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Calculating the Iodine Value of Selected Edible Oils Using Fatty Acid Profiles

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ABSTRACT

The current wet titrimetric methods (eg.,Wijs method) employed for the estimation of iodine value uses dangerous chemicals and involves elaborate procedures for analysis. A calculation method based on the fatty acid measurement was used as an alternate approach.The data obtained are in conjunction with the Wijs titrimetric method. Thus ,the fatty acid profile determination provides two results from one analysis.

Key words: Fatty acids profile,edible oils,iodine value,Wijs solution,triglyceride factor.

Abbreviations

FSSAI – Food Safety and Standards Authority of India , AOCS – American Oil Chemists' Society , FAME – Fatty Acid Methyl Ester , GLC – Gas Liquid Chromatography, FID – Flame Ionization Detector , FTIR – Fourier Transform Infra red ,

Introduction

The iodine value or iodine number is a measure of degree of unsaturation, which is the number of carbon–carbon double bonds in relation to the amount of fat or oil. Iodine value is defined as the grams of iodine absorbed per 100 g of sample. The higher the amount of unsaturation, the more iodine is absorbed and the higher the iodine value.

The conventional titration method uses dangerous chemicals and involves time consuming reagent preparation and chemical analysis procedures.For example,the Wijs reagent ,iodine monochloride,is a corrosive chemicaland can cause skin burn,eye damage,cough or shortness of breath.

Consequently , some greener and simpler alternate approaches which include the use of sophisticated instruments such as GC,HPLC,FTIR and Raman ,UV-Visible and NMR spectroscopies were sought.The current study focus on the fatty acid compositional analysis.

The fatty acid profile analysis provides the amount of all kinds of fatty acids,both saturated and unsaturated, that can be esterified from a given amount of fat or oil. A specific equation incorporating the amount of unsaturated fatty acids and the triglyceride factor was used to calculate the iodine value.

The results were compared with those obtained from titration method.

Materials and Method

The oils such as coconut oil,sunflower oil,palmolein oil,gingelly oil were taken for this study.Appropriate grade of chemicals were procured form approved vendors.

Estimation of IV through Wijs method

The method number FSSAI 02.010.2021 "Determination of Iodine Value" described in the Revised FSSAI Manual of Methods of Analysis of Foods Oils and Fats ,2021 was used for the determination of iodine value.

The iodine value was calculated by the equation

$$IV = \frac{12.69 \times (B-S) \times N}{}$$

W

Where B and S are the standard sodium thiosulphate volume in ml required for reference(blank) and sample ,respectively.N is the normality of sodium thiosulphate , W is the gram weight of sample and 12.69 is the conversion factor from mEq sodium thiosulphate to grams of iodine (molecular weight of iodine is 126.9 (g/mol)

Estimation of IV through GC-FID method

Methyl ester preparation : The fatty acid methyl esters (FAMEs) were prepared by AOCS Official Method Ce 2-66 , "Preparation of Methyl Esters of Long Chain Fatty Acids".

Fatty acid profile determination :The prepared FAMEs were analysed in Thermo Scientific GC-FID TRACE 1110 instrument using the method number FSSAI 02.019.2021 "Determination of Fatty Acid Composition of Oils and Fats by GLC" described in the Revised FSSAI Manual of Methods of Analysis of Foods Oils and Fats ,2021.

The percentage composition of each component was estimated from their peak area.

The iodine value is calculated using a specific equation which sum up the product of percentage composition and the corresponding triglyceride factor for each unsaturated fatty acid.The triglyceride factor is given in Table-1.

Iodine value = $\sum(C_iF_i)$

Where $\mathbf{C_i}$ is the amount (percentage) of fatty acid and $\mathbf{F_i}$ is the corresponding triglyceride factor.

Illustration

The FAME analysis of an edible oil give the following composition

Fatty acid	Percentage
16:0	13.2
16:1	0.2
18:0	2.0
18:1	34.3
18:2	9.1
18:3	1.1

Iodine Value = (0.2 x 0.9502) + (34.3 x 0.8599) + (9.1 x 1.7316) + (1.1 x 2.6154)

= 117.58

Results and Discussion

The Table-2 shows the results of a comparative study of iodine values calculated from fatty acid profile and titrimetric method.The results of comparison suggest that the agreement between the two methods is satisfactory,thus offering an alternative means of obtaining iodine values of edible fats and oils when the fatty acid composition are being determined.

Conclusion

The study suggests that the method for calculating iodine values from fatty acid profiles could be considered for use as a 'Recommended Practice' for calculating iodine values.

Table -4 Triglyceride factor for calculating iodine value

Fatty acid	**No. of carbon & double bond**	**Iodine value of triglyceride**	**Triglyceride factor**
Dodecenoic	12:1	120.29	1.2029
Tetradecenoic (Myristoleic)	14:1	106.17	1.0617

Hexadecenoic (Palmitoleic)	16:1	95.02	0.9502
Hexadecadienoic	16:2	191.49	1.9149
Hexadecatrienoic	16:3	289.44	2.8944
Hexadecatetraenoic	16:4	388.89	3.8889
Octadecenoic (Oleic)	18:1	85.99	0.8599
Octadecadienoic (Linoleic)	18:2	173.16	1.7316
Octadecatrienoic (Linolenic)	18:3	261.54	2.6154
Octadecatetraenoic	18:4	351.16	3.516
Eicosenoic (Gadoleic)	20:1	78.53	0.7853
Eicosadienoic	20:2	158.04	1.5804
Eicosatrienoic	20:3	238.55	2.3855
Eicosatetraenoic (Arachidonic)	20:4	320.09	3.2009
Eicosapentaenoic	20:5	402.68	4.0268
Henocosapentaenoic	21:5	385.52	3.8552
Docosenoic (Erucic)	22:1	72.25	0.7225
Docosatetraenoic	22:4	294.08	2.9408
Docosapentaenoic	22:5	369.76	3.6976
Docosahexaenoic	22:6	446.34	4.44634
Tetracosenoic (Selacholeic)	24:1	66.91	0.6691

Table-2 Calculated v Titrated Iodine Values

Sl No	Nature of Oil	Calculated Result	Titration Result	Difference	% Difference
1	Sesame Oil-1	109.19	109.31	0.12	0.11
2	Sesame Oil-2	110.01	109.19	0.82	0.74
3	Sesame Oil-3	110.32	109.84	0.48	0.44
4	Sesame Oil-4	109.58	109.23	0.35	0.32
5	Sesame Oil-5	110.32	109.21	1.11	1.01
6	Refined Palmolein Oil-1	58.54	60.04	1.50	2.56
7	Refined Palmolein Oil-2	55.67	58.52	2.85	5.12
8	Refined Palmolein Oil-3	55.85	60.04	4.19	7.50
9	Refined Palmolein Oil-4	57.37	58.68	1.31	2.28
10	Refined Palmolein Oil-5	56.13	57.29	1.16	2.07
11	Sunflower Oil-1	128.34	126.82	1.52	1.18
12	Sunflower Oil-2	129.08	127.76	1.32	1.02
13	Sunflower Oil-3	129.30	124.52	4.78	3.70
14	Sunflower Oil-4	128.61	123.09	5.52	4.29
15	Sunflower Oil-5	127.95	125.62	2.33	1.82

16	Coconut Oil-1	8.10	8.02	0.08	0.99
17	Coconut Oil-2	8.25	8.20	0.05	0.61
18	Coconut Oil-3	8.37	8.33	0.04	0.48
19	Coconut Oil-4	7.89	8.57	0.68	8.62
20	Coconut Oil-5	7.80	8.11	0.31	3.97

Conflict of Interest

The authors declare that there is no competent conflict of interest

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