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Optical Study of Six Oils of Indian Origin

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ABSTRACT

Refractive index, density, specific refraction, iodine value, saponification value, molecular weight, relative density and absorption of oils have been calculated at room temperature for six samples of oils. The textures, UV absorption characteristics of these oils have also been studied. Some empirical relations between physical and chemical constants were fitted to the experimental data and the correlation constants for the best fit have been presented. For refractive index measurement Abbe's refractometer, for textures polarizing microscope (Censico 7286) were used.

Keywords: Density, iodine value, saponification value, texture, absorption

INTRODUCTION

Edible oils are among the important food material as they are constituents of our dietary system and some of them are also used for enhancing flavour of food. They are useful in cosmetic, pharmaceutical, lubricant and other industries. During the extraction and purification, they undergo through various processes like heating, distillation, chemical modification etc. These processes modify the various physical properties of oils. Therefore, it is important to characterize them through various physical parameters in order to establish their purity and the safe consumption for the human being.

Literature survey reveals that many researchers have studied many oils and fats and still working on them viz Toscano *et al* reported viscosity, iodine number and saponification value of some vegetable oils and fats [1]. Sankarappa *et al* reported density and ultrasonic velocity at a frequency of 3MHz and in the temperature range 298–333K of some refined and unrefined edible oils, namely coconut oil, castor oil, sunflower oil, kardi (safflower oil) and groundnut oil [2]. Bernat Esteban *et al* discussed the density and viscosity of several vegetable oils within a wide variety of temperatures for their use in engine oil [3]. Vieira *et al* reported the temperature dependence of the refractive index and electric impedance of vegetable oil grape seeds extracted from Vitis vinifera (v. Cabernet) and Vitis labrusca (v. Bordo) by means of experimental techniques [4]. Filali *et al* reported in their study the measurements of viscosity and density of vegetable oils (Rapeseed and Lio) depending on the temperature before and after heating [5]. The aim of the study done by Ismaili *et al* was to analyze the electrical resistivity fluctuations of oils as a function of temperature [6]. Zahir *et al* calculated and reported physicochemical properties like density, viscosity, boiling point, saponification value (SV), iodine value (IV) and peroxide value (PV) of Corn and Mustard oils [7]. Arvind K. Dixit *et al* studied the physico-chemical properties of mint oil of mentha citrate produced in the northern part of the India by RI and relative density [8]. Yunus *et al* studied the refractive index and FTIR spectra of virgin coconut oil and virgin olive oil in the wavelength range from 491.0-667.8 nm [9]. Pandurangan *et al* studied physiochemical properties like viscosity, density, specific gravity, refractive index, conductivity, optical rotation, acid value, saponification value, iodine value and peroxide value of groundnut oil blended with other edible oils such as palm oil and rice bran oil [10].

Majidi and Bader reported the physicochemical properties (refractive index, Specific gravity, saponification value, Free Fatty Acid content, iodine value, acid value, peroxide value) of twenty imported edible vegetable oil in shops in Iraq using standard procedures [11]. Kumar *et al* reported Electrical properties of edible oil dependent on its total polar component, temperature and the frequency of the applied voltage [12]. Subramanian *et al* estimated the density and volume of four Indian edible vegetable oils, sunflower, rice bran, groundnut and coconut, and one Indian nonedible oil, castor oil. The values obtained were used to estimate the volume expansively, hence the thermo acoustic parameters, such as the Sharma constant the isochoric temperature coefficient of internal pressure, the isochoric temperature coefficient of volume expansion, reduced volume, reduced compressibility and the Huggins parameter [13]. Kola Odunaike *et al* estimated five different samples each of imported and locally produced edible vegetable oils were put to test to know their specific heat capacities and viscosities through the electrical method and flow rate method respectively [14]. Kalogianni *et al* reported the effect of deep-fat frying on the viscosity, density and dynamic interfacial tension (against air and water) of palm oil and olive oil [15]. Davies reported the effect of the temperature on dynamic viscosity, density and flow Rate of some vegetable oils [16]. Yang *et al* gave a novel method for determination of peroxide value of edible oils using electrical conductivity [17]. Rudan-Tasic and Klofutar studied characteristics of vegetable oils of Some Slovene Manufacturers [18]. Eromosele and Paschal performed the characterization of seed oils from wild plants [19]. Shriwas *et al* reported comparative study of molecular interactions of refined and unrefined soybean oil and unrefined soybean oil with different organic solvents [20].

Erol *et al* studied the composition and characteristics of Some Seed Oils [21]. Cho *et al* studied correlation between refractive index of vegetable oils measured with surface plasmon resonance and acid values determined with the AOCS official method [22]. Kameswari *et al* reported the density and ultrasonic studies on sunflower Oil [23]. Armenta *et al* reported spectroscopic parameters of edible oil by near infrared spectrometry [24]. Sankarappa and Prashant Kumar reported dielectric properties and ac conductivity in some refined and unrefined edible oils [25]. Mathew *et al* studied dielectric properties of some edible and medicinal oils at microwave frequency [26]. Shah and Tahir studied dielectric properties of vegetable oils [27]. Sharma *et al* studied the effects of hydroprocessing on structure and properties of base oils using NMR [28].

The present paper describes the refractive index, UV absorption and density study of six oils like mustard oil (black and yellow), neem oil, sunflower oil, jasmine oil and sesame oil. Several empirical relations have been used which relates different properties of oils. These equations have been used to correlate refractive index, density with saponification value, iodine value, mean molecular weight, specific gravity and specific refraction of the oils.

MATERIALS AND METHODS

The material (oils) used for the present investigation were procured from Oil Research Institute Anantpur, A.P., India and were used without further purification. The experimental values of absorption, refractive index and density have been measured at room temperature.

In the present work, density of the oil samples was measured by using single-limbed dilatometer with a bulb of capacity 8.1 ml. The stem of dilatometer contained uniform gradation of 0.01 ml. The refractive indices of various oils at room temperature were measured using an Abbe's refractometer. Some of the oils under investigations also showed birefringence. The optical textures for these samples were observed with a polarizing microscope (Censico 7286) using thin films of oils between slide and cover glass.

UV absorption characteristics of oils have been studied with a dual beam UV spectrophotometer. In this instrument there are two beams from a single source of light; one goes through the sample whose absorption we want to measure and another direct to detector. The difference in quantum of light from the two beams gives the absorption or transmission characteristics of the sample placed in the path of beam. The samples of these oils were taken in a quartz cell which is transparent in the UV region. The cell has dimensions of 1×1×5 cm and provides 5 mm path for the UV-Visible radiation. The measurements were done, one by one, after cleaning the quartz cell every time before new oil sample was taken for measurement.

The relation between refractive index and specific volume is given by the [18] equation $r = (n_D - 1)/\rho$, where r is the specific refraction. A more useful relation known as Lorenz - Lorentz equation [18] is given by-

$$r = \frac{n_D^2 - 1}{n_D^2 + 2} \cdot \frac{1}{\rho} \quad (1)$$

Where ρ is the density and n_D is the refractive index of the oil. It appears that the specific refraction has no distinguishing characteristic of the investigated oils. The relationship between refractive index and iodine value (IV) of oils has the form

$$n_D = 1.448 + 0.00022 \times \text{IV} \quad (2)$$

Tels *et al* [18] have derived an empirical relationship between iodine value, saponification values (SV) and specific refraction as

$$r = 0.3307 + 1.68 \times 10^{-5} \times \text{IV} - 1.41 \times \text{SV} \times 10^{-4} \quad (3)$$

The saponification values were calculated with the help of equation (3). Further the value of relative density d or specific gravity can be obtained with the help of following relation

$$d = 0.8308 + 0.00030 \times SV + 0.00027 \times IV \quad (4)$$

The average molecular weight [18] has been calculated using the well-known relation.

$$M = 3 \times 56108 \times 1/ SV \quad (5)$$

where M is the average molecular weight of oils.

RESULTS AND DISCUSSION

The refractive index of various oils measured at 25^0C is shown in figure 1. From the figure 1 it can be seen that the refractive index for black mustard oil has higher value than other oils. The refractive index [9] values vary with increase or decrease in number of double bonds i.e. with mean unsaturation. In general, refractive index of natural oils is related to their average degree of unsaturation in an approximately linear way. The relationship between refractive index, iodine value and saponification values is somewhat more complex. A number of equations have been proposed which have limited applications. Tels *et al* [18] have derived an empirical relation between iodine value, saponification values and specific refraction of fatty oils by [4] making use of the values of group refractivity's obtained from data on hydrocarbons.

Figure 2 presents density data for different oils. It can be seen that the density of neem oil is higher than that of other oils. Probably the constituents of neem oil are more closely packed than the other oils. The relative density or specific gravity [2,3] of oil at any temperature compared to water at specified temperature is known to increase as the mean molecular weight diminishes (i.e. with higher saponification values) and also with higher Iodine values.

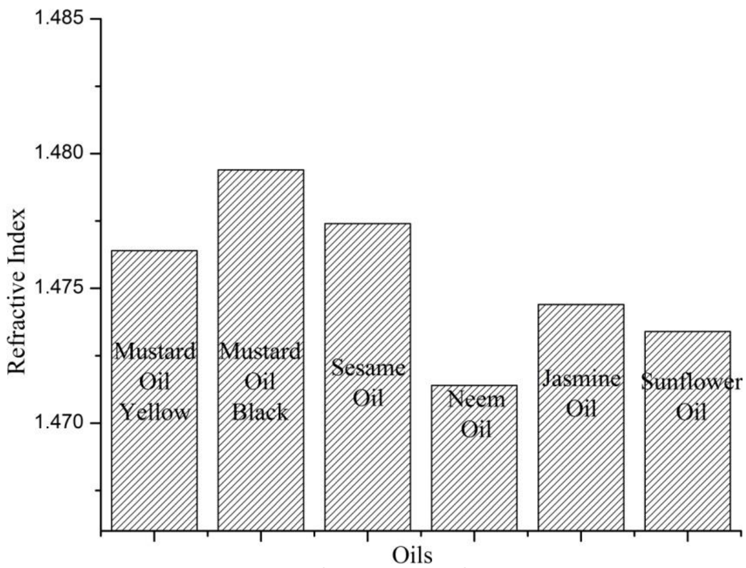

Fig.1 Refractive index of oils

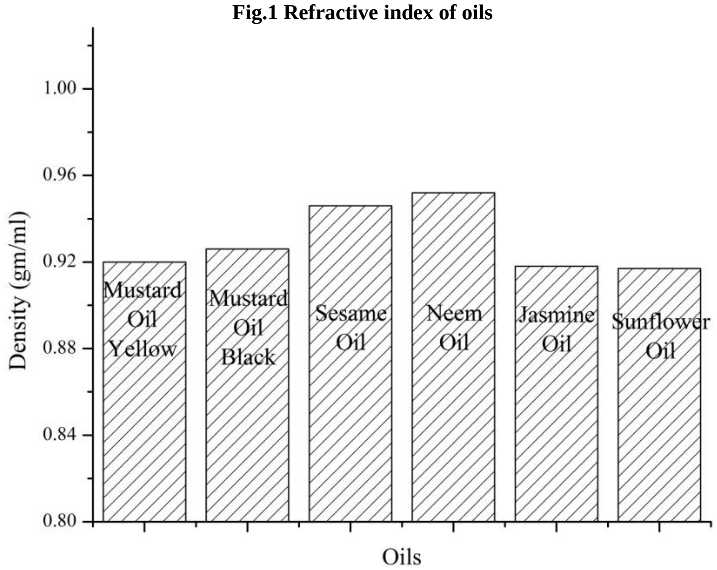

Fig. 2 Density of oils

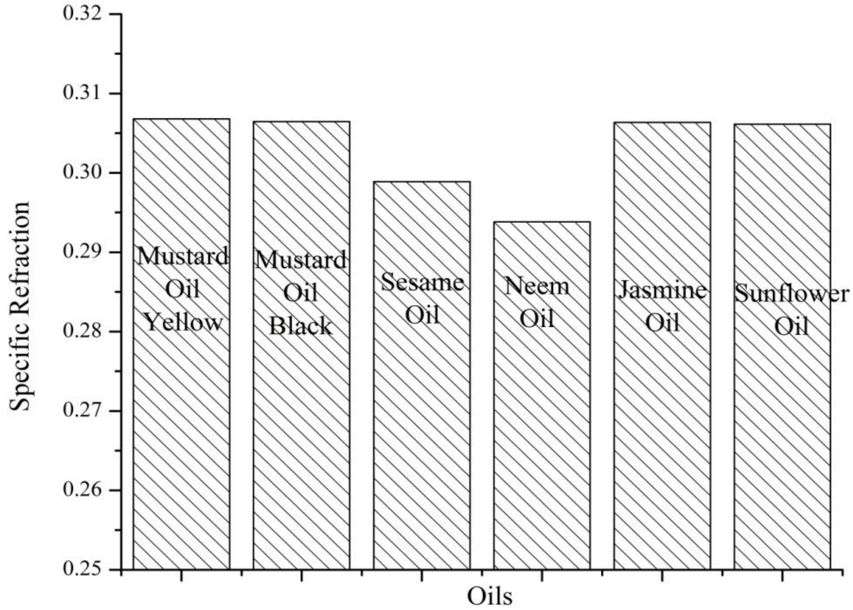

Fig. 3 Specific refraction of oil

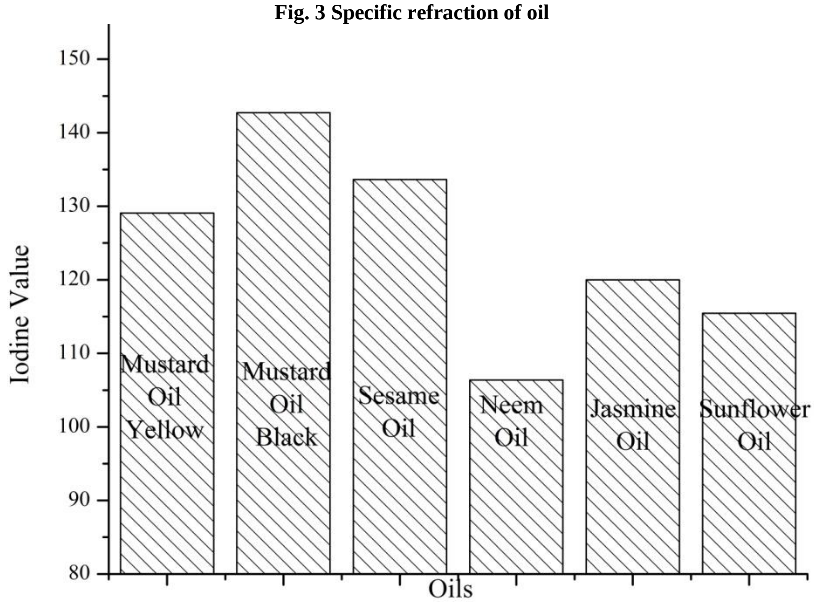

Fig. 4 Iodine value of oils

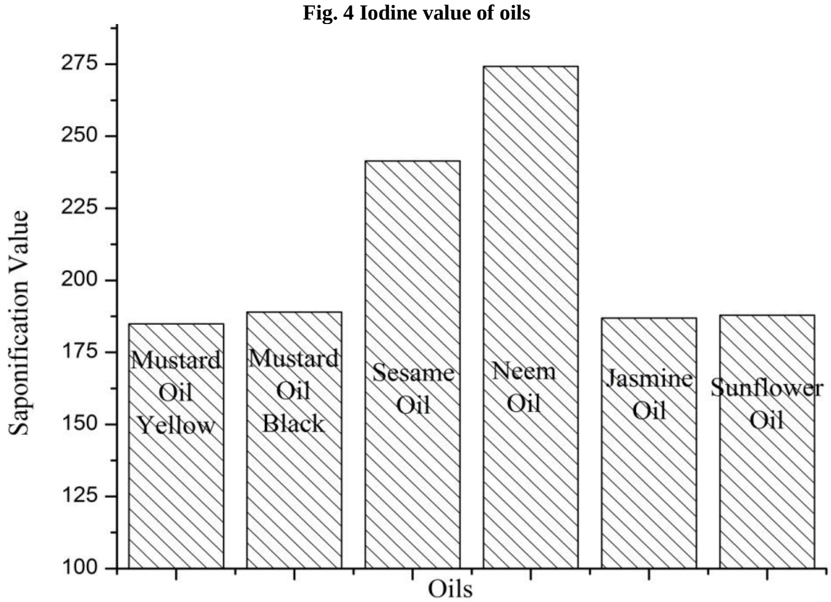

Fig. 5 Saponification value of oils

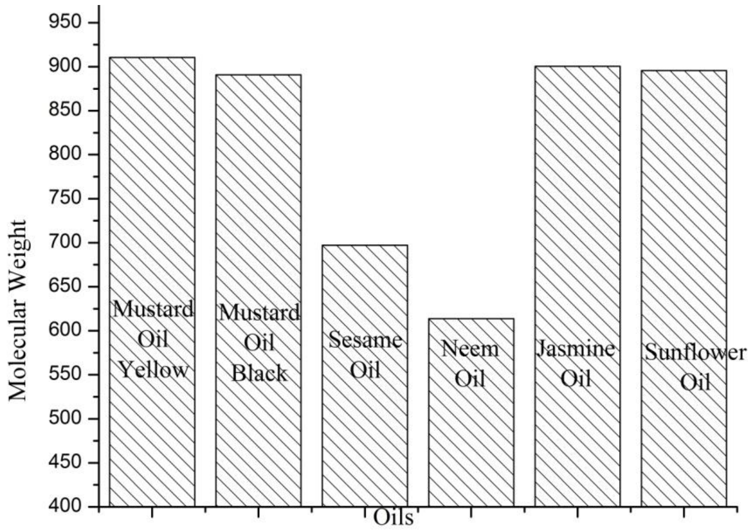

Fig. 6 Average molecular weight of oils

Specific refraction of oils has been presented in figure 3 and & it can be seen that it has maximum for yellow mustard oil and minimum for neem oil. Figure 4 is showing variation in iodine value of various oils and it can be seen that black mustard oil has the highest value and neem has the lowest value among all the oils. Saponification value of oils has been presented in figure 5 and the neem oil has the highest saponification value among all. It shows that the neem oil has the highest degree of soap content in its oil and yellow mustard oil has lowest The molecular weight of neem oil is the lowest and it is presented in figure 6.

Systematic investigations of the optical texture of natural oils have not been reported much. However, it must be mentioned here that studies on the optical textures of pure triglycerides were first reported by Lavigne & Nagappa [29-30] who has observed the occurrence of non-ringed spheruslites in the case of α- phase of trilaurin and tristearin and ringed spheruslites in symmetrical mixed triglyceride. In the case of natural oils, optical textures are generally observable only after leaving the substances for long periods as in, our observation. With specimens of neem oil, only small sperulites could be observed after a period of about 3-4 months, which is shown in fig. (7) and fig. (8). However, when a slide was prepared using the liquid portion at the bottom of container (after settling for about three months), maltese crosses 'drops' and small batonnets could be easily seen to develop within few hours.

The accurate determination of physical and chemical properties of oils is critical for their characterization. To measure these properties, oil samples are frequently investigated by UV-visible absorption (UVVA) spectroscopy [31]. We have used six oils. Three oils show poor absorption in UV visible range while rest of three oils show good absorption in this range. Figure 9, is showing the variation of relative density of various oils and it is highest for neem oil.

Fig. 7 Microphotographs (texture) of neem oil (fresh)

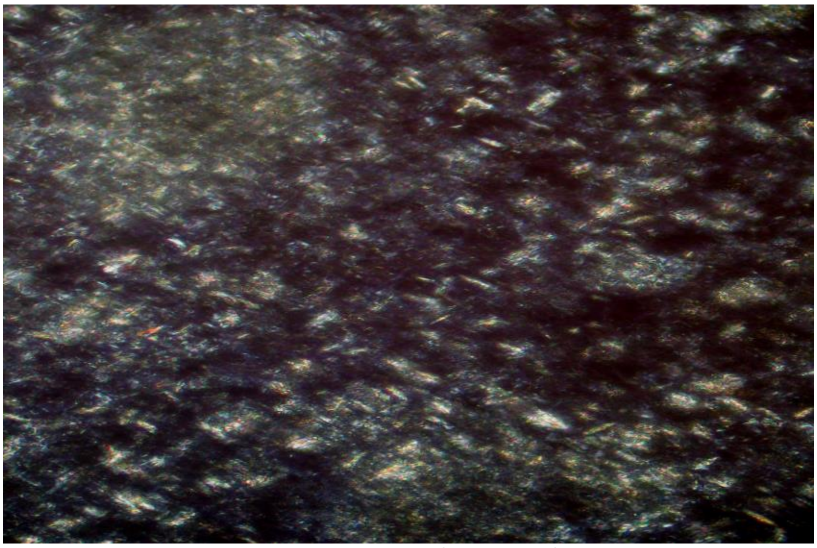

Fig. 8 Microphotographs (texture) of neem oil (after three month)

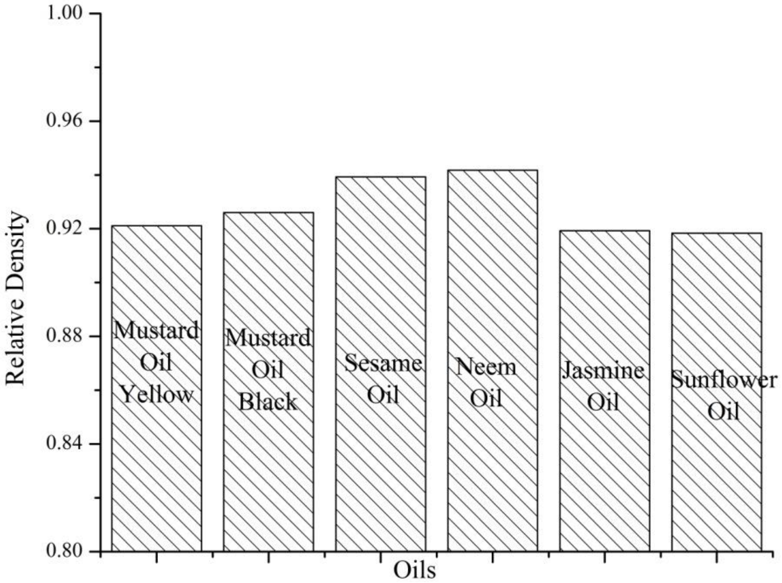

Fig. 9 Relative Density of oils

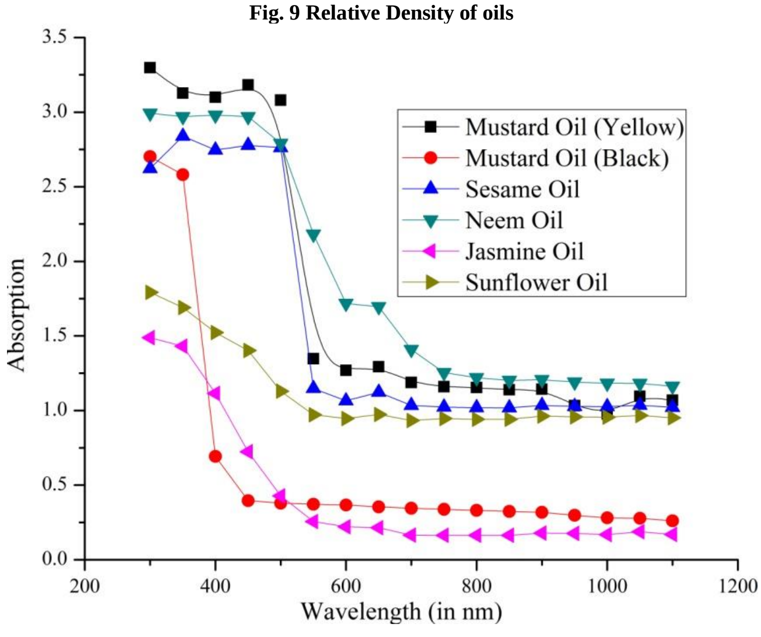

Fig. 10 Absorption of oils

It can be seen from figure 10 that, black mustard, yellow mustard and sesame oils show good absorption while the other three oils, namely, sunflower, neem and jasmine oils shows poor absorption. The highest value of absorption was found to be almost 3.2 for black mustard oil, while their minimum value for the same wavelength was 1.5 for jasmine oil. That is the reason why the oils showing higher absorption are used as an applicant (on skin) for protection against UV radiation from sun. From figure 10 it is observed that the absorption values decrease with increase of wavelength.

CONCLUSION

It can be concluded that the natural oils in general exhibit significant variations in their composition, consequently, it is impossible to define unique values for chemical and physical constants for any oils and it is usually necessary to combine several empirical constants to predict the chemical and physical properties of edible oils. In case of absorption we conclude that some of the oils used as applicant by tropical population show a good absorption in UV visible region. This indicates that these oils could have reduced the UV falling on the skin i.e. their roles in actually protecting the skin from UV light.

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