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Infrared Spectroscopic Behaviour of Coconut Oil and Groundnut Oil

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Simple parameters, *viz*., specific refraction and infra-red spectroscopy were studied for exploring the possibility of developing the rapid method for the detection of adulteration of groundnut oil in coconut oil as a model study. The study indicated that small variation in the value of specific refraction may not give the desired result but the infrared spectra in the frequency range of 3030–3000 cm^{-1} can effectively be utilized for the detection of groundnut oil adulteration in coconut oil.

INTRODUCTION

Chemically, most fats and oils are enough alike to make the detection of one oil in the presence of another oil often quite difficult. If the supplier of edible oils mixes oils together in such a way that the final product satisfies the conventional anlytical contents used as test of identity, *e.g.*, refractive index, saponification value, iodine value etc., adulteration may go undetected. Many tests for detection of one oil in the presence of another oil depend on nonglyceride and glyceride composition. However, modern refining methods that remove these constituents may cause variable results. Because of the large number of possible adulterants, a reasonably complete check on a sample of oil requires the performance of many tests, and hence represents, in most instances, a tedious and time consuming operation. Thus methods of analysis that are rapid and reliable would be very valuable.

Infrared spectroscopy has been widely used for the rapid identification of organic compounds, when first of all infra-red spectra of a few oils and fats have been reported[1,2]. Bartlet *et al.*[3] studied the detection of rapeseed in corn oil and olive oil. No data are available for other oils, which are being widely adulterated. Therefore, the present study was undertaken to explore the possibility of developing rapid methods for the detection of adulteration. This paper deals with the utility of simple procedure, like refractive index and specific gravity based on Lorentz-Lorenz expression and infrared spectroscopy for the detection of adulteration of groundnut oil in coconut oil.

EXPERIMENTAL

Pure refined coconut oil and groundnut oil of various brands were procured from reliable sources. These samples were analysed for refractive index, specific gravity, iodine value and saponification value by following the standard methods[4].

Determination of specific refraction for different oil samples was done by following the Lorentz-Lorenz equation[5], gives as follows:

$$\left[\frac{n^2-1}{n^2+2}\right]\times\frac{1}{D}$$

where n = refractive index and D = specific gravity.

The oil samples were analysed by Perkin-Elmer IR spectrophotometer (model No. 297) by fixing various parameters, given as follows:

Cell: NaCl (Thin film technique).

Concentration: 100%; Solvent: Nil; Scanning time: 7 min; Range: 4000–600 cm^{-1}.

RESULTS AND DISCUSSION

Coconut oil (CNO) and groundnut oil (GNO) having average saponification value 256.96 and 193.90; iodine value 9.22 and 86.61; refractive index (at 30°C) 1.450 and 1.465; specific gravity (at 30°C) 0.918 and 0.911, respectively, were taken in different proportions as given in respective Table-1 for specific refraction and IR spectroscopy.

TABLE -1
SPECIFIC REFRACTION OF COCONUT OIL (CNO) AND GROUNDNUT OIL (GNO) AND THEIR ADMIXTURES

Oil constituents	Refractive index (30°C)	Specific gravity (30°C)	Specific refraction
CNO	1.450	0.9180	0.2927
95% CNO + 5% GNO	1.451	0.9178	0.2934
90% CNO + 10% GNO	1.452	0.9170	0.2942
80% CNO + 20% GNO	1.453	0.9165	0.2949
70% CNO + 30% GNO	1.455	0.9160	0.2962
60% CNO + 40% GNO	1.456	0.9153	0.2970
GNO	1.465	0.9110	0.3035

Results average of three individual experiments.

Specific refraction takes into account two specific properties, namely refractive index and spectific gravity. As a result the limits of standard could be brought to a narrower range, as has been suggested by Nayar *et al.*[5] for the detection of mustard oil in groundnut oil. Table-1 shows the differences in specific refraction as the one specific oil constituent was mixed with other. From the results, it is very much evident that the difference in specific refraction was found to be

0.2927 and 0.2970 for the coconut oil and admixed coconut and groundnut oil in the proportion of 60 : 40 respectively, which did not show significant difference. Therefore, detection based on the specific refraction is not an attractive option.

The pure oil samples were scanned by IR spectrophotometer in the range of 4000–600 cm^{-1} (Fig. 1). It clearly indicates that there is a major difference in band spectrum of groundnut and coconut oil in the frequency region near 3000 cm^{-1}. The frequency region near 1250–1050 cm^{-1} also shows a good difference in the band spectrum of coconut oil and groundnut oil. The frequency region 3000 cm^{-1} seems to be more useful in the detection of groundnut oil adulteration in coconut oil when mixed in different proporitions because of the sharp and significantly different band spectra in case of both the oils.

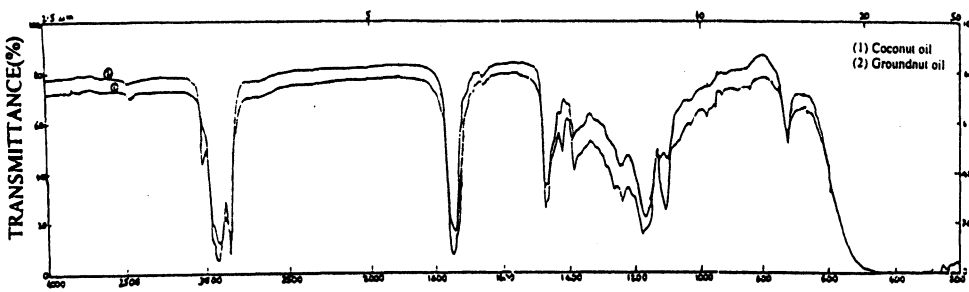

Fig. 1. IR spectra for pure coconut and groundnut oils.

Fig. 1 clearly shows that groundnut oil showed a band spectrum in the frequency region 3030–3000 cm^{-1} but coconut oil doesn't show any band. It may be due to the ═CH absorption in this range. Since groundnut oil has comparatively much larger degree of unsaturation than coconut oil, therefore groundnut oil probably showed a larger band spectrum, *i.e.*, greater ═CH absorption. It has already been suggested[6] that one of the most valuable means of detection of double bonds through IR spectra is the examination of the region near 3000 cm^{-1}. It has also been reported that normal CH vibrations of saturated structures occur at frequencies below 3000 cm^{-1} which can also be seen in Fig. 1. Coconut oil hardly showed any ═CH vibration in the frequency region 3030–3000 cm^{-1} which may be due to very little degree of unsaturation. Figs. 2 and 3 show that the amount of groundnut oil in coconut oil, *i.e.*, the degree of unsaturation increased; it showed the more stretching vibrations and a sharper band spectrum. Infrared spectroscopic behaviour of the various oil samples clearly infers that the presence of groundnut oil in cocount oil can be easily detected in IR spectra.

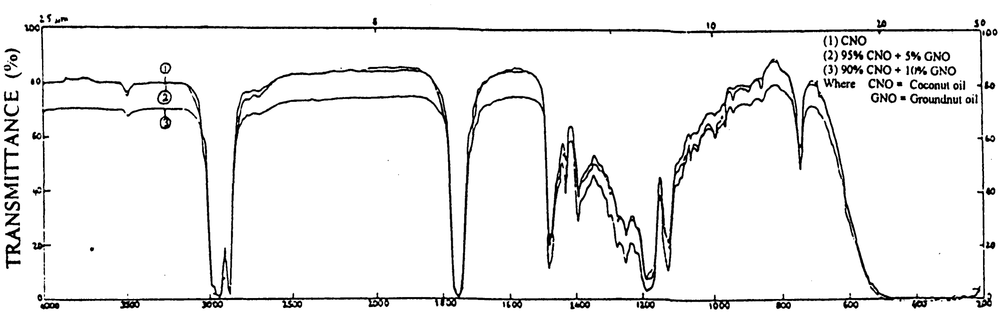

Fig. 2. IR spectra for pure coconut and groundnut oil admixtures.

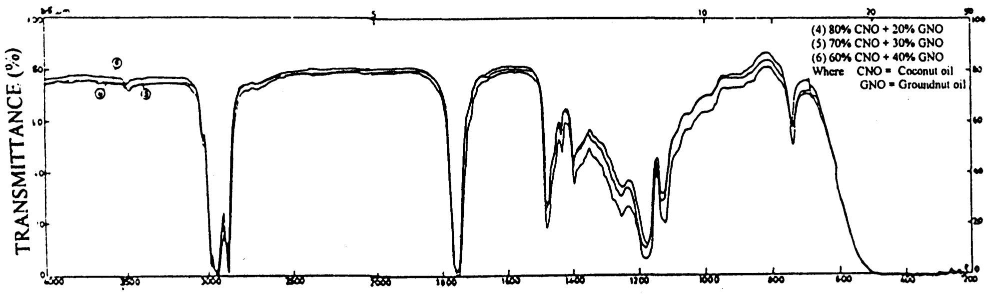

Fig. 3. IR spectra for pure coconut and groundnut oil admixtures.

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