Ultrasonic Studies on Mustard Oil: A Critical Review

R. P. Yadav[1], Bibha Kumari[2]

[1]Department of Physics, Govt. P. G. College, Bisalpur (Pilibhit) – 262201, India

[2]Department of Physics, Invertis University, Bareilly-243001, India

Abstract: ***A critical review on ultrasonic studies of mustard oil gives an insight into the Physico –Chemical and Dynamic properties of mustard oils. Heart-friendly oil should be cholesterol- and trans-fat free, low in saturated fats and high in monounsaturated fat (MUFA) and polyunsaturated fat (PUFA), a high smoking point and also it should have an ideal N6 to N3 acids ratio very essential for healthy heart. Mustard oil meets all these criteria and that's why it is the best cooking oil. Mustard oil is a perfect blend of saturated and unsaturated fatty acids. These acids balance the cholesterol levels by increasing good cholesterol or HDL and decreasing bad cholesterol or LDL, thus minimizing the risk of cardiovascular diseases.This reviewfocuses on the compositional study of physico-chemical properties for mustard oil andits beneficial applications using traditional and ultrasonic method. Over last decade less works have been done in evaluation of physico-chemical for a wide variety of mustard oil using ultrasonic technique. Mustard oil has widely consumed in lipid source for everyday food product provide characteristics flavour and textures, primarily in north and east India for centuries.Mustard oil from Brassica nigra contains 30 per cent protein, calcium, phytins, phenolics and natural anti-oxidants.There are two important reasons of its parametric studies, firstly for nutritional value and secondly for bio fuel product. An Ultrasonic technique is powerfulcurrent analytical technique that can be used for the characterization of fat & oils. It has advantages over many of the traditional techniques used in material characterizations. It is non- destructive and non-invasive capable of rapid and precise measurement. It is relatively inexpensive and can be used in systems which are optically opaque or electrically non-conducting. Low power ultrasound [LPU] in the food industry is as an analytical technique for providing information about the physicochemical properties of foods, such as composition, structure and physical state are responsible for changes in acoustical parameters. Mustard oil has characterized for specific gravity, pH, ash content, iodine value, acid value, saponification value, peroxide value, free fatty acid, flash point, kinematic viscosity, and refractive indices using standard methods. The mustard oil has a distinctive pungent taste, characteristic of all plants in the mustard (Brassica) family. Mustard oil is the safest oil and as good as any other edible oil for our heart. A study by WHO recommends N3/N6 ratio of 4:5 which is almost closer to mustard oil.***

Keywords: Ultrasonic, Mustard oil, Physico-chemical properties, Fatty acid, Experimental/analytical review

1. Introduction

This review paper introduces the ultrasonic technology as an alternate means of characterizations of oils over other conventional techniques. The current review presents this technology as a more economic, efficient, convenient and flexible approach for oil characterization in comparison to conventional method and would fulfill the needs of oilseed industry. Mustard oil, used astraditional edible oil in most parts of India for centuries, is well known for its medicinal utilities *(Rastogi et al., 2004; Dasgupta and Bhattacharyya, 2007).*The aimof this review is to summarize the most important information about ultrasonic study of mustard oil for the past two decades beneficial to clinical application. This paper included the introduction of mustard plant, family and its physico-chemical properties, importance of their uses and also short overview of fundamental of ultrasound thatis considered to be most important analytical technique frequently used in characterization of mustard oil. It will be useful to learn more about therapeutic uses mustard oil. The paper contains many tables and citations which will be helpful to know what research has been done so far in this area. Ultrasonic studies are important because of their extensive use in bio engineering, food engineering, pharmaceutical industry, process industry, textile industry, and nuclear energy.

2. Ultrasound and its Application

Ultrasonic waves are the source of sound waves above the limits of human audibility. Depending on the frequency, ultrasound is divided into three categories, namely power ultrasound (20 KHz-100 KHz), high frequency ultrasound (100 KHz-1MHz) and diagnostic ultrasound (1MHz-50 MHz). Ultrasound ranging from 20 to 100 KHz is used in chemically important systems, in which chemical and physical changes are desired as it has ability to cause cavitation of bubbles *(Pilli et al 2011)***.** When applied on liquid, ultrasound waves consist of a cyclic succession of expansion (rarefaction) and compression phases imparted by mechanical vibration *(Tang 2003)***.**Diagnostic ultrasound includes a series of pulse-echo techniques commonly used by the medical industry to evaluate the state of internal tissue structures (medical imagingwhich is non-invasive, low power (100 mow cm-2), high frequency (1–10 MHz) techniques. Acoustic waves used for diagnostic applications are so low in intensity or power that they do not induce change to the physicochemical properties of the tissue. Low intensity ultrasound is a powerful analytical technique for the characterization of edible fats and oils and assessing the physical and chemical properties such as crystallization and melting temperatures, SFC, hardness, oil content and oil composition. High frequency ultrasound has been used extensively in several food science applications including monitoring of crystallization of lipids *(McClements & Povey 1987, 1988; Singh et al. 2004; Sagging&Copland 2002;),* characterizing edible oils and fats *(McClements & Povey 1988, 1992)*,predicting viscoelastic properties of the material *(Sagging&Copland 2001, 2004, Maliki et al. 2007)*, characterizing emulsions and suspensions *(Mc Clements et al. 1990,1991 ; McClements et al. 1990; McClements & Povey 1989; Copland&McClements 2001)***,** monitoring crystallization of lipids in emulsions *(Iodate et al. 1997; Kashchiev et al. 1998; Kaneko et al. 1999; Vanapalli & Coupland 2001;Gülseren &Coupland 2007a, b; Mc Clements et al. 1993).*

Ultrasound propagating through a continuous liquid system interacts with it and changes its properties, such as intensity and phase. Decay of the ultrasound intensity usually referred to as "ultrasound attenuation". Ultrasound phase is related to the speed of ultrasound propagation through the particular liquid system. Variation of these two properties of ultrasound (attenuation and sound speed) would depend on the properties of the system. If we measure variations of the ultrasonic properties then we would be able to extract some information about properties of the system(*Dukhin et al., 2002).*Ultrasound when propagated through a biological structure induces compressions and depressions of the medium particles imparting a high amount of energy. Ultrasonic material analysis generally involves looking at parameters, such as sound speed, sound attenuation or scattering and frequency content of echoes. These parameters help to analyze or qualify material properties, including an elastic modulus, density, grain structure, and crystal orientation or polymerization patterns. As the physical structure of a material changes, it will change speed of sound waves that pass through it. Ultrasonic velocity and attenuation measurements have useful in investigations of structures of oils and interactions between the molecules. Specifically, Interferometric Technique is employed in the analysis of oil. A significant advantage of this technique over other tools used to characterize materials is that it is non-invasive, non-destructive, and can be used in concentrated and opaque materials.

The aim of this review paper is to reveal the compositional and beneficial study of mustard oil (medicinal oil) using ultrasound. There is insufficient work in therapeutic use of mustard oil. Edible vegetable oils are the chief source of nutritionally required fatty acids in human diet. Mustard oil, soybean oil, sunflower oil, sesame oil, coconut oil and groundnut oil are among the edible vegetable oils mostly consumed in India. Mustard oil is commonly used as food or medicinal oil having many beneficial healing properties. Due to this mustard oil is very important oil among other vegetable edible oil. Now a day's Mustard Essential Oil is attributed with its properties as a stimulant, irritant, appetizer, antibacterial, antifungal, insect repellant, hair vitalizer, cordial, diaphoretic, antirheumatic and tonic substance. Physicochemical properties like density, viscosity, boiling point, saponification value (SV), iodine value (IV), and peroxide value (PV) of Mustard oils have studied to evaluate the compositional quality of oil.Moreover, ultrasonic testing parameters are significantly affected by changes in microstructural or mechanical properties of materials. Acoustic parameters such as:ultrasonic velocity (v), attenuation (α), and adiabatic compressibility (βa), intermolecular free length (Lf), acoustic impedance (Z), and relaxation time (τ) are computed on the basis of these measurements at different temperatures and different frequencies such as 2MHz, 4MHz and 5MHz. By tuning frequency, ultrasound can be utilized in monitoring the composition and physico-chemical properties of edible oils.Various molecular interactions in mustard oil and their blends have been analyzed on the basis of the variation of these parameters with concentration, temperature and frequency.Changes in composition of fatty acids profiles may be selected as parameters to monitor in oils. The data and the results obtained during the investigation using ultrasound give detail information regarding molecular interactions in mustard oil. The propagation of ultrasonic waves and the measurement of their velocity in oil form an important tool for the evaluation of various acoustical and thermo dynamical parameters which gives an insight into the nature of various molecular interactions in oil. Purity, shelf life, rancidity and adulterations may also be detected using ultrasound. Ultrasonic NDT is more common applications for thickness gaging, flaw detection, and acoustic imaging, high frequency sound waves can also be used to discriminate and quantify some basic mechanical, structural, or compositional properties of solids and liquids. Modern technologies offer today various methods of ultrasonic applications these are some examples: non-destructive testing and defectoscopy; ultrasonic imaging-acoustic microscopy and tomography systems, underwater acoustics; acousto-optic and opto-acoustic methods and systems; high power ultrasonic systems, like reactors for extracting and mixing; cleaning in intensive ultrasonic fields; etching and cutting; metal and plastic welding and many others.

3. Introduction to Mustard Oil

Scientific Name(s): Sinapis alba L. (white or yellow mustard), Brassica nigra L. Koch (black or true mustard), and Brassica juncea L. Czern. et Cosson (oriental, leaf, or Indian mustard).
Family: Brassicaceae.

*Common Name(s)***:** Mustard, black mustard, Indian mustard, leaf mustard, true oriental mustard, white mustard, yellow mustard. Brassica juncea L. is also known as Indian mustard or mustard greens or leaf mustard, is perennial herb, usually grown as annual or biennial mustard.

B. juncea is an amphidiploid and second most important edible oilseed crop in India after groundnut and accounts for about 30% of the total oilseeds produced in the country. Mustard is widely cultivated as a vegetable but its seeds are also used in a variety of applications as food condiment and as ingredient in health and medicinal products. India has an abundant source of edible oils at home–mustard seed oil *(Ildiko et al, 2006).* Sarson" (mustard) is central to our Indian culture. Mustard oil has become an integral part of human diet in India. Major mustard producing countries include Canada, China, Germany, France, Australia, Pakistan, Poland and India. Though mustard oil provides many benefits it is banned in some countries and sold only for external use in the countries like United States, Canada and European Union as it is considered to be harmful for consumption in these countries. The use of Indian mustard oil is discouraged in the International market due to its high erucic acid and glucosinolate content. It is being used in India past so many years and also has a niche in rich Indian culture. But its side effects have not been observed yet in India. No significant results are observed about toxicity with mustard oil either boiled or unboiled *(Parul Batra, 2003)*.Glucosinolate, the pungent principle in mustard oil, has anti-bacterial, anti-fungal and anti-carcinogenic properties, which account for many medicinal utilities of the oil *(Duke, 2008.)* It still has and will have a special place in future for cooking purpose in kitchens of North India.

Mustard oil is the mixture of various acids like, linoleic acid and linolenic acid which have beneficial properties. Mustard essential oil is totally different from mustard oil, in terms of the process of extraction, chemical composition and medicinal properties. Both of these oils are extracted from the seeds of mustard, which bears the scientific name Brassica Nigra (Black Mustard) or Brassica Hirta (White Mustard). Mustard oil is extracted at low pressure at low temperature (40-600).It contains 0.30-0.35% essential oil (Allyso-Thiocynate) which acts as preservative. Mustard and its oil have been used as a topical treatment for rheumatism and arthritis, as a foot bath for aching feet, and in the form of plasters over the back and chest to treat bronchitis and pneumonia. *(Leung et al, 1980)*Mustard oil contains a high amount of selenium and magnesium, which gives it anti-inflammatory properties. It also helps stimulating sweat glands and helps lowering body temperature. In traditional medicines, it is used to relieve the pain associated with arthritis, muscle sprains and strains. Mustard is not just edible oil also an important medicine in the indigenous Ayurveda system of healthcare. It is used for therapeutic massages, muscular and joint problems. Oil with garlic and turmeric is used for rheumatism and joint pains. Mustard oil is also used as a mosquito repellent.

4. Physico-Chemical Properties of Mustard Oil

Different physical and chemical parameters of mustard oil like density, viscosity, boiling point, saponification value (SV),iodine value (IV), and peroxide value (PV) of Mustard oils are studied to evaluate the compositional quality of oils.*Ceriani et al.,(2008) and Mousavi et al., (2012)*were used these parameters to monitor the quality of edible oil. The main chemical component of mustard oil is allyl isothiocyanate, about 92% of oil. Mustard oil is hazardous oil because of its high content of allyl isothiocyanate. Mustard seeds contain numerous chemical constituents, including phytoalexins (sinalexin, sinalbins A and B), sterols and steryl esters (primarily sitosterol and campesterol), and flavonoids (eg, apigenin, chalcone) *(Das et al., 2009).* Crude mucilage from mustard contains 80% to 94% carbohydrates, 1.7% to 15% ash, and 2.2% to 4.4% protein (*Cui et al., 1993).* The flavour of mustard seeds derived from glucosinolates which are thiocyanate glycosides. Glucosinolates are nontoxic sulphur containing secondary Metabolites*(Fahey et al. 2001).* Sinalbin is responsible for the flavor of white mustard seed; sinigrin is responsible for the sharper taste associated with black and brown mustard seeds. The pungency is produced by glucosinolates, which are hydrolyzed by the enzyme myrosinase (a thioglucoside glucohydrolase) to flavor-active isothiocyanates (mustard oils). Glucosinolate in mustard oil has antibacterial, anti-fungal and anti-carcinogenic properties, which account for many medicinal utilities of the oil. Mustard oil has 30 per cent protein, calcium, phytins, phenolics and natural anti-oxidants *(Kim et al., 2003).*

Table 1: Various properties of Mustard oil (Kachhi Ghani)

S.N.		
1	Visual	Clear. Free from sediments, suspended matter, separated matter
2	Colour on Lovi bond scale in ¼" Cellexpressed as Y + 5R	50 max
3	Specific gravity at 30 Degree Cel.	0.907 to 0.910
4	Refractive Index at 40 Degree Cel.	1.4646 to 1.4662
5	Saponification Value	168 to 177
6	Iodine value	96 to 112
7	Unsaponifiable matter 1.20 % max.	1.20 % max.
8	Percentage of natural essential	0.25 to 0.60
9	Acid value	1.5 Max
10	Presence of other oils	Negative
11	Colour	Added Colouring matter
12	Rancidity	Free from any rancidity
13	Moisture & Insoluble matter	1.25 Max
14	Argemone Test (TLC)	Negative
15	Mineral Oil Test	Negative
16	Taste &Flavour	Characteristic

Selected physical properties for mustard oil are shown in Table 1. Specific gravity, refractive index, acidic and iodine value are measured physical characteristics of the mustard oil. Mustard oil contains significant amount of sulfur may improve the stability of oil. Mustard oil is sometimes adulterated with argemone oil, which is toxic. Adulteration should check to be negative.Relative density increased from 0.907 to 0.910 for Mustard oil (KachhiGhani). The refractive index of unblended mustard oil was found to be 1.46262 to 1.4662. The range of SV value obtained 168-177 mg KOH/g for Mustard oil shown in Table 1 significantly affected by temperature. It was observed that measured iodine values Mustard oils are of range 96 to 112. These low iodine values may have contributed to its greater oxidative storage stability. Maximum acid value of unblended mustard oil was found 1.5%.

Table 2: Fatty Acid Composition of Mustard oil

Fatty Acid Composition of Mustard Oil

Sr.	Name of Acid	Range
1	Palmitic	1-3%
2	Stearic	0.4-3.5%
3	Arachidic	0.5-2.4%
4	Behenic	0.6-2.1%
5	Lignoceric	0.5-1.1%
6	Oleic	12-24%
7	Eicosenoic	3.5-11.6%
8	Erucic	40-55%
9	Linoleic	12-16%
10	Linolenic	7-10%

A variety of analytical techniques, gas chromatography coupled to mass spectrometry (GC-MS) have been used to follow the quality of insonated mustard oil. The range of fatty acid composition of mustard oil has shown in table2and the results for the Fatty Acid (FA) profiles of some vegetable edible oils on GLC (Gas Liquid Chromatogram) have shown in table 3.Mustard oil is basically composed of oleic fatty acid, linoleic acid and erucic acid. Mustard oil is rich in monounsaturated and polyunsaturated fats as well as omega-3 and omega-6 fatty acids. The oxidative and chemical changes in oils during storage are characterized by an increase in free fatty acid contents and a decrease in the total unsaturation of oils *(Perkinet al. 1992).*

Table 3: Fatty acid composition edible oil measured on GLC.

	Fatty acid composition of the analyzed edible oils(wt%)								
Vegetable Edible oil	Tetradecanoic (myristic) C14:0	Hexadecanoic (palmitic) C16:0	Hexadecanoic (palmiotoleic) C16:1	Octadecanoic (estearic) C18:0	Octadecenoic (oleic) C18:1	Octadicadienoic (Linoleic) C18:2	Octadicatrienoic (Linolenic) C18:3	Docosenoic (Erucic) C22:1	Systemetic Name Common Name Carbon Number
Mustard	_	2,366		1.12	9.517	14.566	12.722	47.077	
Sunflower		6.756		3.899	25.944	63.401			
Soybean	0.084	11.305		4.207	21.485	54.23	8.431		
Cottonseed	0.7231	24.0817	1.0146	2.2924	19.0122	52.766	0.111		
Groundnut		12.048		4.114	42.564	35.141	1.051		
Canola		4.565	0.1768	1.5208	63.064	19.8902	8..6165		

A favourable composition has been observed from above investigation. Mustard oil contains fewer amounts of saturated fatty acids likeC16:0 (Palmitic), C18:0 (Stearic) and good ratio of monounsaturated fatty acids, polyunsaturated fatty acids like C18:1 (oleic), C18:2 (Linoleic), C18:3 (Linolenic). It contains the least amount of saturated fatty acids, making it safe for heart patients.The relatively high level of oleic acid and the favorable balance between linolenic and linoleic acids is present in mustard oil which is good for heart compare to other edible oils.

Chromatogram with few peaks for kachhi Ghani mustard oil is shown in fig.1. Fatty acid composition of some edible oils in table 3 and kachhi Ghani mustard oil shown in table 4 obtained by Gas Chromatography atB.L.Agro Oils Ltd, Bareilly (India). Biochemical characterization and fatty acid composition by GLC analysis revealed that the mustard crop being commonly grown in India are characterized by high Erucic acid content (47.07) in the oil with low levels of myristic acid. Erucic acid is the major and characteristic component occurs extensively in seed oils of the mustard family (Cruciferae) and Tropaeolaceae. Erucic acid, also known as cis–13-docosenoic acid, is an unbranched, monounsaturated fatty acid with a 22–carbon chain length and a single double bond in the omega 9 position. *Roine et al (1960)* were the first to report the toxic effects of rapeseed oil. High erucic acid content is beneficial for the polymer industry, whereas low erucic acid is recommended for food purposes. (http://www.foodstandards.gov.au) Mustard oil contains SFA, MUFA, PUFA 13%, 60%, 21% respectively and Smoking point- 254◦C (489◦ F) can be used in Cooking, frying, deep frying, salads, and dressings. When we compare mustard, soya and sunflower for their smoking point's mustard is the most stable of all. There is a major difference between the PUFA percentage of olive oil (extra virgin) to mustard oil- saturated fats 14%/ 13%, MUFA 73%/ 60%, PUFA 11%/ 21%.High PUFA of mustard oil can be attributed to its being rich in Omega-3 and Omega-6 and thus makes it a better choice for daily cooking.

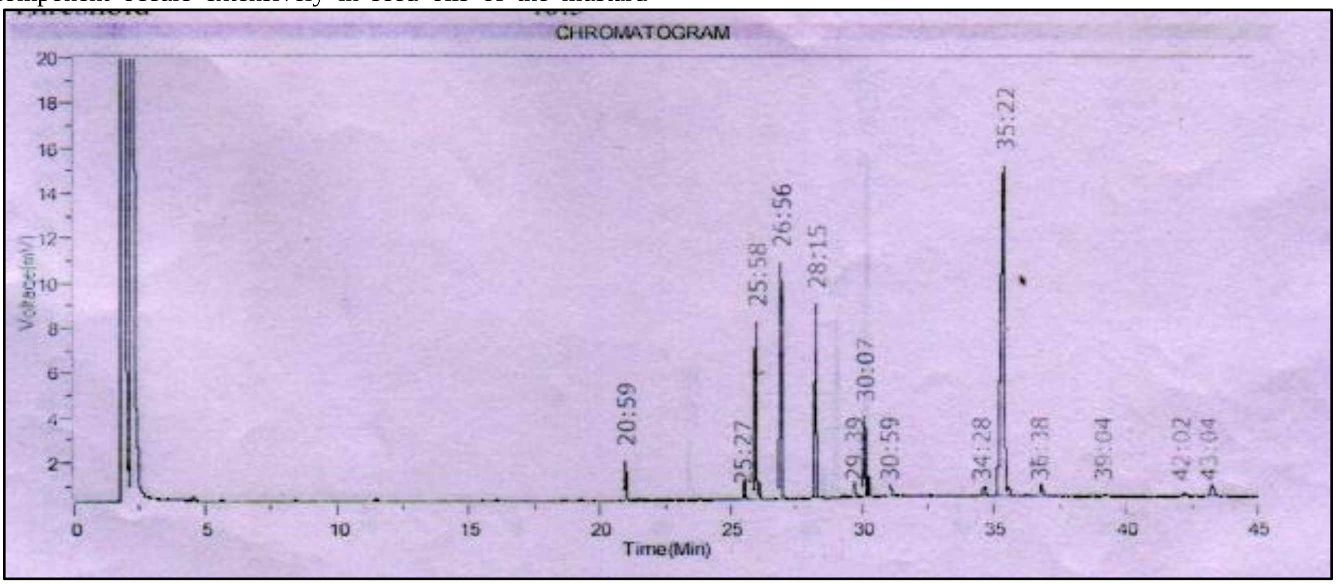

Figure 1: Gas chromatogram of mustard oil. Description of peaks is as follows: (20:59 Palmitic acid), (25:28 Stearic acid), (25:59 Oleic acid), (26:56 Linoleic acid), (28; 15) Linolenic acid), (30:7Ecosenoic acid), (34:29 Behenic acid), (35:22 Erucic acid).

International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Table 4

Peak No.	RT (Min)	Area (mV-Sec)	Height (mVolt)	RF	Amount (ML)	Amount%	Component Name
1	20:59	7.652	1.728	1.000	7.652	2.366	Palmitic
2	25:28	3.622	0.024	1.000	3.622	1.120	Stearic
3	25:59	38.861	7.935	1.000	38.861	9.517	Oleic
4	26:56	48.721	10.511	1.000	48.721	14.566	Linoleic
5	28:15	37.909	8.630	1.000	37.909	12.722	Linolenic
6	29:39	2.827	0.042	1.000	2.827	0.874	Arachdic
7	30:7	19.474	3.511	1.000	19.474	6.022	Eicosenoic
8	30:59	2.410	0.014	1.000	2.410	0.745	Eicosadienoic
9	34:29	3.628	-0.001	1.000	3.628	1.122	Behenic
10	35:22	145.774	14.699	1.000	145.774	47.077	Erucic
11	36:39	4.129	0.001	1.000	4.129	1.277	Docosadienoic
12	39:5	1.124	0.006	1.000	1.124	0.347	Lignoceric
13	42:3	1.661	0.013	1.000	1.661	0.514	Y- Lignoceric
14	43:4	5.598	0.000	1.000	5.598	1.731	Nervonic

Table 5: Shows the area and height of the peak for fatty acid composition of kachhi Ghani mustard oil measured on Gas Chromatography.

Fatty acid composition and functional properties of oils can be modified by hydrogenation, inter-esterification, genetic modification, and blending of different oils. Blending of oils can also modify fatty acid composition without any chemical or biological process *(Liu & White 1992)*.Low value of linolenic in mustard oil exhibited improves frying performance and better storage stability of fried products *(Petukhov et al., 1999; Warner & Mounts, 1993).* Oxidative stability of oil can be improved by modification of fatty acid composition *(Tatum & Chow, 2000)*.Mustard seed meal is good source of protein (28−36%) and phenolic antioxidants such as sinapine and sinapic acid. Mustard oil is extracted from the black mustard seeds, which have been macerated in warm water by steam or water distillation, when the seeds came in contact with water and the essential oil is formed when a glycoside decomposes due to enzymatic action. Mustard oil is extracted at low pressure at low temperature (40-600).It contains 0.30-0.35% essential oil (Allyso-Thiocynate) which act as preservative. It is also loaded with essential vitamins. EFAs are polyunsaturated, and include linoleic acid (n-6 or - ω 6 fatty acids), and α-linolenic acid (n-3 or ω -3 fatty acids). The mustard oil has the ideal ratio of omega-3 and omega 6 fatty acids, a high content of antioxidants and vitamin E. EFA deficiency and Omega 6/3 imbalance is linked with serious health conditions, such as heart attacks, cancer, insulin resistance, asthma, lupus, schizophrenia, depression, postpartum depression, accelerated aging, stroke, obesity, diabetes, arthritis and Alzheimer's Disease, among others. A primary function of EFAs is the production of prostaglandins, which regulate body functions such as heart rate, blood pressure, blood clotting, fertility, conception, and play a role in immune function by regulating inflammation and encouraging the body to fight infection.EFAs support the cardiovascular, reproductive, immune, and nervous systems. *(Singh et al., 1997; Dwivedi et al., 2003; Rastogi et al., 2004; Risa et al., 2008; Degirolamo et al., 2010).*

Mustard Oil is one of the best cooking oil particular for heart patient because it has an Omega 3 (MUFA) and 6 Fatty Acid compositions (Linoleic and alpha Linoleic Acid respectively) in good proposition close to 10.1 rarely found in any other oil. The ideal ratio of Omega 6 and Omega 3 is 10:1.Speciality oils having high amounts of a specific fatty acid are of immense importance for both nutritional and industrial purposes. A desirable n- 6/n-3 ratio is in the range of 5 –10. A ratio above 50 is injurious to health. Further, health agencies such as WHO and American Heart Association recommends that fats and oils should not supply more than 30% energy of diet and that the fatty acid composition in oil and fats should have a SFA, MUFA, PUFA ratio of 1: 1.5: 1. A higher MUFA in oils and fats is recommended for health benefits that human should consume more ω-3 fatty acids.(*Khan et al., 2013)* Mustard oil,high in MUFA and PUFA, helps in lowering low-density lipoprotein (LDL) cholesterol.*(Lichtenstein and Schwab, 2000; Buckley and Howe, 2009)* havereportedabout the speculation that PUFA rich mustard oil can be beneficial in high fat diet induced obesity and its biochemical complications.The Alpha linolenic acid found in mustard oil reduces the adhesion-aggregation tendency lower levels of saturated fats, cholesterol reducing and anti-oxidant properties and good source of essential vitamins. Also, good fats raise our High Density Lipoprotein (HDL) or "good cholesterol". One of the functions of this (HDL) or "good cholesterol" is to grab the bad cholesterol, Low Density Lipoprotein (LDL), and escort it to the liver where it is broken down and excreted. In other words, these good fats attack some of the damage already done by the bad fats. *(Lewington et al., 2007).*

According to Dr S. C. Manchanda, former professor, Department of Cardiothoracic Diseases at AIIMS, mustard oil is healthier oil because it has no trans-fats, low saturated fats, high mono-unsaturated fats, high polyunsaturated fatty acids such as omega-3 and stability at high temperatures, which makes it ideal for cooking and even deep frying. The Indian Olive Association (IOA) appreciates the article, Granny is right: Mustard oil best for your heart (May 18, 2012), comparing the fat content in different cooking oils. Also IOA agrees with most of Dr S C Manchanda's conclusions, it disagrees with his dismissiveness of the health risks associated with erucic acid in mustard oil. Investigations indicate that mustard juice is highly protective against B (a) P-induced DNAdamage in human derived cells and that induction of detoxifying enzymes may account for its chemo protective properties. The effects of crude juice cannot be explained by its allyl isothiocyanate contents. *(Dutta et al., 2006)*

5. Short Overview on Mustard Oil

*Datta et al., (1981)*have detected some admixtures such as rapeseed in mustard oil by using critical solution.The percentage of erucic, eicosenoic and linolenic acids can be used to detect semi-quantitatively the proportion of Indian rape-mustard oil present in rice bran oil studied by*Adhikari & Adhikari, (1991).Nasirullah et al. (1992)* describedthe method for detection of rice bran oil, mustard oil and karanja oil in other vegetable oils and detection of rice bran cake in other oilseed cakes. Mustard oil is detected by a colorimetric test for isothiocyanates. Blended oils are gaining popularity worldwide due to advantages they offer such as improved thermal stability, oxidative stability, nutritional benefits *(Sharma et al., 1996)* and an ability to tailor the desired properties. Thermal and storage stabilities of refined cottonseed oil- mustard seed oil blends (80:20) were investigated by *(Premavalli et al., 1998).*Mustard seed oil only was used in the frying experiments as a control. Storage result showed that the oil blends remained stable for up to 12 months under ambient conditions. Thermal stability results showed that the oil blends remained in good condition for up to 12 hr. of frying. Overall thermal stability of the oil blends was lower than that of the mustard seed oil. Mustard Oil and Sunflower oil have oryzanol in trace amounts but RBO is rich source of oryzanol. There are mainly three aspects to consider any oil as the healthiest cooking oil, that is, ratio of saturated/ mono unsaturated/ polyunsaturated fatty acid, ratio of necessary fatty acids and existence of natural antioxidants *(White, 2000).*Mustard also has potential pharmacological effects in cardiovascular disease, cancer, and diabetes; however, there are limited clinical applications of mustard oil to support its use for any indication. The cytotoxicity of mustard derivatives, organic isothiocyanates, on neuroblastoma cells for cancer chemoprotective activity has investigated by *Tseng et al., (2002) and Uhl M et al., (2003).*

Allyl isothiocyanate have antimicrobial and antifungal activity. The antibacterial effect of mustard flour and oil has been evaluated for application in the processed meat industry for its inhibitory effect on Escherichia coli and salmonella *(Coggiola B et al, 2005; Graumann et al.,2008).* Because of its topical irritant effects, mustard have been used traditionally as a rubefacient and irritant. These properties have served as models for animal analgesia experiments. *(Walker et al., 2007)* Numerous studies elucidating the mechanism of action of nociceptive chemicals, including mustard oil have been published. *(Cavanaugh et al., 2008).Prakash et al., (2001)* studied the effects of blending on sensory odour profile and physico-chemical properties of selected vegetable oils. Three types of vegetable oils commonly consumed in India (groundnut, sunflower and mustard oils) were used as base oils and were blended with 20% sesame, rice bran or refined palm oil, and analyzed for changes in sensory profile, colour and viscosity. With regard to the 3 base oils, mustard oil had a strong sulphury and pungent flavour note which did not decrease significantly in the blends, whereas the characteristic aroma of groundnut and sunflower oils decreased in intensity upon blending. The high-quality rice bran oil has a very neutral, delicate flavour and high smoke point therefore is considered good cooking oil. Beside this, the oil is known for its significant nutritional attributes due to the naturally occurring antioxidants *(Sharma et al., 2006).*

Aman Paul et al., (2012) did comparative study about oryzanol content by pan and microwave heating for MO with RBO & SFO.*Md Abdul et al. (2012)* studied the positional fatty acid composition, sterols, tocopherols and oxidative stability of mustard oil (MO) and rapeseed oil (RSO). %). The oxidative stability determined by Rancimat test of MO (PF, 1.57) was higher compared with RSO. The changing fatty acid compositions at different position led to different physical properties MO contained higher amount of total tocopherols (38.32 mg/100g) but lower amount of total sterols (606.32 mg/100g) than that of RSO (631.98 mg/100g and 25.57 mg/100g).

6. Ultrasound and Mustard oil

Some foodstuffs as edible oils have composition based on the well-known chemical compounds and can be investigated with physical methods using ultrasound. Many techniques like Photo-luminescence, classical and Photopyroelectric (PPE) spectroscopy, Gas-chromatography;Optothermal window, NMR (Nuclear magnetic resonance)have been used to study the edible oils. Such analysis is required laboratory facilities, sample preparation and also may damage compositions by heating, radiation etc. to some extent. It was of interest to find new method to investigate the oil using ultrasound. It is quite easy to employ ultrasound for characterizing a wide variety of real heterogeneous and homogeneoussystems. It is known for a long time that ultrasound offers unique features for characterizing liquid based food products in their intact state, with no sample preparation and no sample destruction. It can be used for on-line process control, which makes it even more attractive. Ultrasound (US) technology is very useful to assess the oil composition. Very well-known scientist on the field of ultrasound characterization of food products, J. Mc Clements stresses importance of the sound speed is better for characterizing particular effect in the given food product while some others in Dispersion Technology used attenuation for characterization procedure.

Mc Clements et al., (1992) used ultrasound to determine the dynamic rheology and composition of edible oils, the oil content and droplet size of emulsions and the solid fat content of partially crystalline emulsions. Ultrasonic techniques therefore proved a useful addition to the existing analytical techniques used to characterize fats and oils. *Coupland et al., (2004)* studied on physical properties of liquid edible oils. The values of density, viscosity, adiabatic expansion coefficient, thermal conductivity, specific heat (constant pressure), ultrasonic velocity, and ultrasonic attenuation coefficient are compiled for a range of food oils and a series of empirical equations are suggested to calculate the temperature dependency of these parameters. *Shriwas et al., (2004)* studied on 'Effect of Temperature on Thermo-acoustic Properties of Olive Oil in Alcohol Mixture'. This paper presents ultrasonic velocity, density, adiabatic compressibility in olive oil with alcohol at different concentration that has been measured in the temperature range from 283.15K to 298.15K. *Chemat et al., (2004)* studied 'Deterioration of Edible Oils during Food Processing by Ultrasound'. During food emulsification and processing of sunflower oil (most used edible oil), a metallic and rancid odour has been detected only for isonated oil and food. Different edible oils (olive, sunflower, and soybean) show significant changes in their composition (chemical and flavour) due to ultrasonic treatment. The determination of the trace elements (Cd, Cr, Cu, Fe, Mn, Ni, Pb, and Zn) in edible oils (sunflower, hazelnut, canola, corn and olive oils) have gained more importance in the last few years because of the fact that quality of edible oils is directly related to concentration of trace metals in oils (*Souza et al.,2005*). The content of the trace elements in edible oils was determined using inductively coupled plasma optical emission spectrometry (ICP-OES) after ultrasonic extraction, wet digestion, and extraction induced by emulsion breaking procedure (EIEB).*Aurel Pasca et al., (2006)* reported that ultrasound attenuation can be used in analysis of fresh oil and aged or adulterated oil. It is a new method for investigation the properties of the edible oils. It was determined that attenuation of ultrasound increases with oil concentration with different aging time.

Suhashini et al., (2011) have studied Acoustical and Excess Thermodynamical parameters of Sesame Oil in Different Organic Solvents. *Jeremiah et al, (2013)* have extracted antioxidants from mustard (Brassica juncea) seed meal using high-intensity ultrasound. The ultrasound-assisted extraction (UAE) variables included temperature, solvent-to-material ratio, sonication duration, and EtOH concentration. Extracts were analysed for total phenolics content (TPC), antioxidant activity, and sinapine content. Sonicated solutions of pure sinapine and sinapic acid showed 1st-order reaction kinetics with greater degradation of isolated compounds than those present in extracts. From research indicates that ultrasound treatment can assist the extraction of antioxidants from B. juncea meal by reducing both the temperature and time requirement without significant degradation of the primary antioxidants present applicable in many applications. Brassicaceae seed meals contain residual compounds with antioxidant and antimicrobial properties that may be incorporated in various food products to extend their shelf life. Ultrasound-assisted extraction can potentially enhance the extraction of these compounds for the development of value-added products. Brassicaceae oilseeds provide feedstocks for the biofuels industry, but value-added co-products are necessary to supply financial incentives for increased production. *Rubalya et al., (2015)* have studied the efficiency and stability of natural antioxidant in unrefined mustard oil, groundnut oil and sesame oil on heating using ABTS and DPPH radical scavenging assay. Vegetable oils contain natural antioxidants like sterols, phosphatides, tocopherols, tocotrienols etc. Various physicochemical parameters of the oils like conductivity, density, viscosity, ultrasonic velocity, saponification value, iodine value and free fatty acid (FFA) content are observed to estimate their characteristics and stability on heating to cooking temperature. The physical and chemical parameters are compared and correlated between the oils to analyse the oxidative stability at different times of heating. This study helped in the identification of the best oil suited for repeated cycles of heating.

A summary of the various applications including the mechanisms, parameters and effects of ultrasound in Mustard oil and edible fats & oils are shown in Tables 5.

Table 5: Applications of ultrasonic and other methods in analysis of Mustard and other edible oils.

Advantages of application	Parameters / Methods	Edible fat & oils	References
Degree of emulsification	Velocity & attenuation	fat within milk	Wood &Loomis (1927)
Nano-emulsion	Ultrasound	Basil, Cinnamon and Mustard oil	Taylor et al. (1934)
hysico-chemical properties	Velocity & attenuation	Vegetable edible oils	Mc Clements et al. (1992)
Extent of crystallization	Velocity	Palm oil	Hodate et al. (1997)
Ischemic heart disease	Case study	Mustard oil	Rastogi et al. (2004)
Nano-emulsions	Surfactant (Tween 20)	Basil, Cinnamon &Mustard oil	Abismail et al. (1999
Physical characteristics	Applying principal component	Blends of MO, RBO, GNO.SFO	Ravi et al (2005)
	analysis (PCA)	& RPO	
Content of the trace elements in in edible oils	ICP-OES and Ultrasonic	Canola ,SFO, Hazelnut & Corn	Souza et al., (2005).
VLDL & HDL cholesterol	Gamma- linolenic acid,GLA	Mustard oil	Das et al. (2007)
Quality assessment of frying oil	velocity & attenuation	SBO	Driss Izbaim (2009)
Transesterification	NaOH and Methanol	Mustard oil	Hasib et al. (2011)
Nano-emulsion	Surfactant (Tween 80)	Edible oils	Qian and McClements
Comparative analysis of heat	Microwave & Pan heating	MO,RBO & SFO	Aman et al. , (2012)
degradation in oryzanol			
Micro emulsification	Surfactant (Tween 20	Mustard oil	Ghosh et al. (2012)
Performance of engine using	physical property	Waste Mustard oil and	Sandeep et al, (2013)
Biodiesel		waste Cottonseed oil	
Antioxidant extractions	High frequency ultrasound	(Brassica juncea) seed meal	Dubie et al. (2013)
(Total phenolic contents)			
Transesterification	LPU / Pulse echo	Waste Mustard oil	Razat et al. (2014)

Transesterification	Catalyst (NaOH) and ethanol	Waste mustard oil	Samanta et al. (2014)
Physico-chemical properties	GC, UV & FT-IR spectroscopy	Corn and Mustard oil	Zahir et al. (2014)
after heating and frying			
Stability of natural antioxidants	ABTS & DPPH methods	Seasame Groundnut and	Rubalya et al. (2015)
in oils		Mustard oil	
Storage and thermal stability during deep frying oils		Mustard ,Soybean,Groundnut and Sunflower	Pranjali et al. (2015).

Tween20- Polyethylene glycol sorbitan monolaurate
PCA- Principal Component Analysis
MO-mustard oil, SFO-Sunflower oil, RBO-Rice bran oil, SBO- Soybean oil and GNO- Groundnut oil
LPU- Low power ultrasound
GC- Gas-Chromatography
UV-Ultra Visible Spectrometry
FT-IR- Fourier Transform Infrared
ABTS-2, 2'-azino-bis 3-ethylbenzthiazoline-6-sulfonic acid
DPPH-1, 1'-diphenyl-picryl-hydrazyl free radical
EIEB-Emulsion breaking procedure
ICP-OES-Plasma optical emission spectrometry
GLA-Gamma-linolenic acid

7. Ultrasonic Emulsification of Mustard Oil

Another major application of LPU is for monitoring emulsion, which is important for the quality of many food emulsion products such as butter, margarine, whipped cream and ice cream. Emulsification is the process of mixing two immiscible phases (e.g., oil and water) with the aid of a surface active agent (emulsifier) into homogeneous dispersion or emulsions used in remove contaminants and are called cleaners. LPU is a very precise method of measurement needed in order to characterize the samples even a low concentrations of water in oil introduce small changes in the acoustic parameters to be measured. The velocity measurement method can be used to determinate water contents in oil. *Higuti et al.(1999)* Most of the main parameters of US emulsification; role of surfactants, energy supply, physico-chemical properties of two phases (mainly density, viscosity, surface tension) and volume fraction of dispersed phase. Pharmaceutical emulsions are normally prepared by mechanical stirrers, emulsifiers, homogenizers or colloid mills but Ultrasound-assisted emulsification was initially developed by Wood and Loomis in 1927. The effect and mechanism of ultrasonic emulsification have been investigated by many authors as *Neduzhii (1965),Li and Fogler (1978a and b).* Stirring speed also exhibited effect on emulsion droplet size. Compared to mechanical agitation, the use of ultrasound required less amounts of surfactants (surface active agent) and produced smaller and more stable droplets *(Abismail et al. 1999; Behrend et al. 2000; Canselier et al, 2002; Juang & Lin, 2004).*

There is increasing interest within the food, beverage and pharmaceutical industries in utilizing edible nanoemulsions to encapsulate, protect and deliver lipophilic functional components, such as oil-soluble flavours, vitamins, preservatives, nutraceuticals, drugs and cosmetics. Nanoemulsion is optimized for different process parameters such as oil type, surfactant type, surfactant concentration, oil-surfactant mixing ratio and sonication time. A study showed that increasing irradiation time and/or ultrasonic irradiation power increases the dispersed phase volume and decreases droplets size, and when the concentration of surfactant was increased; an increase in droplet size was observed. *Taylor et al, (1934)* studied on oil concentration used in all the nanoemulsion formulations i.e. basil oil nanoemulsion, cinnamon oil nanoemulsion, mustard oil nanoemulsion and sesame oil nanoemulsion by ultrasonic emulsification method. *Tadros et al., (2004),* present energy calculations for a high-pressure homogenization using Tween80; being a non-ionic surfactant, aid the formulation of nanoemulsion process by lowering interfacial tension at oil/water interface. The process of nanoemulsion formation is non-spontaneous. Tween80, being a non-ionic surfactant, aid the formulation of nanoemulsion process by lowering interfacial tension at oil/water interface. *Qian and McClements (2011)* reported small molecule surfactants like Tween80 are more effective in minimizing droplet size emulsion surface rapidly and reduce the interfacial tension at 108 oil/water interface. Hence, small molecule surfactants are more effective in minimizing droplet size when compared to high molecular surfactants like polymers. Emulsification time is directly correlated with droplet diameter of nanoemulsion. On increasing emulsificationtime the diameter of nanoemulsion droplets get reduced. Using 6 % of Mustard oil and 18 % Tween80, when emulsification time increased from 10 min to 30 min, 110 droplet size reduced from 199 nm to 65 nm (using cinnamon oil), from 191 nm to 67.5 nm (using mustard oil) and from 124 nm to 20 nm (using sesame oil)respectively. Sonication time, sonicator frequency and sonicator power plays an important role in determining nano-emulsion droplet size.

Saxena, et al. (2012) have studied about micro-emulsion blend oil obtaining by blends of diesel with biodiesel, blends of vegetable oil with micro-emulsions and blends of vegetable oil with alcohols. The use of micro-emulsion in blend form not only increases the engine efficiency but also increases the atomization of diesel fuels for smooth running Vegetable oil based fuels such as mustard, sal, palm, soy, castor seed oil based are more eco-friendly and biodegradable in comparison to the mineral oil based such as petrol & diesel due to the low toxic constituents. So their blend with micro-emulsion along with good surfactants will provide us a sharp edge over the old and conventional fuels. To prevent harmful and poisonous gases from going in to environment, a better and less polluted one alternate vegetable oil fuel or biofuel will be better substitute of fossil and non-renewable diesel oil. Extensive field tests confirm that the ultrasonics can provide a movable sensor for detecting oil/water emulsion problems in separator control systems.

8. Frying Properties of Mustard oil

Deep frying and the use of same oil for frying many times is a general practice mostly in commercial and sometimes in domestic cooking processes. The repeated use of oil can affect the shelf life and nutritional quality of fried foods due to the development of rancidity in the frying oil taken up by the products. Therefore, it is essential to monitor the quality of oil to avoid the use of degraded oil due to the health purpose, to maintain the quality of fried foods and to minimize the production costs associated with early disposal of the frying medium *(Vijayan et al., 1996).* During frying, due to hydrolysis, oxidation and polymerization processes the composition of oil changes which in turn changes the flavour and stability of its compounds changes due to changes occur in *(Gloria and Aguilera, 1998).* Repeated frying causes several oxidative and thermal reactions which results in change in the physicochemical, nutritional and sensory properties of the oil *(Che et al. 2000).* The oil is continuously exposed to the air at high temperature and contact with moisture during frying, which accelerates the oxidation of the oil *(Lopaczynski & Zeisel 2001).* During deep frying different reactions depend on some factors such as replenishment of fresh oil, frying condition, original quality of frying oil and decrease in their oxidative stability (Choe and Min, 2007). Atmospheric oxygen reacts instantly with lipid and other organic compounds of the oil to cause structural degradation in the oil which leads to loss of quality of food and is harmful to human health *(Bhattacharya et al., 2008).Chopra et al.,(2004)* studied that by blending different types of oils it can be possible to obtain a better quality product with respect to flavour, frying quality and value.

Several researchers have worked on thermal stability of mustard oil. Mustard oil is one of the main constituents of the diet commonly used for cooking purposes in India. Deep fried food items comprise a major rate of formation of decomposition products varies with the nature ofoil used, foods fried, and temperature during frying. The oil used for frying must have good flavour and oxidative stability in order to achieve good shelf life for the products fried. To meet today's consumer demands the frying oil must be low in saturated fat, linolenic acid, and have good flavour, high oxidative stability and should be trans-fat free *(Danowska and Karpinska,2005). Farhoosh et al., (2008), Li et al., (2010)& Jinfeng et al., (2011)* have studied the impact of temperature on the stability, viscosity, peroxide value, and iodine value to assess the quality and functionality of the oil. *Jana et al., (2011)* reported that frying is one of the popular food preparation technique which helps in imparting desired properties to fried foods such as colour, flavour and texture. *Sridevi et al. (2012)* have studied on storage stability and sensory characteristics of blending oil. Different analytical methodologies used for quantitative evaluation of heated oils are Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), Ultra Visible Spectrometry (UV) and Fourier Transform Infrared (FT-IR) Spectroscopic techniques. *Erum Zahir et al, (2014)* were studied physicochemical properties of mustard oil with corn oil to evaluate the compositional quality of oils and also to investigate the effect of repeated frying in same oil as it changes the physicochemical, nutritional and sensory properties of the oil using FT-IR spectroscopy. They revealed that a notable difference in the spectral band which showed that the proportions of the fatty acids were changed due to temperature change. Effects of deep frying were investigated on the vegetable oil of sunflower, Groundnut, Soybean and Mustard oil simultaneously by *Pranjali et al. (2015).* They have found mustard oil shows highest oxidative stability during deep frying as compare to other oils. The oil rich in monounsaturated fatty acids shows higher oxidative stability than the oil containing polyunsaturated fatty acids during deep frying.*Rubalya et al., (2015)* have studied the efficiency and stability of natural antioxidant in unrefined mustard oil, groundnut oil and sesame oil on heating using ABTS and DPPH radical scavenging assaymethod. Vegetable oils contain natural antioxidants like sterols, phosphatides, tocopherols, tocotrienols etc.

9. Production of biofuel using mustard oil

The inventor of biodiesel engines, Rudolf Christian Karl Diesel (1858–1913)demonstrated the use of vegetable oils as a substitute for diesel fuel inthe19thcentury.The investigation of vegetable oils as fuel started in 1978 and1981 in the United States and South Africa, respectively. In 1982, methyl ester was produced in Germany and Austria from rapeseed oil, and a small pilot plant was built in Austria at1985.Commercial production of methyl ester first began in Europe in 1990.

Ultrasonic technique is also very useful for biodiesel production as it enhances Transesterification reactions between oil and alcohol in the presence of a catalyst. Mixing of oil and alcohol is the main factor that increases the biodiesel yield because both oil and alcohol cannot be miscible completely in conventional processes. Researchers concluded that low frequency ultrasonic waves are the best solution*(Ji et al. 2006)*.The transesterification reaction is carried out by two different methods (ultrasonic irradiation and ultrasonic irradiation with vibration). Researchers have used various types of homogeneous and heterogeneous catalysed transesterification reaction for biodiesel production such as membrane reactor, reactive distillation column, reactive absorption but ultrasonic and microwave irradiation significantly influenced the final conversion, yield and in particular, the quality of product. The main advantages of ultrasonic irradiation process are:

(1)shorterreactiontime,(2)lowermolarratioofalcoholtooil,(3)lessenergyconsumption(50%),(4)loweramountofcatalystutilization(enzyme), (5) increased reaction rate, (6) enhanced conversion, (7)improved yield, (8) different reaction path way, (9) simpler equipment setup, (10) better process economy, (11) simpler separation and purification processes, (12) higher quality glycerol production. Conventional methods transfer heat to the reaction by convection, conduction, and radiation from reactor surface but, microwaves transfer energy in a form of electromagnetic and not thermal heat reflux. The microwave energy is directly delivered to the reactant and preheating step is eliminated. The main drawbacks for industrial (large-scale) application of microwave processes are: (1) high microwave output (power) may cause damage to organic molecules (triglycerides) (*Saifuddin et al., 2004*), (2) safety aspects. The most important limitation of this process is the scaling-upto industrial (Large-scale) production plant from laboratory scale process, due to the low penetration depth (a few centimetres) of microwave radiation into the absorbing material (*Yoni et al. ,2008) & Vyas et al.,2010)*

Vegetable oils and fats are the esters of glycerol and fatty acids. They are called glycerides or triglycerides. Vegetable oils are extracted from plants and their combustion yields completely recycle carbon dioxide (CO_2).The mustard oil is pure form of fatty acid and triglyceride, which can be used for biodiesel production. It is also concluded that mustard oil can be used for efficient biodiesel production as an alternate to fossil diesel. Vegetable oils are promising alternative fuels for diesel engines, since they are easily handled liquid fuels with properties close to those of diesel in many respects. Vegetable oils have good lubricity, comparatively good friction and wear property, and excellent viscosity index. Results investigated that mustard oil is most common vegetable edible oil, renewable and easily accessible from any region in subcontinent including India. Some researchers have studied on properties of mustard oil to make enable for bio diesel. They examined the physical properties, rheological behaviour and phase diagram of mustard oil and compared a conventional mineral oil. *Anbumani et al., (2010)* studied the feasibility of using two edible plant mustard (Brassica nigra, Family: Cruciferae) and neem (Azadirachta indica, Family: Meliaceae) as diesel substitute a comparative study on their combustion characteristics on a C.I. engine were made. Oils were esterified (butyl esters) before blending with pure diesel in the ratio of 10:90, 15:85, 20:80, and 25:75 by volume. Pure diesel was used as control. Studies have revealed that on blending vegetable oils with diesel a remarkable importance. *Hasib et al, (2011)* studied the prospect of mustard oil as a renewable and alternative fuel. *Sandeep et al, (2013)* utilizes waste cooking oil as a key component of biodiesel production. Properties of waste oil (cotton seed oil and mustard oil) have been compared with the properties of petro-diesel, showing a comparable satisfactory optimized blend which is to be selected for the better performance of a C.I. engine with biodiesel. *Rajat et al, (2014)* produced biodiesel from waste mustard oil through alkali catalysed transesterification process. Biodiesel is simple to use, biodegradable, non-toxic and essentially free of sulphur and aromatics. Physical properties like density, flash point, kinematic viscosity, cloud point and pour point were found out for biodiesel produced from waste mustard oil. The values obtained from waste mustard oil ethyl ester (biodiesel) are closely matched with the conventional diesel fuel and it can be used in diesel engine without any modification. Thetransesterification reaction is the best method for production and modification of biodiesel.

Mustard oil was analysed for their physico-chemical properties using ultrasound. By increasing the proportions of pure mustard oil in blends, the values of ultrasonic velocities, acoustic impedance and relative association show a significant difference in pure oils and their blends and in this context, ultrasonic velocities, acoustic impedance and relative association at some frequency may be considered independent quantifying parameters in an estimation of edible oil contents. The study revealed that regression equations based on the oryzanol content, palmitic acid composition, ultrasonic velocity, relative association, acoustic impedance, and iodine value can be further used for the quantification of rice bran oil in blended oils.*(Mishra et al. 2012)* However, a future study pertaining to the quantification of individual oils by implementing ultrasonic velocities, acoustic impedance and relative association is necessary for these variables to be explored in depth.

10. Conclusion

The ultrasonic studies in liquids are great use in understanding the nature and strength of molecular interactions. Recently ultrasonic is the rapidly growing field research, which has been used in the oil& food industry for both analysis and modification of food products. This paper reports on several work done that demonstrate the usefulness of the technique for on-line process monitoring the composition of mustard oil. This paper presents bio medical applications assistultrasonic that revealed the therapeutic use of mustard oil. Mustard oil is medicinal oil used as a functional food having beneficial physiological effects in humans. Monitoring the composition and physicochemical properties of oil using ultrasonic method one can obtain the most reliable result about its quality, shelf life, stability. Ultrasonic has good potential as a source of energy for emulsification.

The use of enzymes in oil extraction is not the only option there is another method that has had attention is the use of ultrasound can be applied. When oil extraction is carried out, it improves the performance of extraction of mustard oil, reduces the extraction time of oil from seed and also enhances the yield amount about 95%. This method increases the oil extractability significantly and does not alter the fatty acid composition of the oil that is produced. With the cold-press method, ultrasound can also be used as a pre-treatment instead of using enzymes or heat. *(Azadmard et al., 2010)*It is also very useful for biodiesel production as it enhances transesterification reactions between oil and alcohol in the presence of a catalyst. Biodiesel is simple to use, biodegradable, non-toxic and essentially free of sulfur and aromatics.

Ultrasonic nondestructive testing is a versatile technique that can be applied to a wide variety of material analysis applications. A variety of techniques like X-ray diffraction, Refraction measurements (RI), Nuclear magnetic resonance (NMR), Neutron scattering and differential scanning calorimetry (DSC) have been used to characterize oils. Some other non-destructive methods are NIR spectroscopy, Electronic nose, X-ray imaging and Biosensors used in assess of oil. A major disadvantage of using these methods is the difficulty of performing online measurements. A combined system of ultrasonic spectroscopy and a low-resolution pulsed nuclear magnetic resonance spectrometer was used to monitor crystallization of fats and determine SFC (saturated fat contents) online *by Martini et al., (2005a, 2005b).* The simplicity, portability and low cost of ultrasound devices make them essential elements in research laboratories, pilot plants and processed food industries. Traditional methods are expensive, time consuming methods requiring personal technical and laboratory facilities. Today, ultrasound is one of the most widely used imaging technologies in medicine. It is portable easy in handling, free of radiation risk, and relatively inexpensive when compared with other conventional physical and chemical methods. There are few other technologies which are capable of analyzing the liquid material and therefore it seems likely that the ultrasonic technique will find increasing applications in the future. With these advantages, surely there is no reason to not be able to produce high quality edible oil with environmentally friendly method.

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