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A STUDY OF OXIDATIVE STABILITY OF GOLDEN CROP SOYBEAN OIL ON INDUCTION COOK TOP HEATING

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ABSTRACT

The main objective of this study is to evaluate oxidative stability of refined soybean oil as a result of induction cook top heating. Oxidation changes occurred during study were assessed by common traditional parameters such as acid value, free fatty acid value , iodine value and peroxide value as well as by Fourier transform infrared (FTIR) spectroscopy Changes in the 3050 2800 and 1745cm^{-1} spectral region after heating at elevated temperatures are discussed for oxidation process monitoring.

KEYWORDS: Fourier, Transform, Infrared, Ftir, Spectroscopy, Peroxide, Value, Free, Fatty, Acid, Iodine, Value, Induction, Cook, Top

INTRODUCTION

Oil and fats are important parts of the healthy human diet as they are also used as food preparation and flavoring eg. salad dressing and bread dips. Fats and oil belongs to a group of biological substances called lipids. Vegetable oil is an important and widely used lipid source for our everyday food products. Its application is increasing day by day for food purposes and for the manufacturing of a number of toiletry products. The ideal cooking oil should contain higher amount of mono-unsaturated and polyunsaturated fat with a minimal or no saturated fat and trans fat .The consumption of trans fats increases the risk of coronary heart disease by raising levels of LDL bad cholesterol and lowering levels of good HDL cholesterol

Soybean were grown for centuries in Asia mainly for their seeds. The world's largest soybean producers nations are U.S. Argentina, Brazil, China and India and represent more than 90% of global soybean production.

India is sixth largest producer of Soy oil in the world. In India Soybean oil production is restricted mainly to Madhya Pradesh, Uttar Pradesh, Maharashtra, and Gujarat. Madhya Pradesh is known as "*Soybean state*" of India, comprising 55% of the total national area of soybean cultivation. Soybean oil is 61% polysaturated fatty acid (PUFA) and 24% monounsaturated fatty acid (MUFA) which is comparable to the total unsaturated fat content of other vegetable oil (~ 85%). Soybean oil has a better omega - 3 fatty acid, omega - 6 fatty acid ratio 1:7 much higher then other vegetable cooking oil. Omega -3 fatty acid which have shown to reduce the risk of cardiovascular disease and decreases triglycerides levels. One tablespoon of soybean oil provide daily recommended value of vitamin E .In addition the oxidative stability of oils, i.e their resistance to the oxidation rocess is an important indicator of performance and storage life.Normally an oil sample is oxidized when subjected to air or oxygen flow, heating, exposure to light , catalysers etc.

Induction Cook Top Heating

Induction cooking uses a high frequency induction coil below the cook top s smooth surface that heats the cookware by a surface that heats the cookware by a magnetic fields. Induction cooking is the only methods that directly uses the cookware as a part of the cooking system. Induction is unlike any other form of cooking heat but the results of induction heating have the same effect on food. Unlike gas or electric cook top's an induction cook top creates an electro, magnetic fields that causes the metal of the pan itself to get hot. All of the energy is transformed directly to the bottom of the pan so no heat is lost in the process Induction is different from microwave cooking which uses a different type of cooking process.

The two major benefits of induction cooking is speed and energy efficiency. The US dept of energy says that induction cooking has an absolute efficiency of 84% while gas and electric have efficiency rating with a higher wattage rating more heat will generated at the max power setting.

Induction cooktop technology only heats the area that comes in contact with the magnetic iron content cookware leaving the unused portion of the elements unheated .Other modes of heating of various vegetables oils including soybean oils via microwave or thermal is very well reported so it was decided to use induction cook top heating methods for determination of oxidative stability of soybean oil as it is very common edible oil used at home for cooking in M.P.

MATERIALS AND METHODS

Five samples of (100 gm) of oil were placed in stainless steel pan having diameter of 20 cm at 100^{o}C, 180^{o}C, 210^{o}C, 240^{o}C and 270^{o}C respectively (at 500W, 1200W, 1400W, !600W, and 2000W). Each oil samples heated up to oil smoke point (Max time was 2 minute 32 sec). Oil samples were cooled at r .t. for the analysis and kept in glass vial till the analysis. All the reagents were AR grade and acid value peroxide value determination were performed by use of 10 ml burette (grade 'A' with graduation intervals of 0.05 ml) as the graduation level of the commonly used burette (50 ml capacity) was found to insufficient to capture the reading accurately or precisely. FTIR absorption spectra of heated refined soybean oils were measured on Perkin Elmer spectrophotometer at Central Drug Research Institute Lucknow. All spectra were recorded from 4000-400 cm^{-1}

Oils

Refined soybean oil of fortune brand of Adani wilmer company were purchased from local market.

Determination of Free Fatty Acid (FFA) and Acid Value

The acid value and FFA content was determined by directly titrating the heated oil samples in an alcoholic medium against standard Potassium hydroxide solution.

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

AV = 1.99x FFA

V= Volume in ml standard KOH

N= Normality of KOH solution

W= Weight in gm of the oil

FFA conc. in the heated oils is calculated as percent oleic acid.

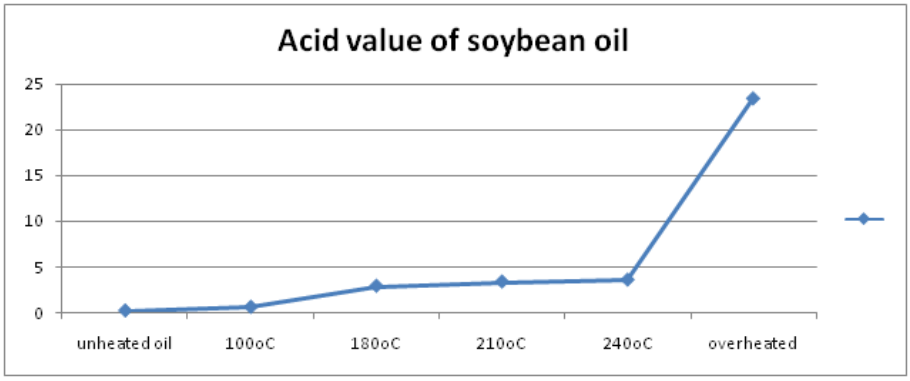

Figure 1

Determination of Iodine Value (IV)

Iodine value was determine by the AOCS standard method and calculated as follow

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

B=Volu of 0.1 N $Na_2S_2O_3$ solution.needed for Blank

S=Volu. of 0.1 N $Na_2S_2O_3$ solution.needed for samples

N=Normality of Standard $Na_2S_2O_3$

W=Weight in gm of the oil

(Here we used (0.5 g $\pm$ 0.1 g) of oil sample for determination

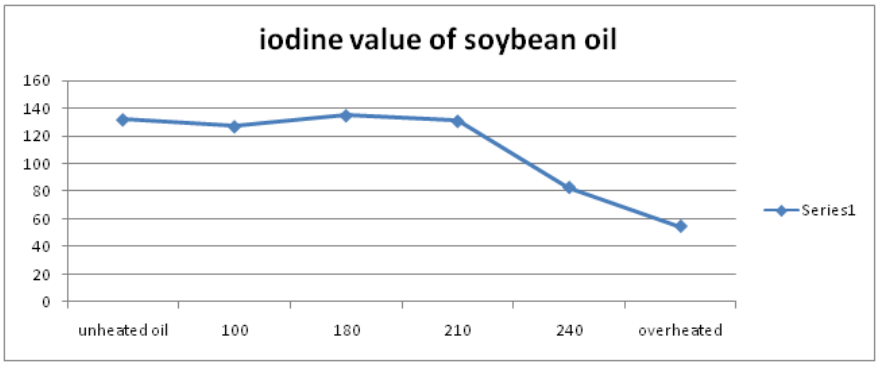

Figure 2

Determination of Peroxide Value

Peroxide value determination was done according to AOCS standard methods. The values were expressed as meq of peroxide O_2 / Kg oil and mg KOH /gm oil respectively.

$$\text{Peroxide Value} = \frac{10x\ V}{W}$$

V=Volume of 0.01 N $Na_2S_2O_3$ solution

W=Weight in gm of the oil

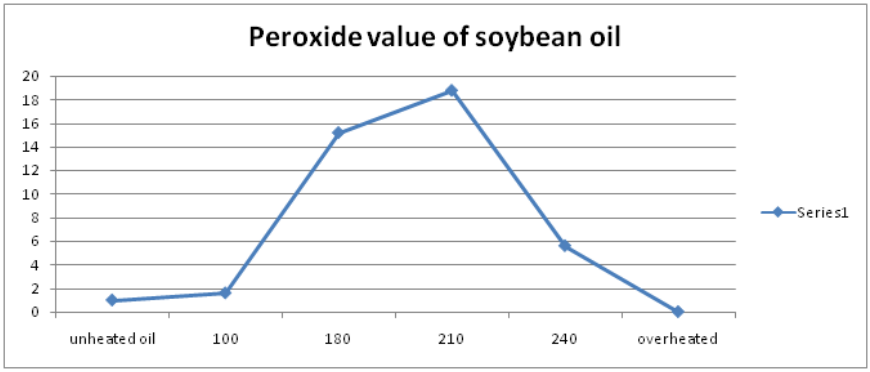

Figure 3

RESULTS AND DISCUSSION

FTIR Absorption for Non Heated and Heated Soybean oil Samples

Wave no. cm^{-1}	3009	2925	2854	1745	1654
Unheated oil	0.71	0.90	0.98	0.88	0.37
100°C heated	0.48	0.55	0.61	0.49	0.36
180°C heated	0.47	0.54	0.60	0.48	0.35
210°C heated	0.46	0.52	0.57	0.50	0.34
240°C heated	0.43	0.47	0.51	0.42	0.31
Overheated	-	0.29	-	-	0.28

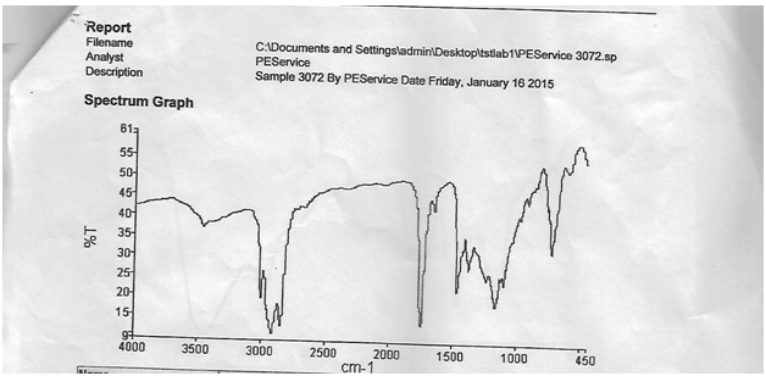

Figure 4: IR Spectra of Unheated Soybean Oil

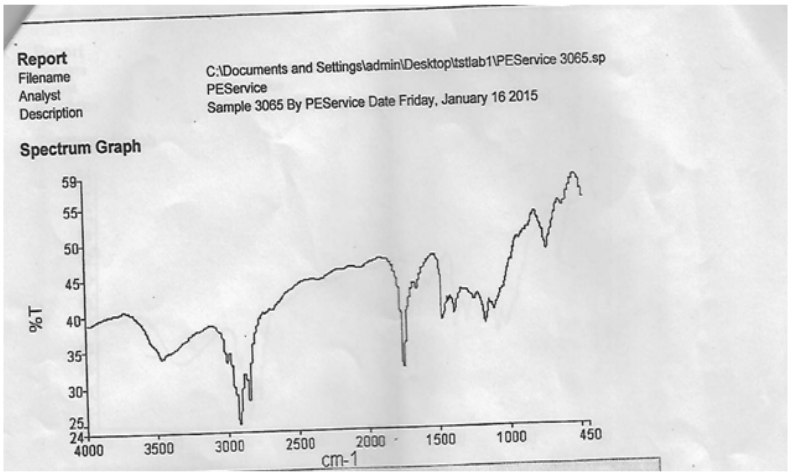

Figure 5: IR Spectra of 100°c Heated Soybean Oil

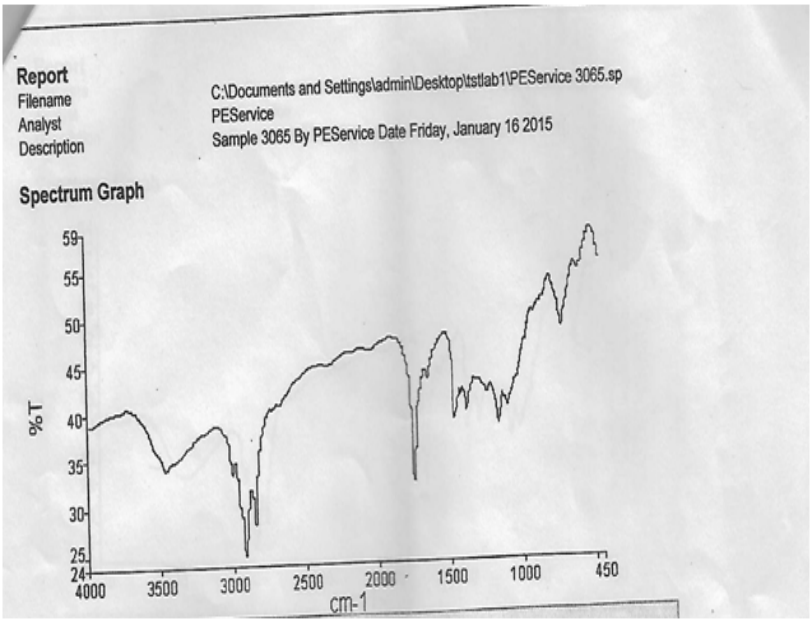

Figure 6: IR Spectra of 180°c Heated Soybean Oil

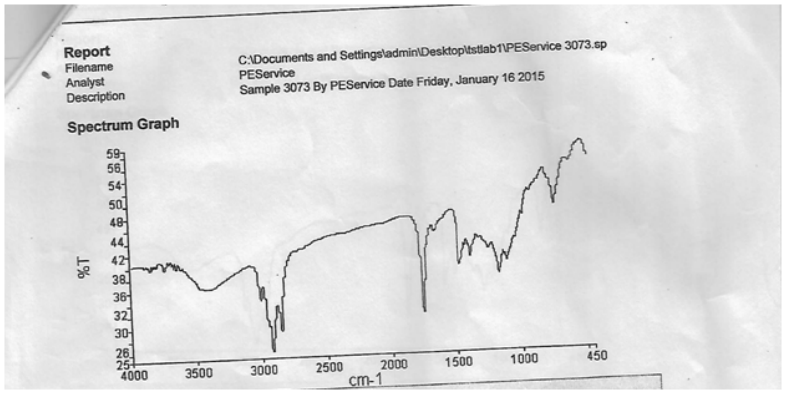

Figure 7: IR Spectra of 210°c Heated Soybean Oil

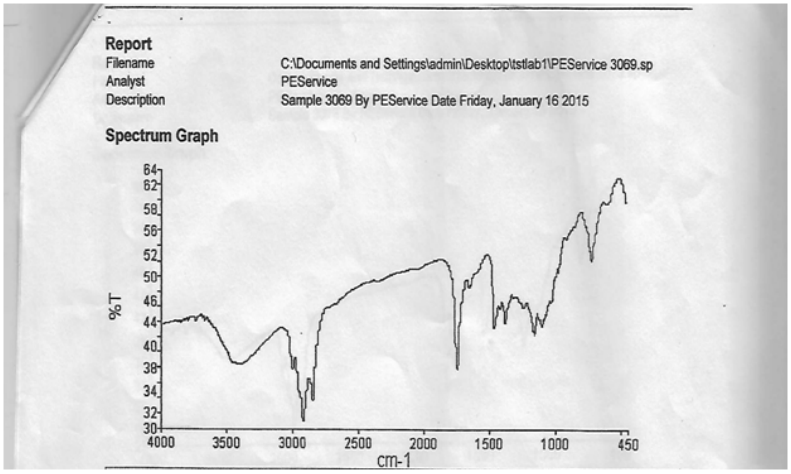

Figure 8: IR Spectra of 240^{o}c Heated Soybean Oil

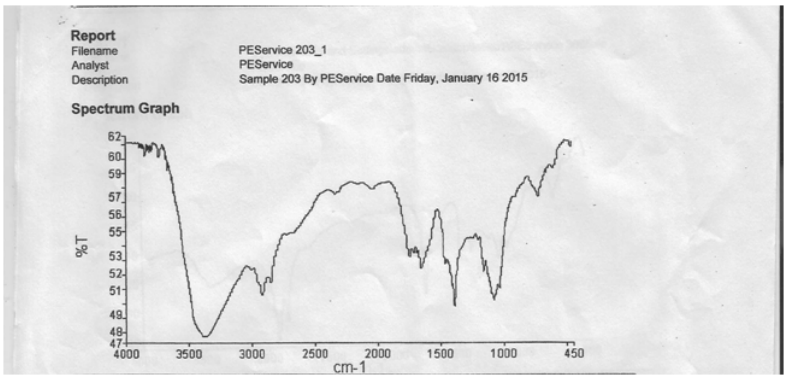

Figure 9: IR Spectra of Overheated Soybean Oil

Gullien and Cabo (1999) developed a respective methods which is based on Fourier transform infrared spectroscopy FTIR and assumes that frequency changes in specific band allow for the differentiation of stages of the oxidation process and detection of the oxidation level of the analyzed oil sample. FTIR spectra of soybean oils present a series of bands with different intensities and form. The result obtained by measuring the intensity of FTIR absorption at different frequency for heated refined soybean oils at different temperature are presented in Table 1 The spectrum showed peak at 3006-3009 cm^{-1} as C-H stretching vibration of the cis double bond and 2854, 2825 cm^{-1} showed C-H asymmetric and symmetric stretching vibration of the aliphatic CH_2 respectively .As we increase heating temperature the percentage transmittance of almost all the peaks increase indicating a decrease in absorption which may be due to the hydrolysis of oil at elevated temperature and the formation of free fatty acids mono and diglycerides. Same interpretation can be done from FFA value obtained by AOCS methods. The region 1745. cm^{-1} shows C=O ester carbonyl double bond stretching of triglycerides and 1654 cm^{-1} region represents C=C stretching vibration of the cis olefins. 3473 cm^{-1} assigned to O-H stretching vibration of hydro peroxide. In a sample 6 (overheated oil) there is an additional peak at 3633 cm^{-1} which shows that the secondary oxidized products has been formed during repeated heating (as PV value ND in this sample) gets converted into secondary oxidation products such as aldehyde or ketone

CONCLUSIONS

In this study soybean oil thermally heated via induction cook top devices and some of its physiochemical

parameters were determined. During induction cook top treatment there can be observed a temperature dependants oxidative degradations and increase in free fatty acid value and it is clearly reflected in different heated samples and result are found in good correlation with FTIR spectroscopic data. Main outcome of research suggests that induction cook top heating is very efficient as compared to other modes of heating. Thermal reaction involving long chain fatty acids esters, that usually require many hours of heating or stirring at room temperature, can be achieved in few minutes heating by the use of induction cook top. It can be concluded from above results that vegetable oils like soybean containing 52% PUFA are not expose to high temperature even more than 152 sec during cooking and repeated heated oil up to smoke point is not healthy for cooking. It can be suggested to public awareness well from above study that all the essential cooking preparations must be completed before in advance especially when cooking is done via induction cook top and oxidative stability results obtained with induction cook top heating are parallel to other modes of treatment (microwave and thermal).

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