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Ultrasonic Velocity Studies in Recycled Edible Oils at 1MHz Frequency

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ABSTRACT

Because of the cost factor of the edible oils, it became a common practice in household and commercial establishments to reuse edible oil several times i.e. recycling the same oil for cooking purpose which is harmful to human health conditions. Hence an attempt is made to find out whether edible oil is in its pure form or whether recycled by using ultrasonic technique. Ultrasonic velocity was measured in five edible oils in their pure and recycled forms at 1MHz frequency using Ultrasonic Multi frequency Interferometer at room temperature. The present study gives information about the ultrasonic velocity changes when the oil was recycled and data presented will be highly useful to identify whether the given oil is unused, used or how many times it was used.
Keywords: Ultrasonic Velocity, density and Edible Oils.

I. INTRODUCTION

Oil is a viscous liquid at ambient temperatures, which is a neutral and non-polar chemical substance. Oil is both hydrophobic and lipophilic in nature. The chemical composition of oils denotes high carbon and hydrogen content. Oils are usually flammable and viscous. Oils extracted from vegetables are called as vegetable oils. Vegetable oils are originally lipid materials extracted from seeds or flowers of plants. Most of the oils are extracted from seeds of the plants. Oils are composed of triglycerides. Vegetable oils may be edible or inedible. Examples of edible oils are Coconut oil, Palm oil, Cottonseed oil, Rice bran oil, Groundnut oil, Sesame oil, Mustard oil, Soybean oil, Safflower oil, Sunflower oil and Clove oil. Edible oil in its pure form is used for cooking first time and in this process it is heated. The left out oil is preserved leading to cooling process and again it is reused called as recycling. The profit minded commercial establishments are recycling the same oil several times which is hazardous to human health.

Various techniques have been used to study the properties of the oils or characterization of oils. Few such methods are Nuclear magnetic resonance (NMR), refraction measurement (RI), differential scanning calorimetry (DSC), X-ray diffraction and density measurements.

As ultrasonic is a non destructive test device, Ultrasonic velocity studies in vegetable oils were carried out by several scientists leading to an insight into the Physico – Chemical properties of the oils. Ultrasonic techniques have been widely used to study a number of physical properties of oils. Ultrasonic wave velocity data is used to detect adulteration in a number of animal and vegetable oils [1]. Variation of ultrasonic velocity and absorption with temperature and frequency in high viscous vegetable oils were studied and it was observed that ultrasonic velocity of vegetable oils decreases with the increases of temperature [2]. Physical properties of edible oils were measured using velocity of sound [3].

Studies on thermal stability of blended oils like groundnut and cottonseed oils were done. From the thermal studies it was found that blended oils are more stable than the pure or unblended oils. It was also found that groundnut oil and cottonseed oil blends of 50:50 are more stable than pure cottonseed oil [4]. Thermal studies on the vegetable oils were done to know the importance of blended oils on nutritional levels. Pure coconut, groundnut oils and their blends were used for frying of dehydrated potato chips in order to study the pattern of uptake of oil constituents during frying. Investigations on the analysis of the oil and fatty acid composition in the fried product and the oil remaining in the frying pan suggested a preferential uptake of saturated lipid constituents by the potato chips, while the oil remaining in the frying pan was rich in unsaturated constituents [5]. The frequency dependence of the ultrasonic attenuation coefficient of canola oil, olive oil, peanut oil, safflower oil, soybean oil and sunflower oil at 25^0 C was studied. The measurement indicates the ultrasonic attenuation coefficients of a wide range of edible oils are fairly similar and can be described by a simple power law function [6]. Ultrasonic longitudinal and shear measurements in vegetable oils at a frequency 0.5MHz was done. The measured data in vegetable oils like shear modulus as a function of temperature and the attenuation measurements allow determining the Physcio-chemical and dynamic properties of vegetable oils [7].

II. MATERIALS AND METHODS

Five commonly used refined edible oils were collected from a standard establishment. Ultrasonic studies in recycled refined oils were carried out for 5 recycles. Recycled oil samples were prepared by taking 250ml of refined oil in a steel bowel and then heated for a period of 15minitues which is common cooking or frying time. The time was measured with a stop clock of accuracy ±1Sec. After cooling the oil to the room temperature the ultrasonic velocity readings were taken. Thus the first recycle is over. Again the first recycled oil is heated for a period of 15minutes and cooled down to the room temperature; the readings were taken for second recycled oil. This procedure was continued till 5 recycles are over. The experimentation in all the 5 recycles is done in one sequence without any preservation after first recycling, second recycling, third recycling, fourth recycling and fifth recycling. Common and Scientific names of these oils were presented in Table 1. A variable path Ultrasonic Interferometer (Mittal Enterprises, Model M - 81) with a least count of 0.0001cm of its micrometer was used to determine the velocity of Ultrasound in these oil samples at room temperature by adopting standard procedure. Densities of the samples were measured by using a specific gravity bottle of 10ml capacity and a digital balance of accuracy 0.01 X 10^{-3} Kg at room temperature.

Table 1 Common and Scientific names of edible oils

S. No.	Common name	Scientific Name of Sample
1	Coconut Oil	Cocus nucifera
2	Sesame Oil	Sesammum indicum
3	Groundnut Oil	Arachis hypogaea
4	Sunflower Oil	Helianthus annuus
5	Palm oil	Elaeis guineensis

III. RESULTS AND DISCUSSION

The density of the unused and recycled refined edible oils was measured by using standard procedure and is presented with standard deviation in Table 2. The percentage change in density of recycled refined edible oils is presented in the same table.

Table 2 Density of recycled refined Edible Oils

S No	Sample Code	Common Name	Density (x10^3 Kgm^{-3}) Number of times Edible oil recycled: 0	1	2	3	4	5	Percentage change in density after 5 recycles
1	CCNO	Coconut Oil	0.857 ±0.001	0.904 ±0.002	0.908 ±0.001	0.911 ±0.003	0.912 ±0.001	0.915 ±0.001	6.767
2	SESO	Sesame Oil	0.900 ±0.001	0.900 ±0.002	0.903 ±0.001	0.905 ±0.001	0.906 ±0.003	0.909 ±0.001	1.027
3	GNDO	Groundnut Oil	0.899 ±0.002	0.899 ±0.001	0.903 ±0.002	0.906 ±0.001	0.908 ±0.002	0.910 ±0.003	1.223
4	SUFO	Sunflower Oil	0.905 ±0.001	0.906 ±0.002	0.908 ±0.002	0.908 ±0.001	0.909 ±0.001	0.916 ±0.003	1.243
5	PAMO	Palm oil	0.899 ±0.001	0.900 ±0.002	0.898 ±0.003	0.899 ±0.002	0.898 ±0.002	0.917 ±0.001	1.972

From the above data, it is clear that the density of the edible oils increases with the number of recycles. A significant increase of density is observed in all the oils at 5th recycling. A maximum of 6.8% of increase in density is observed in Coconut oil after 5th recycling when compared to other oils. Density of recycled refined edible oils with number of times oil recycled is shown in Figure 1.

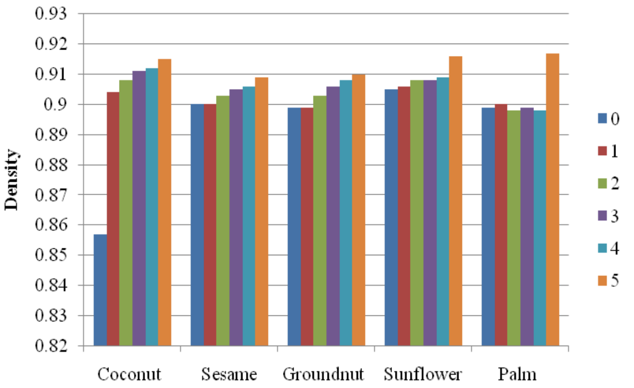

Figure 1 Density of recycled refined edible oils with number of recycles

The ultrasonic velocity of these refined recycled oils was measured at 1MHz frequency and is presented with standard deviation in Table 3. In all the five edible oils, in general the ultrasonic velocity is found to be increasing after each recycling. In case of Sunflower oil, there is an increasing in velocity of 10 to 11msec^{-1} after first recycling which is very significant. In the case of Sesame oil the increase in ultrasonic velocity is 7msec^{-1} after first recycling. In the case of Groundnut oil, Coconut oil and Palm oil the observed increase in velocity is about 3 to 5msec^{-1} after first recycling.

Variation of ultrasonic velocity of recycled refined edible oils with respect to number of times oil is recycled at 1MHz frequency is shown in Figure 2.

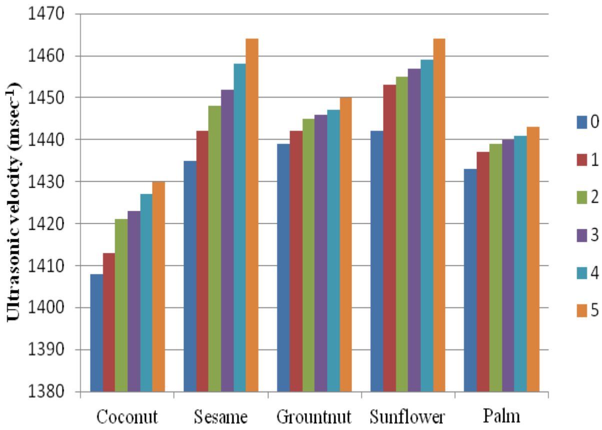

Figure 2 Ultrasonic Velocity in recycled refined edible oils with number of times oil recycled at 1MHz frequency

Table 3 Ultrasonic velocity in recycled refined Edible Oils at 1MHz Frequency

S No	Sample Code	Common Name	Ultrasonic Velocity (m.sec^{-1})						Percentage change in velocity after 5 recycles
			Pure oil	1st recycling	2nd recycling	3rd recycling	4th recycling	5th recycling	
1	CCNO	Coconut Oil	1408±2	1413±1	1421±1	1423±1	1427±1	1430±2	1.56
2	SESO	Sesame Oil	1435±2	1442±1	1448±1	1452±2	1458±2	1464±1	2.02
3	GNDO	Groundnut Oil	1439±1	1442±1	1445±1	1446±1	1447±1	1450±2	0.76
4	SUFO	Sunflower Oil	1442±1	1453±2	1455±1	1457±1	1459±2	1464±1	1.53
5	PAMO	Palm Oil	1433±1	1437±1	1439±1	1440±1	1441±1	1443±1	0.70

From the Figure 2, it is clear that the Ultrasonic velocity in all edible oils increases with the increase of recycling. The percentage change of Ultrasonic velocity in recycled refined edible oils at 1MHz frequency is presented in Table 3. From the Table 3, it is found that a maximum of 2.021% increase in Ultrasonic velocity is observed in Sesame oil and a minimum of 0.697% increase of velocity is observed in Palm oil.

All the 5 edible oils used in the current study are composed of Unsaturated fatty acids (USFA) and saturated fatty acid (SFA) with different percentages as shown in Table 4. From the date shown in Table 3 and 4, it is observed that the ultrasonic velocity of pure edible oils is found to be increasing with the increase of percentage of USFA. In general the ultrasonic velocity studies reveal after every recycle of the given oil the ultrasonic velocity is found to be increasing due to the fact that the thermal energy supplied leads to lower the percentage of SFA and higher the percentage of USFA in the oil medium.

Table 4 SFA and USFA percentages of different edible oils

S. No.	Sample Code	Common Name	% of SFA	% of USFA
1.	CCNO	Coconut Oil	92	08
2.	PAMO	Palm Oil	50	50
3.	GNDO	Ground Nut Oil	22	78
4.	SESO	Sesame Oil	14	86
5.	SUFO	Sunflower Oil	13	87

IV. CONCLUSIONS

The study clearly reveals that the variation of ultrasonic velocity depends on the percentage of SFA and USFA contained by the various Edible oils. From the Ultrasonic velocity and percentage of SFA and USFA data it is clear that the ultrasonic velocity in unused refined edible oils increases with the decrease of percentage of saturated fatty acid. The change in ultrasonic velocity in recycled oils can also be attributed to the disturbance caused in the original structure of these oils and to the percentages of SFA and USFA.

The significant increase in ultrasonic velocity after first recycling of all the oils may be attributed to the reduced SFA% and increased USFA% of the oils studied and also to the disturbance caused to the original molecular structure due to the supply of thermal energy. Thus the increase in velocity may be attributed to break down of molecular structures in the systems studied. The observed increase in ultrasonic velocity in Coconut, Groundnut and Palm oil is in the range of 3 to 5msec^{-1}, where as in Sunflower, it is 11msec^{-1} after first recycling. These results may be attributed to the decrease in SFA% and increase in USFA% due to heating and cooling process or first recycling. Thus the increase in velocity may also be attributed to break down of molecular structures causing an imbalance in SFA% and USFA% in the systems studied. It can be clearly seen from the ultrasonic velocity values of the pure unused oils from Table 3, as the SFA is decreasing the ultrasonic velocity is increasing (Table 4). This also supports the above discussion given in case of various recycled oils.

From the present studies it can be clearly established whether given oil is pure or used or how many times it was used (recycled). With the ultrasonic velocity data presented one can easily find out how many times the oil is recycled. The data can also be used for calibration purpose of the oils either in their pure and recycled form.

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