Trends In Physio-chemical Characteristics Of Coconut Oil Blended With Refined Palmolein Oil

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***Abstract* - Vegetable oils are used for the preparation of many food products.In order to improve their textural, oxidative and nutritive properties and also industrial applications, vegetable oils are modified by methods such as hydrogenation, interesterification, acetylation,winterization, blending etc.Blending should not have any adverse health impact.In this study coconut oil is blended with palmolein oil and trends in physio-chemical properties are established.**

***keywords* - Refractive index,Iodine value, Saponification value,ethanol, coconut oil, blending etc**

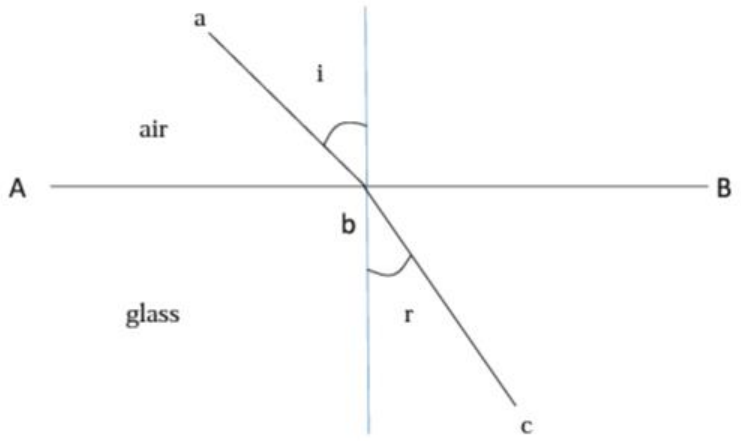
I . INTRODUCTION

The Food Safety and Standards (Food Products Standards and Food Additives) Regulations,2011 allows the blending of two edible vegetable oils with the specification that the proportion by weight of any edible oil in the admixture is not less than 20 %. The commonly used two edible oils – coconut oil and refined palmolein oil – are blended in different proportions and trends in physio-chemical properties are studied.The analysed properties include

Physical Properties

1. The refractive index

The Refractive Index is a number expressing the ratio between the velocity of light in air and its velocity in some other medium. More particularly it expresses the ratio between the sine of the angle of incidence of a ray of light on the surface separating two media and the sine of the angle of its refraction. This ratio is a constant for any two media.



In the diagram, the line **AB** is the boundary between air and glass, and **ab** is a ray of light passing from air into glass where it is refracted along the line **bc**. Then whatever may be the value of the angle of incidence **(i)** the angle of refraction (**r)** will always be so related to it that

$$\frac{\sin i}{\sin r} = n$$, a constant called index of refraction.

The index of refraction is thus a quantity which is a constant for a pure substance under standard conditions of temperature and pressure. The various glycerides differ in their refractive power and its determination is thus a useful figure for ascertaining the purity of an oil or fat.The index of refraction decreases as the temperature rises; however, it increases with increase in the length of the carbon chains and also with the number of double bonds present. The Butyro Refractometer Reading (BRR) is calculated from conversion chart.

2. Specific gravity

The specijic gravity is the weight of any volume of a substance compared with the weight of an equal volume of pure water at a standard temperature, e.g. 15.5°C

Chemical Properties

1.Iodine Value

The degree of unsaturation of the fatty acids in a fat or oil can be quantitatively expressed by the Iodine Value of the fat. Iodine value refers to the number of grams of iodine absorbed by 100 g of fat. Since the iodine reacts at the sites of unsaturation much as would hydrogen in hydrogenation, the higher the iodine value the greater the degree of unsaturation in the fat.

2.Saponification Value

The saponification number is defined as the number of milligrams of potassium hydroxide required to saponify 1g of fat .The number is inversely proportional to the average chain length of fatty acids and hence gives an idea about the average molecular weight of fatty acids.Very high saponification number implies preponderance of fatty acids with very short chains (very low molecular weights).

3. Acid Value

The acid value of an oil, fat, or wax is a measure of the free fatty acidity, and represents the number of milligrams of potassium hydroxide required to neutralise the free fatty acids in 1 gram of the substance.Commercial samples of oils and fats usually contain more or less free fatty acids. This is due to hydrolysis of the glycerides on contact with air, apparently by the action of minute quantities of enzymes derived from the tissues of the plants and animals. In the case of vegetable oils,however, a slight degree of acidity is almost always met with in the freshly expressed oils. The degree of acidity is greater in unripe seeds and fruits and diminishes as the fruit ripens.Since rancidity is accompanied by the formation of free fatty acids though the acidity does not of itself account for the phenomena accompanying rancidity—the test often serves to determine the quality of the fat and to define its commercial grade. It should however be borne in mind that acidity in an oil or fat is often accompanied by

1. More or less breaking down of the higher fatty acids into lower(volatile) acids.
2. Partial splitting of the glycerides resulting in the formation of mono and di-glycerides.
3. Oxidation of the liberated fatty acids.
4. Decomposition of the glycerol produced.

Thus oils and fats which have identical acid values may vary a good deal in quality, and the acid value is not, in itself, an absolute criterion of quality,though it gives, in most cases, a fair indication.

Adulterant tests

The common adulterants in coconut oil and palmolein oil include mineral oil, cottonseed oil, sesame oil, argemone oil and added colouring matter , which are also checked.

II. MATERIALS & METHODS

Materials

Study Setting : This study was carried out at Government Analysts Laboratory,Trivandrum,Kerala under the Commissionerate of Food Safety,Government of Kerala.

Collection and Preparation of Sample : The samples used for this study include three different samples each of coconut oil and refined palmolein oil purchased from local market.The samples are analysed separately and also in blended stage.The blending is done as per the FSS regulation requirements.I also blended the oils in proportions lesser than 20 % for studying the adulteration.The composition of oils used for blending is given in the table.

Coconut oil	100 %	98 %	95 %	90 %	80 %	70 %	60 %	50 %	40 %	30 %	20 %	10 %	0 %
Palmolein Oil	0 %	2 %	5 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	100 %

The oils are mixed in the following way

Blend-1 Coconut oil-1 and Refined Palmolein-1
Blend-2 Coconut oil-1 and Refined Palmolein-2
Blend-3 Coconut oil-2 and Refined Palmolein-1
Blend-4 Coconut oil-2 and Refined Palmolein-2
Blend-5 Coconut oil-3 and Refined Palmolein-3

Apparatus and Reagents :

Electronic balance
Refractometer
Pyknometer
UV cabinet
Water bath

Sodium hydroxide (0.1 Normal)
Sodium thiosulphate (0.1 Normal)
Hydrochloric acid (0.5 Normal)

Phenolphthalein
Starch Soluble

Chromatographic set up such as TLC plate,paper chromatographic sheet and chromatography glass chamber with lid, chemicals such as ethanol,carbon tetrachloride , chloroform , hexane , furfural ,carbon disulphide , sulphur,amyl alcohol, sodium chloride, diethyl ether,n-butanol,petroleum ether and 2,7-dichlorofluorescein and glasswares such as specific gravity bottle,conical flask, saponification value flasks with air condenser,iodine value flask, beakers, pipette,burette,funnel etc are also used.

Method :

Refractive Index : It is measured using the instrument ATAGO RX-5000i refractometer.The correlation values of refractive index and BRR can be read from IS 548 (Part 1) 1964:Reaffirmed 2015

Specific gravity : It is measured by pyknometer method

Iodine Value:It is measured by Wijs iodine monochloride method described in IS 548 (Part 1) 1964:Reaffirmed 2015. In this method, a known quantity of oil sample is dissolved in carbon tetrachloride or chloroform and reacted with excess of Wij's iodine solution. After standing in the dark for half an hour, the excess, unreacted iodine is measured by thiosulpate titration.

$$\text{Iodine value} = \frac{12.69 \times (B-S) \times N}{W}$$

where W- weight of sample,N-Normality of Sodium thiosulphate,B-volume of sodium thiosulphate for blank and S- volume of sodium thiosulphate for sample

Saponification Value:It is measured by IS 548 (Part 1) 1964:Reaffirmed 2015.About 2g of oil is refluxed with an excess of alcoholic KOH until the oil has completely saponified. The amount of KOH consumed can be determined by titrating the excess KOH with standard HCl.

$$\text{Saponification value} = \frac{56.1 \times (B-S) \times N}{W}$$

where W- weight of sample,N-Normality of hydrochloric acid,B-volume of hydrochloric acid for blank and S- volume of hydrochloric acid for sample.

Acid Value:It is also measured by IS 548 (Part 1) 1964:Reaffirmed 2015.A known quantity of oil is boiled with hot neutral ethanol and titrate with standard NaOH.

$$\text{Acid value} = \frac{56.1 \times V \times N}{W}$$

where W- weight of sample,N-Normality of Sodium hydroxide and V-volume of sodium hydroxide for sample.

Qualitative tests for the presence of adulterants such as mineral oil (TLC method), argemone oil(Paper Chromatography Method) ,sesame oil (Baudouin test),cotton seed oil(Halphen test) and added colouring matter are also conducted as described in IS 548 (Part-2) 1976:reaffirmed 2010 method.

III. RESULTS

Pure Oil Analysis

The refractive index,BRR,iodine value,saponification value and acid value of analysed coconut oils and palmolein oils are given in Table-1.

TABLE-1

Sl No	Nature of Sample	RI at 40$_o$C	BRR at 40$_o$C	SG	AV	SV	IV
1	Coconut Oil-1	1.44874	34.9	0.9249	2.17	259.97	8.04
2	Coconut Oil-2	1.44892	35.1	0.9246	1.98	260.04	8.28
3	Coconut Oil-3	1.44896	35.3	0.9248	2.03	257.52	8.41
4	Refined Palmolein-1	1.45856	48.9	0.9137	0.48	196.35	55.48
5	Refined Palmolein-2	1.45927	50.0	0.9139	0.46	195.94	55.23
6	Refined Palmlein-3	1.45948	50.2	0.9140	0.48	198.41	56.75

The adulterants-mineral oil,sesame oil,cottonseed oil,argemone oil and added colouring matter are tested to be negative for all samples

The reference values of quality parameters for coconut and palmolein oil under FSSR, 2011 are given for comparison in Table-2.

TABLE-2

Quality Parameter	Range for Coconut Oil	Range for Palmolein Oil
Butyro-refractometer reading at 40 $_o$C	34.0 to 35.5	43.7 to 52.5
Refractive Index at 40 $_o$C	1.4480 to 1.4500	1.4550 to 1.4610
Saponification Value	Not less than 250	195 to 205
Iodine Value	7.5 to 10	54 to 62
Unsaponifiable matter	Not more than 1.0 % by weight	Not more than 1.2 % by weight
Acid Value	Not more than 6.0	Not more than 6.0 Not more than 0.5(refined)
Test foe Argemone Oil	Shall be Negative	Shall be Negative
Test for Mineral Oil	Shall be Negative	Shall be Negative
Test for Sesame Oil (Baudouin Test)	Shall be Negative	Shall be Negative
Test for Cotton seed Oil (Halphen Test)	Shall be Negative	Shall be Negative

Added Colouring Matter	Shall be Absent	Shall be Absent

The average composition of fatty acid profile for coconut and palmolein oils are

Sl No	Fatty acid	% in Coconut oil	% in Palmolein oil
1	Caproic acid	0 - 0.8	---
2	Caprylic acid	5.0 – 9.0	---
3	Capric acid	6.0 – 10.0	----
4	Lauric acid	44.0 – 52.0	----
5	Myristic acid	13.0 – 19.0	0.5 – 2.0
6	Palmitic acid	8.0 – 11.0	32.0 – 45.0
7	Stearic acid	1.0 – 3.0	2.0 – 7.0
8	Oleic acid	5.0 – 8.0	38.0 – 52.0
9	Linolenic acid	---	---
10	Linoleic acid	0 – 1.0	5.0 – 11.0
11	Archidic acid	0 – 0.5	---

Blended Oil Analysis

The Food Safety and Standards (Food Products Standards and Food Additives) Regulations,2011 allows the blending of two oils with the following specifications.

Item 24 of sub clause 2.2.1 Oils in the regulations read as follows

24. "Blended edible vegetable oil" means an admixture of any two edible vegetable oils where the proportion by weight of any edible vegetable oil used in the admixture is not less than 20 percent.The individual oils in the blend shall conform to the respective standards prescribed by these regulations.The blend shall be clear,free from rancidity,suspended or insoluble matter or any other foreign matter,separated water,added colouring matter,flavouring substances,mineral oil,or any other animal and non-edible oils,or fats,argemone oils,hydrocyanic acid,castor oil and tricresyl phosphate. It shall also conform to the following standards, namely:—

a) Moisture and volatile matter not more than 0.2 per cent by weight;

b) Acid value:— Nature of oil Acid Value

(1) Both raw edible vegetable oils in the blend — Not more than 6.0

(2) One raw edible vegetable oil (s) and one refined vegetable oil (s) in the blend — Not more than 5.0

(3) Both refined edible vegetable oils in the blend — Not more than 0.5

(4) Unsaponifiable matter, percent by weight

(i) Blended with chemically refined rice bran oil — Not more than 3.0 percent by weight

(ii) Blended with other edible vegetable oil — Not more than 1.50 percent by weight

(iii) Blended with physically refined rice bran oil — Not more than 4.0 percent by weight;provided that oryzanol content be minimum of 0.20 % (by weight) with rice bran oil at 20 % level and with an increment of 0.05 % with every 5 % rise in rice bran oil content in the blend

(5) Flash point (Pensky Martin closed method) — Not less than 250°C

Test for Argemone oil shall be negative

However, it may contain food additives permitted in these Regulations and Appendices

Further, if the oil is obtained by the method of solvent extraction and the oil imported into India whether obtained by solvent extraction or otherwise, it shall be supplied for human consumption only after refining and shall conform to the standards laid down under regulation 2.2.1 (16).The oil so refined shall not contain hexane more than 5.00 ppm.

The blended oils are analysed for quality parameters,tabulated in Table-3 A to E.More over,all blended oils are tested negative for adulterants such as mineral oil,sesame oil,argemone oil,cottonseed oil and added colouring matter.

TABLE-3A Blend-1 : Coconut oil-1 and Palmolein-1

Composition Coconut oil-Palmolein	**RI at 40₀C**	**BRR at 40₀C**	**SG**	**AV**	**SV**	**IV**
100-0	1.44874	34.9	0.9249	2.17	259.97	8.04
98-2	1.44894	35.1	0.9242	2.09	259.09	8.55
95-5	1.44914	35.5	0.9236	1.98	256.01	9.03
90-10	1.44981	36.4	0.9230	1.90	252.28	11.24
80-20	1.45070	37.7	0.9225	1.86	250.61	15.59
70-30	1.45177	39.2	0.9214	1.68	242.23	20.27
60-40	1.45269	40.4	0.9205	1.59	237.91	23.67
50-50	1.45370	41.8	0.9197	1.40	228.90	26.61
40-60	1.45430	42.7	0.9190	1.35	214.11	32.75
30-70	1.45561	44.6	0.9185	1.01	206.50	38.07

20-80	1.45665	46.0	0.9177	0.83	200.42	43.33
10-90	1.45762	47.5	0.9152	0.65	198.03	47.42
0-100	1.45856	48.9	0.9137	0.48	196.35	55.48

TABLE-3B Blend-2 : Coconut oil-1 and Palmolein-2

Composition Coconut oil-Palmolein	**RI at 40₀C**	**BRR at 40₀C**	**SG**	**AV**	**SV**	**IV**
100-0	1.44874	34.9	0.9249	2.17	259.97	8.04
98-2	1.44897	35.3	0.9239	2.06	256.27	8.69
95-5	1.44912	35.5	0.9231	1.93	252.84	9.22
90-10	1.44972	36.3	0.9224	1.88	248.31	11.95
80-20	1.45003	36.7	0.9217	1.70	243.89	15.78
70-30	1.45108	38.2	0.9203	1.63	239.97	20.65
60-40	1.45174	39.0	0.9198	1.48	237.91	24.02
50-50	1.45281	40.6	0.9182	1.36	226.02	26.99
40-60	1.45402	42.3	0.9170	1.27	212.75	33.18
30-70	1.45497	43.7	0.9165	1.12	208.61	38.72
20-80	1.45629	45.6	0.9153	0.93	202.55	44.06
10-90	1.45847	48.8	0.9139	0.75	197.47	47.89
0-100	1.45927	50.0	0.9135	0.46	195.94	55.23

TABLE-3C Blend-3 : Coconut oil-2 and Palmolein-1

Composition Coconut oil-Palmolein	**RI at 40₀C**	**BRR at 40₀C**	**SG**	**AV**	**SV**	**IV**
100-0	1.44892	35.1	0.9246	1.98	260.04	8.28
98-2	1.44897	35.3	0.9240	1.93	257.85	8.53
95-5	1.44916	35.6	0.9236	1.85	253.62	9.08
90-10	1.44989	36.5	0.9231	1.78	250.01	11.94
80-20	1.45086	37.9	0.9227	1.73	247.98	15.98
70-30	1.45181	39.2	0.9216	1.65	242.02	20.01
60-40	1.45276	40.6	0.9211	1.53	237.23	24.21
50-50	1.45378	42.0	0.9193	1.42	228.67	27.32
40-60	1.45437	42.8	0.9186	1.38	215.32	33.11
30-70	1.45566	44.7	0.9175	1.17	208.84	38.48
20-80	1.45668	46.2	0.9168	0.92	200.67	43.88
10-90	1.45774	47.6	0.9155	0.71	198.46	47.93
0-100	1.45856	48.9	0.9137	0.48	196.35	55.48

TABLE-3D Blend-4 : Coconut oil-2 and Palmolein-2

Composition Coconut oil-Palmolein	**RI at 40₀C**	**BRR at 40₀C**	**SG**	**AV**	**SV**	**IV**
100-0	1.44892	35.1	0.9246	1.98	260.04	8.28
98-2	1.44907	35.5	0.9244	1.93	255.94	8.46
95-5	1.44919	35.6	0.9232	1.88	251.02	9.18
90-10	1.45001	36.7	0.9226	1.82	248.56	11.62
80-20	1.45089	37.9	0.9219	1.76	245.67	15.73
70-30	1.45184	39.2	0.9211	1.61	241.88	20.03
60-40	1.45295	40.9	0.9206	1.52	238.05	23.88
50-50	1.45382	42.0	0.9194	1.39	229.00	26.93
40-60	1.45448	43.0	0.9186	1.33	215.43	32.94
30-70	1.45566	44.7	0.9180	1.14	208.52	38.29
20-80	1.45694	46.4	0.9172	0.85	205.33	43.84
10-90	1.45759	47.5	0.9158	0.72	201.74	47.47
0-100	1.45927	50.0	0.9139	0.46	195.94	55.23

TABLE-3E Blend-5 : Coconut oil-3 and Palmolein-3

Composition Coconut oil-Palmolein	**RI at 40₀C**	**BRR at 40₀C**	**SG**	**AV**	**SV**	**IV**
100-0	1.44896	35.3	0.9248	2.03	257.52	8.41
98-2	1.44907	35.5	0.9245	1.96	254.91	8.73
95-5	1.44917	35.6	0.9241	1.90	253.00	9.48
90-10	1.44983	36.4	0.9234	1.84	249.83	12.04

80-20	1.45076	37.8	0.9227	1.72	247.61	15.96
70-30	1.45183	39.2	0.9219	1.65	243.42	20.65
60-40	1.45274	40.4	0.9211	1.53	238.94	24.00
50-50	1.45366	41.8	0.9198	1.45	229.19	26.84
40-60	1.45437	42.8	0.9191	1.38	216.45	33.02
30-70	1.45568	44.7	0.9184	1.20	207.69	38.04
20-80	1.45677	46.3	0.9175	0.86	203.77	44.05
10-90	1.45783	47.7	0.9156	0.71	200.32	47.98
0-100	1.45948	50.2	0.9140	0.48	198.41	56.75

The adulterants-mineral oil,sesame oil,cottonseed oil,argemone oil and added colouring matter are tested to be negative for all sets of blended oils.

IV. DISCUSSION

The fatty acid profile indicates that palmolein oil contains more unsaturated fatty acids than coconut oil. Since RI,BRR and IV are directly proportional to degree of unsaturation,the values of these parameters increases with increase in proportion of palmolein.The trend is well established in the results shown in Table-3 A to E.

The coconut oil in rich in low molecular weight fatty acids,which account for high saponification value.Thus,the trend in decreasing saponification value with increasing proportion of palmolein is due to decrease in the proportion of low molecular weight fatty acids.

Refined edible oils have an acid value not more than 0.5 and coconut oil has an acid value maximum 6.0 .Since palmolein used in this study is refined,evidently,the acid value decreases with increase in proportion of palmolein.

The most interesting and shocking thing is that addition of a reasonable quantities(upto 10 %) of palmolein will not appreciably change the physio-chemical properties of coconut oil and remain well within the prescribed limits under the FSS Regulations.

V. CONCLUSION

The study establishes that the refractive index,BRR,and iodine value increases and saponification value decreases with increase in proportion of palmolein oil in the coconut oil-palmolein mixture.The trend depends on increase in degree of unsaturation and molecular weight of fatty acids.The addition of a reasonable quantities of palmolein (upto 10 %) will not appreciably change the prescribed limits for coconut oil.Eventhough the food safety regulator in India,FSSAI,intended to improve the qualities of oils by blending process,the evil practise of adulterating coconut oil with small quantities of palmolein will continue and remain unnoticed.More accurate and specific methods have to be developed for detecting and curbing this.

VI. REFERENCES

[1] The Food Safety and Standards Act,2006
[2] Food Safety and Standards (Food Products Standards and Food Additives) Regulations,2011
[3] IS 548:1964 (Part-1) Reaffirmed 2015
[4] IS 548:1976 (Part-2) Reaffirmed 2010
[5] Food Chemistry 4th Edition H.D.Belitz et al
[6] Food Science 5th Edition N.N Potter
[7] Essentials of Food Chemistry 1st Edition K.C.Jagat Bahadur and B.K Rai
[8] Essentials of Food Science 3rd Edition V.A Vaclavik and E.W. Christian