reaction variables including; molar ratio of methanol to oil (6:1–12:1), temperature (55–65 °C) and catalyst concentration (0.6–1.8 wt.%) and residence time (20–180 s) under various flow rates of reactants (1–11 ml min⁻¹) on Fatty Acid Methyl Ester (FAME) transesterification reaction was studied. The optimum condition was found at molar ratio of methanol to oil (9:1), catalyst concentration (1.2 wt.%) and temperature (60 °C) with a FAME % of about 89%. Considering optimum parameters, by changing the reactant residence time the FAME % was reached to 98% at 180 s.

Ethanolysis of waste cottonseed oil over lithium impregnated calcium oxide: Kinetics and reusability studies

A series of Li/CaO catalysts has been prepared by **Mandeep Kaur and Amjad Ali** by impregnating 0.5–5.0 wt% Li in CaO by wet chemical method. Prepared Li/CaO catalysts have been characterized by powder X-ray diffraction, scanning electron and transmission electron microscopy and Brunauer–Emmett–Teller (BET) surface area studies, in order to establish the structure and surface morphology of the catalyst [**Renewable Energy**, **63**, 272-279, (2014)]. Hammett indicator test study was performed to determine the basic strength of the Li/CaO catalysts. The prepared Li/CaO catalysts have been employed as a heterogeneous catalyst for the transesterification of waste cottonseed oil (having 2.8 wt% free fatty acid contents) with ethanol. Under optimal reaction conditions viz., ethanol/oil molar ratio of 12:1, catalyst to oil weight fraction of 5% and 65 °C reaction temperature, 98% fatty acid ethyl ester yield was obtained in 2.5 h of reaction duration. Under the optimized reaction conditions, the pseudo first order constant and Arrhenius activation energy were found to be 0.03 min⁻¹ and 70.0 kJ mol⁻¹, respectively. Further Li/CaO catalyst was also found to be effective for the ethanolysis and methanolysis of vegetable oils having up to 3.4 wt% free fatty acids. The use of 3-Li/CaO catalyst is advantageous considering that it not only utilizes waste cottonseed oil as a feedstock, but also renewable and nontoxic alcohol, ethanol, for the biodiesel production.

Review of biodiesel synthesis from waste oil under elevated pressure and temperature: Phase equilibrium, reaction kinetics, process design and techno-economic study

The synthesis of biodiesel under elevated pressure and temperature could be promising technology which could result in sustainable biodiesel production, from renewable and waste streams like waste oil or used

frying oil, thereby having no impact on biodiversity and the environment. This paper is comprehensive review of biodiesel synthesis by **Sandra B. Glisic and Aleksandar M. Orlovic** from waste oil under elevated pressure and temperature: the supercritical or subcritical conditions of alcohol, with or without the use of heterogeneous catalyst [**Renewable and Sustainable Energy Reviews**, **31**, 708-725, (2014)]. The review comprises the thermodynamic data, phase equilibria, phase composition and distribution during reaction, kinetic parameters and kinetic modeling, are presented. This type of data is necessary for process design and optimization. Process economics is analyzed and the impact of different production parameters (feedstock type, process parameters as temperature, pressure and alcohol to oil ratio, and different technology) is summarized and discussed.

Study of fuel properties of rubber seed oil based biodiesel

The scarcity of the fossil fuel, environmental pollution and food crisis are the world's major issues in current era. Biodiesel is an alternative to diesel fuel, environment friendly and biodegradable and is produced from either edible or non-edible oils. In this study, a non-edible rubber seed oil (RSO) with high free fatty acid (FFA) content of 45% were used for the production of biodiesel by **Junaid Ahmad et al.** The process comprises of two steps. The first step is the acid esterification to reduce the FFA value and the second step is the base transesterification [**Energy Conversion and Management**, **78**, 266-275, (2014)]. The response surface methodology (RSM) was used for parametric optimization of the two stage processes i.e. acid esterification and base transesterification. The yield of biodiesel was analyzed using gas chromatography. The FTIR (Fourier Transform Infra-Red) spectrum was also determined to confirm the conversion of fatty acid to methyl esters. The fuel properties were analyzed according to the ASTM D6751 and EN14214 and were compared with the previous finding of researchers. All analyzed properties fulfilled the biodiesel standard criteria.

Pressing and supercritical CO₂ extraction of *Camelina sativa* oil

Tihomir Moslavac et al evaluated the oil extraction process from *Camelina sativa* (L.) Crantz seeds by screw pressing followed by extraction with supercritical CO₂. In pressing experiments, the response surface methodology (RSM) was conducted in order to study the effects of temperature, frequency and nozzle size on oil recovery and quality parameters [**Industrial Crops and Products**, **54**, 122-129, (2014)]. The optimal condition to obtain the highest oil recovery

and the best oil quality within the experimental range of the variables studied was at temperature of 52 °C, frequency of 20 Hz and using nozzle of ID 9 mm. The experimental values agreed with those predicted, thus indicating suitability of the used models and the success of RSM in optimizing the pressing conditions of investigated system. The cake resulting from pressing at optimal conditions was extracted with CO₂ in a new designed and built a homemade supercritical fluid extraction system. The residual oil in the pressed cake was almost totally extracted by supercritical CO₂. The aim of this study was also to investigate the influence of natural antioxidant (rosemary extract Oxy.Less CS, Oxy.Less CLEAR and StabilEnhance OSR, green tea extract, olive leaf extract, pomegranate extract) on the oxidative stability of *C. sativa* oil. The rosemary extract Oxy.Less CS in concentration of 0.3% was the most effective in protecting the oil from oxidative deterioration.

Solubility of β -Carotene and Glyceryl Trioleate Mixture in Supercritical CO₂

The phase behavior of the system β -carotene–glyceryl trioleate–CO₂ has been investigated by **Darija Cor et al** using a variable-volume high-pressure cell. The mass fraction of β -carotene in the initial mixture with glyceryl trioleate was 0.1 [**J. Chem. Eng. Data**, **59**, 653–658, (2014)]. The gas rich phase was sampled in the pressure range from (25 to 60) MPa at temperatures of (313, 323, and 333) K. The solubilities in dense CO₂ under the investigated conditions were in the range from (4.51 · 10⁻⁷ to 1.22 · 10⁻⁵) mol · mol⁻¹ for β -carotene and from (0.38 · 10⁻³ to 1.91 · 10⁻³) mol · mol⁻¹ for glyceryl trioleate. The results were compared with those found in the literature. The experimental data were correlated using a density based model proposed by Chrastil.

Preparation of Low Calorie Structured Lipids Catalyzed by 1,5,7-Triazabicyclo[4.4.0]dec-5-ene(TBD)-functionalized Mesoporous SBA-15 Silica in a Heterogeneous Manner

1,5,7-Triazabicyclo[4.4.0]dec-5-ene (TBD, a strong bicyclic guanidine base) functionalized SBA-15 material has been found to be an efficient solid catalyst for the interesterification between tributyrin and methyl stearate in a solvent-free system for the production of low-calorie structured lipid (LCSL). The solid base catalyst was characterized by **Wenlei Xie and Cong Qi** using small-angle X-ray scattering, Fourier transform infrared spectra, thermo gravimetric analysis, scanning electron microscopy, transmission electron microscopy, nitrogen adsorption–desorption, and elemental analysis techniques [**J. Agric. Food Chem.**, **62**, 3348–3355, (2014)]. The obtained LCSL was analyzed by reverse-phase high-performance

liquid chromatography for triacylglycerol composition. The influence of various reaction parameters, such as the substrate ratio, reaction temperature, and reaction time, on the interesterification reaction was investigated systematically. More than 90% LCSL was obtained at 80 °C within 1 h when the methyl stearate/tributyrin molar ratio of 2:1 was employed. The obtained solid catalyst could be recovered easily and reused for several recycles with a negligible loss of activity. By using the solid base catalyst, an eco-friendly more benign process for the interesterification reaction in a heterogeneous manner was developed.

Characteristics and Feasibility of Trans-Free Plastic Fats through Lipozyme TL IM-Catalyzed Interesterification of Palm Stearin and Akebia trifoliata Variety Australis Seed Oil

Akebia trifoliata var. *australis* seed oil (ASO) was used as an edible oil in China. However, in-depth research studies on ASO have yet to be conducted for production of plastic fats in food industry. In this work, an immobilized lipase from *Thermomyces lanuginosus* (TL IM) was employed to catalyze palm stearin (PS) with different ratios of ASO in a laboratory-scale operation at 60 °C by **Shi-Qiang Zhao et al**. The physical properties [e.g., fatty acid profile, slip melting point (SMP), solid fat content (SFC), polymorphic form, and microstructure] of physical blends (PBs) were analyzed and compared with those of the interesterified products (IPs). Results showed that SMPs of IPs (33.20–37.60 °C) decreased compared with those of PBs (48.03–49.30 °C) [**J. Agric. Food Chem.**, **62**, 3293–3300, (2014)]. Meanwhile, IPs showed a good SFC range from 16.11% to 28.29% at 25 °C with mostly β' polymorphic forms determined by X-ray diffraction analysis. It should be mentioned that no trans fatty acids (TFAs) were detected in any products, suggesting much more health-benefits of IPs. Texture tests showed that PBs (3318.19 ± 86.67 g) were markedly harder than IPs (557.02 ± 12.75 g). Conclusively, our study demonstrated that ASO can be utilized to produce trans-free plastic fats with good qualities through lipase-catalyzed interesterification.

Development and Validation of a Gas Chromatography–Flame Ionization Detection Method for the Determination of Epoxy Fatty Acids in Food Matrices

A reliable and suitable method for the determination of epoxy fatty acids in various food matrices based on the Bligh and Dyer lipid extraction procedure was developed and validated by **Edward Mubiru et al**. The method involves the use of a methylated epoxy fatty acid as internal standard (IS), extraction of the analytes from the matrices followed by room temperature

methylation, a three-step solid phase extraction (SPE) separation of the fatty acid methyl esters (FAMES), and detection with gas chromatography–flame ionization detection (GC-FID) [**J. Agric. Food Chem.**, **62**, 2982–2988, (2014)]. The method was validated in four different food matrices chosen as model systems, namely, vegetable oils, unprocessed pork, fried potato crisps, and infant formula. The extraction technique allows the method to be applied for routine analysis of a large amount of samples. Intraday repeatability ranged from 1 to 19%, and interday reproducibility ranged from 2 to 9%. The limit of quantification (LOQ) ranged from 3.32 to 20.47 $\mu\text{g g}^{-1}$ of sample with recoveries ranging from 94 to 115%. The results verify the accuracy and reproducibility of the analytical technique and its ability to provide reliable quantification of epoxy fatty acids. Finally, levels of epoxy fatty acids in several food products on the Belgian market were screened and are presented.

Effects of Emulsifier Addition on the Crystallization and Melting Behavior of Palm Olein and Coconut Oil

Two commercial emulsifiers (EM1 and EM2), containing predominantly monoacylglycerols (MAGs), were added in proportion of 1.0 and 3.0% (w/w) to coconut oil and palm olein. EM1 consisted of approximately 90% MAGs, whereas EM2 consisted of approximately 50% MAGs. The crystallization behavior of these systems was evaluated by differential scanning calorimetry (DSC) and microscopy under polarized light by **Jessica Mayumi Maruyama et al**. On the basis of DSC results, it was clear that the addition of EM2 accelerated the crystallization of coconut oil and delayed the crystallization of palm olein [**J. Agric. Food Chem.**, **62**, 2253–2263, (2014)]. In both oils EM2 addition led to the formation of smaller spherulites, and these effects improved the possibilities for using these fats as ingredients. In coconut oil the spherulites were maintained even at higher temperatures (20 °C). The addition of EM1 to coconut oil changed the crystallization pattern. In palm olein, the addition of 3.0% (w/w) of this emulsifier altered the pattern of crystallization of this fat.

Natural Garlic Oil as a High-Performance, Environmentally Friendly, Extreme Pressure Additive in Lubricating Oils

Weimin Li et al describe natural garlic oil (NGO) as a high-performance, environmentally friendly, extreme pressure additive for lubricating oils [**ACS Sustainable Chem. Eng.**, **2**, 798–803, (2014)]. The chemical composition of NGO was analyzed by gas chromatography–mass spectrometry (GC-MS). The load-carrying capacities of NGO and sulfurized isobutylene (SIB) in different base fluids were

comparatively evaluated by a four-ball tester and an optimol SRV-IV oscillating reciprocating friction and wear tester (SRV tester). The four-ball test results revealed that incorporation of 1 wt % NGO into the base fluids could significantly improve the weld point of the base fluids from approximately 126 to 800 kgf or higher. Moreover, the four-ball test and SRV test results demonstrated that NGO could provide superior load-carrying ability in the selected base fluids than the conventional extreme pressure additive SIB. In addition, X-ray photoelectron spectroscopy (XPS) results showed that NGO and SIB experienced a similar tribochemical process with the generation of tribofilms composed with iron oxides, iron sulfates, iron sulfide, etc. NGO showed great promise for use as an effective, eco-friendly, extreme pressure additive for application in environmentally sensitive areas.

Influence of Microwaves Treatment of Rapeseed on Phenolic Compounds and Canolol Content

Rapeseeds were treated with microwaves under 800 W for 0, 1, 2, 3, 4, 5, 6, 7, and 8 min at a frequency of 2450 MHz, and oil was extracted with a press to investigate the influence on phenolic compounds by **Mei Yang et al**, including sinapine, the main free phenolic acids, and canolol content in the rapeseeds and oil from them [**J. Agric. Food Chem.**, **62**, 1956–1963, (2014)]. The results indicated that sinapine and sinapic acid was the main phenolic compound and free phenolic acid in the rapeseed, respectively, and canolol was the main phenolic compound in the oil from rapeseed by cold press. Microwave treatment significantly influenced phenolic compounds content in the rapeseeds and oil from them. The sinapine, sinapic acid, and canolol content in rapeseed first increased and then decreased depending on the period of microwave radiation ($p < 0.05$). The canolol content of 7 min microwave pretreatment rapeseed increased to the maximum and was approximately six times greater than that of the unroasted rapeseed. The amount of canolol formed was significantly correlated with the content of sinapic acid and sinapine (for sinapic acid, $r = -0.950$, $p < 0.001$, for sinapine, $r = -0.828$, $p < 0.05$) and also the loss of sinapic acid and sinapine (for sinapic acid, $r = 0.997$, $p < 0.001$, for sinapine, $r = 0.952$, $p < 0.05$) during roasting. There were differences in the transfer rate of difference phenolic compounds to the oil extracted by press. Almost all of the sinapine remained in the cold-pressed cake and only 1.4–2.7% of the sinapic acid, whereas approximately 56–83% of the canolol was transferred to the oil. The transfer ratio of canolol significantly increased with microwave radiation time ($p < 0.001$). Microwave pretreatment of rapeseed benefited improving the oxidative stability of oil.

Biodiesel from vegetable oils

Biodiesel is gaining acceptance in the market as fuel and lubricant. It is expected that biodiesel industries will rapidly grow worldwide in the coming years and information on biodiesel feedstock, production, and characteristics will be crucial than ever especially for those using vegetable oils as feedstock as these are currently the major sources for making biodiesel. In the present paper, a comprehensive review is reported on feedstock, production technologies, and characteristics of biodiesel. More specifically, selected available vegetable oils are explored as feedstock for biodiesel production. Production technologies including latest catalyst developments are discussed. Finally, biodiesel characteristics and parameters influencing the corresponding properties are revealed. Since this paper by **Titipong Issariyakul and Ajay K. Dalai** covers a wide range in biodiesel area, it serves as a general public education medium as well as a research reference for biodiesel production from vegetable oils [**Renewable and Sustainable Energy Reviews**, **31**, 446-471, (2014)]

Rapid determination of phospholipid content of vegetable oils by FTIR spectroscopy combined with partial least-square regression

A rapid mid-FTIR method was developed to quantitatively determine the total phospholipid (PL) content of vegetable oils. The method by **Xianghe Meng et al** simply requires that the oil be diluted 4:1 (w/w) with hexane, its spectrum taken and ratioed against a hexane background. A calibration was devised using partial least squares by adding purified soybean PL at levels of 0.02–2.0% to phospholipid-free oils (soybean, rapeseed, sunflower) using the spectral region encompassing 1357–1000 cm^{-1} and validated using the AOCS 12–55 [**Food Chemistry**, **147**, 272-278, (2014)]. Using calibration and leave-one-out cross-validation predictive errors, a 200–20,000 ppm calibration was accurate to within ± 362 and 488 ppm, respectively, while for sub-calibrations ranging from 200 to 2000; 2000 to 8000 and 8000 to 20,000 ppm, they were ± 72 –172, ± 119 –220, and ± 242 –371 ppm, respectively. Although limited to 3 oil types in this study, the calibration is simple to devise and can be broadened to the universe of oil types of interest, the analytical protocol being straightforward and the analysis readily automatable.

Electrochemical ultra-micro sensors for the determination of synthetic and natural antioxidants in edible vegetable oils

Sebastian Noel Robledo et al described the application of square wave voltammetry at ultramicroelectrodes for the determination of natural antioxidants (α , δ , and γ tocopherols), and tert-butyl hydroxytoluene in edible vegetable oils [**Sensors and Actuators B: Chemical**, **192**, 467-473, (2014)]. Tocopherol determinations were performed in benzene/ethanol (1:2) + 0.1 mol L^{-1} H_2SO_4 + oil samples at a carbon fiber disk ultramicroelectrode, and tert-butyl hydroxytoluene was determined in acetonitrile (ACN) + 0.1 mol L^{-1} $(\text{C}_4\text{H}_9)_4\text{NF}_6\text{P}$ at a Pt band ultramicroelectrode after performing its extraction from the oil sample with ACN. Recovery percentages determined by the standard additions method were in the range from 92% to 102%, with variation coefficients between 0.5% and 4%. Antioxidant concentrations calculated by this methodology were in good agreement with those values declared by the manufacturers.

Potential application of *Terminalia catappa* L. and *Carapa guianensis* oils for biofuel production: Physical-chemical properties of neat vegetable oils, their methyl-esters and bio-oils (hydrocarbons)

In this work, two different perennial tree species were studied by **Oswaldo K. Iha et al** as triacylglyceride sources for producing biofuels [**Industrial Crops and Products**, **52**, 95-98, (2014)] . These species grow wild in the Amazon and along the Brazilian coast and may be a good solution for oil production that does not rely on food sources or fossil fuels while encouraging preservation of the rain forest and seashore vegetation. Consequently, we studied the oils obtained from *Terminalia catappa* L. (TC) and *Carapa guianensis* (CG) to evaluate their characteristics and chemical composition. Furthermore, we produced biofuels from these oils and analyzed their physical-chemical properties. The physical-chemical properties of the TC and CG biodiesels make them acceptable for use in diesel engines showing a promising economic exploitation of these raw materials. The bio-oils obtained from TC and CG were not completely deoxygenated; however, their physical-chemical properties demonstrated the potential of these oils as acceptable renewable fuels for diesel engines.

[Contributed by KN Prasanna Rani]

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OTAI - AOCS Joint Membership

Oil Technologists' Association of India and American Oil Chemists' Society have come out with an attractive Joint Membership proposal for the members of OTAI. Members are requested to contact the Honorary Secretaries of the respective zones for availing this opportunity.



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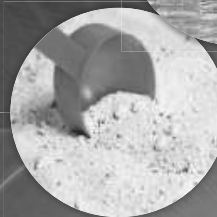
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**For any further information please contact:
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E-mail: otai2014@otaicentralzone.org
Website: www.otaicentralzone.org**

FORTHCOMING EVENTS

1. 105th AOCS Annual Meeting & Expo, at Henry B Gonzalez Convention Center, San Antonio, Texas, USA during May 4-7, 2014. For details, contact: AOCS Meetings & Exhibits Department, Phone: +12176934821, e-mail: meetings@aocs.org.
2. Fats, Oils and Grease Management Workshop at NJWEA Annual Conference Ballys, Atlantic City, New Jersey, during May 12-13, 2014. For details, contact: www.wef.org.
3. 13th Practical Short Course on Fundamentals of Edible Oil Refining, Processing and Quality Management at Crown PlazaMontpellier Corum, Montpellier, France, September 13-14, 2014. For details, contact: Dr Ignace Debruyne. Tel: +32476460798; e-mail: info@smartcourses.com.
4. Globeoil India 2014 at Renaissance Mumbai Convention Centre, Renaissance Hotel, Mumbai, during 26-28 September, 2014. For details, contact: Tefla's, Phone: 91-22-28710245/28710246; Fax: 91-22-28710247; e-mail: teflas@gmail.com.
5. World Conference on Fabric and Homecare, at Montreux Music and Convention Centre, Montreux, Switzerland during October 6-9, 2014. This meeting is organized by American Oil Chemists' Society. For details, contact: AOCS Meetings Department, Phone no. +1 217-693-4821; Fax: +1 217-693-4865; e-mail: meetings@aocs.org; website: <http://aocs.org/meetings>.
6. Oils and Fats International Congress 2014 (OFIC 2014) at Kualalampur Convention Centre, Kualalampur, Malaysia during November 5-7, 2014. For details, Contact: Ms. Michelle Lim, OFIC Secretariat, MOSTA, Selangor, Malaysia. E-mail: mosta.secretariat@gmail.com.
7. 69th Annual Convention of Oil Technologists' Association of India and International Conference on Sustainable Technologies and Futuristic Trends: Oilseeds, Oil Processing and Surfactants & Expo 2014 at Hotel Radisson Blue, Agra, India during November 14-16, 2014. For details, contact: Prof R K Trivedi, President, OTAI Central Zone. Phone: +91-9415024771. E-mail: otaicentralzone.org; website: www.otaicentralzone.org.

NEW BOOKS PUBLISHED

1. Toxins and Biologically Active Compounds from Micro-algae, Volume 1 by Gian Paulo Rossini, CRC Press, Cheriton House, North Way, Andover, Hants, SP10 5BE, UK. ISBN : 9781482210682, \$159.95, 2013.
2. Batch Processing: Modeling and Design by Urmila Diwekar, CRC Press, Cheriton House, North Way, Andover, Hants, SP10 5BE, UK. ISBN : 9781439861196, \$149.95, 2013.
3. Solid State Fermentations for Foods and Beverages by Edited by Jian Chan and Yang Zhu,, CRC Press, Cheriton House, North Way, Andover, Hants, SP10 5BE, UK. ISBN : 9781439844960, \$179.95, 2013.
4. Post Harvest Technology and Food Process Engineering by Amalendu Chakraverty and R Paul Singh, CRC Press, Cheriton House, North Way, Andover, Hants, SP10 5BE, UK. ISBN : 9781466553200, \$159.95, 2013.
5. Trans Fats Replacement Solutions, Edited by Dharma R Kodali, AOCS Press, 2710 South Boulder Drive, P O Box 17190, Urbana, Illinois, IL 61803-7190, USA. E-mail: publications@aocs.org. ISBN : 9780983079156, \$195, 2014.
6. Engineering of Polymers and Chemical Complexity, Volume 1: Current State of the Art and Perspectives, Edited by Ling Shu Liu and Antonio Ballada, CRC Press, Cheriton House, North Way, Andover, Hants, SP10 5BE, UK. ISBN : 9781482231687, \$149.95, 2013.
7. Extracellular Glycolipids of Yeasts, Biodiversity, Biochemistry and Prospects, by Ekaterina Kulakovskaya and Tatiana Kulakovskaya, Elsevier Publications, Academic Press, The Boulevard, Kidlington, Oxford 51 GB, UK. ISBN : 9780124200692, \$179.95, 2013.
8. Canola and Rapeseed, Production, Processing, Food Quality and Nutrition, Edited by Usha Thiyam-Hollander, N A Michael Eskin and Bertrand Matthaus, AOCS Press, 2710 South Boulder Drive, P O Box 17190, Urbana, Illinois, IL 61803-7190, USA. E-mail: publications@aocs.org. ISBN : 9781466513860, \$195, 2013.

All the members of OTAI are requested to update their membership details and send the information to their respective zonal secretaries

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OTAI ANNUAL MERIT AWARDS

1. Dr. S Hussain Zaheer Memorial Award (Single Person Award for Basic Research): Annual Cash Award of Rs. 5,000/- was instituted with the support of Zaheer Science Foundation, New Delhi. The award is for excellence in research contribution in Oil Chemistry and Technology, Surface Coatings and Allied Subjects, through research papers, which include applicant's name among the authors and which appeared during the previous three calendar years.
2. Dr. S D Tirumala Rao Memorial Award (Single Person Award for Applied Research): Annual Cash Award of Rs. 5,000/- was instituted with the support of Anantapur Chapter of OTAI (SZ). The award is for excellence in research contributions in relevant subject "Wealth from Waste" or "Value-added Products from the Waste generated in Vegetable Oil Industry" through research papers, which include applicant's name among the authors and which appeared during the previous three calendar years.
3. RBGV Swaika Memorial Award (Team Award for Applied Research): Annual Cash Award of Rs. 5,000/- was instituted with support of Shri B K Swaika and Shri N K Swaika of M/s Swaika Vanaspati Products, Kolkatta. The award is for excellence in Specific Process or Product Development or Innovation or Improvement in the Oils, Oilseeds, Surface Coating and Allied Field over three calendar years.
4. Dr. Santinath Ghosh Memorial Research Award: Annual Cash Award of Rs.10,000/- and citation was instituted by OTAI (EZ) with corpus fund donated by Dr. Pubali Ghosh Dhar in memory of Dr. Santinath Ghosh for the Young Researcher (age below 35 years as on 1st January of the particular year). The award is for excellence in the field of Oil Technology and Allied Sciences with Best Social / Industrial Implication through patent / research paper, which include applicant's name among the authors which appeared during the previous calendar year.
5. S R Bhatnagar (SARBI) Memorial Research Award: Annual Cash Award of Rs 15,000/- and citation was instituted by OTAI (WZ) with the Corpus fund of donated by Mrs. Cherry Churi, Director, Ms Sarbi Petroleum & Chemicals Pvt. Ltd. in memory of Late Mr. S R Bhatnagar for the post graduate students. The award is for excellence in the research in the field of Tribology / Lubricant and allied fields for the research papers published which include applicant's name among the authors which appeared during the previous or current calendar year.
6. O P Narula – OTAI (SZ) Technology Award: Annual Cash Award of Rs. 7,500/- was instituted with the support of Shri O P Narula, New Delhi and OTAI (SZ). The award is for the best project report prepared for a specific topic identified by OTAI (SZ). The applicant has to submit a 10 to 15 page report (5 copies) on the above topic to the Secretary, OTAI (SZ).
7. O P Narula – OTAI (SZ) Young Scientist Award: Annual Cash Award of Rs. 5000/- was instituted with the support of Shri O P Narula, New Delhi and OTAI (SZ). This award is for a researcher who is engaged in Oils & Allied Products and should not have completed 35 years of age as on 1st January of the particular year. The award is for Publications/Patents which include applicant's name among the authors.

For further details and prescribed proforma for Award Nos. 1, 2 & 3, the applicants may contact Prof R K Trivedi, Hony. General Secretary, Oil Technologists' Association of India, C/o. HBTI, Kanpur – 208 002. For Award No. 4, the applicants may contact Dr. Mahua Ghosh, Hony. Secretary (EZ), C/o. Dept. of Chemical Technology, University of Calcutta, 92, A.P.C. Road. Kolkata 700 009, West Bengal. For Award No. 5, the applicants may contact Dr Rajeev Churi, C/o Oils, Surfactants & Oleochemicals Div., ICT, Matunga, Mumbai-19. For Award No. 6 and 7, the applicants may contact Dr. B V S K Rao, Hony.Secretary, OTAI (SZ), C/o CSIR-IICT, Hyderabad – 500 007. Any member of the OTAI engaged in an Academic or Industrial Research Organization or in industry is eligible for all the awards. The same award may be given second or more times to the same person, but only after the lapse of three years.

8. Prof. R K Khanna Memorial Award: Annual Cash Award of Rs. 5,000/- was instituted with the support of OTAI (Central Zone) in memory of Prof. R K Khanna. This team award is for the best research paper published in all issues of the Journal of Lipid Science and Technology, which appeared during previous calendar year. No application is required for this award.



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