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Errata : The Editorial team has been informed by some honorable members that Page No 20 was not printed in JLST 50(1) Jan - Mar 2018 issue. Although the PDF copy contains the said page, the printer has acknowledged the concern of our valuable readers and the article is being printed once again at Page Nos 89, 90 in this issue.

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From Editors Desk



Hello Friends,

This time I thought it prudent to raise the general health issue and its relation with the present industrial practices. Unfortunately, the competition in food items is unfair as some honest industries are packing the same food inside as they claim versus other set of industries which are claiming one thing and packing some thing else. The regulatory bodies are either not having manpower to check it or their expert teams are not aware of the malpractices that are happening in our great country. Interesterification is permitted in the industry, the only thing is that on packaged food, it is to be mentioned that the oil is esterified and which fats are used. Presently the Industry is involved in esterification of fat with glycerol thus flouting the norm but may be for short of manpower regulatory bodies are not able to identify the culprits.

Though the FSSAI has become very proactive in framing the laws, packaging laws have been changed and are being implemented vigorously, quality rules have been changed in recent times. The rules for quality parameters have become extra ordinarily stringent like the level of pesticides, metals etc.

At times, expert teams also does not think of people below the poverty level. Here, I wish to mention that melting point of vanaspati in regulation of BIS used to be 37°C which was later on enhanced to 41°C to push in more of palm oil into the vanaspati manufacture. However, in the recent past the expert committee changed it and the limit has been removed. Now as the melting point limit is removed even tristyrene can be fed to those poor people who consume vanaspati and all of us who are framing rules don't eat vanaspati. With no limit on saturation, the poors will continue to consume unbalanced fat (hydrogenated).

(R.P. SINGH)

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EFFECT OF INFRARED RADIATION AS A PRE-DRYING TECHNIQUE A CASE STUDY ON REDUCING THE OIL UPTAKE DURING DEEP FAT FRYING OF POTATO CHIPS

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ABSTRACT

The most important energy source in the human diet is carbohydrates, and can be found in abundance in potatoes. Among the many processed varieties, deep fried potato chips are highly appreciated by the consumers. But high oil content in fried products is one of the major issues making them unsuitable for daily consumption. The average fat absorption of potato chips is usually 20-30%. Longer the frying period, the greater the absorption, so by using an alternative and rapid heat source during the pre-drying, we can reduce the process time. Infrared radiation can be one of the options to this pre-drying of potato slices followed by deep frying to study the reduction of oil uptake. In the present investigation the pre-drying time using infrared radiation is compared with that of conventional tray drier using drying curves at 50°C, 60°C and 70°C and the oil uptake is compared with pre-drying followed by frying which resulted in reduced oil content around 18.6 %. The surface morphology for porosity is also studied using scanning electron microscopy.

Key words: *Infrared radiation, oil uptake, deep fat frying, porosity, scanning electron microscopy*

1. INTRODUCTION

Drying is one of the oldest methods of food preservation. The most common is drying, in which heat is transferred from the hot air to the product by convection, and evaporated water is transported to the air also by convection. In convective drying, resistances to the heat and mass transfer are in the boundary layer and their magnitude is dependent on air velocity, or more generally on the Reynolds's number. On the other hand, resistances to heat and mass transfer in the material undergoing drying are large and strongly affect kinetics of the water evaporation. Convective drying usually is long and causes many undesirable changes in the material. One of the ways to shorten the drying time is to supply heat by infrared radiation. This method of heating is especially suitable to dry thin layers of material with large surface exposed to radiation by catalytic reaction (Fig.1). Application of infrared heating to food drying is recently of special interest because of the progress in radiator construction. Their efficiency is between 80% and 90%, the emitted radiation is in narrow wavelength range and they are miniaturized (Fig.2)

Food products subjected to drying usually contain large amounts of water. Hence, absorption of infrared energy by water is an important variable, which affects drying kinetics. Generally, solid

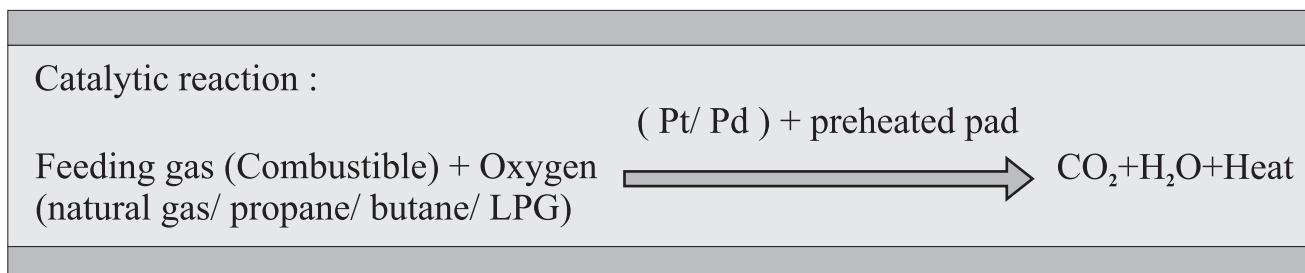


Fig.1: Catalytic Reaction

materials absorb infrared radiation in a thin surface layer. However, moist porous materials are penetrated by radiation to some depth and their transmissivity depends on the moisture content. During drying, radiation properties of the material are changing due to decreasing water content. As consequence, its reflectivity increases and the absorptivity decreases.

The most important energy source in the human diet is carbohydrates, and can be found in abundance in potatoes. Among the many processed varieties, deep fried potato chips are highly appreciated by

the consumers. But high oil content in fried products is one of the major issues making them unsuitable for daily consumption. The average fat absorption of potato chips is usually 20-30%. Fat absorption depends upon the time of frying (the longer the frying period, the greater the absorption), the total surface area of the food (the greater the area, the more absorption), the type of food surface (rough or porous surfaces absorb more fat), the frying temperature (the lower the temperature, the greater the absorption), the nature of the food and the nature and condition of the fat. So by using an alternative and rapid heat source during the pre-

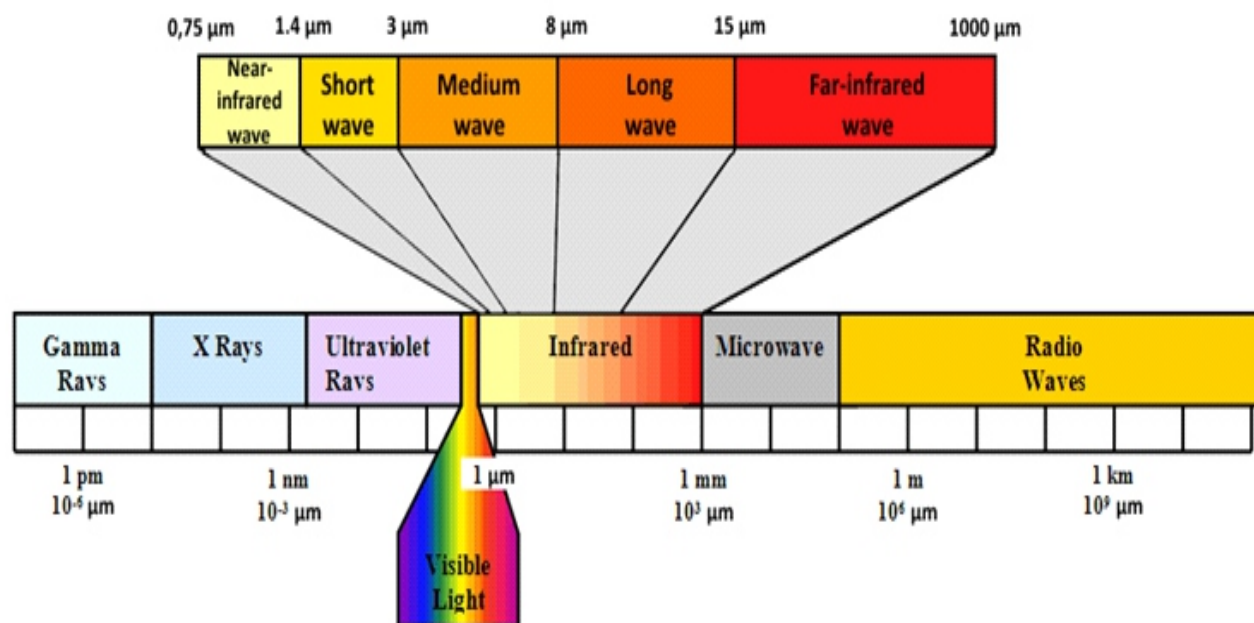


Fig. 2: Wavelength spectrum of electromagnetic waves

drying, we can reduce the process time and the expansion due to thermal exposure and consequently reduce the oil uptake in the deep fried chips.

2. METHODOLOGY

2.1 TRAY DRYING OF POTATOES Drying experiments were carried out in a tray drier (Fig.3). The samples were dried in the perforated tray. Weight loss of samples was recorded by using a digital balance. The samples of the potato weighing about 50 ± 0.5 g were spread on the tray. The drying experiments were conducted at 50°C , 60°C and 70°C . Air flows parallel to the drying surfaces of samples. During drying process, the sample was weighed at every 30 seconds for 5 minutes and then weighed at 30 minutes time intervals. Then, the moisture content values were used for plotting the drying curves.

2.2 INFRARED DRYING OF POTATOES

Drying experiments were carried out in an infrared heater (Fig.4). The samples of potato weighing about 10 gm were spread evenly on the pan of moisture meter. The drying experiments were conducted at 50°C , 60°C and 70°C . During drying process, the readings were taken at 30 seconds for 5 min and then weighed at 5 minutes time intervals. The moisture content values were used for plotting the drying curves.

2.3 DATA ANALYSIS

Graphs are plotted between to find the effectiveness of IR radiation as compared to the conventional tray drier as Drying time vs. Moisture content

2.4 DEEP FAT FRYING AND OIL UPTAKE

Two groups of (tray dried and infrared dried)

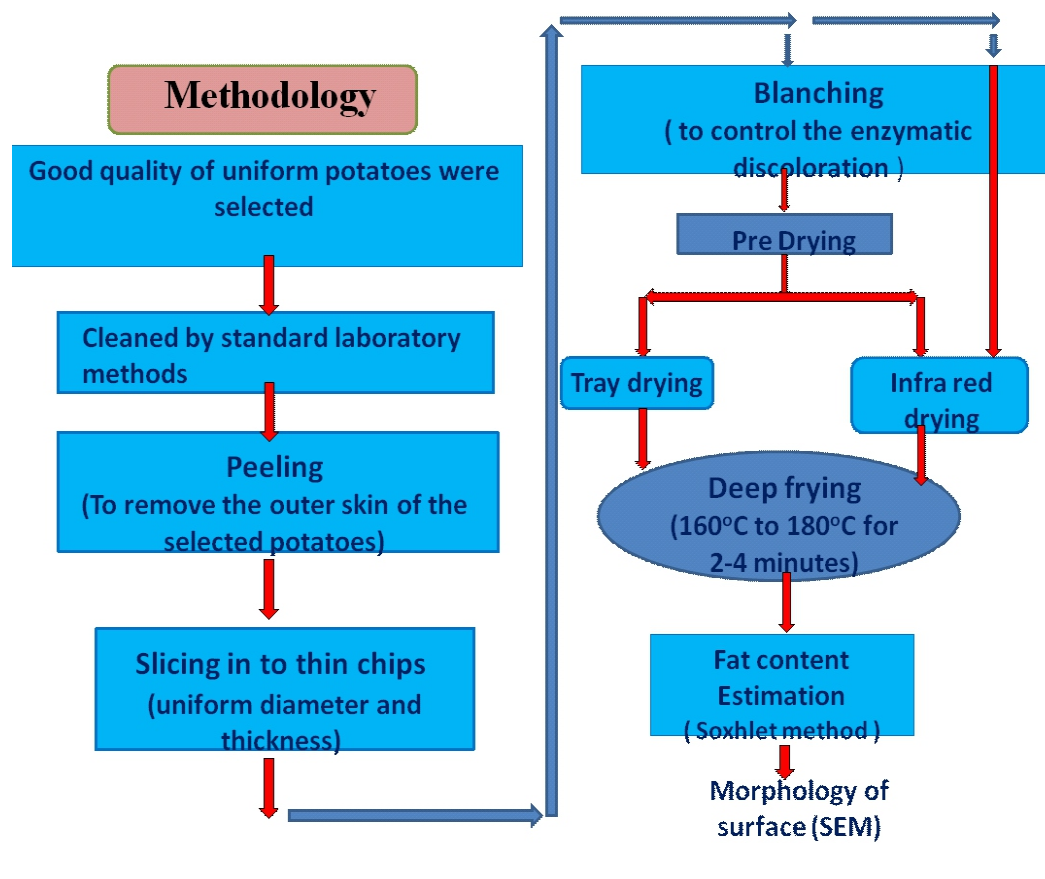


Fig.3: Flow chart of the methodology

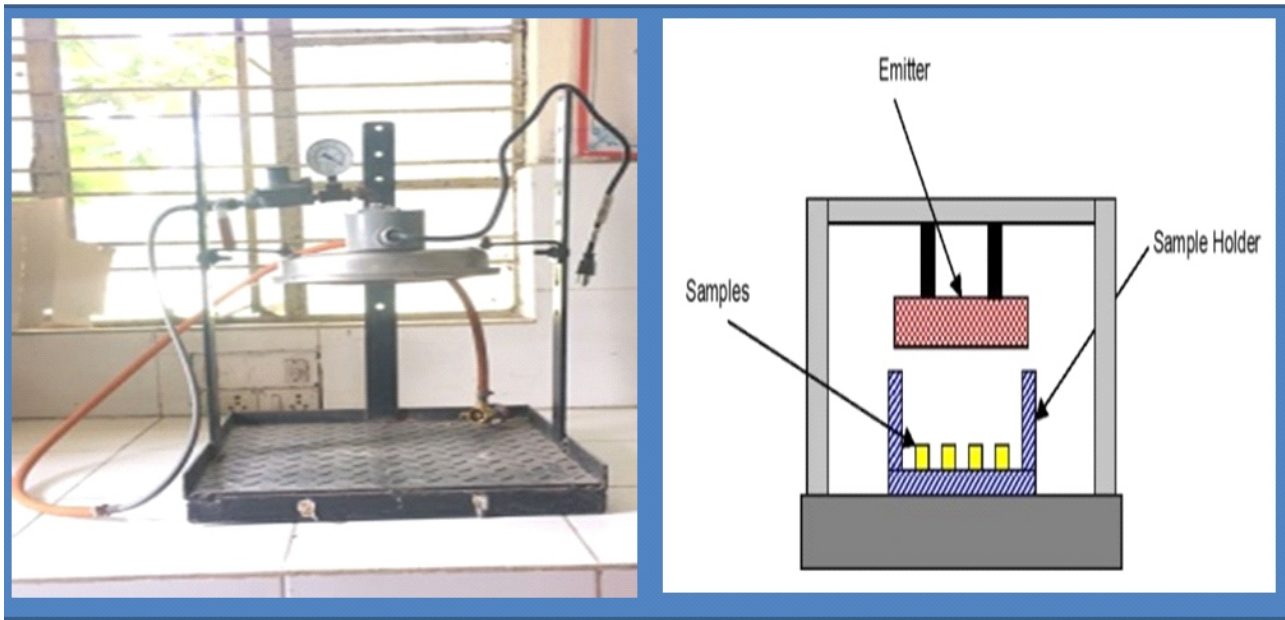


Fig.4: Infrared heater set up and schematic diagram

uniform sliced potatoes were fried at 160°C to 180°C for few minutes by using countertop fryer using cooking oil (smoke point more than frying temperatures) ,then the oil uptake was calculated by using the Soxhlet extraction method (SoxTRON- Sox4) .Total oil content was expressed as g oil per g of total material taken for frying. All experiments were performed in triplicate

2.5 SURFACE MORPHOLOGY

The surface morphology of dried and fried potato slices were studied using Scanning electron

microscopy (HITACHI – S3700N)

3. RESULTS AND DISCUSSIONS

3.1 Drying Curves

From Fig.5, it is clear that the moisture content decreases continuously with drying time by using Tray dryer. The drying air temperature had a significant effect on the moisture content of samples. The rate of moisture loss was higher at higher temperatures, and the total drying time reduced substantially with the increase in air temperature. The drying time reduced from 218 to 123 min when the air temperature was increased

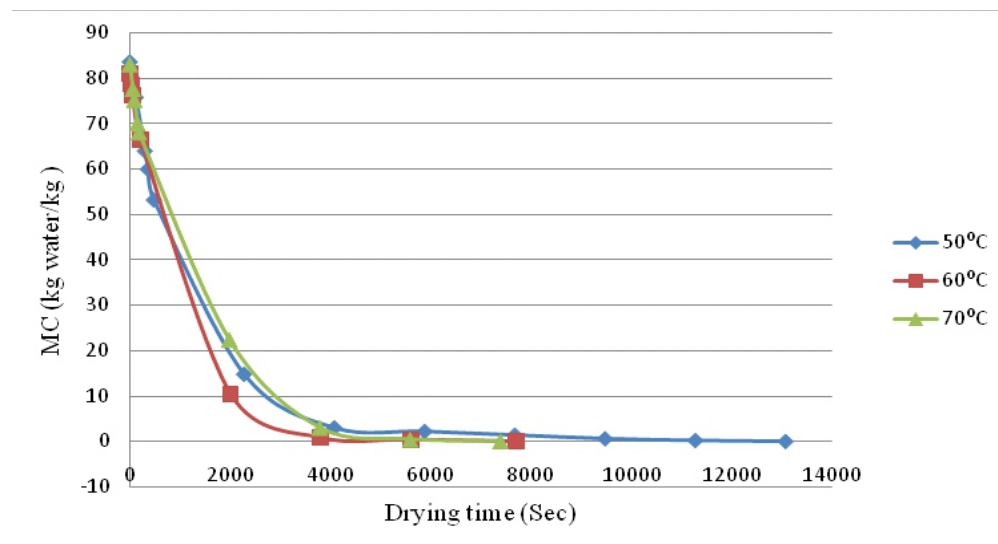


Fig. 5: Variation of moisture content with drying time of potato slices dried at 50°C, 60°C, 70°C temperatures using Tray dryer

from 50°C to 70°C. (Table.1, Table 2 & Table.3)

From Fig.6, it is clear that the moisture content decreases continuously with drying time by using Infrared dryer. The temperature had a significant effect on the moisture content of samples. The rate of moisture loss was higher at higher temperatures, and the total drying time reduced substantially with the increase in air temperature. The drying time reduced from 55 to 35 min when the air temperature was increased from 50°C to 70°C. (Table.1, Table 2

& Table.3)

3.2 Oil Uptake

The fat content of potato chips treated with Tray drying were compared with Infrared pre-drying, which resulted in reduction of the fat content from 20.62 g fat per 100 g to 16.79 g fat per 100 g of fried product.(Fig.7)

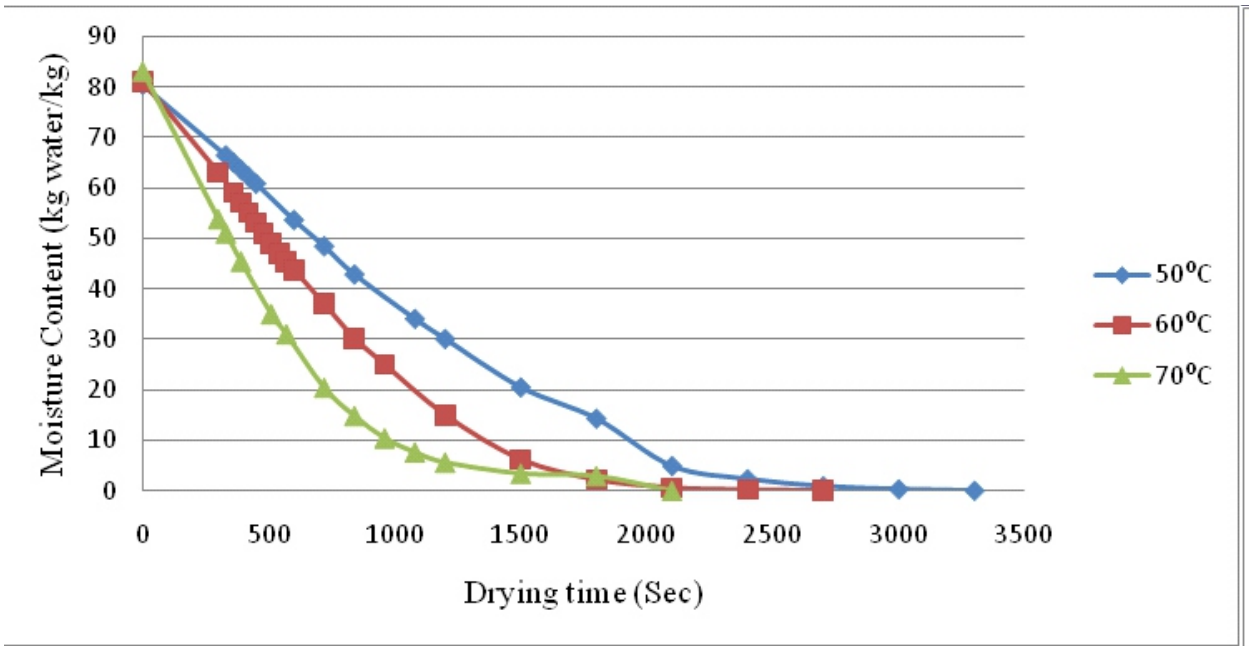


Fig.6: Variation of moisture content with drying time of potato slices dried at 50°C, 60°C, 70°C temperatures using Infrared dryer.

Type of drying	Time (min)	Moisture content (%)
Tray drying	218	88.6
Infrared drying	55	80.5

Table 1: Comparison of Tray dryer with Infrared dryer at 50 °C

Table 2: Comparison of Tray dryer with Infrared dryer at 60 °C

Type of drying	Time (min)	Moisture content (%)
Tray drying	150.5	89.2
Infrared drying	45	81

Table 3: Comparison of Tray dryer with Infrared dryer at 70 °C

Type of drying	Time (min)	Moisture content (%)
Tray drying	123	89
Infrared drying	35	82

3.3 Surface Morphology

The study of SEM images (Fig.8 & Fig.9) showed that, the surface of infrared treated slices was smoother and less broken than the pre treated tray

dried slices.

4.CONCLUSION

From table 1,table 2 and table 3 we can conclude that the process time for pre-drying period is much

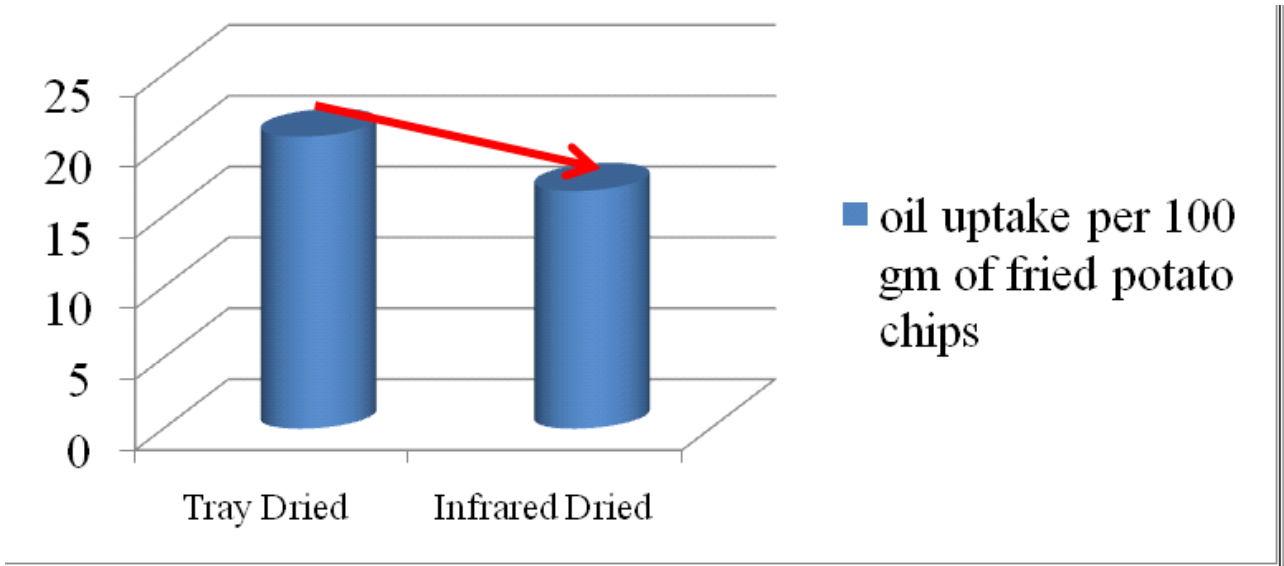


Fig.7: Reduction in oil uptake per 100gm of sample Tray dryer Vs Infrared Dryer

lesser in infrared radiation than that of tray drying, the thermal expansion of solid surface area is also less which leads to the overall reduction in the porosity, as a result the oil absorption has reduced by around 18.6 %. The same effect is observed even in the morphological study of the surface of potato slices by Scanning Electron Microscopy. So using the infrared radiation for pre drying of potato chips is not only reducing the time of the process also reducing the oil uptake of the final product.

5. ACKNOWLEDGMENT

The authors wish to thank for the supports received from Head, Department of Food Technology Srinivas Maloo, Principal Prof. R. Shyam Sundar, Dean Prof. Ravindranath and entire teaching and non-teaching staff of Food Technology and College of Technology, Osmania University. We also would like to extend our sincere thanks to the entire teaching and non-teaching staff of JNTU Ananthpuram for their unconditional support.

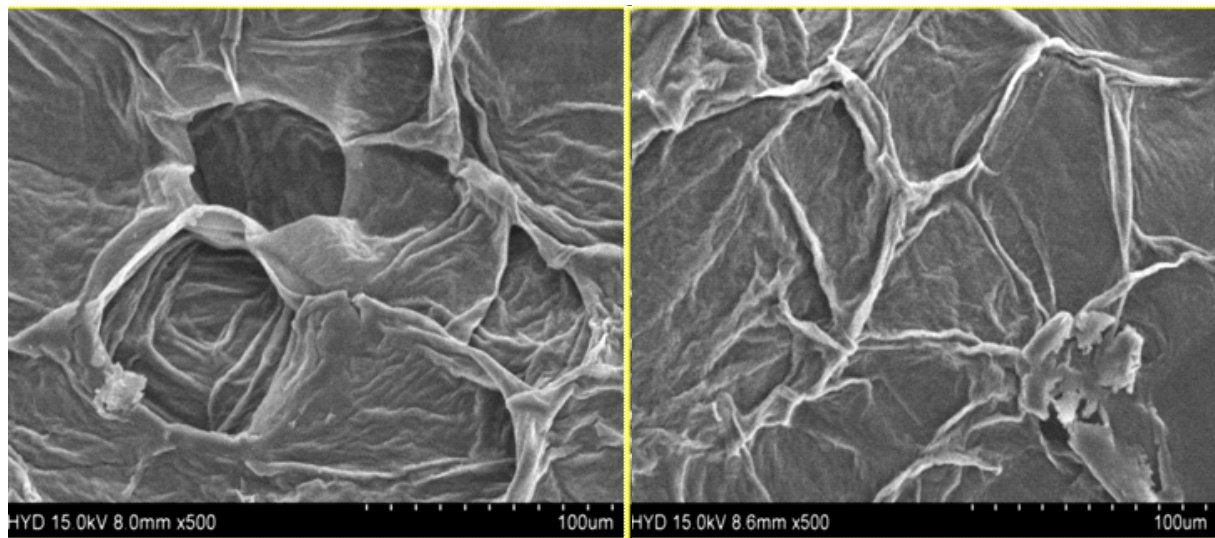


Fig.8: before frying - Tray dried sample and Infra red dried Sample

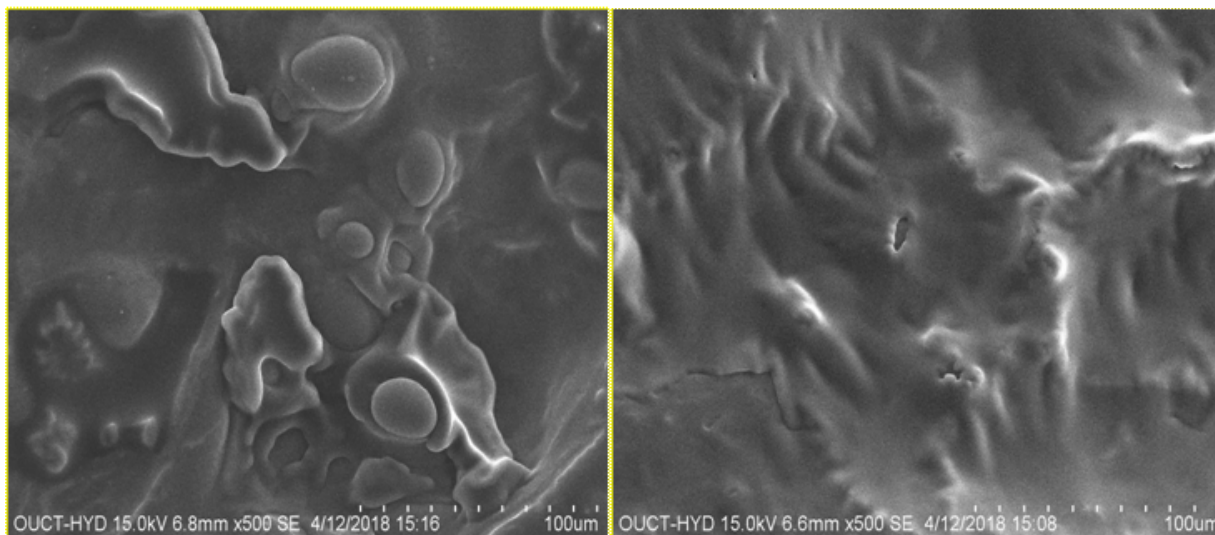


Fig.9: after frying - Tray dried sample and Infra red dried Sample

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To Study the Synthesis of Diacylglycerol from Vegetable Oils by Enzymatic Catalysis Reaction and it's Application

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ABSTRACT

Lipase TLIM was used to synthesize DAG in the glycerolysis of oils. When glycerol as such was used the DAG yield was very low i.e. only 14-15 wt% because glycerol may form a layer around the hydrophilic lipase particles due to which limitations can occurs in contact between the lipase and hydrophobic oil phase. Glycerol absorbed on silica gel was used in the lipase catalyzed glycerolysis reaction which results in increased yield of DAG, i.e. 58-62 wt%.

Mustard oil and Palm kernel oil were used as hydrophobic phase. The DAG yield of both the oil was higher when glycerol absorbed on silica gel was used than glycerol.

Keywords:

DAG, enzyme, glycerol, glycerolysis, hydrophobic phase.

Introduction:

Diacylglycerol is minor natural component of various edible oils and fats [1] which was used as nonionic emulsifiers in the foods, pharmaceuticals and cosmetics [2]. A mixture of MAG and DAG is used for these industrial applications because of the good performance of the mixture and which is also cost effective. Naturally DAG is present in two isomeric forms approximately at the ratio of 3:7, sn-1, 2 (2, 3) and sn-1, 3-DAG and the 1, 3-DAG form is responsible for beneficial effects due to its metabolism along a different metabolic pathway [3]. DAG oil was manufactured as cooking oil in Japan and United States in which DAG content is ~80 wt % and the rest of TAG [4].

Many literatures shows the studies on dietary effects of humans and animals after intake of DAG oil in comparison to DAG and TAG oils have shown a suppressed accumulation of TAG in body and

liver and decrease in postprandial TAG levels in serum [5, 6].

A mixture of MAG and DAG oils can be produced by using catalyst such as sodium, potassium, or calcium hydroxide at high temperatures ~250°C chemically [7]. In this reaction DAG can be formed both by removal of an acyl moiety from TAG molecule and by acylation of the MAG formed during the reaction.

In present study we used enzymatic reactions catalyzed by Lipase TLIM which is advantageous over chemical method such as increased selectivity, higher product purity and quality, energy conservation, and the omission of toxic catalysts. For manufacturing of MAG in high yield many lipase catalyzed synthesis of partial acylglycerols has been studied thoroughly, [8, 9, 10] however, for the synthesis of DAG as major component few reports are available on esterification reactions with and without use of organic solvent [11, 12]. For the synthesis of DAG glycerolysis reaction used which was catalyzed by lipase-TLIM [13].

For the production of 1, 3-DAG with high purity involves the partial hydrolysis of fat or oil to obtain partial hydrolysate with a high FFA content, followed by 1, 3-specific lipase-catalyzed esterification of the FFA in the hydrolysate with glycerol in recent methods [14]. In this work for production of DAG we used the solvent free glycerolysis of TAG oil directly because there is no need to liberate FFA and it avoids costly and time consuming process of solvent recovery and the DAG product can be use in food safely. In present study Lipase TLIM was used for the production of DAG. Lipase was used because it lowers process temperature which decreases the energy input; no by-products were formed so eliminating the need for a purification process and through

immobilization. In one case glycerol as such and in other the glycerol used was absorbed on silica gel to reveal the interactions between the lipase carrier material and glycerol.

2 EXPERIMENTAL SECTION:

2.1 MATERIALS:

Glycerol (99%), Silica gel (150-200 mesh size), Molecular sieves (4Å), AR grade chloroform and acetone were procured from M/S Thomas Baker; Immobilized Lipozyme TLIM (*Thermomyces lanuginosus*) enzyme was provided by M/s Novozymes India Pvt. Ltd., Bangalore as gift sample; Mustard oil, Palm kernel oil etc.

2.2 METHODS:

The DAG was synthesized by two methods:

2.2.1 Glycerolysis reaction using Glycerol directly.

In the first method Glycerol as such was used in the glycerolysis reaction with vegetable oil and the catalyst Lipozyme TLIM.

Glycerol and vegetable oil were taken in molar ratio of 2:1 in a conical flask and kept in orbital shaker for 15 min at 60°C and 150 rpm for mixing of reactant and then 5% of the total mass Lipozyme TLIM was added in reaction mixture and the flask was kept in orbital shaker incubator for 28 hours at 60°C and 150 rpm and the reaction was stopped by adding chloroform which separates the phases. This reaction was carried out for two different vegetable oils Mustard oil and palm kernel oil.

2.2.2 ADSORPTION OF GLYCEROL ONTO SOLID SUPPORT:

Equal amounts of water-free glycerol and silica gel were mechanically mixed until the glycerol was completely adsorbed on to silica and free flowing dry powder was obtained. The glycerol adsorbed on silica gel was kept in oven at 110°C and in anhydrous condition.

2.2.3 REACTION PROCEDURE:

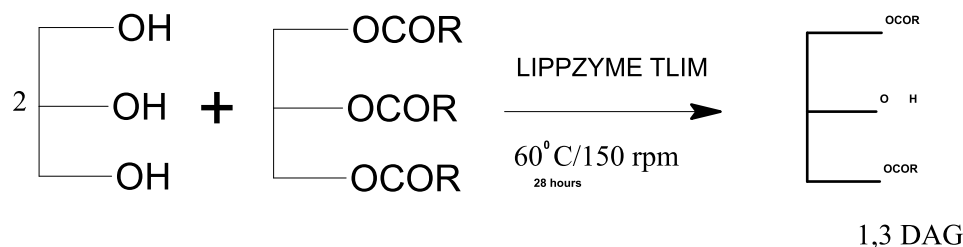
Vegetable oil and glycerol were taken in molar ratio of 1:2 for the glycerolysis reaction and the Lipozyme TLIM enzyme was taken 5% of the total mass. Glycerolysis reactions were carried in 250 ml conical flask with cotton plugs. Initially 20 g of vegetable oil and glycerol were charged into the flask and kept in orbital shaker for 15 min at 60°C and at 150 rpm to allow mixing between the two oil and glycerol phase, then Lipase TLIM was added to the flask and kept in orbital shaker incubator for 28 hours at 60°C and 150 rpm. The reaction was stopped by addition of chloroform into the flask to separate the phases. Same procedure repeated for glycerol absorbed on the silica and DAG yield of both samples was compared.

The enzymatic glycerolysis reaction was carried out in the same manner for the two different vegetable oil samples i.e. Mustard oil and Palm kernel oil.

The reaction scheme was shown in **figure 1**.

The adsorption of glycerol on silica gel served two purposes; firstly, the active sites of the enzyme were free of glycerol blockage and so available for reaction. Glycerol was immiscible with

Figure 1: Reaction Scheme:



Enzymatic Synthesis Of DAG Oil

hydrophobic organic solvents, by adsorption of glycerol on silica; an artificial liquid-liquid interphase was generated which drives the reaction. When the glycerol was used directly without adsorption on silica gel the rate of reaction decreased and the conversion of oil to DAG was lowered.

1 ml of reaction mixture was withdrawn and analyzed by thin layer chromatography to monitor the progress of the reaction. After the completion of reaction, silica gel and enzyme were separated by filtration to obtain a crude reaction mixture. The mixture consists of diglycerides (major), some monoglycerides and triglycerides (minor) and the unreacted fatty acid. The crude reaction mixture was recrystallized with methanol. Triglycerides, monoglycerides and fatty acids are fairly soluble in methanol, even at low temperature which prevents them from recrystallization.

2.2.4 PURIFICATION OF FINAL PRODUCT:

Reaction was stopped by adding 20-30 ml of chloroform and the conical flask was brought to room temperature. The contents were passed through filter paper to remove the lipase and the suspended silica gel. The conical flask was rinsed with chloroform then with water. The lipase were recovered and reutilized. The contents of the

product separated by using chloroform and water, chloroform layer contains unreacted vegetable oil and the product (1, 3-DAG), and the water layer contains unreacted glycerol.

The product was then subjected to quantitative and qualitative analysis by means TLC, LCMS and FTIR.

3.RESULTS AND DISCUSSION:

The structure of compound was confirmed by TLC, FTIR and LCMS

3.1 TLC:

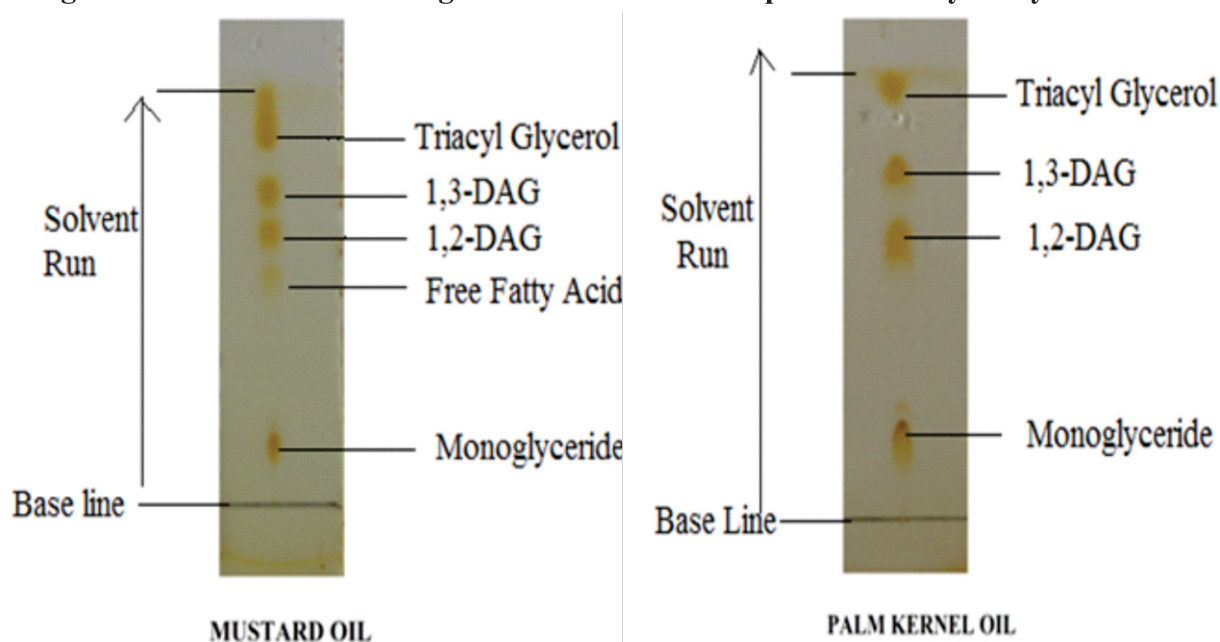
A mixture of Chloroform: Acetone (96:4) was used for elution of TLC plate. TLC plates were used for the analysis of glycerolysis reaction and separation of final lipid product.

The TLC of compounds was shown in **figure 2**.

3.2 LCMS:

The final products were analyzed for LCMS to analyze the molecular weight of compounds. The mustard dag shows m/z values for 989 for triacylglycerol and 683 as base peak for diacylglycerol. The Palm-kernel shows the m/z values at 688 for triacylglycerol and at 439 as base peak for diacylglycerol.

Figure 2: TLC: Retention Diagram for Different Components of Glycerolysis Reaction:



The graphs of mass spectra were shown in graph in **figures 3 and 4**.

The DAG yield of Mustard oil was 13-15 % for glycerol and 58-60% for glycerol adsorbed on silica gel. The DAG yield of Palm kernel oil was 12-15% for glycerol and 60-62% for glycerol adsorbed on silica gel.

3.3 FTIR:

The FTIR spectra were obtained by using a model Miracle 10.DRS plate of the sample was subjected

to analysis with 45 scan. The final products of enzymatic glycerolysis of vegetable oils were analyzed by Infra red Spectroscopy to identify the functional groups in the end product and to determine the synthesis of 1, 3- diacylglycerols. The graphs were shown in **figure 5**.

The hydroxyl group of glycerol shows characteristic peak at $\sim 3500\text{cm}^{-1}$ and the carbonyl of ester at $\sim 1735\text{cm}^{-1}$.

FIGURE 3: MS of Mustard DAG:

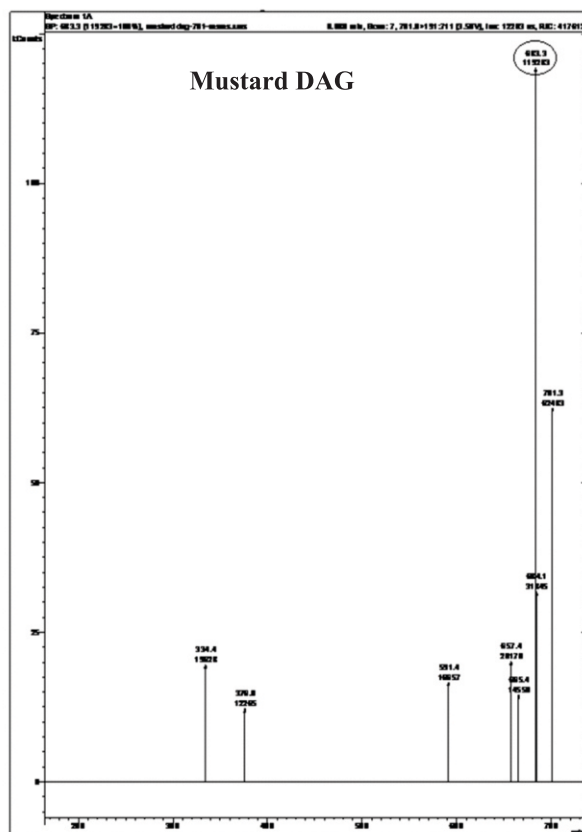


FIGURE 4: MS of Palm kernel DAG:

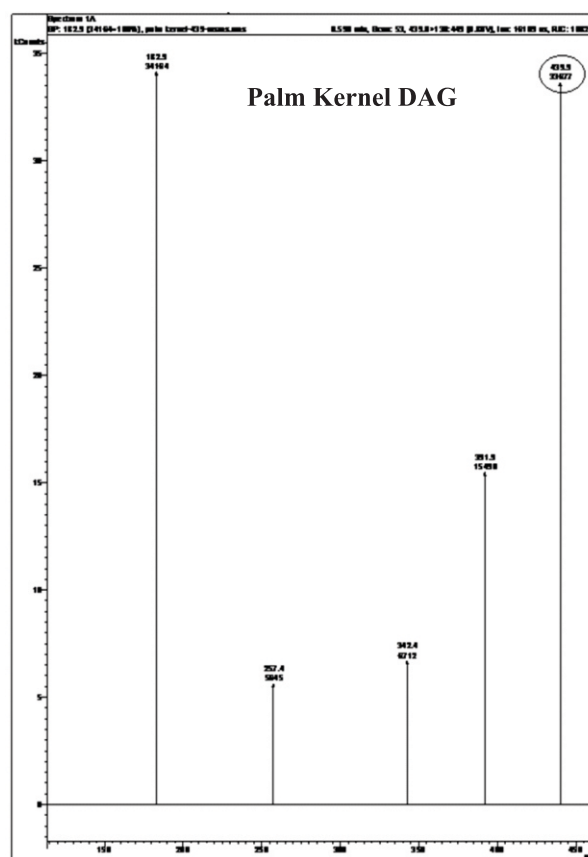


FIGURE 5: IR of Palm kernel and Mustard DAG:

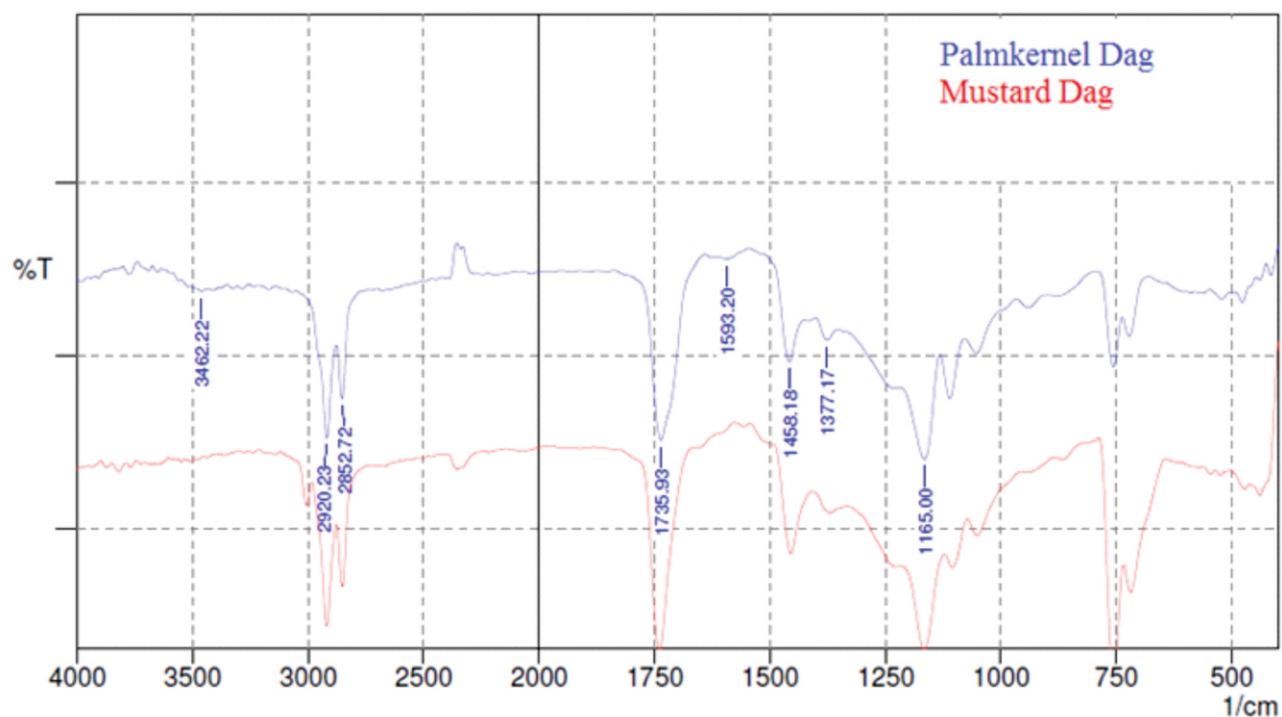


Table 1: Analytical Values

Sample	Acid Value (mg KOH/g)	Saponification Value (mg KOH/g)	Iodine Value (mg KOH/g)	Hydroxyl Value (mg KOH/g)	Ester Value (mg KOH/g)
Palm kernel (DAG)	1.89±0.009	218.46±0.01	11.69±0.008	99.00±0.01	216.57±0.02
Palm kernel (Oil)	1.7904±0.01	250.87±0.02	18.05±0.01	20.40±0.01	249.21±0.02
Mustard (DAG)	1.733±0.009	133.01±0.01	51.32±0.01	35.38±0.01	131.28±0.01
Mustard(Oil)	1.4481±0.008	174.012±0.01	105.01±0.08	10.34±0.009	172.55±0.02

3.4 Acid Value:

The acid value of the reaction mixture was determined according to the American Oil Chemists Society (A.O.C.S.) Official Method Te1a-64.

Acid value is the measure of reaction progress towards esterification. The low acid values are an indication of lower rancidity of oils. But higher contents were found in crude product in comparison with purified oils; showing they were much more rancid than purified oils.

Acid Values are shown in **Table 1**.

3.5 Saponification Value:

Saponification value is the number of milligrams of potassium hydroxide (KOH) required to saponify completely the fatty material present and also to neutralize the free fatty acids present in one gram of the fat or oil. The long chain fatty acids found in fats have low saponification value because they have relatively fewer numbers of carboxylic functional groups per unit mass of the fats as compared to short chain fatty acids.

The saponification value of the reaction mixture was determined according to the American Oil Chemists Society (A.O.C.S.) Official Method Cd 3-25. And the values are shown in **Table 1**.

The sap value of triglycerides (oils) was higher than that of product i.e. diglycerides (dag oil) because in the glycerolysis reaction the ester group of triglycerides was replaced by hydroxyl group so as the no. of carboxyl group decreases sap value also decreases.

3.6 Hydroxyl Value:

The hydroxyl value of the reaction mixture was determined according to (A.O.C.S.) Official Method Cd 13-60 and the values are shown in **Table 1**.

Hydroxyl value is the measure of the content of free hydroxyl groups in a chemical substance. As the glycerolysis reaction takes place the carboxyl group attached to glycerol moiety was replaced by hydroxyl group so the hydroxyl value of dag oil was increased.

3.7 Iodine Value:

The iodine value (I.V.) of the reaction mixture was determined according to (A.O.C.S.) Official Method Cd 1-25 and the values are shown in **Table 1**.

The iodine value (I.V.) gives a measure of the average degree of unsaturation of a lipid; the higher the iodine value, the greater the number of C=C

Table 2: Analytical Values

Sample	Refractive Index	Specific Gravity	% of Glycerol	% of FFA
Palm kernel (DAG)	1.4505±0.0001	0.9415±0.0001	17.79±0.009	0.95±0.01
Palm kernel (Oil)	1.4550±0.0001	0.873±0.0002	13.63±0.01	0.90±0.01
Mustard (DAG)	1.4586±0.0002	0.9479±0.0002	10.78±0.009	0.87±0.01
Mustard(Oil)	1.4646±0.0001	0.908±0.0001	9.44±0.008	0.73±0.008

double bonds. Iodine value (I.V.) is directly proportional to the degree of unsaturation (No of double bonds) and inversely proportional to the melting point (M.P.) of lipid. An increase in I.V. indicates high susceptibility of lipid to oxidative rancidity due to high degree of unsaturation.

3.8 Ester Value:

The ester value is defined as the mg of KOH required to react with glycerin after saponify one gram of fat. It is calculated from the saponification value (SV) and the acid value (AV). The results are shown in **Table 1**.

Ester Value (EV) = Saponification Value (SV)
Acid Value (AV)

3.9 Percent of Glycerol:

Percent of glycerol was calculated from ester value and the results are tabulated in **Table 2**. As the glycerolysis reaction takes place the percent of glycerol are increased in DAG.

3.10 Percentage of Free Fatty Acid:

Percentage of free fatty acid (%FFA) can be calculated from acid value by following formula,

$$\% \text{ FFA} = \text{AV} \times 0.503$$

The percent of free fatty acid was slightly increased in DAG than in vegetable oil and the values are shown in **Table 2**.

3.11 Refractive Index:

Refractive Indices of all compounds were calculated and are shown in **Table 2**. The use of higher refractive index ingredients in the aqueous phase facilitates formulation and reduces the need to add other components to increase the index of the aqueous phase.

3.12 Specific Gravity:

Specific gravity of DAG and oil were measured and listed in **Table 2**. Specific gravity of DAG was higher than corresponding oil.

4. APPLICATION:

By using Diacyl Glycerol as emulsifier Margarine was synthesized and can be used as such as cooking oil as it contains high percent of dag.

Procedure for preparation of margarine: 20 g of coconut oil and 30 g of sunflower oil were taken in beaker and the beaker was placed in ice water, mix the contents well. After mixing the beaker was taken out of ice then 10 ml milk and 10 ml egg yolk were added also 1 gram of emulsifier (synthesized dag) mix well and salt was added, lemon juice and herbs were added for enhancing flavor and test. The synthesized margarine has good spreadability, texture and it is a satisfactory substitute for butter; the results were shown in **Table 2**.

The function of DAG in margarine synthesis is aeration and foam stabilization, emulsion stabilization, dough straightening and crystal modification. DAG involves in the emulsion mechanisms such as charging of droplets of dispersed system, creation of an interfacial film between immiscible phases and reduction of interfacial tension between oil and water phases.

5. CONCLUSION:

The glycerol adsorbed on silica facilitates the reaction towards esterification and the DAG yield higher than glycerol as such. The synthesis of DAG by this method had greater properties than triglycerides or oils. Lipozyme TLIM was specific to 1, 3 position, product obtained with high purity.

The sap value and iodine value is decreased as compared to the oils where as hydroxyl value was increased showing the breakdown of ester. Percent of glycerol also increased indicating dag formation takes place.

Percent of free acid was low so the dag oil is good for health and can be used as good replacement for vegetable oils. Margarine synthesized by using these DAG has good texture and spreadability.

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SAFETY ASPECTS IN SOLVENT EXTRACTION PLANTS

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1. INTRODUCTION

Extraction process of oil from oil bearing materials with the help of volatile substances is a traditional practice followed by edible oil industries world wide. The first study related to this process was done by Mr. E. Deiss for the extraction of fat from bones and from wool using Carbon BiSulphide and he was granted a patent on November 13, 1855 After struggle of several years, the above process can be applied commercially to extract oil residue from olives which had already been pressed. With the discovery of new volatile solvents in 1878 mainly Paraffin hydrocarbons much safer as compare to than Carbon Bi-Sulphide, the extraction system took a big leap and reached new heights in the field

of oil bearing seeds[1,2]. During initial periods seed oil industry showed very little interest in solvent extraction probably due to two things; first, because the prosperity-minded oil crushers paid no attention to the low percent oil left in the cake coming from the presses, and second, because of the many accidents which had happened to dry cleaners who were using gasoline without any knowledge of the safety measures which should be followed in that connection.

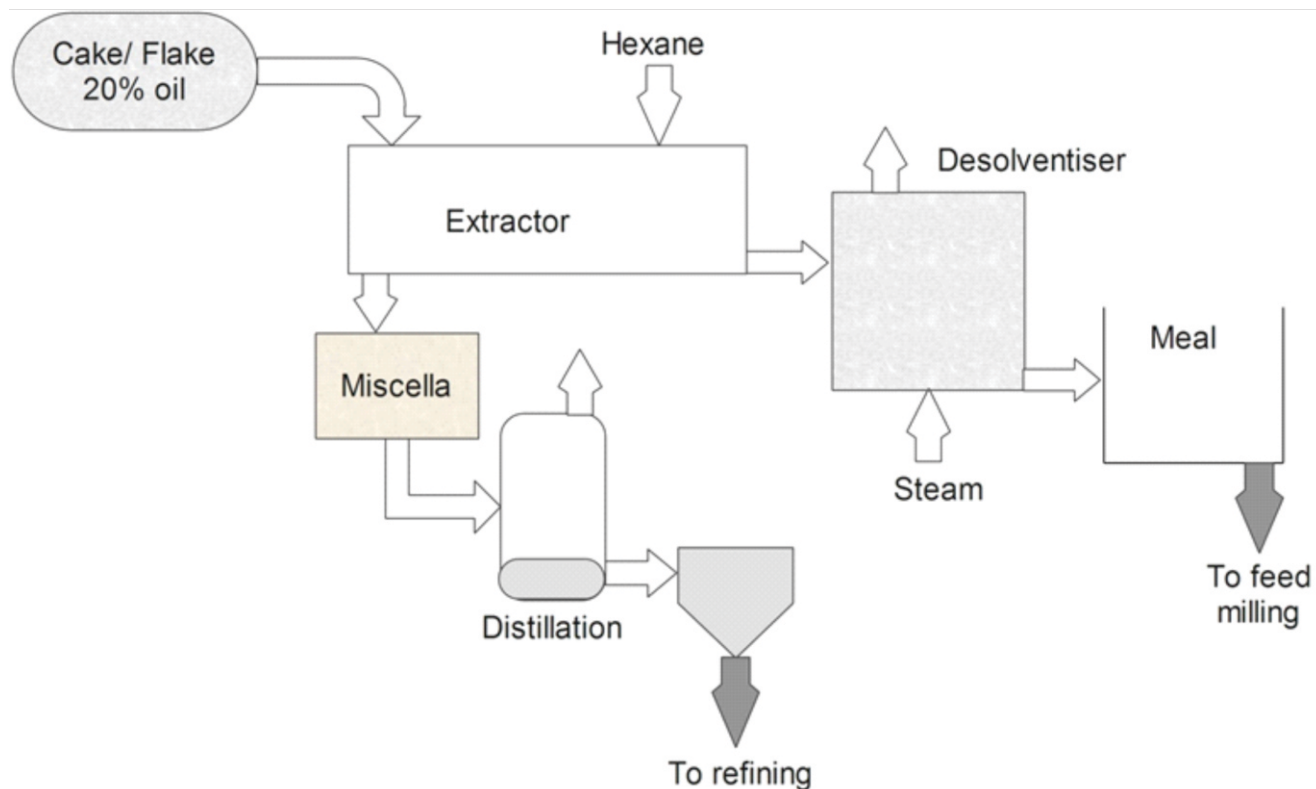


Fig:1 Typical solvent extraction process

2. HAZARDS OF PROCESS

2.1 HANDLING OF SEEDS

It is very difficult to manage and handle bulk quantities of oil seeds without liberating huge quantity of dust so in most of the operations related to conveying and storage there is a very high probability of dust explosion[1,2,3]. This hazard has always been neglected as compare to the others while it can create the greater problems as compare to solvent explosion. The fundamental principles to reduce dust explosion is similar to other hazardous processes: contaminant of dust, prevention from naked flame or high temperature sources of ignition, and so on. Majority of plants are designed taking all the safety measures in mind yet had been allowed to become unsafe because of a of human errors: insufficient inspection , poor house- keeping, and very often a misconception of the idea that a dusty environment is normal and acceptable in this industry.

2.2 SOLVENT EXTRACTION PROCESS

The process of solvent extraction process is regarded a process of high hazard because of application of huge amount of volatile and possibly explosive solvents. However, when past history is studied, it is observed that majority of [4] accidents in this industry, as in all industry, are caused not by technological failure but by human error. However, technical precautions are also very to the prevention of any sources of ignition which might initiate a dust or solvent explosion. Following is the list of few accidents that took place in world wide.

Table 1: Summary of few accidents that took place in Solvent extraction plants [Facts, TNO 2007][22]

A severe accident happened in a vegetable oil refinery in Italy in 2006. During maintenance operations, an explosion occurred in a pomace olive oil-storage tank, resulting 4 fatalities among personnel and damaging the nearby equipments.

Fig:1 Typical solvent extraction process

Year	Country	Location	Operation	Fatalities	Injuries	Abstract
1975	The Netherlands	Harbour/port/ dock	Maintenance (cleaning)		>1	During cleaning operation of a tank on tanker after unloading cocosoil, some hexane vapors caused at least 1 casualty
1976	The Netherlands	Factory	Processing		4	Wear and tear of pump seal caused hexane release under the space of building, ignition, explosion and 4 casualties
1977	Germany	Factory	Processing			Fire in extractor of soya factory
1979	The Netherlands	Inland navigation	Maintenance		1	Vapor cloud explosion on vessel in locks caused fire and 1 casualty
1980	Denmark	Factory	Processing		27	hexane release at extraction plant for soya bean caused evacuation of the plant & after switch off (un)loaded power supply line an explosion occurred causing 27 casualties
1983	Argentina	Storage/depot	Storage	1	>1	A fire in an elevator ignited gas from sunflower pellets in silo setting of an explosion causing more than 2 casualties
1983	Germany	Factory	Processing	2	11	Explosion and fire at oil extraction plant
1984	The	Factory	Processing		2	While working in the

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The reason of this explosion was the accidental ignition of the residual solvent vapor during welding operations. A similar type of accident occurred in Spain only after a few months. The residual solvent probably accumulated in the vapor phase, mixed with air and forming flammable mixtures which possibly resulted in the confined explosion of the storage vessel due to presence of ignition.

3. FACTORS RESPONSIBLE FOR ACCIDENTS AND HAZARDS IN SOLVENT EXTRACTION AND SAFETY MEASURES

With the new technological developments chemical engineers now days are in a position to maintain a high level of safety measures in solvent extraction plants. Earlier It was the common belief that liquid gasoline was far more dangerous than vapors and while a careful attention was diverted to any liquid gasoline spilled or dripping in the plant, very little care was paid to any smell of gasoline vapors noticed in or around the plant. Another primary reason of accidents in the early development of the industry was the misconception of the operators that danger of ignition was in the near by areas of the volatile solvent. Very cruel experiences have taught us a lesson that, depending upon situation, sometimes hazard and danger lies even a thousand or more feet away. Several accidents involving severe casualties have happened in industries because required attention was not taken of the role of static electricity. Following are the few factors responsible for the hazards in solvent extraction plants.

3.1 HUMAN FACTORS

The main reason of accidents that occurred because of the common and well-known habit of human beings to become more and more careless as they spend time and getting practiced to being near danger site[1,2,5,6]. With the scientific development of now days, it would be possible to develop and operate a solvent extraction plant with an almost perfect degree of safety. A high level of discipline must be expected in the plant as well as in the surroundings. Perfect cleanliness, plenty of room, well updated equipments and sharp care of the equipment must give the workers the constant impression of the highly-specialized job they must handle; that impression emphasized at all times by the very minute inspections and exigency of the foreman and the superintendent. The ideal worker

who is best adapted to a solvent extraction plant must be a logical-thinking, calm, quick, machine-loving person. He should be a person of thinking that a little smell of solvent in the extraction plant should have the same meaning to him as a hole in a ship would have to a sailor. The worker must be given proper instructions regarding physical and chemical characteristics of the solvent and made familiar with the entire process before being promoted to the apprentice level. Each worker must be completely aware of each step of the operation and know exactly the working of the instruments and devices in related with the process. In this way only they execute orders with complete accuracy. About minded and half way minded persons are not required in these plants. The in charge should make frequent rounds and inspections to observe whether the instructions have been thoroughly followed. Danger of explosion must be kept in mind, but not made an object of extreme fear, which gives the impression that the man is powerless. All workers allowed to enter an extraction building must have shoes with soles made of felt or some special material that, when dampened by the natural perspiration of the feet, is a good conductor of electricity. No place for sitting or hiding and no boxes or cabinets should be permitted in the extraction building. Obviously, the carrying of any sort of source of ignition like matches, lighters, or objects having potential of producing sparks must be prohibited and strictly enforced. It would be well to make workers wear uniforms having no pockets. In general human factors are also very important to be taken care.

3.2 PLANT LAY OUT AND BUILDING

In order to have low insurance rates and keeping view of safety the extraction building must be separated from the area in which oleaginous materials are processed for extraction or where the extracted meal storage is there[1,2,7,8]. It should be located at least fifty feet from other buildings, far away from main lines of railroads or from residences. The railway tracks should be made in such a manner that engine should always remain 200 feet or more from the plant. There should be no grass around the building for a radius of almost one hundred feet, the parking of cars should not be permitted within that same radius, and the driveway should be at least fifty feet away. In these types of designs of extraction area the developer should have in mind that whenever some explosion takes

place there should be minimum catastrophic effect. The so-called building should be developed to have the steel frame, supporting the extraction and distillation equipments, with siding and roof of light sheet metal with provision fastened with light clamps. In this manner the force of an explosion would be minimized should it occur and there would be no projection of material create problem in the vicinity. Such a type of metal, well bonded and grounded, will act, also, as a protection against lightning. The building should have more height as compare to width and the upper part should be constituted of louvers which should always be left open and to be closed only in case of heavy rain. [9] The lower part of the building should be provided sufficient ventilation with plenty of windows and doors which also should be left open. In this way, in as much as the distilling and extraction apparatus and the steam lines—even if they are well insulated—will radiate some heat, there will always be a circulating draft from the bottom to the top of the building, which draft will serve to dilute and carry away vapors coming from any eventual dripping of solvent.

4. GENERAL AND SPECIFIC SAFETY GUIDELINES IN SOLVENT EXTRACTION PLANTS FOR VEGETABLE OILS

Vegetable oil processing involves the transport, storage, and use of bulk quantities of acids, alkalis, solvents, and hydrogen during extraction and refining. Their transport, storage, and handling provide opportunities for spills or other types of releases with potentially negative impacts on soil and water resources. Their flammability and other potentially hazardous characteristics also present a risk of fire and explosions. Hazardous materials should be managed according to the General Environmental health and safety (EHS) Guidelines. [10-21] **Occupational Health and Safety** Occupational health and safety issues during the operational phase include:

1. Chemical hazards

2. Physical hazards

➤ (a) Electrical hazards

➤ (b) Risk of fire

➤ © Noise

1. Chemical hazards

Operators in vegetable oil facilities may be exposed to hazardous substances via, inhalation of hexane or

other solvents used for extraction; inhalation of toxic chemicals (e.g., sodium methylate can cause burns on the skin and lung tissue if inhaled); eye or skin exposure to acids or bases; inhalation of dust from the transportation of raw materials (e.g., seeds and beans to the crushing plant); inhalation of dust from meal treatment and shipment; inhalation of dust from bleaching earth, filter aid, and nickel catalyst; and inhalation of aflatoxins present in raw materials. The guidelines are

Ø Replacement of the hazardous substance with a less hazardous substitute.

Ø Implementation of engineering and administrative control measures to avoid or minimize the release of hazardous substances into the work environment keeping the level of exposure below internationally established or recognized limits Keeping the number of employees exposed, or likely to become exposed, to a minimum.

Ø Communicating chemical hazards to workers through labeling and marking according to national and internationally recognized requirements and standards, including the International Chemical Safety Cards (ICSC), Materials Safety Data Sheets (MSDS), or equivalent. Any means of written communication should be in an easily understood language and be readily available to exposed workers and first-aid personnel.

2. Physical Hazards

Physical hazards in vegetable oil production and processing facilities are similar to those present in other industry sectors and include the potential for falls caused by slippery floors and stairs; injuries caused by unprotected machinery or moving parts; hazards associated with potential collisions with internal transport, such as trucks; and accidental contact with conveyor systems, such as those used in crushing plants and in the removal of spent earth.

(a) Electrical Hazards

Electrical systems are a source of danger for workers that can lead to injuries or fatalities. The General EHS Guidelines provide guidance on hazard prevention and control of electrical systems. Panels, cables, cords and hand tools, can pose a serious risk to workers. Overhead wires can be struck by metal devices, such as poles or ladders, and by vehicles with metal booms. Vehicles or grounded metal objects brought into close proximity with overhead wires can result in arcing

between the wires and the object, without actual contact.

Recommended actions include :

Ø Marking all energized electrical devices and lines with warning signs

Ø Locking out (de-charging and leaving open with a controlled locking device) and tagging out (warning sign placed on the lock) devices during service or maintenance

Ø Checking all electrical cords, cables, and hand power tools for frayed or exposed cords and following manufacturer recommendations for maximum permitted operating voltage of the portable hand tools

Ø Double insulating / grounding all electrical equipment used in environments that are, or may become, wet; using equipment with ground fault interrupter (GFI) protected circuits

Ø Protecting power cords and extension cords against damage from traffic by shielding or suspending above traffic areas

Ø Appropriate labeling of service rooms housing high voltage equipment ('electrical hazard') and where entry is controlled or prohibited.

(b) Risk of fire

The workplace should be designed to prevent the start of fires through the implementation of fire codes applicable to industrial settings. Other essential measures include

Ø Equipping facilities with fire detectors, alarm systems, and fire-fighting equipment. The equipment should be maintained in good working order and be readily accessible. It should be adequate for the dimensions and use of the premises, equipment installed, physical and chemical properties of substances present, and the maximum number of people present

Ø Provision of manual firefighting equipment that is easily accessible and simple to use.

Ø Fire and emergency alarm systems that are both audible and visible

© Noise

Noise prevention and mitigation measures should be applied where predicted or measured noise impacts from a project facility or operations exceed the applicable noise level guideline at the most sensitive point of reception. The preferred method for controlling

noise from stationary sources is to implement noise control measures at source. Methods for prevention and control of sources of noise emissions depend on the source and proximity of receptors.

Ø Noise reduction options that should be considered include:

Ø Selecting equipment with lower sound power levels

Ø Installing silencers for fans

Ø Installing suitable mufflers on engine exhausts and compressor components.

Ø Installing acoustic enclosures for equipment casing radiating noise

Ø Improving the acoustic performance of constructed buildings, apply sound insulation.

Ø Installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m² in order to minimize the transmission of sound.

SPECIFIC GUIDELINES FOR SOLVENT EXTRACTION PLANTS

Few special recommendations are also there for solvent extraction plants, these are

Ø In oil extraction areas, ensure that there is adequate air circulation to reduce the concentration of solvents.

Ø Provide ventilation, especially at workstations devoted to raw-material handling, milling, handling of bleaching earth, and use of solvents.

Ø Maintain air concentrations of VOCs below 10 percent of lower explosive limits. For hexane, the lower explosive limit is 1.1 percent volume per volume (v/v) and the upper explosive limit is 7.5 percent v/v.

Ø Ensure proper distillation of oil after extraction for effective solvent removal.

Ø Prevent leaks and spills of oils in the extraction plant.

Ø Control the flash-point temperature of the incoming extracted oils and use temperature control for all facilities receiving solvent-extracted oils.

Ø When feasible, use hot water, rather than solvents, to facilitate cleaning.

5. CONCLUSION

It is concluded that “safety” should never be considered an extra work load or an extra burden

for hard-pressed management, but that it must be accepted as a routine part of everyday plant life by human resource at all levels in solvent extraction plants to have safe operations and for better quality control.

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A Short communication

Sunit Mukherjee

“Unknown facts about sauerkraut”

Indian sauerkraut as characterised by “Hand book of Indigenous Fermented Foods, Ed K.H. Steinkraus, Pub: Mercel Dekker Inc, N.Y & Basel, 1983” is a debatable item in Indian culinary.

Highly perishable primary foods like fruits and vegetables should be processed in India at least to an intermediate stage at the village level where the raw materials are grown. For several reasons, such approach was effective in the early stage of development in U.S.A in the thirties and much later in Canada. Continued training, pilot production and preservation at low cost, developing appropriate products and processes may be required to achieve success.

It should be appreciated that the waste from the processing of fruits and vegetables could be as much as 40-50%, which is fully biodegradable & can be a powerful pollutant of the environment. However, the waste could be used as organic manure in the nearby agriculture field. It would be appropriate if biogas plants are set up to utilize the waste efficiently for production of energy and simultaneous generation of organic manure containing nitrogen, phosphorous and potassium for use in the agricultural field.

It is known that traditionally & commercially Sauerkraut is prepared in the western world by fermentation with natural flora present in the cabbage, which is to certain extent lactic acid bacteria. Under appropriate conditions the vegetable will undergo spontaneous lactic acid fermentation. A definite sequence occurs in the growth of Lactic acid bacterial species, wherein the fermentation is initiated by heterofermentative *Leuconostoc mesenteroides*, and followed by heterofermentative rods such as *Lb brevis*, homofermentative *Lb plantarum* and *Pediococcus cerevisiae*. *L. mesenteroides* is a unique flora which produces acetic acid, ethyl alcohol, carbon dioxide and hydrogen peroxide apart from lactic acid each of which has special significance. Sauerkraut is known to provide certain laxative

properties, which are due to the formation of acetyl choline and lactyl choline coming from lecithin. It is also known that an optimum temperature of 18°C. favours the development of desirable flavour, taste and texture and when the pH falls below 4, no pathogen can grow and the sauerkraut is largely safe for consumption. The author's basic studies (Sunit Mukherjee & H. Ganguly, J.F.S.T. 8, 127-131, 1971) indicate that though the flora followed the traditional path the Indian sauerkraut did not have the flavour and texture similar to the one in western world, as the temperature is generally above 18°C. Further Studies at Dr. Subhas Mukherjee Memorial R.B. Research centre, Food & Nutrition Division indicate (Ref 1) that the loss of solid in the Kraut juice is as much as 20-25%. The juice can be diluted and mixed with sugar & spices. Such product can be an acceptable drink for the Indian population. At the level of 3% salt the development of acid and subsequently change in pH is enumerated in the following table.

Changes in pH & acidity at different temperature during Indian sauerkraut fermentation at a salt level of 3%

Based on the above considerations it is suggested that during the cabbage season in West Bengal in particular and others states in India in general, when ambient temp. Ranges from 20°C to 30°C, the time of fermentation may be maintained at 5 to 7 days. After which the sauerkraut may be dipped in a solution of sodium benzoate for further preservation up to 4 months, such that the final concentration of sodium benzoate in the sauerkraut comes to 1000ppm.

In such way mixed vegetables can be preserved where the share of cabbage should be 80%, preferably. Sliced cauliflower, carrot, radish, green papaya and peas can be used in the mixture. Green vegetables should be avoided as in acid pH they turn brown. With our efforts the Food Safety & Standards Act of India -2006 has incorporated the standards of sauerkraut in India, where the

Research Roundup July-September 2018

Chemical Compositions of Walnut (*Juglans regia* L.) Oils from Different Cultivated Regions in China

A comprehensive report on the quality of Chinese walnut oil, from different cultivated regions in China is presented by Gao et al. A total of 16 walnut samples from China were selected, and walnut oils were obtained using the pressing process. The lipid compositions and micronutrient contents were analyzed. The fatty acids corresponded to palmitic acid (3.05–8.25%), oleic acid (12.56–26.03%), linoleic acid (51.21–68.97%), and linolenic acid (6.83–15.01%), and the main triacylglycerols were trilinolein (27.87–39.47%), followed by oleoyl-linoleoyl-linolenoyl-glycerol (17.07–24.18%), dilinoleoyl-oleoyl-glycerol (9.65–15.46%), palmitoyl-dilinoleoyl-glycerol (5.96–14.98%), and dilinoleoyl-linolenoyl-glycerol (6.42–12.43%). In addition, high amounts of micronutrients, including phytosterol, squalene, tocopherol, and total phenolic content, were found in walnut oils ranging from 540 to 1594, 17 to 131, 345 to 1280, and 1.04 to 20.39 mg kg⁻¹ among different samples, respectively. The differences in the geographical location and climate caused different regions of cultivation, which resulted in the differences in the chemical composition of walnut oil [*J. Amer. Oil Chem. Soc.* 95, 825–834 (2018)]. Further multiple linear regression analyses between oxidative stability indices, fatty-acid compositions, and micronutrients revealed that linoleic acid ($R = -0.891$; $P < 0.05$), α -tocopherol ($R = 0.713$; $P < 0.05$), and total phenolic content ($R = 0.369$; $P < 0.05$) were the main factors that affect the oxidative stability of the walnut oil.

Physicochemical Characterization, Fatty Acid And Tocopherol Content of *Moringa ovalifolia* (African *Moringa*) Oil From Namibia

Moringa ovalifolia tree is indigenous to Namibia and is a multipurpose tree whose leaves, pods, fruits, and flowers are edible. The tree is well adapted to the harsh climatic conditions of the region and easily cultivated. In this paper, Cheikhoussef et al. investigated the physicochemical characteristics of the oil extracted from *M. ovalifolia* seeds collected from Remhoogte Farm, Khomas region, Namibia. The oil yield was $34.86 \pm 2.47\%$. The oil contained a high level of monounsaturated fatty acids, with oleic acid (18:1) being the dominant one. The oil had high levels of tocopherol, with a total of $44.56 \text{ mg } 100 \text{ g}^{-1}$ of

oil, comprising α -tocopherol ($33.94 \text{ mg } 100 \text{ g}^{-1}$), β -tocopherol ($6.64 \text{ mg } 100 \text{ g}^{-1}$), and δ -tocopherol ($3.98 \text{ mg } 100 \text{ g}^{-1}$). High levels of stigmasteryl ($142.41 \text{ mg } 100 \text{ g}^{-1}$) and β -sitosterol ($330.70 \text{ mg } 100 \text{ g}^{-1}$) were also detected [*J. Amer. Oil Chem. Soc.* 95, 1163–1170 (2018)]. The seed oil exhibited good-quality characteristics, making it a useful new seed oil to be considered for food and nonfood applications.

Thioether-Functionalized Corn Oil Biosorbents for the Removal of Mercury and Silver Ions from Aqueous Solutions

Heavy-metal contamination is one of the most important environmental problems faced in the world, particularly in developing countries. Metals such as silver and mercury from drinking water, food, and air sources can accumulate in living organisms and present significant health concerns. Meanwhile, the demand for these metals in many industries continues to increase. In the present

study, thioether-functionalized corn oil (TFCO) from a photoinitiated thiol-ene synthesis was utilized by Dunn et al. to remove Ag⁺ and Hg²⁺ ions from an aqueous solution. An aqueous solution containing AgNO₃ and Hg(NO₃)₂ was prepared and contacted directly with TFCO. After vortex mixing for 60 s, the experiment ran for 351 min with the aqueous phase being periodically sampled for the analysis of metal ions (Mⁿ⁺). Results showed that 88.9% of Ag⁺ and 99.6% of Hg²⁺ ions were removed from the aqueous phase by the TFCO. Mass balances indicated that the total Mⁿ⁺ concentration in the oil phase was 13.890 g kg^{-1} under the conditions studied. TFCO exhibited higher selectivity for removing Hg²⁺ than for Ag⁺ ions [*J. Amer. Oil Chem. Soc.* 95, 1189–1200 (2018)]. Analysis of the adsorption kinetics showed that a pseudosecond-order model may be used to determine the rate of Ag⁺ ion sorption by the oil phase. The presence of the Hg²⁺ ions interfered with the adsorption of Ag⁺ ions from the aqueous solution.

Enzymatic Interesterification of Heterotrophic Microalgal Oil with Rapeseed Oil to Decrease the Levels of Tripalmitin

High lipid heterotrophic microalgae (HM) *Schizochytrium limacinum* is a good dietary source of long-chained polyunsaturated fatty acids. HM biomass has successfully been used in aquafeeds. However, the high saturated fatty acid content of the

allowable limit for addition of sodium benzoate has been set at 1000 ppm.

It should be appreciated that large majority of the population in India do not have the facility of canning in tiny or small scale sector, also they do not have the facility for refrigeration, hence class II preservative is allowed by the FSSAI. Furthermore, after long experimentation it is seen that the fermented sauerkraut is not well accepted in the raw form, hence the kraut was washed with hot water to remove much of the lactic acid as well as

the preservative, and then the washed cabbage and vegetables are cooked in Indian style with spices and only then the product is more acceptable to the Indian consumers. It should be acknowledged that the Indian cooking practices lose most of vitamins B and C. Fortunately much of the carotenoids in carrot is retained even after washing & cooking.

The potential for utilisation of seasonal vegetables exists in India and should be explored in practical programs wherever needed.

Av. Temp	No. of days of Fermentation	pH (approx)	Acidity %lactic acid
18°C	3 days	4.2	0.70
18°C	7 days	3.8	0.85
30°C	3 days	3.9	0.94
30°C	7 day	2.8	1.77

Based on the above considerations it is suggested that during the cabbage season in West Bengal in particular and others states in India in general, when ambient temp. Ranges from 20°C to 30°C, the time of fermentation may be maintained at 5 to 7 days. After which the sauerkraut may be dipped in a solution of sodium benzoate for further preservation up to 4 months, such that the final concentration of sodium benzoate in the sauerkraut comes to 1000ppm.

In such way mixed vegetables can be preserved where the share of cabbage should be 80%, preferably. Sliced cauliflower, carrot, radish, green papaya and peas can be used in the mixture. Green vegetables should be avoided as in acid Ph they turn brown. With our efforts the Food Safety & Standards Act of India -2006 has incorporated the standards of sauerkraut in India, where the allowable limit for addition of sodium benzoate has been set at 1000 ppm.

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The potential for utilisation of seasonal vegetables exists in India and should be explored in practical programs wherever needed.

triacylglycerol (TAG) could limit the applications of HM as a main feed lipid source. Enzymatic interesterification of HM oil with unsaturated oils may increase the utilization efficiency and remove the technical challenges in using such oils. In the present study, Borgevik et al. extracted oil from HM biomass (Alltech Inc.) with rapeseed oil are mixed, and interesterified enzymatically with either Lipozyme RM IM or Lipozyme 435 in reactions with no, addition or 5% addition, of distilled water. The experimental oil mixes are formulated to target a total fatty acid profile similar to fish oil. No addition of water to the reaction mixture leads to more efficient TAG recovery after interesterification. Overall, enzymatic interesterification of HM and rapeseed oils with Lipozyme RM IM produces oils with lower levels of tri-saturated TAG isomers, higher content of TAG isomers with unsaturated fatty acids and a lower slip melting point [Eur. J. Lipid Sci. Technol.120, 1800063 (2018)]. Animal studies need to be performed to evaluate the biological effects of interesterified against unprocessed highly unsaturated oils.

Fatty Acid Composition and Sterol Contents of Some *Origanum* Seed Oils

The present study is aimed to determine oil content, fatty acid composition, and sterol profile of several *Origanum* species from Turkey by Matthäus et al. to show the usefulness of this unusual raw material for oil processing. The oil content of *Origanum* seeds are found between 7.8% (*O. brevidens*) and 27.2% (*O. majorana*). Linoleic [10.7% (*O. brevidens*) to 20.8% (*O. vulgare* subsp. *viride*)] and α -linolenic acid [34.4% (*O. brevidens*) and 67.4% (*O. minutiflorum*)] are the predominant fatty acids of *Origanum* seed oils. The seed oils of *Origanum* samples only contain low levels of saturated fatty acids with palmitic and stearic acid as the main saturated fatty acids. Among all oil samples, the highest phytosterol content is found for β -sitosterol ranging between 2462 mg kg⁻¹ (*O. vulgare* subsp. *hirtum*) and 5280 mg kg⁻¹ (*O. minutiflorum*). Most of the *Origanum* species are very similar to *O. vulgare* regarding fatty acid and phytosterol composition, only *O. brevidens* shows a fatty acid composition with oleic and linoleic acid as predominant [Eur. J. Lipid Sci. Technol.120, 1800094 (2018)].

Phosphonated Lipids as Primary Plasticizers for PVC with Improved Flame Retardancy.

MaevaBocqué et al. synthesized bio-based plasticizers bearing moieties exhibiting flame retardancy properties. [Dimethyl (methyl oleate)phosphonate (PMO), diethyl (methyl oleate)phosphonate (PMO2), dimethyl (methyl linoleate)phosphonate (PML), dimethyl (dimethyl oleate)phosphonate (PDE)] from methyl oleate, methyl linoleate, and oleic diacid through free-radical addition of dialkyl phosphonates. SoftPVC is prepared from PMO, PMO2, PML, and PDE primary plasticizers and compared to materials containing usual diisononyl phthalate DINP. Rheological behavior, thermal stability, mechanical properties, and flame resistance performances of these PVC films are carefully investigated [Eur. J. Lipid Sci. Technol.120, 1800062 (2018)]. The presence of the phosphonate group into the plasticizer structure explains the best thermal stability of the PVC films based on phosphonated plasticizer than that of based on DINP. Regarding all these results, PMO and PDE can be considered as efficient flame retardant primary plasticizers for PVC and can substitute phthalates in soft PVC based materials.

Hexane-Free Green Solvent Extraction of Canola Oil From Microwave-Pretreated Seeds and of Antioxidant-Rich Byproducts

The ethanol extraction from microwave-pretreated and untreated canola seeds is studied by Sánchez et al. in a detailed study. Two processes are used to obtain the oil: in a control process (P1), the solvent-free total extract (E) is washed with hexane, obtaining an oil fraction (OF). The second process (P2) consists of the partial evaporation of the solvent of the total extract (E), cooling, centrifugation, and separation by decantation of the generated phases: oil-rich phase (OF + Ethanol), solvent-rich phase (EthF + Ethanol), and solid phase (SF); and then evaporating the solvent to obtain OF and an extract of soluble in the phase rich in ethanol (EthF). No significant differences due to microwaves are detected in the yields. P2 gave mean yields of 32.8%db of OF, lower than obtained with P1 (42.1%db), 4.2%db of precipitated solids, and 7.7%db of EthF, which present a mean content of hexane-solubles of 5.1%db [Eur. J. Lipid Sci. Technol.120, 1800209 (2018)]. However, the quality analysis shows a smaller oxidative damage and an increase in canolol content due to the

microwaves. P2 also generates an antioxidant-rich byproduct, allowing to recover the canolol prior to a refining stage of the oil.

Lipase-Catalyzed Butanolysis of *Echium* Oil for the Selective Enrichment in Gamma-Linolenic and Stearidonic Acids

Enzymatic butanolysis of *Echium* oil in the presence of lipases from *Candida rugosa* and *Rhizopus oryzae* has been studied by [Marta Corzo-Martínez](#) et al. for selective enrichment of polyunsaturated fatty acids. The effects of lipase immobilization, hydration of the reaction mixture and oil oxidation degree on lipase catalytic activity, fatty acid selectivity, and inactivation degree are evaluated. The utilization of butanol containing 2.5% (w/w) of water produces the highest catalytic activity of lipases in both powder and immobilized form; particularly of immobilized lipase from *Rhizopus oryzae*, which led to the complete conversion of triacylglycerols. The presence of 2.5% water also improves the biocatalyst stability, as the rate of immobilized lipase from *Rhizopus oryzae* inactivation ($K_d = 0.0084 \text{ h}^{-1}$) is much lower than in the absence of water ($K_d = 0.0285 \text{ h}^{-1}$). Stability of immobilized lipase from *Rhizopus oryzae* further increases when bleached oil is used ($K_d = 0.0008 \text{ h}^{-1}$). Then, fatty acid selectivity of immobilized lipase from *Rhizopus oryzae* is investigated by determining competitive factors for each fatty acid from *Echium* oil. Results indicates a very good activity, stability, and very important discrimination of this lipase against stearidonic and gamma-linolenic acids which can be utilized for the efficient and selective oil enrichment in polyunsaturated fatty acids [Eur. J. Lipid Sci. Technol. 120, 1800251 (2018)].

Optimization of Alkyl-diethanolamides Synthesis from *Terminalia catappa* L. Kernel Oil through Enzymatic Reaction

Alkyl-diethanolamides (fatty acid diethanolamides) synthesis from *Terminalia catappa* L. kernel oil was optimized by Gunawan et al. using lipozyme as a catalyst. The result showed that the optimal reaction conditions were 2 hours reaction time, with a ratio of oil mass (g) to diethanolamine (mmol) of 1:5, a ratio of oil mass to enzyme (g) of 1: 0.075, and a temperature of 40°C. The percentage of alkyl-diethanolamides at optimum condition was 56-60%. The synthesis results were also analyzed

by FTIR. FTIR spectra revealed specific absorption at several wave numbers (3434 cm^{-1} , 1655 cm^{-1} , 1280 cm^{-1}), indicating that amide and alcohol bonds (C=O, C-N, and O-H) were formed. GC-MS was employed to identify the types of fatty acid diethanolamides that were successfully synthesized [J. Oleo Sci. 67, (8) 949-955 (2018)]. The fatty acid diethanolamides formed were palmitoyl-diethanolamide ($R_t = 32.96 \text{ min}$) and oleyl-diethanolamide ($R_t = 35.57 \text{ min}$). The total nitrogen content of alkyl-diethanolamides was 0.26%, or 0.19 mmol of the amide group in 1 g of sample

Use of cardanol-based acrylate as reactive diluent in UV-curable castor oil-based polyurethane acrylate resins

A biobased diluent, cardanyl acrylate (CA), was synthesized from cardanol and used to modify a castor oil-based polyfunctional polyurethane acrylate (PUA) resin by Hu et al. Firstly, chemical structure of CA was characterized by FT-IR, ^1H NMR, and ^{13}C NMR. Subsequently, the effect of CA's content on the biobased content, viscosity, and volumetric shrinkage of the obtained bioresins were studied and compared with the petroleum-based hydroxyethyl acrylate (HEA) diluents [Ind. Crops & Products 117, 295-302 (2018)]. Moreover, ultimate properties of the UV-cured biomaterials such as thermal, mechanical, coating, swelling, and hydrophobic properties were investigated. Finally, UV-curing kinetics of the resulting bioresins were determined by real-time IR. By the addition of CA, the biobased content of the resulting bioresins were improved and the viscosity and volumetric shrinkage were reduced. For example, the obtained bioresin containing 30% of CA possessed a biobased content of 62.8% and volumetric shrinkage of 9.51%, which were clearly better than those of the bioresin with 30% of HEA (50.8% and 21.94%), respectively. Furthermore, many other properties of the UV-cured biomaterials, such as thermal stability, coating's hardness and adhesion, and hydrophobic properties, were improved by the incorporation of CA. The final C good potential in the development of UV-curable coatings.

Design of multifunctional nanostructured lipid carriers enriched with α -tocopherol using vegetable oils

Vegetable oils are commonly used as components in

many cosmetic products intended for daily care due to their high beneficial and multifunctional effect on skin. The general objective of this study by Dragana et al. was to develop new nanostructured lipid carrier (NLC) formulations containing vegetable oils and enrich them with α -tocopherol (TOC) in order to explore their potential as effective and safe advanced biocosmetic prototypes. The influence of lipids composition and physical state on the production and physicochemical properties of vegetable oil NLCs and enriched nanoparticles with TOC (TOC-NLCs), as a model bioactive antioxidant compound, was studied. Sunflower, sweet almond, olive and coconut oils were successfully used in the development of free and loaded NLCs. The formulations of free lipid nanoparticles with each vegetable oil presented an appropriate nanoscale size from approximately 120–350 nm and good physical stability with zeta potential values ranging between -45.6 to -65.9 mV [Ind. Crops & Products 118, 149-159 (2018)]. Likewise, the TOC-NLCs demonstrated suitable particle sizes from approximately 240–315 nm and zeta potential values ranging between -45.6 to -55.1 mV, being then verified that these parameters were affected by differences on the lipids core composition. TOC-NLCs presented a high entrapment efficiency with values above 79.4% and also assured a controlled release of TOC, independently of the percentage of incorporated active compound. Differential scanning calorimetry results showed that the incorporation of TOC and the increase of its concentration on NLCs lipids matrix caused a decrease on the onset and melting temperatures, indicating a reduced crystallinity of the obtained vegetable oil TOC-NLCs. These lipid nanoparticles and free NLCs presented good antioxidant activity with scavenging activity values above 56.7%, which was improved by the encapsulation of TOC (scavenging activity values above 64.3%) and demonstrated the ability to be incorporated in long-term stable cosmetic products based on stability studies performed during 8 months.

Catalytic cracking of waste cooking oil for biofuel production using zirconium oxide catalyst

In the present work, Bhale Rao and Goud studied catalytic cracking of waste [cooking oil](#) (WCO) for the production of liquid fuels in a semi batch reactor under N_2 atmosphere. Catalytic cracking was performed at a temperature range of 400–500 °C using zirconium oxide (ZrO_2) as a catalyst. The

influence of temperature, heating rate, residence time and catalyst loading on the product yield has been studied. The physicochemical properties such as calorific value, density, flash point and kinematic viscosity of organic liquid product (OLP) was analysed for its suitability for fuel application. The chemical compositions and functional groups present in OLP were identified by [gas chromatography-mass spectrometry](#) (GC-MS) and Fourier transformed [infrared spectroscopy](#) (FTIR). From the overall study, the optimal ZrO_2 load, reaction temperature, residence time and heating rate were found to be 4 wt%, 475 °C, 120 min and 10 °C/min, respectively at which 83 wt% of OLP was obtained [Ind. Crops & Products 118, 282-289 (2018)]. From the results of catalyst characterization, it was confirmed that the catalyst can be regenerated after use. Development of tri-functional biobased reactive diluent from ricinoleic acid for UV curable coating application cracking of waste [cooking oil](#) (WCO) for the production of liquid fuels in a semi batch reactor under N_2 atmosphere. Catalytic cracking was performed at a temperature range of 400–500 °C using zirconium oxide (ZrO_2) as a catalyst. The influence of temperature, heating rate, residence time and catalyst loading on the product yield has been studied. The physicochemical properties such as calorific value, density, flash point and kinematic viscosity of organic liquid product (OLP) was analysed for its suitability for fuel application. The chemical compositions and functional groups present in OLP were identified by [gas chromatography-mass spectrometry](#) (GC-MS) and Fourier transformed [infrared spectroscopy](#) (FTIR). From the overall study, the optimal ZrO_2 load, reaction temperature, residence time and heating rate were found to be 4 wt%, 475 °C, 120 min and 10 °C/min, respectively at which 83 wt% of OLP was obtained [Ind. Crops & Products 118, 282-289 (2018)]. From the results of catalyst characterization, it was confirmed that the catalyst can be regenerated after use. Development of tri-functional biobased reactive diluent from ricinoleic acid for UV curable coating application Renewable based materials have come out as an environmentally friendly alternative to petrochemical based materials due to their sustainability, lower carbon footprints and often lesser price. A tri-functional acrylate monomer was synthesized by Phalak et al. from Ricinoleic acid (RA) and used as biobased reactive diluent along with an oligomer for a UV curable coating

application. The ricinoleic acid was modified by using sodium methoxide catalyzed amidation with diethanolamine and converted into fatty amide based triol. This synthesized ricinamide triol (RTO) was further reacted with glycidyl methacrylate in presence of triphenylphosphine. The synthesized products were fully characterized by FTIR, GPC and end group analysis. The chemical structure of RTO and ricinamide triacrylate (RTA) was elucidated from ^1H NMR, ^{13}C NMR spectroscopy. In comparison, the commercial triacrylate was examined. The influence of addition of reactive diluents on the viscosity of oligomer with varying concentrations up to 10–30 wt% was studied using rheometer. The UV curing behavior of coatings was estimated by FTIR. The UV cured coatings was further characterized by DSC, XRD, and TGA analysis [Ind. Crops & Products 119, 9-21 (2018)]. From the results of catalyst characterization, it was confirmed that the catalyst can be regenerated after use.

Development of tri-functional biobased reactive diluent from ricinoleic acid for UV curable coating application

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content and water absorption property of UV cured coatings was also examined.

Development and evaluation of a green corrosion inhibitor based on rice bran oil obtained from agro-industrial waste

In this study by Solano et al., agro-industrial waste was used to prepare a green corrosion inhibitor based on rice bran oil. Firstly, the rice-bran oil was recovered and filtered, and then a semi-refined process was applied to separate the waxes. The performance of the synthesized inhibitor was evaluated on a 1018 steel surface by means of different electrochemical techniques such as potentiodynamic polarization, open circuit, linear polarization resistance and electrochemical impedance spectroscopy (EIS). The present results have shown that the addition of 10 and 25 ppm of inhibitor improves the performance of the system, presenting efficiencies above 99% [Ind. Crops & Products 119, 111-124 (2018)]. Interestingly, the free-energy calculated for the rice bran oil ($\Delta G_{\text{ads}} = -53.80 \text{ kJ/mol}$) pointed out the good affinity of the inhibitor with respect to the steel surface. Moreover, the EIS spectra showed the formation of a protective layer caused by the adsorption of the inhibitor on the steel surface. This layer improved remarkably the charge-transfer resistance of the metallic material.

The application of ultrasound and microwave to increase oil extraction from *Moringa oleifera* seeds

Microwave-assisted extraction (MAE) and ultrasound-assisted extraction (UAE) are novel methods, which can reduce the extraction time. However, little information is known regarding the effect of UAE and MAE on the oil extraction from *Moringa oleifera* seeds as well as oil quality. This study by Zhong et al. is aimed to evaluate the influence of MAE and UAE on oxidative stability and physicochemical properties of oil from *Moringa oleifera* seeds. The UAE and MAE showed higher oil recoveries ranged 91%–94% in short extraction duration as compared with conventional extraction (CE) which gave 90% [Ind. Crops & Products 120, 1-10 (2018)]. There were no significant differences in fatty acid composition, acylglycerol profile and thermal properties of oils

among the extraction techniques (UAE, MAE, and CE). Furthermore, the UAE and MAE did not greatly lower the oxidative stability of the oils during the whole 70 days of storage time at 25 °C. Therefore, the UAE and MAE could reduce extraction time without greatly affecting oil quality. This study provides important information about developing UAE and MAE techniques for producing high yield, short extraction duration, desirable physicochemical properties and acceptable stability of Moringa oil.

Physical, thermal and thermodynamical study of high oleic palm oil nanoemulsions

Nanoemulsions are useful for encapsulating nutritionally compounds of the high oleic palm oil (HOPO) including β -carotene and tocopherols. However, some nanoemulsions can be thermodynamically unstable. For this reason, it is important to understand the thermal and thermodynamic stability of nanoemulsions and to investigate both the parameters that cause, and the mechanisms associated with, the destabilization. In this sense, the DSC, TGA and destabilization analysis were used. In this work by Ricaurte et al., the average droplet size (ADS) and zeta potential (ζ) had a significant influence over HOPO nanoemulsions stability. The range of ADS and ζ were between 162 and 839 nm and -9 to -40 mV, respectively. Furthermore, the HOPO nanoemulsions were establish until temperatures of 80 °C, showing lower loss of weight when the ADS was higher. Additionally, the destabilization of nanoemulsions occurred by the Ostwald ripening mechanism [Food Chemistry 256, 62-70 (2018)]. The Ostwald ripening rate was provided as stability parameter which increased to nanoemulsions with ADS higher between 5×10^{-23} and $8 \times 10^{-23} \text{ m}^3/\text{s}$.

Alpha-linolenic acid-loaded oil/water microemulsion: Effects of phase behaviour simulation and environmental stress on phase stabilizing and anti-oxidation capacity

α -Linolenic acid (ALA)-loaded microemulsion (ME) was prepared by Hou et al. from isoamyl

acetate, polyoxyethylene ether 35 (EL-35), ethanol and water. The dynamic phase behaviour was simulated using dissipative particle dynamics (DPD), which showed that spherical ME was formed at water/oil ratios of 1:9 and 9:1, while a lamellar structure with distinctive water-course and oil layer appeared at ratios of 3:7, 5:5, and 7:3. Phase stabilizing and anti-oxidation effect of environmental stresses on ALA-loaded microemulsion were investigated. Results showed that the ME region was large and had good environmental tolerance. Subsequently, the investigation of anti-oxidation stability revealed that more than 60% ALA of ALA-loaded ME could be protected from oxidation under environmental stresses. Furthermore, ALA-loaded ME was applied in aqueous-based foods [Food Chemistry 256, 311-318 (2018)]. The transparency, precipitate, stratification and phase separation were used to evaluate influence of ME on product properties, confirming great feasibility and stability of ALA-loaded ME for practical applications.

Storage stability and composition changes of three cold-pressed nut oils under refrigeration and room temperature conditions

Chemical composition and stability parameters of three cold-pressed nut oils (almond, walnut and pistachio) were monitored for up to 16 months of storage at 5 °C, 10 °C, 20 °C and room temperature by Rabadán et al. Freshly pressed pistachio oil had lower peroxide value than almond oil and higher induction period than almond and walnut oils, indicating a higher stability. The peroxide values increased faster at room temperature than at lower temperatures during the storage time, and the highest increase was for pistachio oil stored at room temperature exposed to daylight. The induction period decreased for all three nut oils during the storage time, regardless of the storage conditions [Food Chemistry 259, 31-35 (2018)]. Pistachio oil remained the most stable oil at the end of the storage time, followed by almond oil. The percentage of polyunsaturated fatty acids decreased slightly throughout the storage.



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