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# ANTIOXIDANT STABILITY IN PALM AND RICE BRAN OIL USING SIMPLE PARAMETERS

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**ABSTRACT**

Fats and oils are recognized as essential nutrients in human diets. Nutritionally, they are concentrated source of energy (9 cal/ gram); provide essential fatty acids which are the building blocks for the hormones needed to regulate bodily systems; and are a carrier for the oil soluble vitamins A, D, E and K. Kinematic Viscosity of unheated and heated (270°C) rice bran oil is measured 30º to 90°C. In this paper, the antioxidant stability in palm oil and rice bran oil at different times of heating is investigated using the parameters like density, viscosity, adiabatic compressibility and acoustic impedance of the oils at different times of heating. The antioxidant stability is resolute at every time of heating. Hence, it can be recommended that rice bran oil can be used for frying without adverse effect preventing the incidence of malignancy and coronary heart diseases.

**Key words**: Viscosity, redwood viscometer, Rice bran oil, and Antioxidant activity

## INTRODUCTION

Rice (*Oryza sativa*) bran oil (RBO) has been used in many Asian countries as cooking oil. Rice bran oil contains a range of fats, with 47% of monounsaturated, 37% polyunsaturated, and 20% saturated fatty acids[1]. The oil may also offer some health benefits, as it contains oryzanol, an antioxidant that help to prevent heart attacks; phytosterols, compounds believed to help lower cholesterol absorption; and relatively high amounts of vitamin E, sterols, γ-oryzanol and tocotrienols[2]. Crude rice bran oil contains ~96% of saponifiable fractions and ~ 4% unsaponifiable fractions of lipids[3] which include phytosterols, sterol esters, triterpene alcohols, hydrocarbons, and tocopherols[4,5]. γ-Oryzanol a major component of rice bran oil is used to decrease plasma cholesterol, platelet aggregation, cholesterol absorption from cholesterol-enriched diets and aortic fatty streaks [2,6]. Other than the promising cholesterol-lowering effects, γ-oryzanol may have other pharmacological effects such as regulation of the estrous cycle, growth-accelerating action and the ability to promote skin capillary circulation[7].

Palm oil with its inherent frying properties is used due to its techno-economic advantages over other oils and fats. Past studies have demonstrated the frying performance of palm olein during continuous frying of snack foods[8]. Palm oil contains saturated fatty acids like palmitic acid 44.3%, oleic acid – 38.7% and linoleic acid – 10.5%, vitamin E especially tocotrienols, Vitamin K and magnesium[1]. The antioxidant activity of the palm oil is due to the presence of carotenoids and Vitamin E. Beta carotene the reason for the yellow color of the palm oil may also be an important factor for the free radical scavenging activity gave a commentary on the antioxidant effect of beta carotene and its role in cardio protection [9].

In this paper, the antioxidant stability in palm oil and rice bran oil at different times of heating is investigated using a simple marker viscosity. This parameter is measured at different times of heating and at different temperature[10]. It is found that the antioxidant stability in rice bran oil is greater than palm oil even under repeated thermal fluctuations.

## EXPERIMENTAL

Commonly available and popular branded palm and rice bran oil has been collected from a local grocery shop located in Thanjavur district of Tamilnadu, India to assess the possibility of usage of repeatedly heated oil by common people. Hundred Milliliter of the sample oil has been placed in a copper beaker and heated on an electric device, stirring manually with glass rod. A microcontroller based temperature controller has been designed and has been used to monitor the sample temperature. To mimic the oil oxidation process during frying, the sample has been heated up to 210 - 250°C for five times. Initially, the sample was heated to 210 - 250°C for half an hour then, it was allowed to cool until room temperature is achieved. Similarly, the sample was subjected to heating up to 210 – 250°C for 1 hour, 1 ½ hours, 2 hours and 2 ½ hours respectively ensuring that every time the sample is allowed to cool up to room temperature before heating it next time. In order to ensure that the sample has been heated to the temperature greater than its smoke point, it has been exposed to successive heating.

### Methods

**Density**:

The density is measured using specific gravity bottle of 5ml and using the formula ρ = Mass/ Volume in kgm / $m^3$. The oils are heated to frying temperature 250°C for four times. The density of rice bran oil remains almost constant but steep increase in palm oil shows the composition of oils getting saturated due to volatile antioxidants present in the oil.

**Adiabatic Compressibility:**

Ultrasonic is a measurement modality that has been under-utilized for chemo metrics ultrasonic techniques have been available for more than 50 years and they are inherently well suited to the characterization of composition, state of reacting systems, mixing and multiphase flow properties detecting plugs and stratification and providing real-time images and characterization of processes. An ultrasonic pulse-echo interferometer measurement system using the assumption of linear, time-invariant components is used to measure the adiabatic compressibility of the sound waves passing through the oil.

When two waves of equal amplitude and frequency traveling in opposite direction cross each other, they interfere to form a standing wave pattern. The ultrasonic waves produced from the crystal moves up and superimposed with the incident wave leads to the formation of standing waves. In standing waves there are high-density regions called 'nodes' and low-density regions called 'antinodes' alternatively are found. The nodes the displacement of the particles is minimum and at antinodes the displacement is maximum. It is known that the distance between two successive nodes or antinodes is equal to half the wavelength of the wave.

Wavelength $\lambda = 2d/N$ m. (1)

Where d is the distance moved for 'N' maxima.

Velocity $v = \nu\lambda$ m/sec (2)

Where ν is the frequency of the oscillator is 2 M Hz.

Adiabatic compressibility $\beta = 1/(V^2\rho)$ $m^2/N$ (3)

Where ρ is the density of the liquid The adiabatic compressibility is calculated using the formula $\beta = 1/v^2\rho$ $m^2/N$. Fig. 2 illustrates the calculated adiabatic compressibility of rice bran oil is found be constant and steep decrease is observed in palm oil may be due to interaction between the ultrasonic waves and strong binding force in the saturated molecules (indicates a strong molecular interaction between oil molecules).

**Acoustic impedance**

Fig. 3 illustrates the experimental results, which apply the same ultrasonic interferometer method to the measurement acoustic attenuation and impedance in samples of heated palm and rice bran oil.

The acoustic impedance $Z = \rho v$ $kgm^{-2}s^{-1}$ (4)

Z is calculated for the oil at different times of heating.

**Viscosity**

Kinematic viscosity (ν) is defined as the ratio of absolute viscosity (η) to mass density. The Redwood viscometer (manufactured by Associated Instrument manufacturers India Private limited, New Delhi, India) consists of an oil cup furnished with a pointer, which ensures a constant head and orifice at the center of the base of inner cylinder. The orifice is closed with a ball, which is lifted to allow the flow of oil during the experiment. The cylinder, which is filled up to, fixed height with liquid whose viscosity is to be determined, is heated by water bath to the desired temperature. The orifice is opened and the time required for collecting 50cc of oil is measured.

The kinematic viscosity is calculated from the following relation:

$$(\nu) = (A^* t - B/t) \times 10^{-4} \ m^2/s \quad (5)$$

A & B are constants, t = redwood time which measure the rate of flow in seconds.

When $t < 34$ $A = 0.0026$ & $B = 1.175$

And When $t > 34$ $A = 0.26$ & $B = 172$

The copper cup in the viscometer is washed with $CCl_4$ after each observation. Each reading is taken from the average of three trials.

The quality of frying oil has been linked to the quality of the finished product by a number of researchers. Although several methods of oil quality measurement have been proposed, measurement of oil viscosity has been selected since there are reports of increasing oil viscosity with oil mistreatment and because oil viscosity is a primary factor in heat and mass transfer occurring during frying.

## RESULTS AND DISCUSSION

Fig 1 and 2 shows the variation of viscosity with temperature range 30º to 90°C. It is observed that the viscosity decreases with increase in temperature. This is due to the high thermal movements among molecules reduces intermolecular forces, making flow among them easier and reducing viscosity. The presence of double bonds in fatty acid that exist in *cis* configurationally form, produces "kinks" in the geometry of the unsaturated molecules. This prevents the chains coming close together to form intermolecular contacts, resulting in an increased capability of the oil to flow. The viscosity is measured for palm oil and rice bran oil of household origin, used for frying different types of food, is characterized in Fig. 2. It is found that viscosity of unheated oil is lesser than heated oil hence the used oil exhibits dilatants change of fluid.

The study of thermal degradation and antioxidant stability in the oil is carried out by heating the oil to the frying temperature up to 250°C for 0.5, 1, 1.5, 2hrs. After heating to desired time, the viscosity of rice bran and palm oil is measured at 30°C. Fig .3 shows the increase in the viscosity of palm oil with the time of heating due to saturation of bonds in the composition of oils. The viscosity of rice bran oil is almost constant due to antioxidant stability in the oil. Viscosity increases with frying time due to oxidation, isomerisation and polymerization reaction. Oxidation reaction leads to the formation of carbonyl or hydroxyl groups bonded to carbon chain making flux among molecules that increases viscosity.

Fig.4 shows the variation of density with heating time. The density of rice bran oil is found to be constant throughout the time of heating illustrates there is no molecular changes due to antioxidant activity in the oil. It is observed that in palm oil there is increase in density due to increase structural changes as there is increase in saturation composition of the oil.

Fig 5 and 6 illustrates the interaction between the ultrasonic waves and the composition of molecules. The acoustic impedance value of palm oil increases as the reflection coefficient increases due to increase in density and saturation in the molecules. Where as in rice bran oil there is no disparity in the structure of the unsaturated composition present in the oil.

## CONCLUSION

The determination of unsaturation in oils makes it possible to classify them and evaluate their oxidative deterioration in the oil. In metabolic activity saturated fatty acids is converted into diacylglycerol which alter colonic epithelial cells that leads to colon cancer. The antioxidant in the oils breaks oxidation by adding hydrogen atom to free radicals. The antioxidant activity of palm oil is found to be lost during heating. The percentage of lose in antioxidant activity of palm oil during heating is due to volatile nature of carotene. The parameter ρ, Z, β and η of rice bran oil shows that the composition of oil does not get saturated due strong stability of antioxidants on heating. Rice bran oil is used for both edible and industrial application. Rice bran oil had better thermal stability than palm olein. The oxidative stability of rice bran oil was equivalent to or better than soybean, corn canola, cottonseed, and safflower oil in a model system that simulated deep frying conditions. A lesser change in carbonyl content and a smaller increase in viscosity were also observed for rice bran oil. Lower peroxide, foam, free fatty acid, and polymer formation in a frying test was reported.

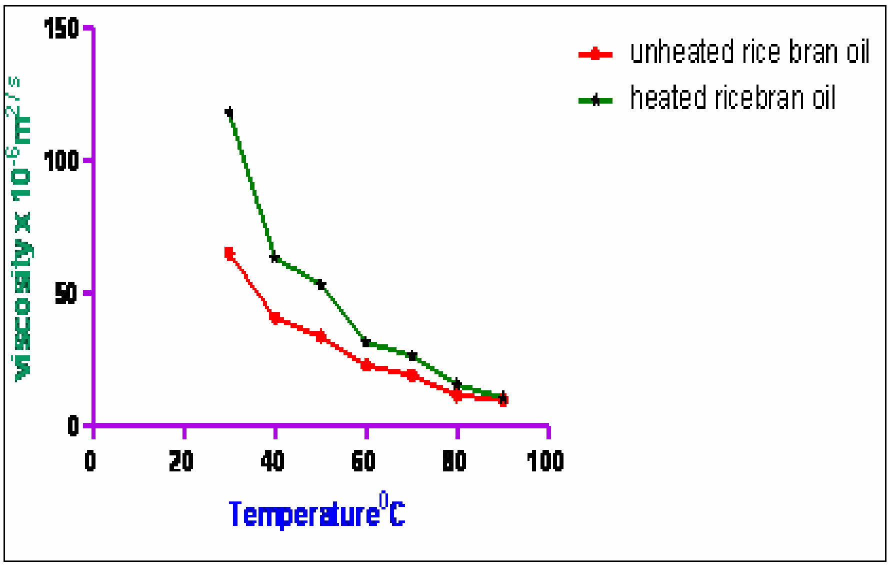


Fig.-1: Variation of viscosity with temperature of unheated rice bran oil and heated rice bran oil

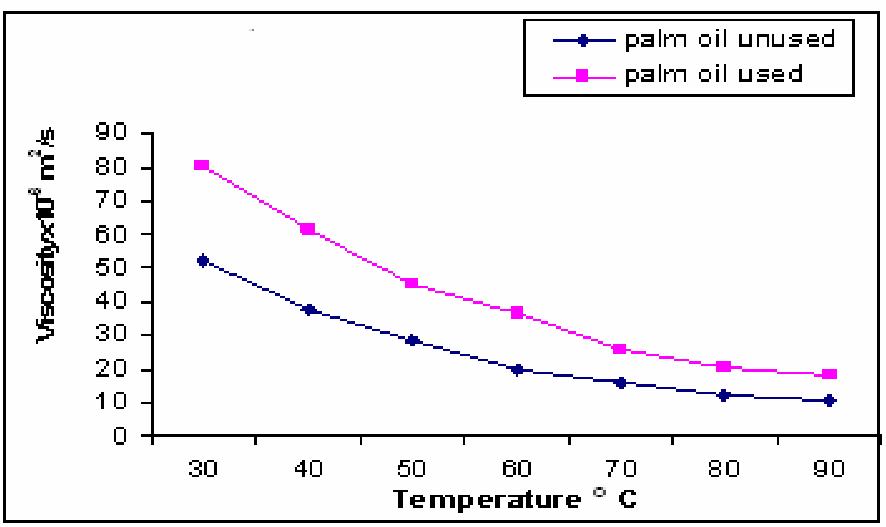


Fig.-2: Variation of viscosity with temperature of rice bran oil

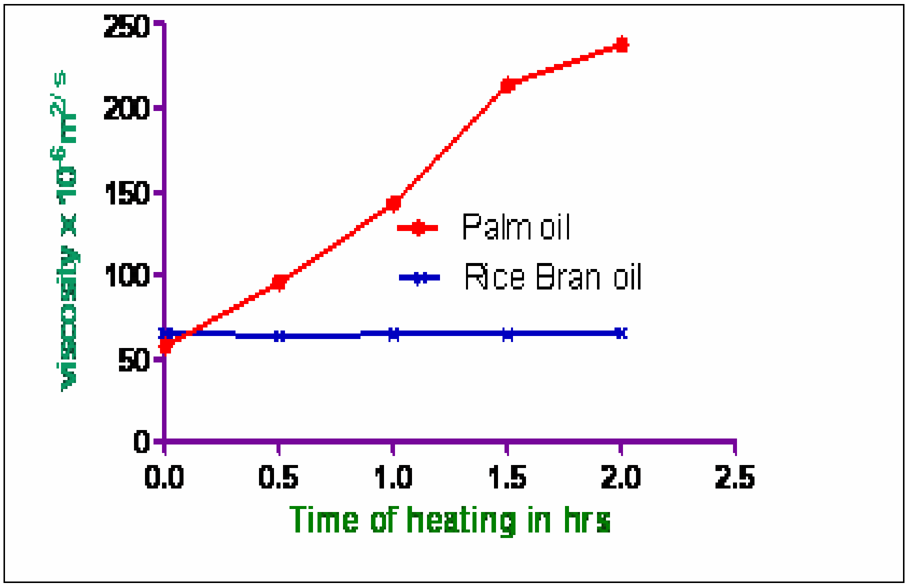


Fig.-3: Variation of viscosity with temperature of Palm oil and Rice bran oil

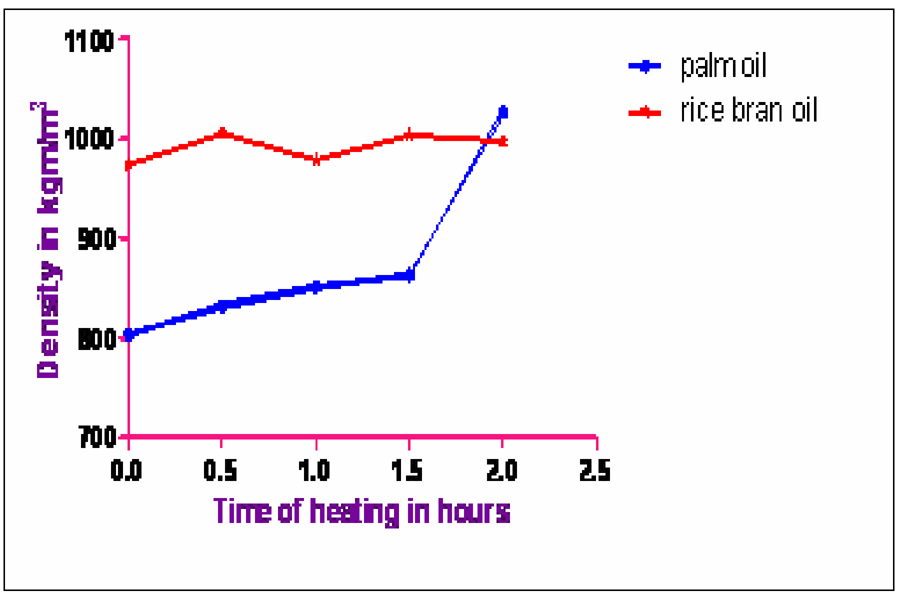


Fig.-4: Variation of density with temperature of palm oil and rice bran oil

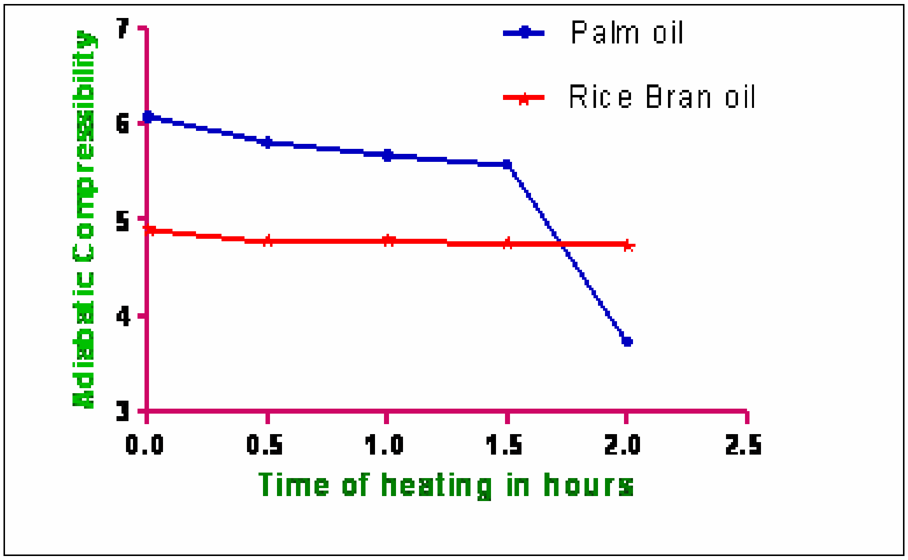


Fig.-5: Variation of adiabatic compressibility with temperature of Palm oil and Rice bran oil

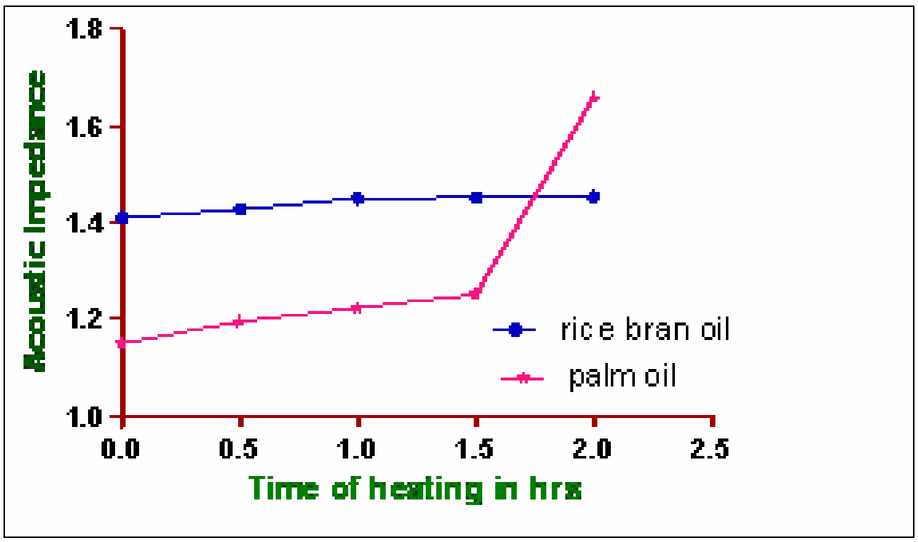


Fig.-6: Variation of acoustic impedance with temperature of Palm oil and Rice bran oil

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