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RESEARCH ARTICLE

INDEXING REFRACTION OF COMMONLY USED EDIBLE OILS - A TOOL FOR FINDING ADULTERATION- THINKING 'RESEARCHY' AT UNDERGRADUATE LEVEL – I

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ABSTRACT

In terms Indexing refractionis an important parameter in studying the characteristics of liquids. In this study the characteristic variation in the indexing of refraction of homemade pure virgin coconut Oil is done with a spectrometer and a hollow liquid prism, when locally available palm oil is added to it as an adulterant. Expected value is calculated at an interval of 5% and Graph is drawn giving regression to the mean value $R^2 = 1$. Different samples of coconut oil are collected from the local market. The refraction of these sample is indexed, and Graph is drawn which gives a regression to the mean value $R^2 = 0.9643$. This Graph is compared with the graph drawn with the standard calculated value. Comparison Graph shows considerable adulteration as reported in the local news during festive season in September 2015 in state Kerala, India, when coconut oil was in high demand. Low cost palm oil was widely available, and the state produces no other cheaper oil other than palm oil to be used as an adulterant. Nonetheless, Simple laboratory experiments still plays an important role in bringing equally important outcomes as that of more expensive and sophisticated instruments in the expensive laboratory settings.

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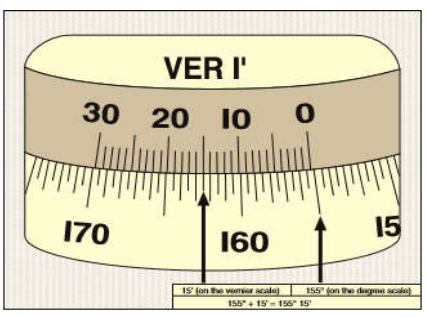
INTRODUCTION

Spectroscopic techniques such as Fourier Transform Infrared Spectroscopy (FTIR), Visible and Near-Infrared Spectroscopy near-infrared (FT-NIR) and Raman (FT-Raman) spectroscopy are widely used in the research laboratories to find adulteration in edible oils especially expensive cooking oils such as extra virgin Olive oil and virgin coconut oil with relatively cheaper oils such as cotton seed oil, rapeseed oil, palm oil, sun flower oil. Index of refraction is an equally important characteristic that can give information regarding the changes in the composition. Generally, the refractive index of a glass increases with its density. Although less dense than water, many oils such as olive oil, coconut oil and ethyl alcohol are more refractive which is contrary to the general correlation between density and refractive index. Virgin coconut oil is well sought-after edible oil in tropics because it has wide applications in health and cosmetic industry in addition to food industry. Hence it is expensive compared to other vegetable oil and the risk of adulteration is high too.

MATERIAL AND METHODS

Homemade coconut oil is pure, unadulterated liquid and can be considered as extra virgin. It can be extracted from the kernels of mature coconuts by squeezing the milk from the ground flesh and heating it to separate oil from the pulp. Homemade virgin coconut oil is used as standard pure oil to study the variation in the index of refraction of various samples of virgin oil available in the market. Refractive index can be studied with the help of refractometers, interferometers, optical sensing methods and spectrometers. Most common method used in school and college laboratory is spectrometers and liquid lens method. A study is conducted here to know whether commercially available coconut oil is adulterated by looking at the variation in the index of refraction in a regular undergraduate laboratory with bare minimum technologically advanced equipment. Basic Spectrometer of least count 1' and a Hollow Equilateral Prism made of approximately 5 cm side having a capacity of 39 ml. are used,



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Index of refraction is calculated using the equation below to an accuracy of 4 significant figures.

$$n = \frac{\sin\left\{\frac{A+D}{2}\right\}}{\sin\frac{A}{2}}$$

Experiment and Results

Refractive index of homemade virgin coconut oil is calculated to 4 significant figures and is found as 1.445. Nine samples of coconut oil are collected from the local market and refraction of each sample is indexed and tabulated. Pure virgin coconut oil is deliberately mixed with locally available palm oil whose purity is unknown. Refraction of the deliberately adulterated samples are indexed at the interval of 5% and tabulated. Standard value of index of refraction of palm oil is taken as the average of few observations as 1.462. In order to control the study, the accurate expected value of index of refraction at each point of adulteration is calculated. It is the standard value of index of refraction of VCO 1.445 plus percentage of adulteration of palm oil at that point.

Example: 5% of deliberate adulteration should give a change in the observed index of refraction as given as

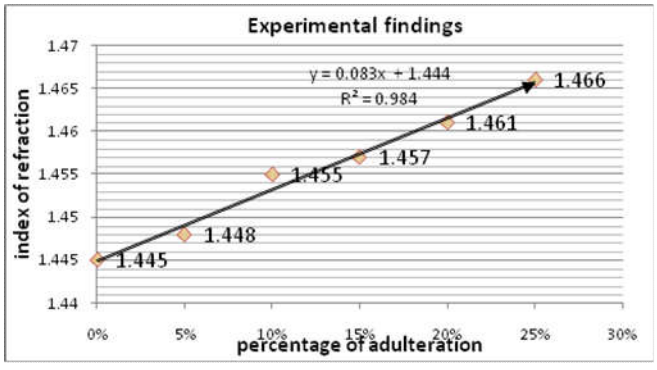
1.445 + 5/100 x (1.462-1.445) = 1.445+0.05 x 0.017 =1.445+0.00085 =1.44585

This can be generalized as 1.445 + X/20 *(1.462-1.445) where x is percentage of adulteration as a multiple of 0.05

Similarly expected change in the index of refraction can be calculated at an interval of 5% up to 100%.Value at 100% is the index value of standard palm oil used. Experimental observation shows a linear increase in the index of refraction as we deliberately adulterated the pure VCO with locally available palm oil. Also, this is experimentally found using spectrometer at an interval of 5% up to 25%. Calculated and observed value shows slight deviation. Standardization is done with calculated value to avoid experimental errors as much as possible.

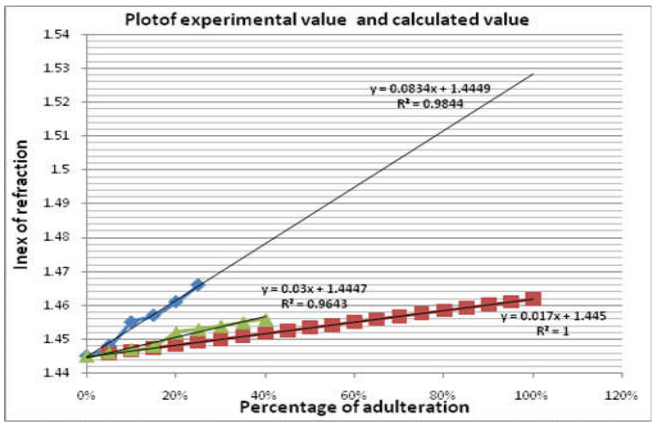
Experimental observations of adulterations of VCO deliberately

Trial	Percentage of adulteration	Observed Refractive index	Calculated value = 1.445 + 1*X/20 *(1.462-1.445) where x is %
1	0%	1.445	
2	5%	1.448	1.44585
3	10%	1.455	1.4467
4	15%	1.457	1.44755
5	20%	1.461	1.4484
6	25%	1.466	1.44925



Comparison of indices of refraction of Collected sample and Created Experimental sample

Index of refraction Pure coconut oil			1.445
Index of refraction of standard palm oil			1.462
Difference in index of refraction			0.017
Percentage of adulteration	Observed Refractive index	Calculated value = 1.445 + 1*X/20 *(1.462-1.445) where x is %	Index of refraction of collected sample
0%	1.445		1.445
5%	1.448	1.44585	1.446
10%	1.455	1.4467	1.447
15%	1.457	1.44755	1.448
20%	1.461	1.4484	1.452
25%	1.466	1.44925	1.453
30%		1.4501	1.454
35%		1.45095	1.455
40%		1.4518	1.456
45%		1.45265	
50%		1.4535	
55%		1.45435	
60%		1.4552	
65%		1.45605	
70%		1.4569	
75%		1.45775	
80%		1.4586	
85%		1.45945	
90%		1.4603	
95%		1.46115	
100%		1.462	

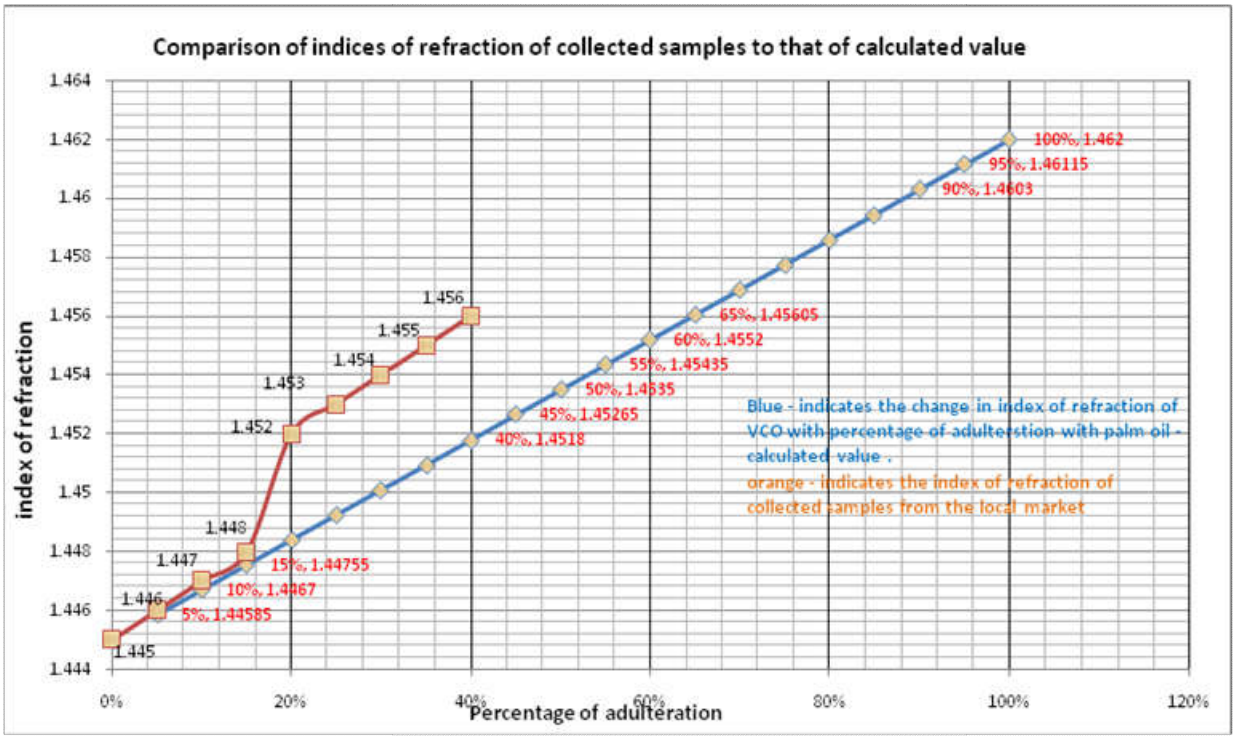


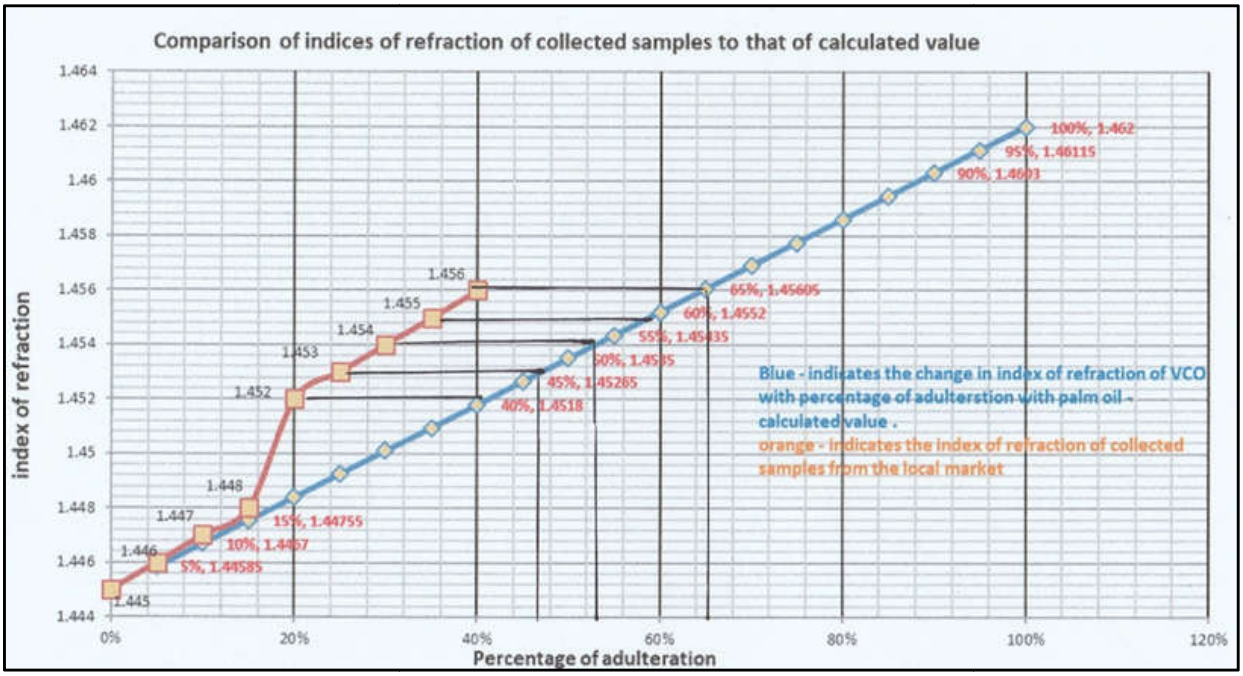
Comparison of indices of refraction of collected samples to that of calculated value

Sample	Refractive index	% of adulteration
1	1.446	0% - 5%
2	1.456	60% - 65%
3	1.445	0%
4	1.447	5%- 10%
5	1.452	40 %
6	1.454	50% - 55%
7	1.455	50% - 55%
8	1.448	15%
9	1.453	40% - 45%

Observations and discussions

Results shows a linear increase in the index of refraction of VCO as we deliberately add locally available Palm Oil with an R2 value $R^2 = 0.9844$ giving good regression to the mean value.Regression to the mean value of the graph drawn for different samples collected is also satisfactory with $R^2 = 0.9643$. Obviously, graph drawn with calculated value of index of refraction is $R^2 = 1$. Slope of the graph drawn with Index of refraction of collected samples is 0.03 which is very close to the slope of the calculated value plotted against percentage of adulteration drawn at an interval of 5% which is 0.017. Hence graph plotted with calculated value is used for standardization for minimizing error in experimental set up.





DISCUSSION

The experimental value of the samples collected from the local market shows closeness to the calculated value of adulteration. Hence standardization is done comparing to the calculated value of adulteration. On top of that, this way of comparison can minimize the error in doing the experiment in a non-sophisticated undergraduate laboratory environment of ordinary college. More controlled study is possible if the experiment is done in temperature controlled room and if the purity of palm oil is known. Despite of this, the calculations can be done for 5 significant figures and more trials for a single sample to find a correct absolute value. Also checking the experimental value with other methods such as ordinary liquid lens experiment or good refract meter can give more control and more reliable experimental values.

Here to minimize experimental error, the comparison of the indices of refraction of different samples collected from the local market is done to the calculated value of index of refraction, which is the expected value if the given sample of pure VCO can be mixed with pure standard palm oil at an interval of 5%. Experiment was conducted in the festive season of September 2015 when Adulteration of coconut oil was reported in news as a serious issue. Considerable adulteration was possible since the demand was very high during the festive season called 'Onam'. Logical conclusion is made in choosing the adulterant as Palm Oil because no other cheaper oil is produced in the state of Kerala in large scale to use it as an adulterant at cheaper price. Also, large-scale imported of palm oil was available. Experiment was done in an ordinary undergraduate lab at atmospheric temperature of about 28^0C as part of partial fulfillment of BSc degree of Vishakh M. Premkumar.

Conclusion

Indexing refraction of possibly adulterated edible oils and standardizing it with calculated results can give equally important information regarding the risk of adulteration in commonly used edible oils under ordinary laboratory settings using simple experiments as that of more sophisticated apparatus and more expensive laboratory settings.

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Discriminant analysis of edible oils and fats by FTIR, FT-NIR and FT-Raman spectroscopy

Rapid Authentication of Olive Oil Adulteration by Raman Spectrometry

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