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PHYSIO-CHEMICAL ANALYSIS OF FATS AND OILS USED BY THE STREET VENDORS OF DELHI: A CHECK FOR QUALITY

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ABSTRACT

The use of fats and oils in cooking is an integral part of traditional Indian cooking. Broadly, two types of fats and oils are used, either of plant origin (mostly unsaturated) or of animal origin(mostly saturated). Most of the popular street foods involve deep-fat frying performed at high temperatures under atmospheric pressure. This operation can lead to deterioration of physical, chemical, nutritional and sensory properties of oil, which affects its frying performance.This examination aimed to research cooking and oil use practices and oil quality among 15-20 small and medium scale street-vendors in West Delhi, India. Data on vendor practices was gathered using a survey and oil quality was investigated utilizing diverse physio-chemical parameters. 12 of 15 sellers were reusing the leftover oil/fat. Just 10% of sellers overviewed knew about the expression "trans unsaturated fat" and its conceivable health impacts. The unsaturated fat profile investigation indicated elevated amounts of saturated fats. Mediation procedures should target both oil production and import policies and spread mindfulness among food unit owners for a beneficial effect on population wellbeing.

INTRODUCTION

Fats and oils are important part of human diet and their functional and textural characteristics contribute to the flavor and palatability of natural and prepared foods. The increased consumption of deep-fried bites has led to an increase in the fat and energy intake levels. Although animal-based fat in the one of the major sources of Trans-fatty acids, however the most are supplied by products process hydrogenated oils (eg. Vanaspati, margarine). These partially hydrogenated vegetable oils are generally utilized by food unit owners in India particularly for deep-frying purposes. A number of metabolic and epidemiological examinations have shown that utilization of trans-fats increases the chances of coronary illness (CHD) because of the changes in blood lipid levels and rearrangement in other physiological pathways adding to the increased risk. Aside from the hydrogenation of vegetable oil, repeated and long thermal heating, and reuse of leftover oil are some other Trans Fatty Acid production. Various geometrical and positional isomers are produced from unsaturated fats after heat treatment, however, only temperatures over 180-1900C will result in formation of Trans Fatty Acids in fats and oils. These temperatures are mostly attained and at times surpassed during deep fat frying, which implies that Trans Fatty Acids, although present in minor parts, increase in oils subjected to frying.

Deep Fat Frying

In deep fat frying, oil is heated at a temperature of around 200°C for several minutes. To save on raw material cost the street vendors re-use the leftover oil repeatedly for multiple cycles. This causes the oil quality to deteriorate in both physical as well as chemicals aspects. Continues heating of oil to high temperatures (180-200°C) causesa change in color and density of oil which can also be noticed by naked eyesover repeated use.

A number of Chemical Reactions in Oil during Deep-Fat Frying including oxidation, hydrolysis, polymerization and fission. These reactions lead to an increase/deviation in various parameters such as Free Fatty Acid (FFA) level, Peroxide Value, Total Polar Compounds (TPC), Iodine value and Saponification value that are used to determine the quality of oil being used.

Oxidation of fats and oil also occurs during frying wherein, desirable or undesirable compounds are formed and changes in the stability and quality of the oil by hydrolysis, oxidation, and polymerization takes place. Highly oxidized oils can also lead to the formation of poly-aromatic hydrocarbons, which may becarcinogenic in nature. It is, therefore, crucial to not only monitor the quality of oils used but to determine their stability under normal conditions of use in cooking.

OBJECTIVES

- To conduct survey for vendor practices using structured questionnaire in West Delhi area.
- To determine the quality of oils samples collected from different food stalls and vendors using standard chemical procedures.
- To determine the effect of temperature and repeated frying of fresh oil samples on their chemical properties.

MATERIALS AND METHODS

S. No	Sample Code	Location of Collection	Type of Oil	Purpose of Oil
1.	A	Market, Sector -10, Dwarka	Refined soya bean oil	Samosa, bread pakora, paneer pakoras etc
2	B	Market, Sec-6. Dwarka	Refined soya bean oil	Bread pakore, kachodi, Samosa
3	C	College Canteen, Dwarka, Sector – 2	Fortune Soya bean oil	Onion pakode, kachodi, Bhature, Matthri
4	D	Kiosk, Sec-12, Dwarka	Refined soya bean oil	Bajjis, finger chips Break pakoras, Samose etc.

5	E	Sector-12, Dwarka New Delhi	Refined soya bean oil	Samose and namkeen
6	F	Janakpuri, Possangipuri market, Near C2	Dalda/Hydrogenated vegetable oil	Imarti, jalebis, Samose, Ghujias
7	G	DDA Vardhaman market, Sec-2, Dwarka	Kacchi Ghani, Dalda mix	Spring rolls, fried momos, samosa finger chips.
8	H	Manikarann market, Dwarka	Sarsotel	Bread pakora, mirch pakora, samosa
9	I	Opposite 40 feet road, C1 Janakpuri	Refined oil	Namkeen and snakcs
10	J	Possangipuri village, Near janakpuri C2, New Delhi	Refined oil	Kachori, samosa, pakore, bhature, Namkeen
11	K	Bindapur Village, Uttamnagar	Kacchi Ghani	Jalebi, Somsa, Pakore, Namkeen
12	L	DDA Flats, Bindapur	Fortune sunflower oil	Kebabs, Mccain, Pakore
13	M	Ber Sarai, R K Puram	Kacchi Ghani	Finger chips, Veg kebabs, Moong Vada
14	N	Opposite PVR cinemas, Vikas puri	Refined soyabean oil	Samose, Bread Pakora, kachori etc
15	O	Tilak nagar Market	Soya bean oil	Tikki, Samose, Aloo chat etc.

Procedure for Chemical Analysis

1. % Free Fatty Acids (%FFA)

Fats are degraded by the process of hydrolysis, which is in the presence of moisture splits triglycerides into their basic components of glycerol and free fatty acids. The free fatty acids, especially if they are of short-chain lengths cause off-odors and rancid flavors in fats and oils.

The term **Acid Value** refers to a measure of free fatty acids present in a fat. Procedure:

- Weigh 5g of a given sample in a dry and clean conical flask.
- Melt the sample gently in a boiling water bath.
- Add 50 ml of neutralized alcohol.
- Titrate against 0.1 N NaOH using phenolphthalein as an indicator under warm conditions and continuous stirring.
- End point is the appearance of faint pink color.
- Repeat twice for concordant titre values.

For NaOH and predominant acid-oleic acid

I. **% FFA** = $\frac{\text{Titre value X N of NaOH X 28.2}}{}$

$$\text{Weight of sample}$$

II. **Acid value** = $\frac{\text{Titre value X N of NaOH X 40}}{\text{Weight of Sample}}$

From (I) and (II)

Acid Value = (40/28.2) X % FFA

2. Iodine Value (Wij's Method)

This isdetermine the degree of completion in processes such as hydrogenation and oxidation that cause changes in the degree of unsaturation.

Procedure:

- Weigh accurately by difference, an appropriate quantity of the oil and fat sample into a clean, dry 250ml iodine flask (i.e., 2.5-3g for coconut oil and 0.1-0.6 for any other oil).
- Add 10ml of CCl_4, followed by the addition of 25ml of Wij's solution.
- Replace the stopper after moistening with 10% KI solution and keep the flask in dark for 30minutes.
- Then, add 15ml of 10% KI solution and then 100ml of distilled water.
- Titrate against 0.1N Sodium thio using starch as an indicator. End point is the disappearance of blue color. Repeat twice for each sample and also carry out blank determination.

$$\textbf{IODINE VALUE} = \frac{\text{(Titre value B – Tire value S) x N x 12.69}}{\text{W}}$$

Where, S = Sample used

B = Blank

N = Normality of sodium thiosulfate solution

W = Weight of sample taken

3. Peroxide Value

This technique is an example of a measurement of the increase in concentration of primary reaction products.

Procedure:

- Weigh 5 g of fat sample in a stoppered conical flask.
- To the sample, add 30 ml of solvent and dissolve.
- Add 0.5 ml of saturated KI and allow the solution to stand exactly for one minute with occasional shaking. Then add 30 ml of distilled water followed by 0.5 ml of starch indicator.
- Titrate against 0.1 N thiosulphate till a colorless end point. Repeat twice for a given sample and one blank minus sample.

$$\textbf{PEROXIDE VALUE} = \frac{(\text{Titre value S} - \text{Titre value B}) \times N \times 1000}{W}$$

(milliequivalents or millimoles per 1000g of fat/oil)

Where,

N = Normality of thiosulphate soln. used

W = Weight of the sample taken (g)

$$\textbf{NORMALITY} = \frac{\text{Weight of } K_2Cr_2O_7 \times 1000}{\text{ml of } Na_2S_2O_3 \times 49.037}$$

4. Specific Gravity

In general, either unsaturation of fatty acid chains or increase in chain length of the fatty acid residues tends to increase the specific gravity.

Procedure

- Note the tare weights of clean dry pycnometers.
- Fill one of the pycnometers with recently boiled and cooled distilled water at 20-230 C, insert the stopper and incubate in a water bath at 25 +/- 20 C for 30 minutes.
- Remove the bottle from the bath, wipe dry and weigh. Note the weight of the water.
- Now fill the pycnometer with oil sample at 20-230 C to brim. Avoid air bubbles.
- Insert the stopper and repeat the same procedure as for water.
- Note the weight and calculate the specific gravity of the oil with the given formula.

Formula Used

SPECIFIC GRAVITY(at 25° C) = (A-B)/(C-B)

Where,

A = Weight of the pycnometer with oil (g)

B = Weight of the empty pycnometer (g)

C = Weight of the pycnometer with water (g)

RESULTS AND DISCUSSION

A. Vendor survey

General characteristics

Off all the shops/kiosks/vendors surveyed during sampling, majority (75% approximately were shops owners. However, the number of employees/workers in the shop or at the kiosk were in varied strength. The mean number of employees in the areas surveyed (n=18) was 5. Depending on the hour of the day and items sold at the shop/kiosk number of buyers were also in varied strength, although roughly 70 % vendors had nearly 50-100 buyers each day.

Table 2. Characteristics of participants/outlets in vendor survey

	Number	Percentage
PEOPLE SURVEYED		
Vendor	11	74
Cook	2	13.3
Helper	4	26.6
Number of employees	6	
Number of customers		
<25	1	7
25-50	3-4	25
50-100	10-11	78
Snacks sold		
Bread pakora	9	60
Samosa	11	73
Kachori	4	27
Pakore (Others)	7	47
Namkeen	5	33
Finger Chips	2	15
Aloo chat	1-2	15

Momos, spring rolls, Kebabs	3	10
Jalebis. Imarti, Ghujia	1	5
Leftover oil		
Use up mostly	-	-
Drainage	-	-

Table 3. Types of Oils used by vendors (as declared by vendors)

	Number (n)	Percentages
Type of oil/fat		
Refined soya bean oil	11	74
Kacchi Ghani/Sarsotel	3-4	20
Vanaspati/Hydrogenated oil	2	10
Sunflower oil	1	5

Table 4. Practices related to deep frying amongst vendors

	Numbers (n)	Percentages (%)
I. Utensils used for frying		
Steel	9	60
Aluminium	-	-
Cast iron	4-5	30
II. Average oil consumption		
Up to 5L	4	27
5-10L	10	67
>10L	1	7
III. replenish the oil amount after first usage		
Yes	12	80
No	3	20
IV. Left over oil processes		
Use it elsewhere	2-3	15-20
Re-usage next day for frying	-	-
Throw it	4-5	30
Sell it	-	-

B. Physio-chemical analysis

All the 15-18 samples collected from different vendors of west Delhi area were analyzed using standard test procedure for different physio-chemical parameters. The procedure used for the

following parameters were carried out under the guidance of mentor and taken from Analysis of food chemistry manual. These parameters were and the results obtained (**refer table 5**) through each test and comparative study of these parameters against the standards (**refer table 6**) given by FSSAI for different oil samples.

Table 5. Results obtained through standard test procedures

Sample Code	%FFA	Acid Value	Iodine Value (WIJ's)	Peroxide value (mEq/kg)	Specific gravity
A	0.388	0.55	68.152	13.2	0.91
B	0.394	0.558	61.422	14.83	0.917
C	0.278	0.394	76.601	10.42	0.92
D	0.276	0.391	79.137	9.44	0.866
E	0.338	0.479	62.32	11.78	0.9
F	0.387	0.548	69.6	12.11	0.9
G	0.487	0.690	73.86	17.4	0.92
H	0.331	0.469	75.07	13.33	0.91
I	0.608	0.862	78.11	32.3	0.923
J	0.55	0.779	69.5412	27.45	0.903
K	0.564	0.799	71.77	29.12	0.915
L	0.156	0.212	70.218	9.1	0.918
M	0.221	0.313	70.99	15.12	0.91
N	0.372	0.527	72.81	13.3	0.924
O	0.413	0.585	72.14	17.8	0.915

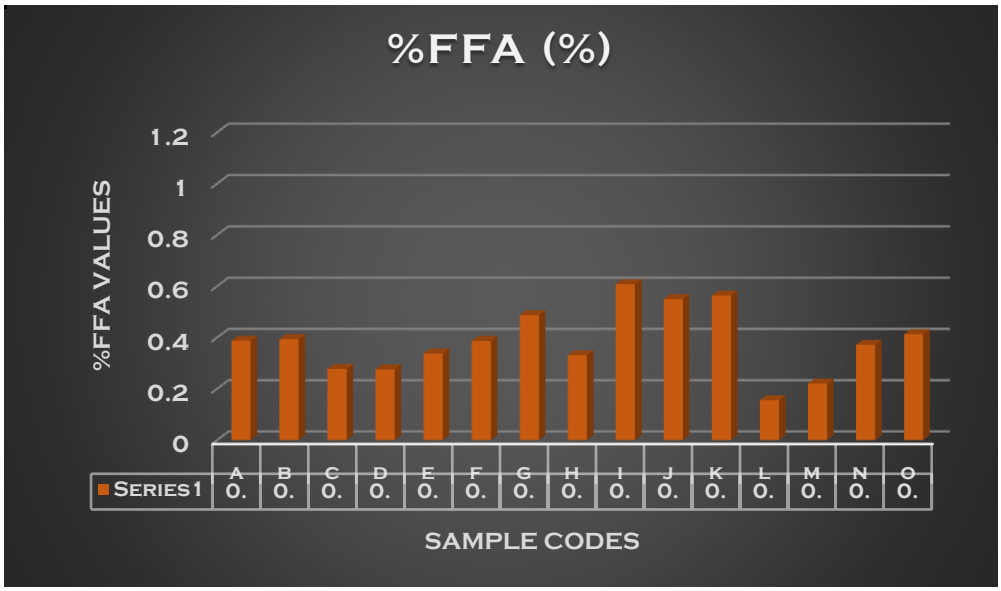
Standards of different parameters for different samples

Table 6. Standard values of different fats/oils

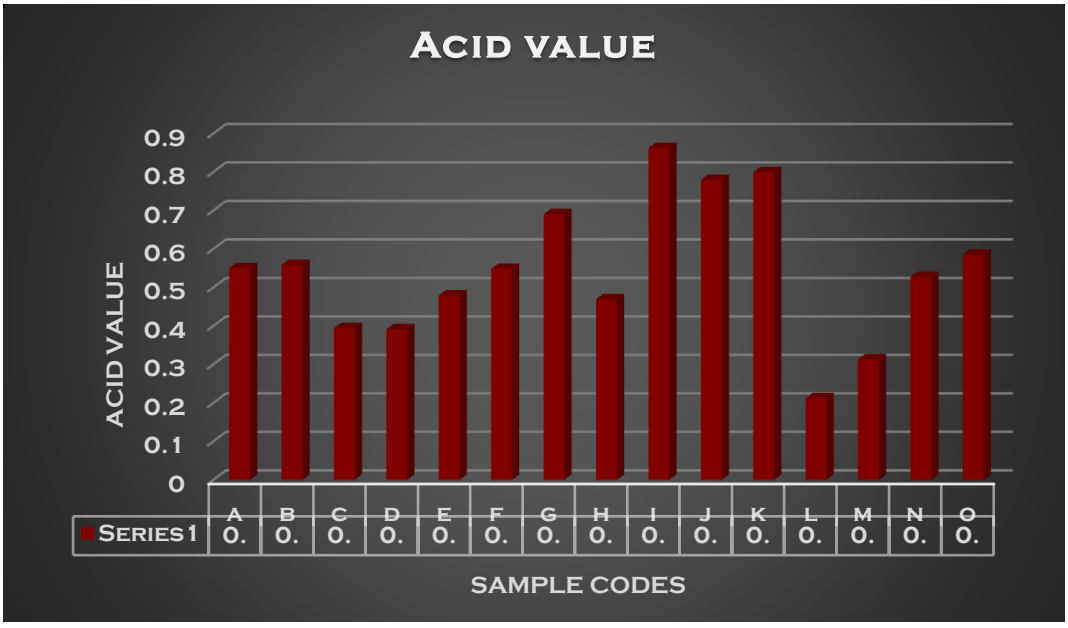
	STANDARDS				
Oil type	%FFA (max. 0.25%)	ACID VALUE	Peroxide value	Iodine value	Specific Gravity
Soya bean oil	0.25	0.5 max	Less than 10mEq/kg.	120-140	0.91-0.92 at 25°C
Mustard oil	0.25	0.5 max	Less than 10mEq/kg.	96-112	0.91-0.92 at 25°C
Vanaspati/ Hydrogenated oil	0.25	0.5 max	Less than 10mEq/kg.	Below 70 number	Less than 0.905 at 40°C
Sunflower oil	0.25	0.5 max	Less than 10mEq/kg	78-90	0.91-0.92 at 25°C

GRAPHS

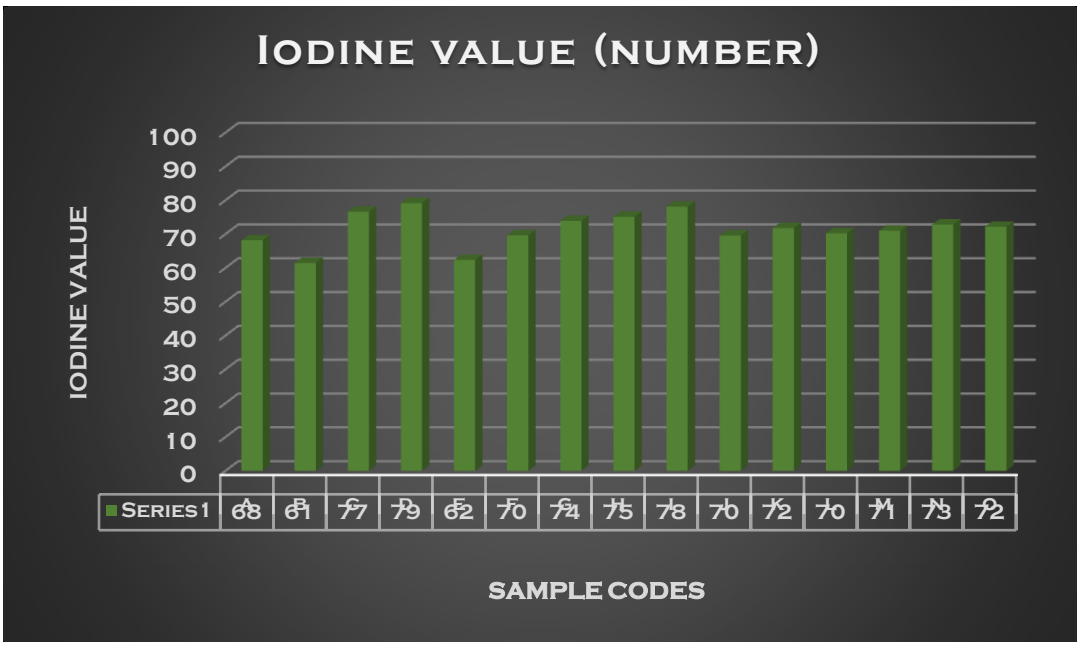
1. %FFA- Standard value (Maximum 0.25%)



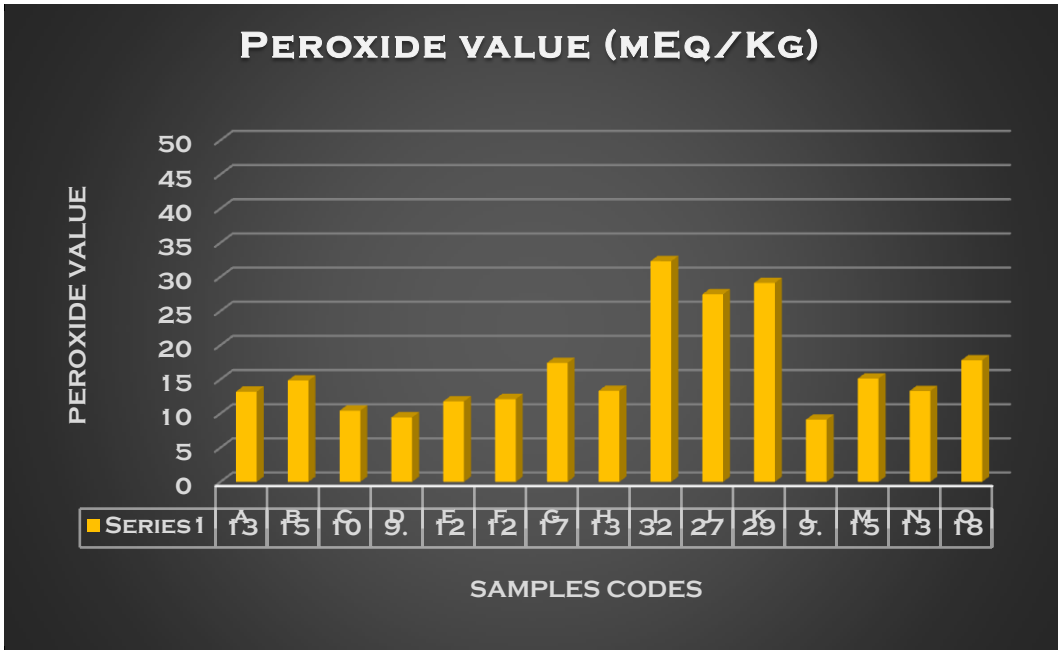
2. Acid Value- Standard value (Maximum 0.5)



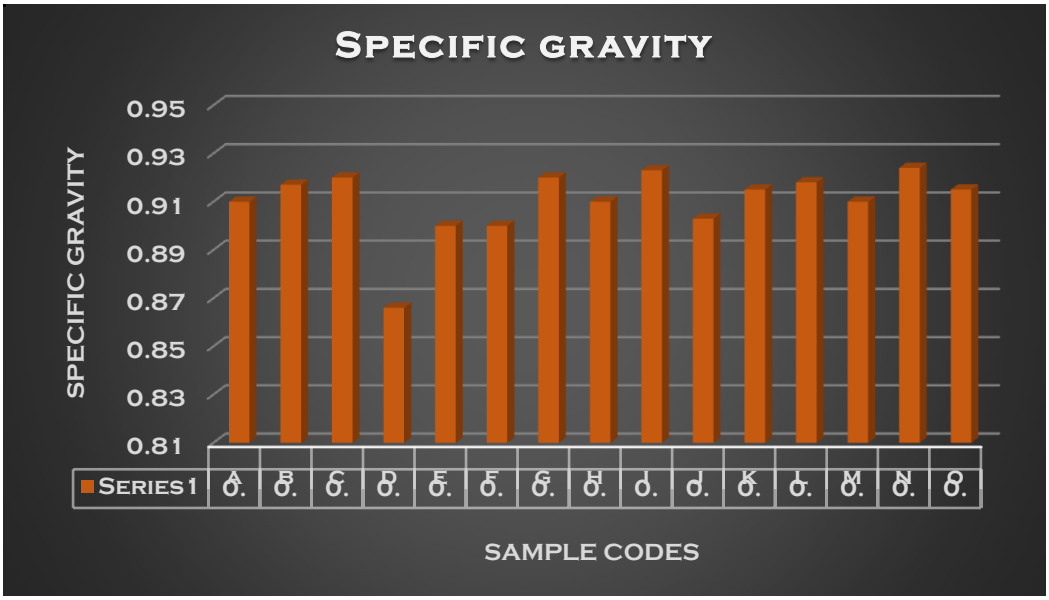
3. Iodine Value-



4. Peroxide Value- Less than 10meq/kg for fresh oils



5. SPECIFIC GRAVITY-



The graphical representation of physio-chemical analysis shows the deviation in characteristics of each sample procured from vendors. Graphs also show the deviation of observed value from the standards given, which goes onto prove there has been certain chain in composition in the oils samples which may be due to repeated frying of foods in oil. The change is characteristics will be discussed in the conclusion below.

DISCUSSION

Following outcomes were observed.

- %FFA of collected samples were above the standard value. Although the samples were collected & kept in sterile containers and the test was conducted after four weeks of procurement,this usually indicates that triacyl glycerol components were undergoing hydrolytic degradation. The results of the study showed the deviations from as low as 0.16 to 0.7% FFA, indicating the quality of fats and oils used is not good. Thus, off odors were observed during testing for %FFA.Only the oil used for in-house frying and one more procured after single frying showed desirable values, i.e., 0.156 & 0.221
- Although declared by the vendor as refined soya bean oil, ghee or mustard oilbut the iodine value/number by Wij's method varied greatly from the standard value given by FSSAI this could be due to experimental error or improper reagent preparation. Although in the results

obtained most samples met the criteria for being a fat/oil and the deviation noted, points out that this could be a result of adulteration i.e., mixing vanaspati into soya bean oil used for frying which is a most common practice by Indian vendors.

- Peroxide value of most samples tested were above the standard value, but it is difficult to provide certain guideline relating peroxide value to rancidity as these values are not static. Although a high value of more than 30mEq/Kg indicate rancid fat or oil but moderates values may be a result of depletion of peroxides after reaching high concentration. Except 2-3 samples, most values were moderate and below 20mEq/Kg but only home fried sunflower oil showed a value of less than 10mEq/kg (Standard value) which indicates some slight rancid reactions may have occurred in the samples during storage.
- Specific gravity of majority samples (95%) was in accordance to the standards.