Final Project Report

Delhi University Innovation Project 2015 -16

SHC 310: A comparative chemical analysis of commercially available newer brands of edible oils for their highlighted benefits for human consumption

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1. **PROJECT CODE:** SHC-310
2. **PROJECT TITLE:** A comparative chemical analysis of commercially available newer brands of edible oils for their highlighted benefits for human consumption
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Certificate of Originality

This is to certify that the research work carried out and the final report submitted by the Project Investigators and the students of Innovation Project having Project code **SHC 310** and title **"A comparative chemical analysis of commercially available newer brands of edible oils for their highlighted benefits for human consumption"** Of **Shivaji College** is original. Any plagiarism/academic dishonesty reported at any stage will be our responsibility.

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1. **Project Title:** A comparative chemical analysis of commercially available newer brands of edible oils for their highlighted benefits for human consumption
2. **Project Code:** SHC-310
3. **Abstract:**

The current investigation explores to understand the consumption trends of edible oils in Delhi and analyze the edible oils available in market for their highlighted health benefits. Total 19 samples of edible oils from market were selected. Focus was on blend edible oils, specially the presence of some non conventional edible oils like rice bran; different grades of olive oils and blend olive oils and edible oils fortified with antioxidants. The edible oils selected were aiming for health benefits to overcome lifestyle disorders (like cardio vascular, diabetes). All the samples were also boiled five times and analyzed for certain parameters. Thus total 38 samples (19 fresh and 19 boiled) were analyzed for complete fatty acid profiles using GC-MS; Minor and major components of lipids (TLC); Free Fatty acids (FFA); Rancidity and antioxidants. Free Fatty acid changes were observed in fresh and boiled samples; some of the oil samples showed increasing trend in FFA value upon boiling while some showed decreasing. No change in FFA was observed in sample 19 (blend oil consisting imported refined sunflower oil and rice bran oil); sample 2 (refined sunflower oil and rice bran oil); sample 10 (blend of refined and extra virgin olive oil); sample 11 (mixture of pomace and extra virgin olive oil). Sample 17B (refined blend oil consisting rice bran and soyabean oil) which showed highest FFA content also recorded positive for

rancidity. Rancidity was also recorded in sample codes 18B (rice bran oil); 19 (rice bran and safflower kardi oil); 7B (refined soyabean oil). It was observed that oil samples consisting rice bran oil and/or soyabean oil are relatively prone to oxidative damage during cooking/processing. Component 2 (Hexadecanoic acid) is present in almost all fresh oil samples. Highest amount was recorded in Rice bran + Seasme oil followed by refined rice bran oil and refined soyabean oil. Component 3 (9, 12-octadecadienoic acid) was present in highest amount in refined rice bran oil + sunflower oil and rice bran oil + safflower oil. Component 8 (9-OCTADECANOIC ACID) is also present in very high amounts in rice bran + soyabean oil and refined rice bran oil. However this component was not reported significantly in other fresh oil samples but was present in almost all boiled samples. Some of the oil samples tested also reported presence of TBHQ which is added to increase shelf life of edible oil. However, it has serious health implications and should be avoided for human consumption.

4. Introduction:

Edible oil is an indispensable commodity for human consumption. Perceptions, preference and knowledge on food safety which is one of the areas marketers are interested has become a global concern in recent times not only to these markets but consumers in general (Scott-Thomas, 2011). The Indian vegetable oil economy is the world's fourth largest after the US, China and Brazil, harvesting about 25 million tons of oilseeds against the world. Edible Oil Companies play a dominant role in the Indian Food Industry as edible oil is one of the most important parts of daily diet requirements. Edible Oil Companies produce oils of different variety under several brand names. The major types of edible oils found in Indian market are refined sunflower, soyabean, groundnut, mustard, canola oil; blend of different types of refined oils; Vanaspati; coconut oil; different grades of olive oils etc. In the market

samples it is generally observed that the proper composition and ingredients are not completely mentioned specially the composition of '*vanaspati'*and blend oils or 'blend refined/vegetable oils' is missing. For popularizing their products and better prices the edible oils are marketed with various technological buzz words as their unique selling propositions which common consumer is unaware about. Some of the unique features which edible oil brands talks about are:

- ✓ Losorb Technology in its edible oils that reduces the absorption of oil in food, which makes this brand the most preferable.
- ✓ Multiseed Technology - blend of two oils which is generally recommended as more health friendly
- ✓ Nutri Lock Technology - Nutri Lock Technology protects the natural goodness of the oil and also contains antioxidants like Oryzanol.
- ✓ Presence of Essential Fatty Acid and antioxidants like "ORYZANOL" which are good for health.
- ✓ Goes through a highly specialised process of winterisation that removes almost all the wax content from the oil
- ✓ Fortification of refined edible oils with the vitamins A, D and E, which are essential for proper growth, cognitive development and overall health.

The changes in eating habits and choices are part of life style and are one of the major causes of non- communicable diseases like cardiovascular disorders (CVDs), obesity, metabolic disorders and diabetes. WHO recommends elimination of trans fatty acid (TFA) with poly unsaturated fatty acids (PUFAs) in diet. The edible oil used in cooking plays a pivotal role in maintaining health. Partially hydrogenated vegetable oils (PHVOs) contain high amounts of TFA. Vegetable fats are very rich in n-6 PUFAs and have very low amount of n-3 PUFAs. The balance between n-3 and n-6 PUFAs is important for good health. The presence of MUFAs and PUFAs are beneficial for good health while saturated fatty acids (SFAs) and TFA not. SFAs and TFA increase the risk of CVDs by elevating blood concentrations of total and LDL cholesterol while n-3 PUFAs may reduce the risk via reductions in ventricular arrhythmias, blood clotting, serum triacylglycerol concentrations, growth of atherosclerotic plaques, and blood pressure (Kris-Etherton et al., 2002). Local Indian market snacks, bakery products are cooked in Vanaspati & are rich in TFAs.

Many studies report that blending inter-esterified oils with liquid oils high in PUFA can result in products with low TFA & SFA. Olive oils rich in MUFA are gaining popularity and regular consumption lowers the risk of heart disease, breast cancer & cholesterol. The main constituents of plant oils are triglycerides and 90% - 95% of the total weight of triglycerides accounts for fatty acids and their content is characteristic of each plant oil (Samarth and Mahanwar, 2015).

The minor components include mono and diacylglycerols, free fatty acids, phosphatides, sterols, fatty alcohols, fat soluble vitamins and other substances (Strayer et al., 2006). Edible oils also contain minor amounts of branched chain and cyclic acids **(**Johnson and Saikia 2009).

Major type of fats found in edible oils and associated health effects as reported from the literatures are presented below:

1. **Unsaturated fats:** Predominantly found in foods from plants, such as vegetable oils, nuts, and seeds. **"Good" unsaturated fats** are of two types:

   Monounsaturated fats (MUFA): Olive, peanut, and canola oils.

   Polyunsaturated fats (PUFA): Sunflower, corn, soybean, canola and flaxseed oils.

   Omega-3 fats are an important type of polyunsaturated fat. The body can't make these, so they must come from food.

   Health Impacts:

   - Lower risk of premature death; decreased levels of harmful LDL and increased protective HDL (*Mensink, R.P., et al., 2003).*
   - Lowers blood pressure, improves lipid levels, and reduces the estimated cardiovascular risk (*Appel, L.J., et al., 2005).*

2. **Saturated Fats:** Saturated fat is mainly found in animal foods, but a few plant foods are also high in saturated fats, such as coconut, coconut oil, palm oil, and palm kernel oil. Many processed foods and snacks which are generally eaten in urban Indian family like pizza, cheese, burger toppings, cookies, desserts etc. are rich in saturated fats.

   Health Impacts: They are generally ***not considered good*** for health and are associated with cardio vascular and other metabolic disorders like diabetes, poor lipid profile and increase in cholesterol levels

3. **Trans Fats:** They are made by hydrogenation & are present in partially hydrogenating vegetable oils. They are very popular because of their higher shelf life & reusability (repeated heating). They are very popular in fast food restaurants or street food vendors. Also commonly found in various baked & processed snacks like microwave popcorn, frozen desserts, baking mixes, pizzas, pies, cookies etc.

   Health Impacts*:*

   - Raises bad LDL and lowers good HDL (worse for cholesterol levels than saturated fats)
   - Creates inflammation
   - Contributes to insulin resistance
   - Linked to cancer and allergies also

   Policy Efforts for reducing TFA (Downs et al., 2013)

   - As part of the Global Monitoring Framework for NCDs, the World Health Organization (WHO) has recommended trans fatty acid (TFA) elimination from the diet and has called for "national policies that virtually eliminate partially hydrogenated vegetable oils (PHVOs) in the food supply and replace them with PUFA"
   - Food Safety and Standards Authority of India (FSSAI), under the Ministry of Health and Family Welfare, has proposed regulation that includes setting an upper limit of 10% (by weight) TFA in PHVOs reducing to 5% over three years.
   - In June 2015 the FDA announced its decision to ban artificial trans fat in the food supply. Food manufacturers in the U.S. will have three years to remove partially hydrogenated oils — the primary source of artificial trans fat — from products.

MINOR COMPONENTS OF OILS (Johnson and Saikia 2009)

- **Mono- and Diacylglycerols:** They occur naturally in very minor amounts in both animal fats and vegetable oils.
- **Free Fatty Acids:** Refining processes reduce the levels of fatty acids.
- **Phosphatides:**Cephalin and lecithin are common phosphatides found in edible fats. Refining removes the phosphatides from fat or oil.

- **Sterols:**Cholesterol is the major animal fat sterol and is only found in vegetable oils in trace amounts. Vegetable sterols are collectively termed as “phytosterols”. Sitosterol and stigmasterol are best known vegetable oil sterols.
- **Fatty Alcohols:** Long chain alcohols are of little importance in most edible fats. A small quantity that is esterified with fatty acids is present in waxes found in some vegetable oils.
- **Vitamins:** Tocopherols (vitamin E) are important minor constituents of most vegetable fats. Fat soluble vitamins A and D are sometimes added to foods which contain fat because they serve as good carriers and are widely consumed.

Recently, fatty acid profile, particularly the ratio of omega-6 (n-6) to omega-3 (n-3) polyunsaturated fatty acids, of cells or tissues has become a biomarker for monitoring the outcome of dietary interventions (i.e., fatty acid supplementation) and for identifying the risk factors for lipid related diseases like cardiovascular disease, (Harris WS, Von Schacky C, 2004). Measurement of the n-6/n-3 fatty acid ratio can be also used to identify animal phenotypes, such as the fat-1 transgenic mice that we created recently (Kang et al., 2004). Thus, analysis of fatty acid composition is a commonly used technique in lipid research.

Free fatty acid (FFA) content is one of the most frequently determined quality indices during edible oils production, storage and marketing. It is a measure of the extent to which hydrolysis has liberated fatty acids from their ester linkage with the parent triglyceride molecule. Edible oils undergo various processing steps, resulting in low FFA content (Mohamed Ali and Abdurrhman, 2013).

Indian eating habits often involve deep and shallow frying. This leads to profound changes in quality of edible oils and formation of deleterious compounds like free radicals. Lipid oxidation of edible oils leads to rancidity, development of off flavors and odors associated with low molecular weight volatiles (Navarro et al., 2012). Consumption of rancid is not advisable as radical oxygen species generated may cause irreversible damages when reacting with biological

molecules such as DNA, proteins or lipids (Bansal et al., 2010; Cabiscol et al., 2010).

Since edible oils are involved in almost any type of cooking in Indian household many of the oils are fortified with antioxidants as it increases shelf life (Chotimarkorn and Silalai, 2008), and also has good effects on health. One of the common ingredients observed in many commercially available edible refined oils is "Oryzanol". It is the major component of rice bran oil. Numerous health benefits specially related to cardiovascular and other lifestyle related disorders like cure for nerve imbalance, cholesterol lowering etc. have been reported by consuming rice bran/oryzanol containing edible oils (Iqbal et al., 2005).

Earlier in India foods were cooked in "ghee" but with the knowledge about its high saturated fat content and health hazards shift went towards vegetable oils. To increase the shelf life and serve the purpose in Indian cooking they were hydrogenated which lead to growing evidences of trans fats in the diet. Trans fats have deleterious effect on health specially to cardiovascular disorders. With the advent of globalization recently Olive oils, blend oils and fortified oils have become popular. Olive oil–rich diets can be a useful tool against risk factors for cardiovascular disease. Olive oils are very rich in antioxidants and PUFA, however they can't be used for frying or high temperature cooking. The right choice of edible oil is important for good heart health. Oil should have adequate composition of MUFA and PUFA and low amounts of saturated fats with negligible trans fats. Right amounts of "good fats" or presence of additional fortified nutraceutical in oils cannot be the only sole criteria for judging its usability in Indian cooking. Smoke point & processing methodologies are some of the other additional important factors.

Since, the edible oils available in market are often blend oils and often fortified with nutraceuticals, it will be interesting to compare the complete fatty acid profile of edible oils (fresh and boiled samples). The comparison will help us understand how the each oil differ in terms of fatty acids; increase the understanding towards our knowledge to know which type of oil is good for consumption in particular health condition; how the particular oil should be cooked/consumed to minimize the loss of its associated health benefits.

Keeping in view of the above cited literature, edible oils which have certain highlighted health benefits were collected from the open market and investigated for the complete fatty acid profiles (to compare various types of oils on basis of types of fatty acids); presence of health beneficial antioxidants (A, D, E); other synthetic antioxidants like TBHQ (added to control rancidity in oil but is a neurotoxic). The oil samples were also analysed for rancidity (Free fatty acids, peroxide values). Further the oils were also boiled five times and compared for the same parameters.

5. Research problem/hypothesis/objectives:

- To analyse the fatty acid composition of selected edible oil samples present in Delhi retail.
- To check the percentage of unsaturated fatty acid, saturated fatty acids and their types in the selected edible oils.
- To determine the composition of the selected blended refined oils.
- To perform the quality check (peroxide value etc.) on the selected samples.
- To check the purity of the available oils as claimed by the manufacturer.

6. Methodology Techniques/Sampling /Tools/Materials:

6.1. Market Survey: To understand the buying and consumptions patterns, the factors influencing /affecting purchase decision, the awareness level of consumers and explore health related aspects of edible oils for edible oils in Delhi.

Sample and Study Setting: In order to achieve the objectives of the study, data was collected on 132 respondents using simple random sampling technique. Demographic details of participants are given in table 1 and 2.

6.2. Free Fatty Acid (FFA) content: This was determined titration (Sadasivam and Manickam, 1996). Dissolve 1g of oil in 50ml of neutral solution (25ml ether + 25ml 95% alcohol + 1ml 1% phenolphthalein, neutralized with N/10 alkali) in 250ml conical flask. Titrate against KOH (0.1N). Shake constantly until pink color which persist for 15 seconds.

Calculations:

ACID VALUES(mg KOH/g)= Titre value × normality of KOH×56.1/ Weight of sample(g)

The free fatty acid is calculated as oleic acid using the equation 1ml N/10 KOH=0.028g oleic acid.

6.3. Peroxide Value (PV): It was determined by titrametric method given by Cox and Pearson, 1962. Weigh 1g of oil or fat in to a clean dry boiling tube and add 1g of powdered potassium iodide and 20ml of solvent mixture. Place the tube in boiling water so that the liquid boils within 30 seconds and allow boiling vigorously for not more than 30 seconds. Transfer the contents quickly to a conical flask containing 20 ml of 5% Potassium iodide solution. Wash the tube twice with 25 ml water each time and collect in to the conical flask. Titrate against N/50 Sodium thiosulphate solution until yellow colour is almost disappeared. Add 0.5 ml of starch, shake vigorously and titrate carefully till the blue colour just disappears. A blank should be set at the same time.

CALCULATIONS: Peroxide value (milliequivalent peroxide/kg sample) = S*N*100/ (g) sample; Where S= ml $Na_2S_2O_3$ (test – blank) and N=normality of $Na_2S_2O_3$

6.3. Thin Layer Chromatography (TLC) for Lipids: Bake TLC plate at 110^{o}C,for 20minutes. Allow it to come to room temperature before loading lipids samples. In one TLC chamber pour 250 ml of solvent (80:20:1) i.e n- hexane: diethyl ether: acetic acid. Seal it properly. Keep it as such for atleast 30minutes so that it becomes saturated. In another dry chamber add some iodine crystals. Keep it sealed for 30 minutes so that vapours don't escape. Dissolve oil samples in chloroform (200:100microliter). On the activated plates load the oil samples dissolved in chloroform. Keep the loaded TLC plate in saturated TLC chamber. Allow it to run till the solvent reaches upto 2 inches below the upper edge. Take out the TLC plate and allow it to air dry. Remove and visualize it after exposing the TLC plate to iodine vapors

6.4. Gas Chromatography coupled with Mass Spectroscopy (GC-MS) for Fatty acid profile: Oil samples under investigation were analysed for fatty acid

profile using *Shimazdu GCMS-QP 2010 having AOC-20 i auto injector*. Oils were first converted into methyl esters. Sample (0.5g) was taken in a test tube. Added 1ml of diethyl ether and shaken. Added 0.5% methanolic KOH (1ml) and shaken vigorously for 10 minutes. Added 1ml of 1N HCL followed by 2-3ml of petroleum ether and shaken for a minute. The upper petroleum ether layer is decanted and dried in a water bath. Then 0.5 ml of N-Heptane was added to the residue and mixed well. Prepared methyl ester (0.2 microlitre) was injected for analysis. Run time was 20 minutes.

6.5. Antioxidants: Oil samples were analyzed for oryzanol (%), Vitamin A, D2 and E (mg/100ml), TBHQ (mg/l) from FICCI Research and analysis Centre, Dwarka, New Delhi-77. Oryzanol was determined by FRAC/SOP/Chem/197 standard method. Vitamin A and E by FRAC/SOP/INST/014 standard method (AOAC 2001.13). Vitamin D2 by FRAC/SOP/INST/087 standard method (EN12821). TBHQ by AOAC 983.15 method.

7. Result and Discussion (main text, tables with titles, graphs and figures with legends) In detail:

Market Survey

Study was planned to explore the buying and consumptions patterns for edible oils in Delhi, to understand the awareness level of consumers and to explore health related aspects. To accomplish the objectives , data was collected on 132 participants and entered in SPSS and analyzed using descriptive and inferential statistics .Findings are presented in following tables and figures.

Table 1: Demographic Variables: Frequency and Percentage

Variables	Types	Frequency (f)	Percentage (%)
Gender	**Male**	21	15.90
	Female	111	84.10
Family	**Nuclear**	101	76.5
	Joint	31	23.5
No. of Family Members	**1-2**	7	5.3
	3-4	61	46.2
	5-6	41	31.1
	6 or More	23	17.4
Monthly Family Income	**Below 10**	5	3.8

	Thousands		
	10-20 thousands	14	10.6
	20-35 thousands	39	29.5
	35-50 thousands	21	15.9
	50-75 thousands	18	13.6
	75,000 and more	7	5.3
	1 Lakh or More	28	21.2

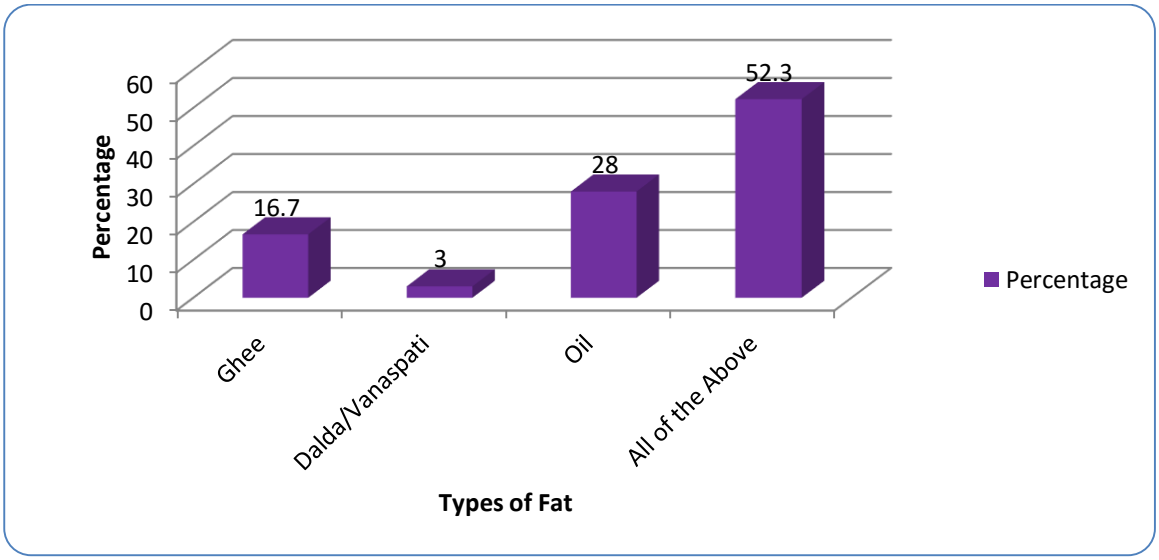


Figure 1: Types of Fat Consumed Percentage, N=132

It is evident from Figure 1 that out of total, 52 .3 % participants scored on all of the above which means they are consuming Ghee , Dalda/Vanaspati and Oil as well . Further table indicates that 28 % participants scored on oil followed by 16.7 % participants on Ghee and 3 % on Dalda/Vanaspati.

Table 2: Types of Fat Consumed; Chi-Square, N=132

Types of Fat	Observed Frequency (f)	Expected Frequency (f)	Chi-Square (χ^2)
Ghee	22	33.0	68.90**
Dalda/Vanaspati	4	33.0	
Oil	37	33.0	
All of the Above	69	33.0	

****p<.001 level**

It is evident from the chi-square table 2 that there is a significant difference between (χ^2 = 68.90, p<.01, df=3) distribution of types of fat in the sample and population. This

means sample is not representative of the population in terms of types of fat consumed by consumers.

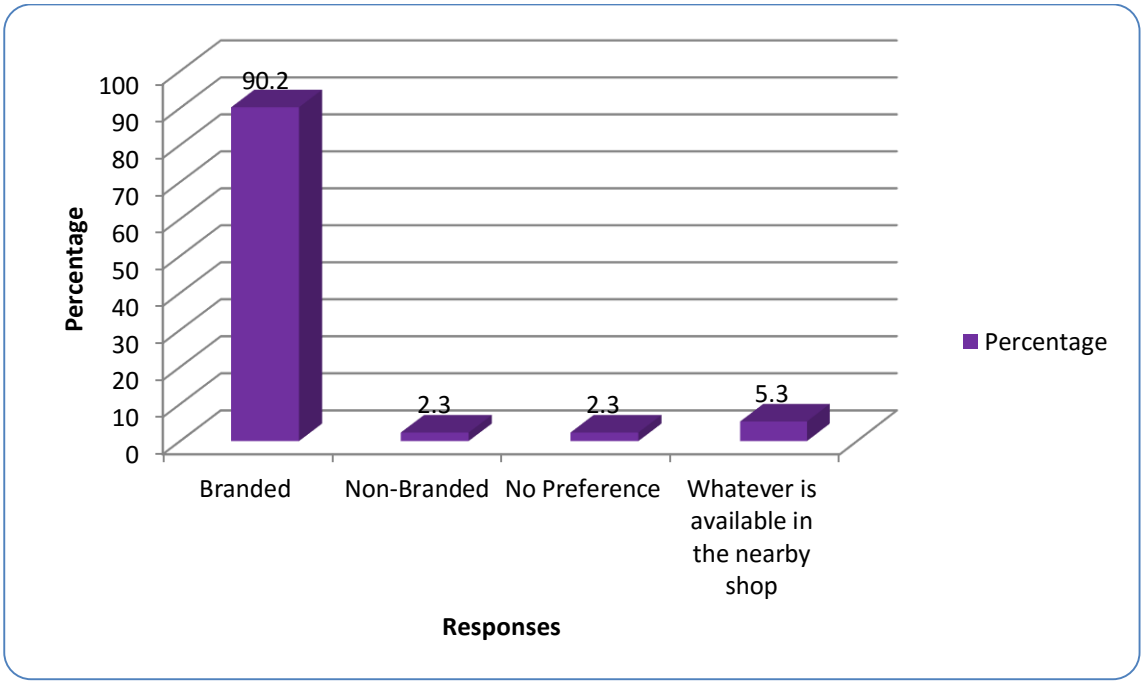


Figure 2: Preference of Edible Oils Percentage, N=132

Figure 2 indicates that out of total, 90.2 % participants prefer branded edible oils whereas 5.3 % participants prefer to use whatever available in the nearby shop. Further, it reveals that 2.3 % participants have no preference and 2.3 % participants prefer non-branded edible oils.

Table 3: Preference of Edible Oils; Chi-Square, N=132

Responses	Observed Frequency (f)	Expected Frequency (f)	Chi-Square (χ^2)
Branded	119	33.0	299.15**
Non-Branded	3	33.0	
No Preference	3	33.0	
Whatever is available in the nearby shop	7	33.0	

****p<.001 level**

Chi Square Table 3 indicates that there is a significant difference between (χ^2 = 299.15, p<.01, df=3) distribution of responses in the sample and population. This means sample is not representative of the population in terms of responses on preference of edible oils.

Table 4: Importance of Choice of Edible Oil for Health; Frequency and Percentage, N=132

Importance Level	Frequency (f)	Percentage (%)
Very much	91	68.9
Some what	28	21.2
Not at all	4	3.0
I am unaware	9	6.8

Table 4 indicates that 68.9 % participants think that choice of edible oil is very much important for their health whereas 21.2 % participants think that choice of edible oil is somewhat important for their health followed by 3 % not at all. Further table indicates that 6.8 % participants are unaware about the choice of edible oil for health. It may be concluded that Consumers are therefore extremely cautious about what they eat and as a result, they want to be sure of the health implication each food component or product has on their body.

Table 5: Brand Consumed; Frequency and Percentage, N=132

Brand Name	Frequency (f)	Percentage (%)
Borges	8	6.1
Dalda	14	10.6
Delmonte	8	6.1
Dhara	9	6.8
Figaro	14	10.6
Fortune	90	68.2
Gemini	3	2.3
Mahakosh	6	4.5
Saffola	38	28.8
Sundrop	18	13.6
Sweekar	4	3
Other brands	10	7.6
Brand does not Matter	8	6.1

(Table is based on multiple response item)

Table 5 indicates that 68.2 % participants use fortune edible oil followed by 28.8 % Saffola ,13.6 % Sundrop and so on.

Table 6: Factors Which Influence Decision of Respondents While Edible Oil Selection; Frequency and Percentage, N=132

Factors	Frequency (f)	Percentage (%)
Advertisements	59	44.7
Brand	86	65.2
Easy Availability	65	49.2
Flavour	60	45.5
Habit	60	50
Nutritional Value	95	72
Packaging	61	46.2
Price	57	43.2
Source of Oil	63	47.7
Taste	60	45.5
Viscosity /Non Stickiness	53	40.2
Shelf Life /Expiry	65	49.2

(Table is based on multiple response item)

Table 6 shows that 72 % participants think that nutritional value of edible oils influences their decision while edible oil selection. 65.2 % participants think that brand influences their decision while edible oil selection. Further, 50 % participants think that habit influences their decision while edible oil selection.

Table 7: Plant Source Preference of Edible Oils; Frequency and Percentage, N=132

Plant Sources	Frequency (f)	Percentage (%)
Mustard	78	59.1
Coconut	12	9.1
Soya bean	38	28.8
Palm	3	2.3
Groundnut	11	8.3
Canola	8	6.1
Olive	28	21.2
Blended	12	9.1
Others	7	5.3

(Table is based on multiple response item)

Table 7 reveals that 59.1 % participants prefer mustard plant source of edible oils whereas 28.8 % participants prefer Soya bean plant source followed by 21.2 % Olive , 9.1 % Coconut and Blended.

Table 8: Re-use of the Oil for Deep Frying; Frequency and Percentage, N=132

Time	Frequency (f)	Percentage (%)
Strictly Only Once	58	43.9
2-3 Times	54	40.9
4-5 Times	8	6.1
Till the Oil is Fully Consumed	12	9.1

Above table 8, shows 43.9 % participants do re use the oil for deep frying purposes specially for Indian delicacies like *Pakoras* , *Bhature* , Potato Chips , *Samosa and Puris* whereas 40.9 % participants do re use 2-3 times for deep frying . Further 9.1 % participants do re use till the oil is fully consumed. 6.1 % participants do re use 4-5 times for deep frying.

Table 9: Awareness of the Health Benefits/Disadvantages of Fats and Vitamins; Frequency and Percentage, N=132

Fats and Vitamins	Frequency (f)	Percentage (%)
Saturated fats	44	33.3
Trans fats	35	26.5
Monounsaturated fat	33	25
Polyunsaturated fat	30	22.7
Cholesterol	53	40.2
Omega 3,6	35	26.5
Antioxidants	45	34.1
Losorb Technology	19	14.4
Multiseed Source	24	18.2
Nutrolock Technology	16	12.1
Presence of Oryzanol	24	18.2
Fortification with Vitamins A,D,E	37	28
Erucic Acid	16	12.1
Smoke Points of Oils	20	15.2
Rancidity	26	19.7
Shelf Life /Best Before	44	33.3

(Table is based on multiple response item)

Table 9 shows the awareness of the Health Benefits/Disadvantages of Fats and Vitamins. Only 40.1 % people had awareness about cholesterol. 34.1 % participants were aware about antioxidants. 26.5 % participants were aware about Trans fat and omega 3 and 6.

Table 10: Main reasons for not paying attention to oil quality; Frequency and Percentage

Responses	Frequency (f)	Percentage (%)
Lack of Knowledge	71	53.8
Lack of Interest	37	28
Monetary Reasons	7	5.3
Never Mattered . All seem similar to me	17	12.9

As per table 10, 53.8 % participants agreed that lack of knowledge is the main for not paying attention to oil quality. 28 % participants told that lack of interest is the main reason while 5.3 % participants projected on monetary reason as main reason for not paying attention to oil quality.

Free Fatty Acid Analysis: Free Fatty Acid Profiles of all the samples were analysed on opening the pack immediately, also the same samples upon boiling after five times were also analysed for FFA. The results are depicted in figure 3. For sample code refer to annexure.

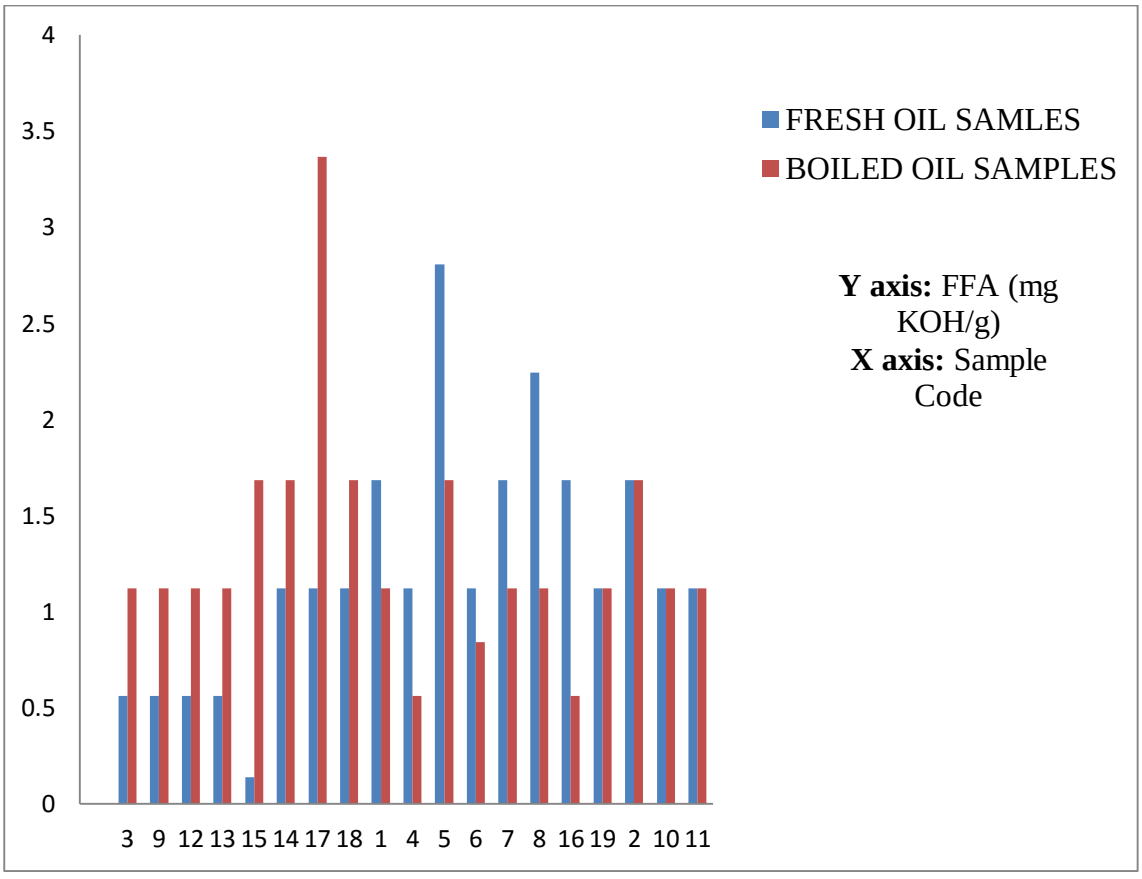


Figure 3: Free Fatty acid content in fresh and boiled oil samples

The figure 3, shows that sample 17 (refined blend oil consisting rice bran and soyabean oil) was highly unstable on boiling as it recorded highest FFA content. Sample 18 (physically refined rice bran oil) also showed high FFA content after sample 17. However no free fatty acids were recorded in sample 19 (blend oil consisting imported refined sunflower oil and rice bran oil); sample 2 (refined sunflower oil and rice bran oil); sample 10 (blend of refined and extra virgin olive oil); sample 11 (mixture of pomace and extra virgin olive oil). Some of the samples showed more FFA content in fresh samples as compared to boiling. This might be that on boiling some other secondary and tertiary free radicals have formed. Sample 5 (blend oil consisting of rice bran oil and filtered sesame oil) showed highest FFA content amongst all fresh samples. Though sesame oil is rich in antioxidants, however there are some reports of high FFA content in some varieties of sesame oil. A high value of FFA in sesame oil is frequently an indication for a strong enzymatic hydrolysis of sesame seeds during harvesting, handling or oil processing (Gharby et al., 2014). The samples having only single seed compositions like sample 7 (refined soyabean oil); 8 (mustard oil); 16 (only olive oil- not a blend of other grades of olive oil); 1 (olive oil only); 4 (refined sunflower oil) reported high FFA in fresh oil samples. Thus single seed oils were more prone to oxidation even after fortifications of natural or artificial antioxidants. This suggests that blending increases the oxidative stability. This is also supported by literature by many workers as cited earlier. Blending of classic olive oil with extra virgin olive oil also increased oxidative stability.

Peroxide Value/Rancidity

As determined by titrametric method none of the samples (both fresh and boiled) reported peroxides in it. This may be due to low levels of peroxides (if any formed) present in the oil samples under investigations which could not be quantified with the above protocol. However, rancidity was observed in few boiled samples. Sample 17B (refined blend oil consisting rice bran and soyabean oil) which showed highest FFA content also recorded positive for rancidity. Rancidity was also recorded in sample codes 18B (rice bran oil); 19 (rice bran and safflower kardi oil); 7B (refined soyabean oil). On comparing the results of FFA and rancidity it can be concluded that oil samples consisting rice bran oil and/or soyabean oil are relatively prone to oxidative damage during cooking/processing.

Thin Layer Chromatography

Thin layer chromatography of all the fresh and boiled oil samples was done to resolve triacylglycerols (major components); MAG, DAG and free fatty acids (minor components) of oils. The result is presented below (Figure 4).

Figure 4: TLC profile of oil samples under investigation (a) Boiled samples 6 to 10, (b) Fresh samples 11 to 15, (c) Boiled samples 11 to 15

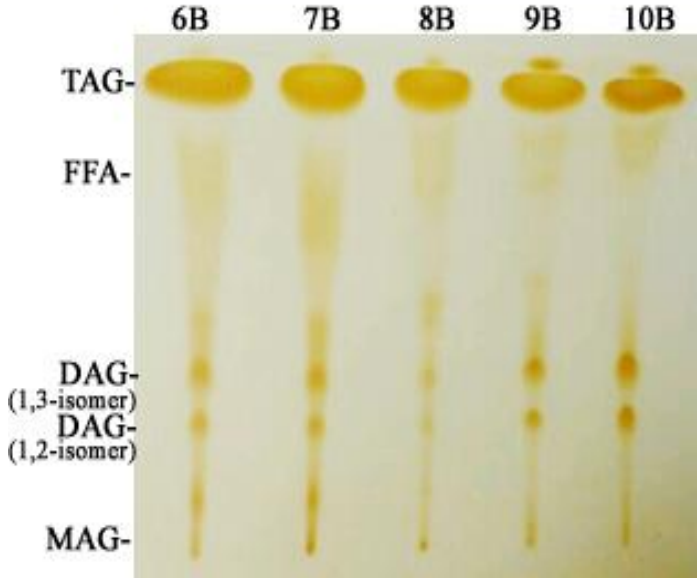
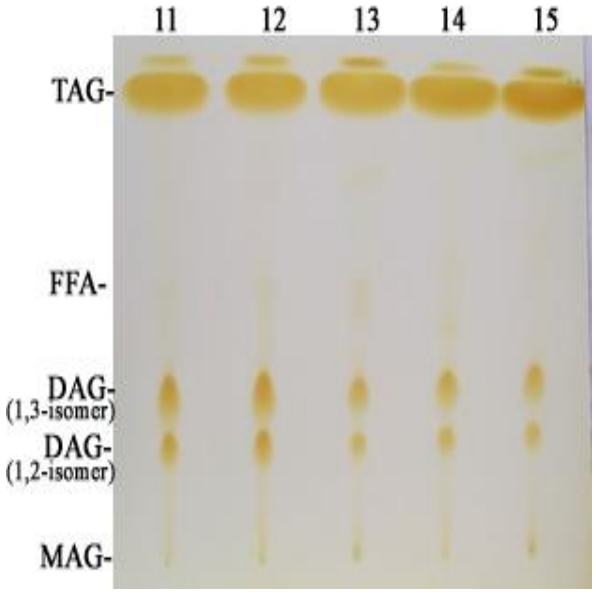


Figure 4a



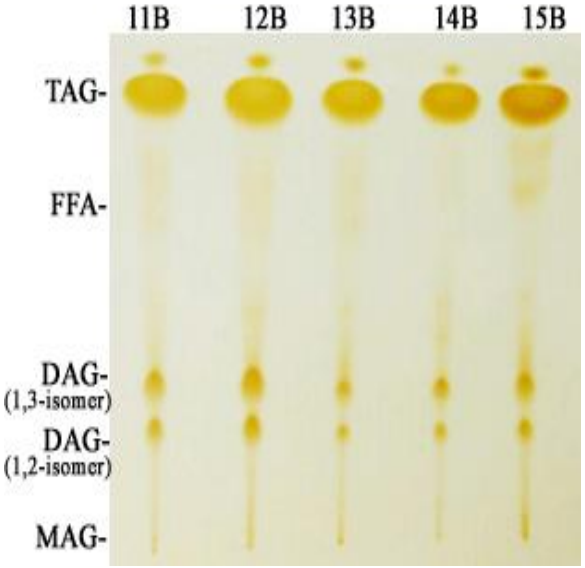


Figure 4b and Figure 4c

GC-MS for Fatty Acid Profiles*

*The complete data analysis to draw some conclusive results is still under process as the analysis of 38 samples took time. The preliminary results are presented below. The chromatograms obtained are provided in appendix.

"F" against the numeric figure suggests the ***fresh oil sample*** and ***"B"*** against the same numeric figure represents ***the same oil sample after boiling 5 times*** (boiled cooled again boiled, repeating the step 5 times). The fatty acids with area % above 1 were taken for plotting the graphs. The list of major fatty acids observed in oil samples under investigations are presented in table 11.

Table 11: Various Fatty acids observed in oil samples under investigation

COMPONENT NAME	COMPONENT NO
9-hexadecanoic acid,methyl ester(Z)	1
Hexadecanoic acid,methyl ester	2
9,12-octadecadienoic acid(z,z)-methyl ester	3
9-OCTADECANOIC ACID (Z)-METHYL ESTER	4
11-OCTADECANOIC ACID,METHYL ESTER	5
METHYL STEARATE	6
METHYL10-TRANS,12-CIS-OCTADECADIENOATE	7
9-OCTADECANOIC ACID,METHYL ESTER	8
CIS-11-EICOSANOIC ACID,METHYL ESTER	9
EICOSANOIC ACID,METHYL ESTER	10
DOCOSANOIC ACID,METHYL ESTER	11
12,15-OCTADECANOIC ACID,METHYL ESTER	12
octadec-9-enoic acid	13

2-FLUORO-2,2-DIMETHYL-4-OXO-1,3,2,LAMBDA(5)-I	14
9-HEXADECANOIC ACID,METHYL ESTER,(E)	15
2-CHLOROETHYL LINOLEATE	16
2-FURANMETANAAMINE,N-(2-FURANYL METHYL)-	17
TETRACOSANOIC ACID,METHYL ESTER	18
Oliec acid	19
squalene	20
ethyl(9Z,12Z)-9,12-OCTADECADIENOATE	21
octadec-9-enoic acid	22

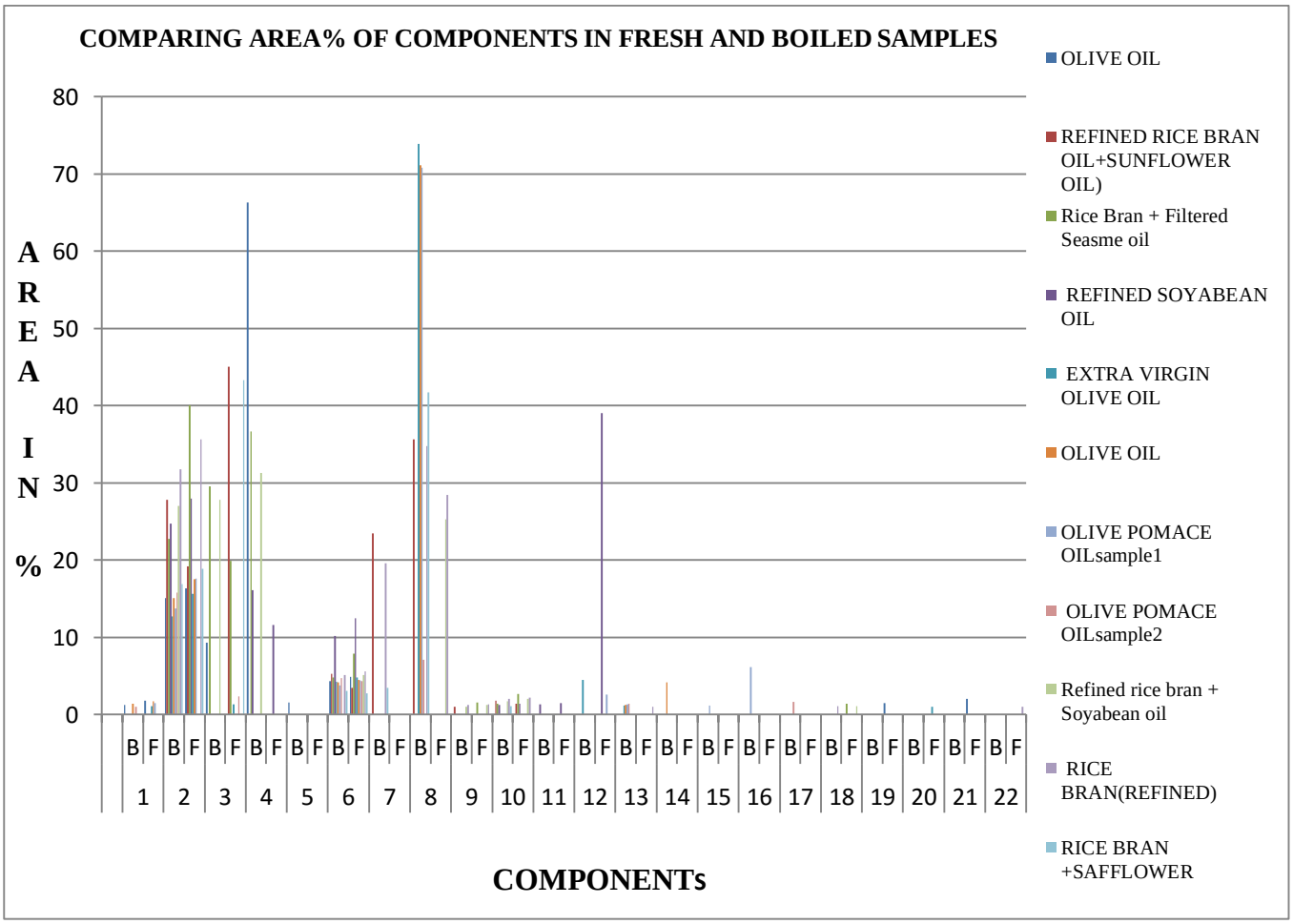


Figure 5: Comparison of Fatty acids type and % in various oil samples before and after boiling

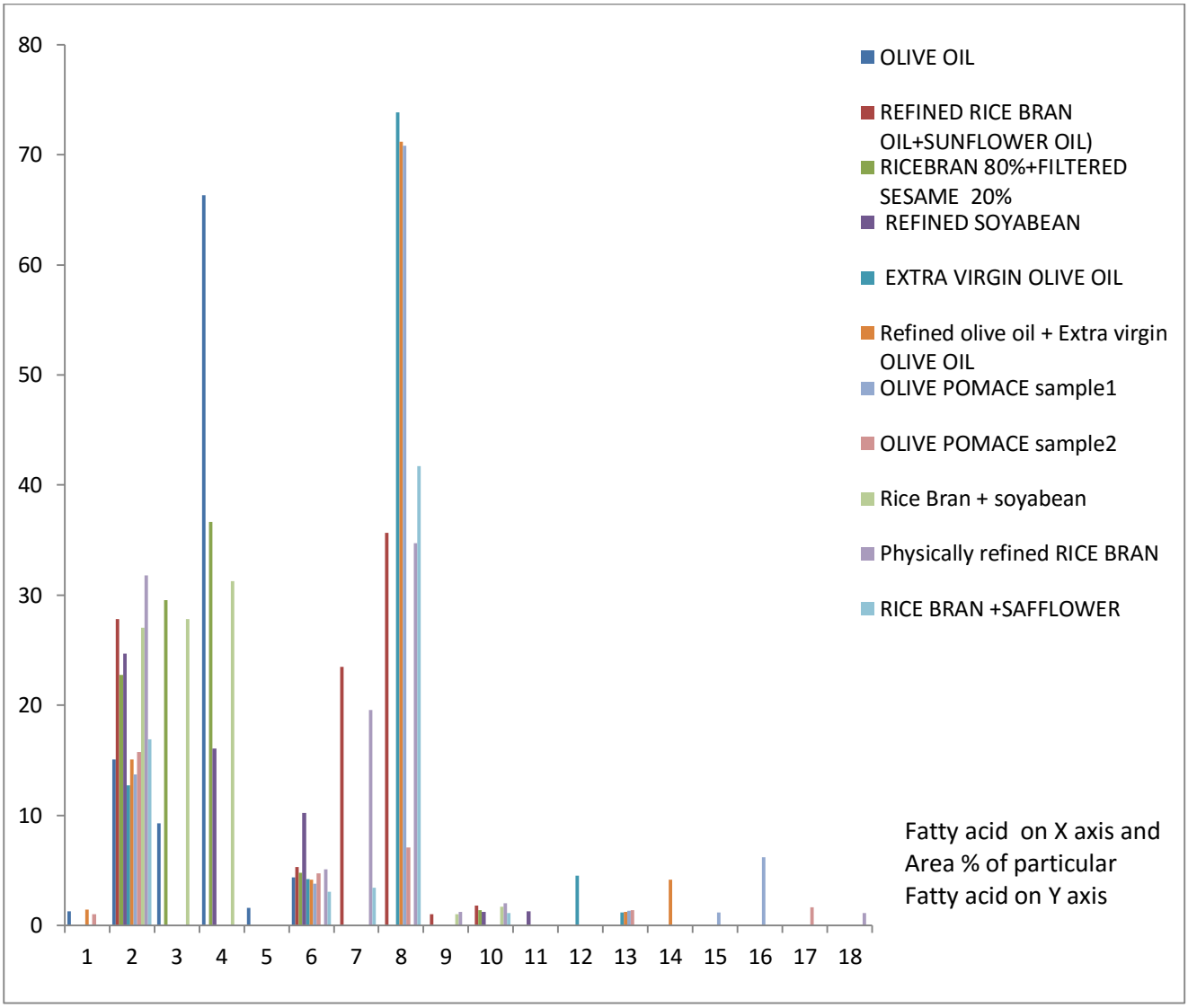


Figure 6: Fatty acid profiles of oil samples after boiling. Fatty acid type is plotted on x axis the numeric component refers to fatty acid tabulated in table 11. The percentage of particular fatty acid is on Y axis.

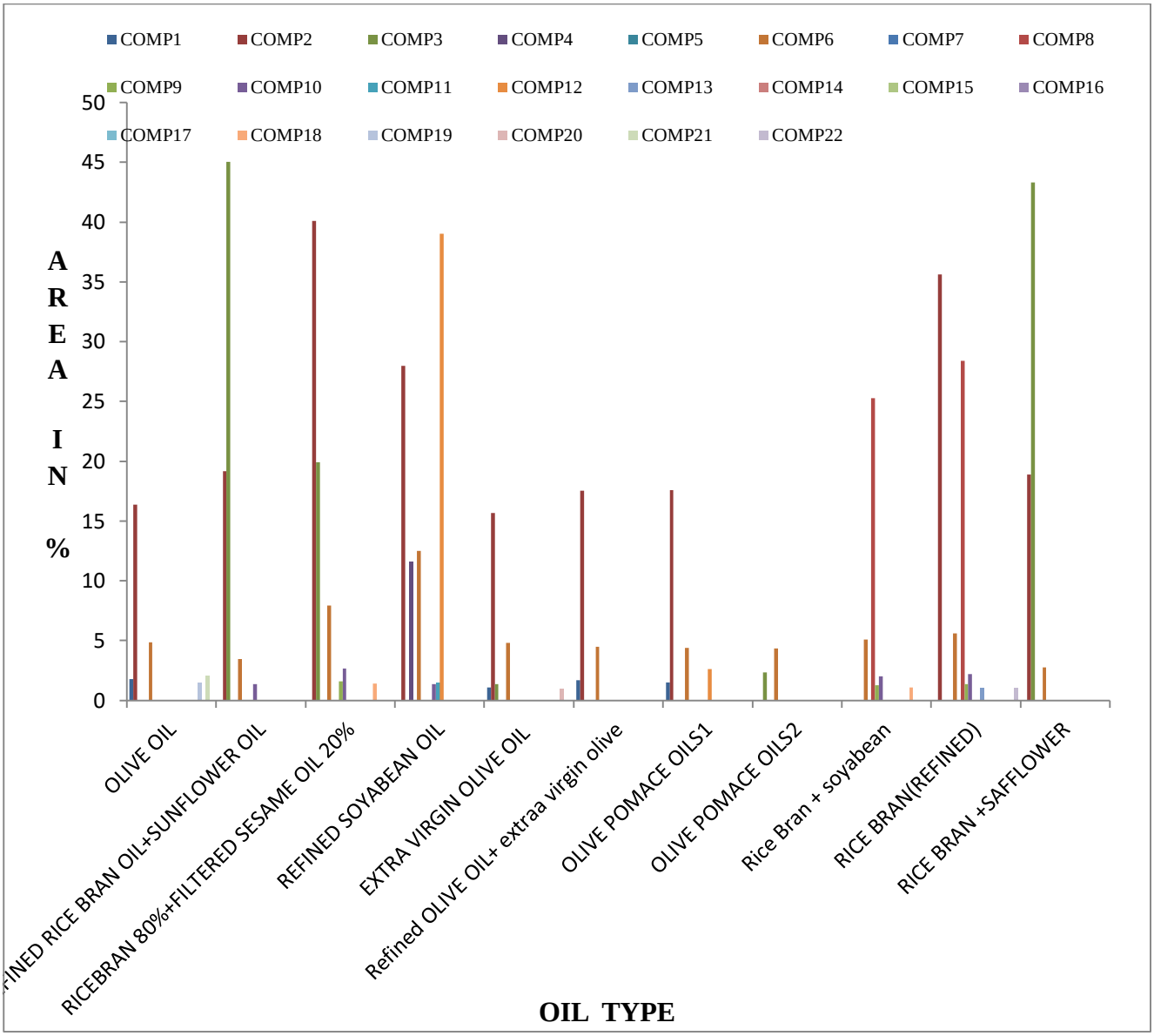


Figure 7: Fatty Acid Profiles of Fresh Oil samples under investigation. Each color bar designated different fatty acid. The component number corresponding to fatty acid is presented in Table 11.

From the ***Figure 5*** it is seen that ***component 8 (9-OCTADECANOIC ACID)*** is present in high amounts in boiled samples. There is not much difference in ***component 2 (Hexadecanoic acid)*** before and after boiling and is mostly present in all oil samples. ***Component 12 (12,15-OCTADECANOIC ACID)*** is exclusively present in fresh soyabean oil and is absent upon boiling. Components 13 to 22 are not present in significant amounts in samples under investigation. ***Figure 6*** shows that amongst boiled samples ***component 8 (9-OCTADECANOIC ACID)*** was present in highest percentage in certain blend oils like blend of refined rice bran and sunflower oil; refined olive + extra virgin olive oil; rice bran + safflower oil. Also this component was present in single seed oils such as refined rice bran oil, extra virgin olive oil and olive pomace oil**.** ***Component 3 (9, 12-octadecadienoic acid)*** was also present in significant amounts in blend oil consisting of filtered sesame oil + rice bran oil and rice bran + soyabean oil. ***Component 2 (Hexadecanoic acid)*** was significantly present in physically refined rice bran oil; rice bran + soyabean oil and refined rice bran + sunflower oil. ***Figure 7*** shows that ***Component 2 (Hexadecanoic acid)*** is present in almost all fresh oil samples. Highest amount was recorded in Rice bran + Seasme oil followed by refined rice bran oil and refined soyabean oil. ***Component 3 (9, 12-octadecadienoic acid)*** was present in highest amount in refined rice bran oil + sunflower oil and rice bran oil + safflower oil. ***Component 8 (9-OCTADECANOIC ACID)*** is also present in very high amounts in rice bran + soyabean oil and refined rice bran oil. However this component was not reported significantly in other fresh oil samples but was present in almost all boiled samples. Further analysis of the GC-MS results is under process.

Antioxidants*:

***The antioxidant analysis was recently undertaken due to financial restrictions. The results of the tests have just been received. To derive certain strong conclusions further analysis of the results received is under progress. The preliminary observations are presented below.

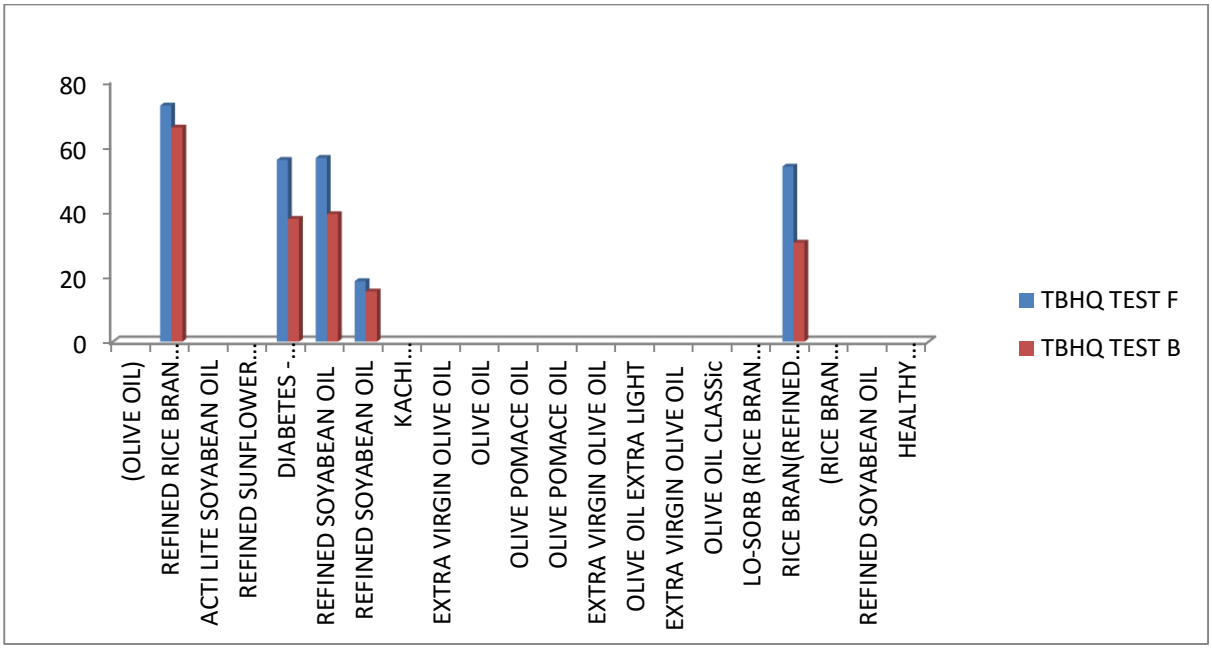


Figure 8: TBHQ (mg/l) changes in fresh and boiled samples

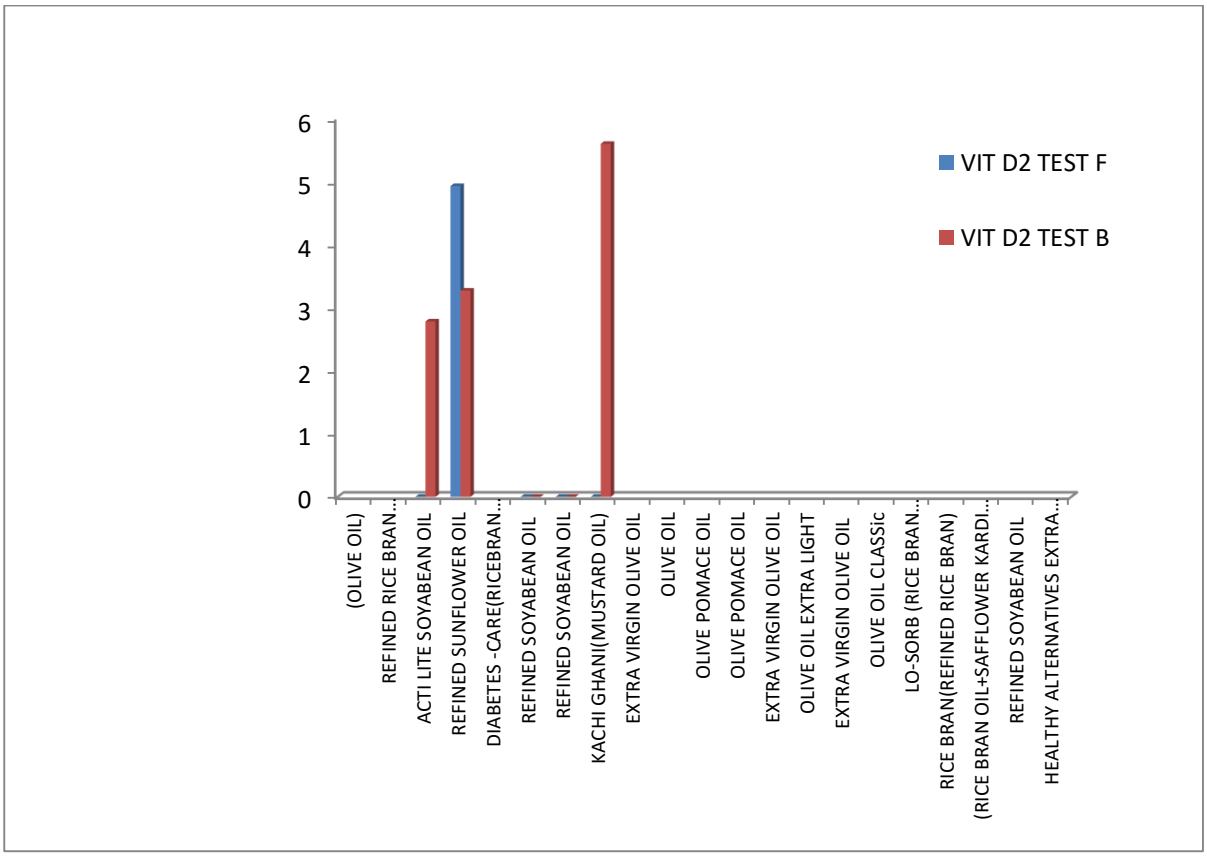


Figure 9: Vitamin D2 (mg/100g) changes in fresh and boiled samples

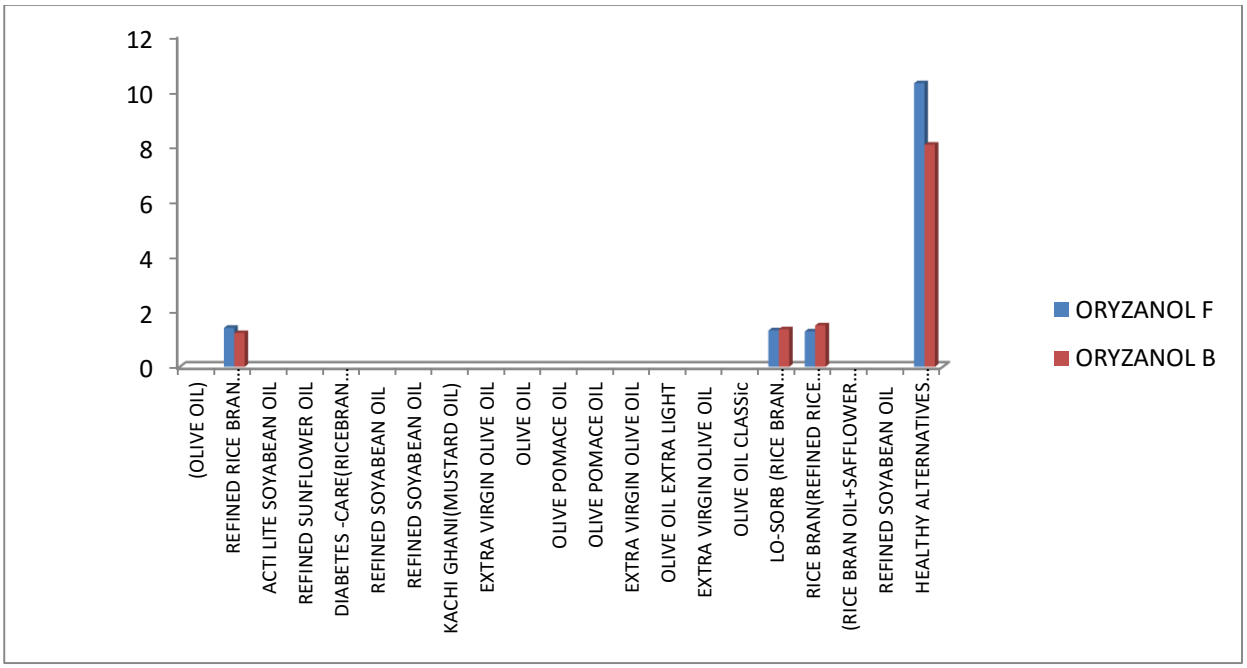


Figure 10: Oryzanol (%) changes in fresh and boiled samples

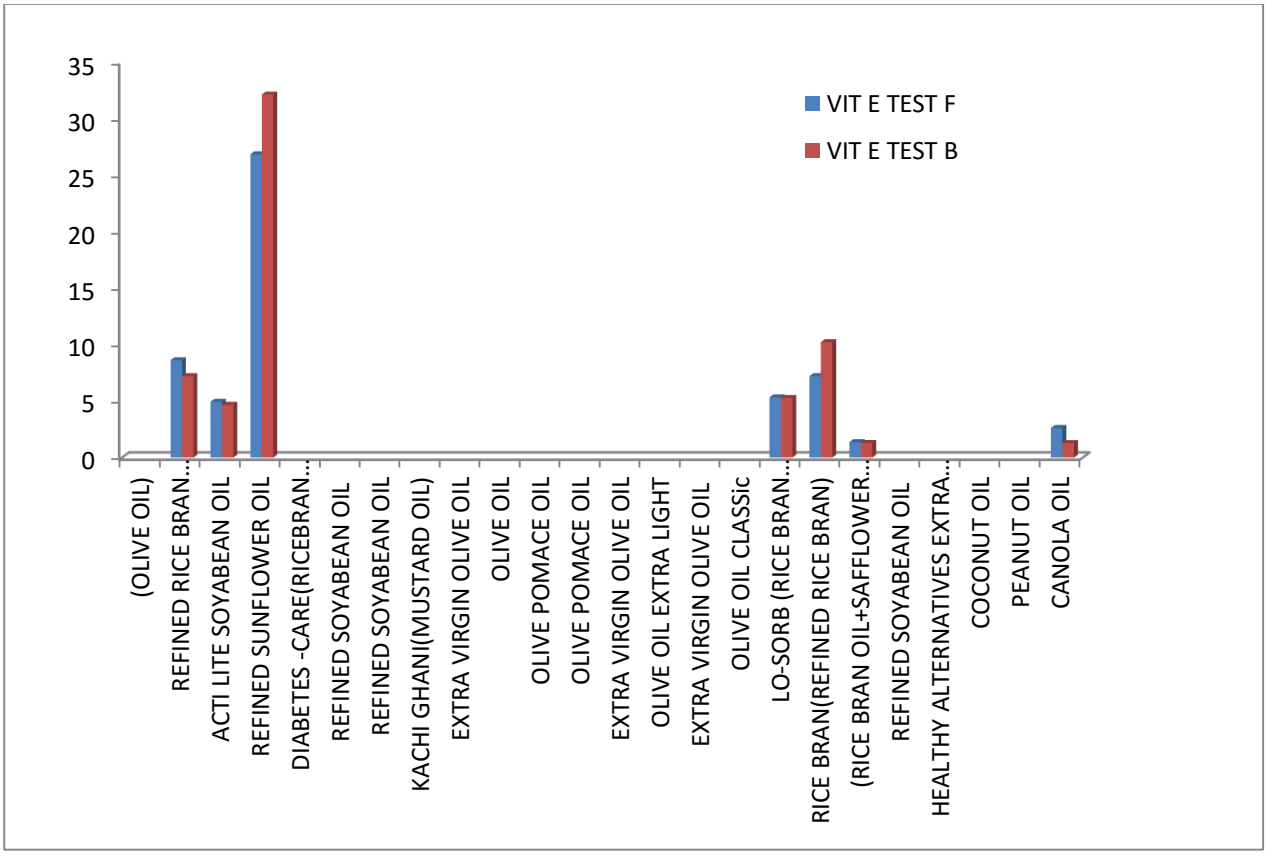


Figure 11: Vitamin E (mg/100g) changes in fresh and boiled samples

8. Innovations shown by the project

The complete result analysis is still under progress. However certain innovations can be projected from current investigation and is summarized below. Most of the literature reports, about health benefits of one type of oil, or some of the blending compositions. Similarly, effect of processing/cooking also is extensively studied for single seed oil. Current investigation is innovative in the sense that it has analyzed diverse groups of single seed and multi-seed refined edible oils, particularly focusing on the presence of heart healthy constituent or having health benefits for overcoming various lifestyle disorders. Complete fatty acid profile of market edible oil samples is generally missing. Extensive studies are done in current investigation on analyzing and categorizing the edible oils in terms of fatty acid constituent, presence of antioxidants (Vitamin AD,E and Oryzanol) and toxic synthetic antioxidants like TBHQ. Indian cooking involved repeated heating of oil samples so we have also analysed oil samples for all the major and minor components after boiling five times. FFA and rancidity is also evaluated. The results can be used for Setting up some guidelines for suggesting oils for patients suffering from different lifestyle disorders. Suggestions from present investigation can be taken up to develop proper ***heating and disposal protocols*** of edible oil for households and catering industries. Some of the common household and consumer questions can be addressed like:

- *How the oils in market differ from each other or are better from their counterpart?*
- *"Which oil should we use?"*
- *"Which oil suits Indian Kitchen?"*
- *"Should we pay more for associated health benefits of edible oils?"*

- Results on variation in the quantity of antioxidants (due to processing/cooking) answers us *"are fortified oils better than simple plain refined…should we pay more?"*
- *"Are traditional oils better then newer advertised blended refined or fashionable olive oils?"*
- *Does Olive oils really suits Indian cooking?*
- *Is your Olive oil is only olive oil or a blend?*
- *What is the need of blend oils over traditional single seed oil?*
- *Why should we pay more for particular oil?*

9. Conclusion and Future direction:

Since consumers are becoming more enlightened in their food intake, their quest for the right combination of food nutrients has become more important particularly as several health-related problems are attributed to food that they consume. Market survey result analysis also revealed that selection of edible oil was based on disease history of family (34.8). Participants (15.9 %) told choice of selection of edible oil depends upon the severity of health condition. The samples having only single seed compositions reported high FFA in fresh oil samples. Thus single seed oils were more prone to oxidation even after fortifications of natural or artificial antioxidants. This suggests that blending increases the oxidative stability. Blending of classic olive oil with extra virgin olive oil also increased oxidative stability. On comparing the results of FFA and rancidity it can be concluded that oil samples consisting rice bran oil and/or soyabean oil are relatively prone to oxidative damage during cooking/processing. As per GC-MS results it was observed that olive oils contained less MUFA and PUFA than the other refined oils present in market.A saturated fatty acid (9- hexadecanoic acid) is also present significant amounts in many oils which is really bad for health leading to cardio vascular diseases and other health problems. In some oils a change was seen in the concentration of a MUFA compound (12,15-octadecanoic acid), it

decreases after boiling of oils. Also, some amount of Erucic acid (Docosanoic acid) is present in the oils which is toxic of human health. ***Component 8 (9-OCTADECANOIC ACID)*** is present in high amounts in boiled samples. There is not much difference in ***component 2 (Hexadecanoic acid)*** before and after boiling and is mostly present in all oil samples. ***Component 12 (12,15-OCTADECANOIC ACID)*** is exclusively present in fresh soyabean oil and is absent upon boiling. Components 13 to 22 are not present in significant amounts in samples under investigation. Some of the oil samples tested also reported presence of TBHQ which is added to increase shelf life of edible oil. However, it has serious health implications and should be avoided for human consumption.

Further work can be carried out by comparing the effects of other processing methods on quality of edible oils. Shelf life studies can also be done to substantiate the work. Edible oils can be explored for presence of membrane related fatty acids. Membrane associated fatty acids are extensively studied in immunology related research. The results obtained have potential to be used as biomarker for developing fatty acid supplements, identifying the risk factors associated with edible oils and making an ideal edible oil blend for human consumption providing recommended dietary allowance of oil/fats and also in addition health benefits for various cardiovascular/lifestyle disorders. Kang et al., 2004 suggested that mmeasurement of the n-6/n-3 fatty acid ratio can be also used to identify animal phenotypes, such as the fat-1 transgenic mice that we created recently (Kang et al., 2004). Thus, analysis of fatty acid composition is a commonly used technique in lipid research. The study has future directions in many areas. Edible oils which are left after cooking as

waste oils, nowdays are used to generate bbiodiesel. Further there is a need to educate people and find ways for proper disposal of waste oil (may be applications of some special adsorbents or nanoparticles). There is a need to develop proper heating and disposal protocols of oil for households and catering industries.

10. References

Bibliography

1. Appel, L.J. et al. (2005). Effects of protein, monounsaturated fat, and carbohydrate intake on blood pressure and serum lipids: results of the Omni Heart randomized trial. *JAMA*, **294(19)**: p. 2455-64.
2. Bansal G, Zhou W, Barlow PJ, et al (2010). Review of rapid tests available for measuring the quality changes in frying oils and comparison with standard methods. *Crit Rev Food Sci Nutr*, **50**, 503-14.
3. Cabiscol E, Tamarit J, Ros J (2010). Oxidative stress in bacteria and protein damage by reactive oxygen species. *Inter Microbiol*, **3**, 3-8.
4. Chotimarkorn C, Silalai N (2008). Addition of rice bran oil to soybean oil during frying increases the oxidative stability of the fried dough from rice flour during storage. *Food Res Inter*, **41**, 308-17.
5. Downs, SM; Gupta,V; Ghosh-Jerath,S;Lock,K; Thow, AM and Singh, A. (2013). Reformulating partially hydrogenated vegetable oils to maximise health gains in India: is it feasible and will it meet consumer demand? *BMC Public Health*, **13:**1139
6. Frank N-E G, Albert M-M E and Asteride EM (2013). Some quality parameters of crude palm oil from major markets of Douala, Cameroon. *African J Food Sc*i **7**(12): 473-478.
7. Gharby, S., Harhar, H., Guillaume, D., Roudani, A., Boulbaroud, S., Ibrahimi, M., Ahmad, M., Sultana, S., Ben Hadda, T., Chafchaouni-Moussaoui, I., Charrouf, Z. (2014). Chemical Investigation of *Nigella sativa* L. Seed Oil Produced in Morocco. *J. Saudi Soc. Agric. Sci*. (in press). http://dx.doi.org/10.1016/j.jssas.2013.12.001.

8. Harris WS, Von Schacky C (2004). The Omega-3 Index: a new risk factor for death from coronary heart disease? *Prev Med*, **39:**212-220.
9. Iqbal S, Bhanger MI, Anwar F (2005). Antioxidant properties and components of some commercially available varieties of rice bran in Pakistan. *Food Chem*, **93**, 265-72.
10. Johnson,S and Saikia, N. (2009). Fatty acids profiles of Edible Oils and Fats in India, A Report by Centre of Science and Environment, Lodi Road, New Delhi-110003
11. Kang JX, Wang J, Wu L, Kang ZB (2004). *Fat-1* transgenic mice convert n-6 to n-3 fatty acids. *Nature*, **427**:504.
12. Kaushik V, Yadav MK and Bhatla SC (2010). Temporal and spatial analysis of lipid accumulation, oleosin expression and fatty acid partitioning during seed development in sunflower (Helianthus annuus L.). *Acta Physiologiae Plantarum* **32:** 199-204.
13. Kris-Etherton PM, Harris WS, Appel LJ. (2002). Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. *Circulation*, **106:** 2747–57.
14. Lopez-Aguilar JR, Valerio-Alfaro G, Monroy-Rivera JA, Medina-Juárez LA, Mahony MO and Angulo O (2006). Evaluation of a simple and sensitive sensory method for measuring rancidity in soybean oils. *Grasas Y Aceites* **57**: 149-154.
15. Mensink, R.P., et al. (2003). Effects of dietary fatty acids and carbohydrates on the ratio of serum total to HDL cholesterol and on serum lipids and apolipoproteins: a meta-analysis of 60 controlled trials. *Am J ClinNutr*, **77(5):** p. 1146-55
16. Mohamed Ali, A.S. and Abdurrhman, AM. (2013**).** Determination of Free Fatty Acids in Palm Oil Samples by Non-Aqueous Flow Injection Using Salicyaldehyde-2,4-Dinitrophenylhydrazone as Colorimetric Reagent. *Chemical and Materials Engineering* **1(3):** 96-103, 2013
17. Navarro M, Castro W, Biot C (2012). Bioorganometallic compounds with antimalarial targets: Inhibiting hemozoin formation. *Organometallics*, **31**: 5715-27.
18. Rao,BS. (2003). Bioactive phytochemicals in Indian foods and their potential in health promotion and disease prevention. *Asia Pacific Journal of Clinical Nutrition*, **12(1):** 9-22

19. Samarth, N.B. and Mahanwar, P.A. (2015) Modified Vegetable Oil Based Additives as a Future Polymeric Material—Review. *Open Journal of Organic Polymer Materials*, **5**: 1-22.
20. Strayer, D. (2006). FOOD FATS AND OILS, Report by Technical Committee of the Institute of Shortening and Edible Oils, Inc., 9th edition

Web Links:

- Scott-Thomas, C. (2011), Consumer survey finds growing food safety concerns. Retrieved from
- *URL:http://monile.foodnavidatorusa. com/suppliers2/consumer-survey-finds-growing foodsafety-concerns#.VHhjPX3LfMI* [November 23, 2014]
- http://www.oliveoiltimes.com
- http://www.ilsi.org
- http://image.slidesharecdn.com/cookingoilusagepatterninindia-131216132710-phpapp02/95/cooking-oil-usage-pattern-in-india-6-638.jpg?cb=1387202303
- http://www.thehealthybutcher.com

11. Publication/s from the work. (attach copies):

Not yet, Publications will be submitted later (if any) arise from the current work.

12. Conference Presentation/s (attach copies):

Following posters were presented from the project

1. Smita Tripathi, Misha Yadav, Deepika Yadav, Palak Shards and Pratima Verma (2016). ***Edible Oil Consumption Trends and Associated Health Implications,*** Poster presented at the National symposium on "Lifestyle Disorders: Understanding the Molecular Mechanisms" organized by the Department of Biochemistry, Shivaji College on January 28-29, 2016.
2. Misha Yadav, Smita Tripathi, Deepika Yadav, Ravi ranjan, Richa Mittal, Sahil Dhingra. ***Significance of edible oil constituents for diminishing the chance of cardiovascular diseases*** Poster Presented at the International conference on "Public Health: Issues, Challenges, Opportunities, Prevention, Awareness" organized by Daulat Ram College from January 15-16, 2016
3. Smita Tripathi, Misha Yadav, Deepika Yadav **,** Aakanksha, Kalpna Agarwal, Sarita Tiwari, Anshul Gupta.***"Recycling of Waste Edible Oil-Promising***

Approach for Greener Environment" Poster Presented at "National Conference in Chemistry Environment & Harmonious Development" being organized by Shyamlal College, University of Delhi during April 7- 8, 2016

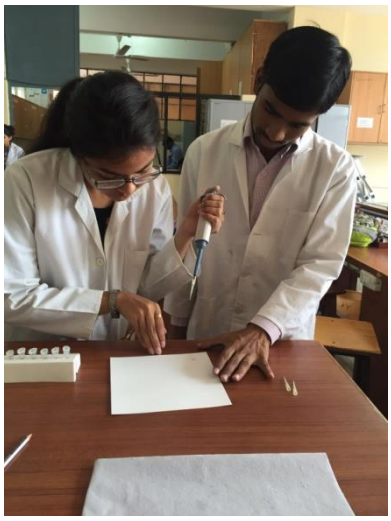
4. Deepika Yadav, Misha Yadav, Palak Sharda, Pratima Verma. ***Biofuel: A Greener approach From Waste to health***. Poster Presented at National symposium on Environment and Urban Health at Shivaji College on 22nd March, 2016.
5. Deepika Yadav and Nishita Gogia. ***Syndrome X in context with some adversarial dietary practice in India.*** Poster presented at Maitreyi College in Man Made Diseases: An Urban Menace on 11th Feb, 2016

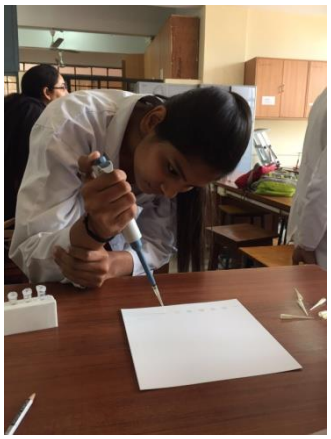
13. Patent/s and Technology Transfer (attach copies): NA

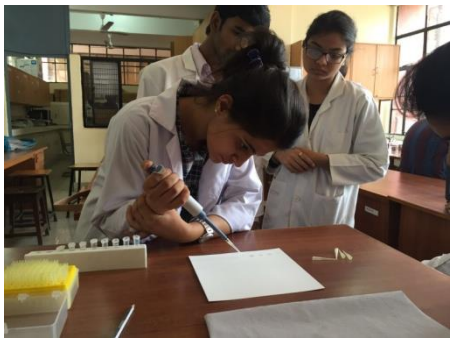
14. Media Coverage (attach copies): NA

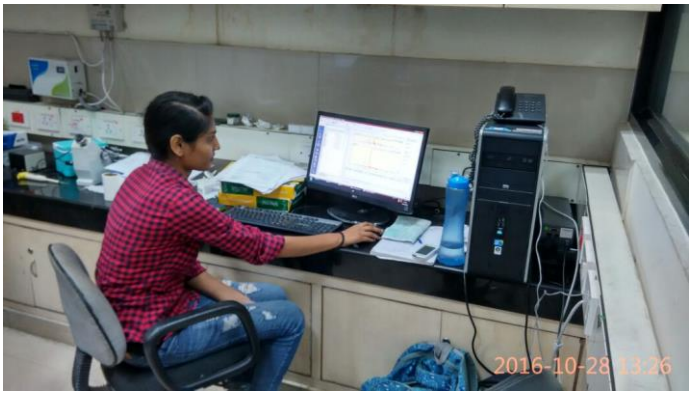
15. Pictures related to the project:

STUDENTS WORKING IN COLLEGE LABORATORY

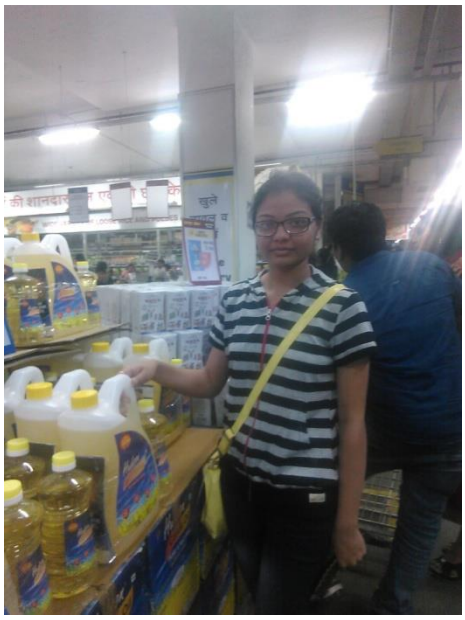


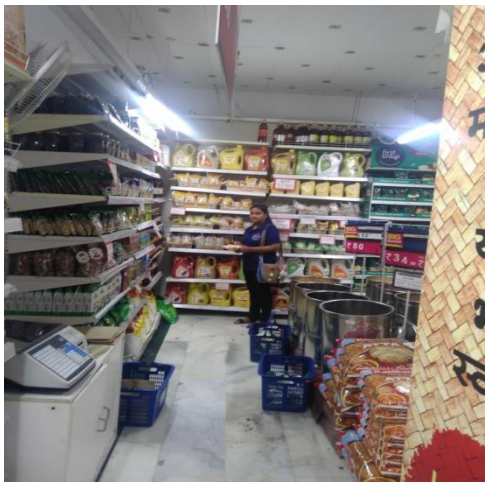




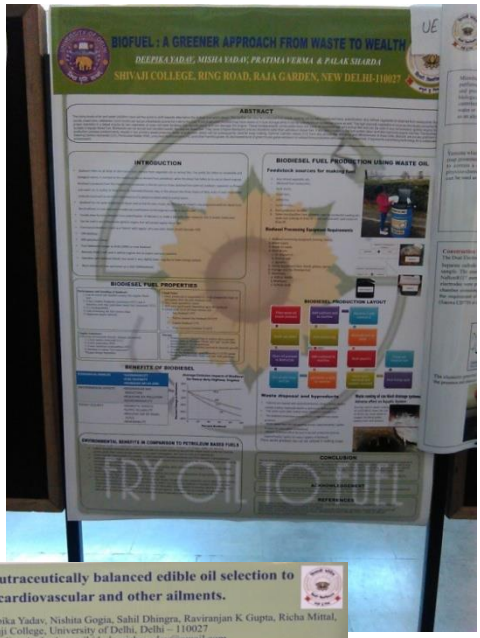


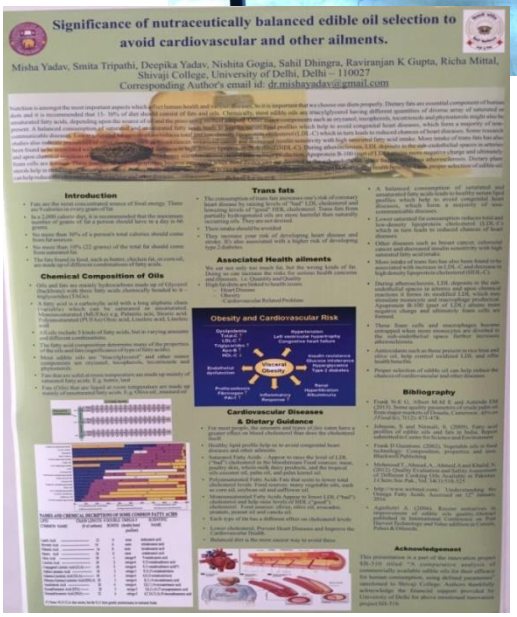
Sample Survey



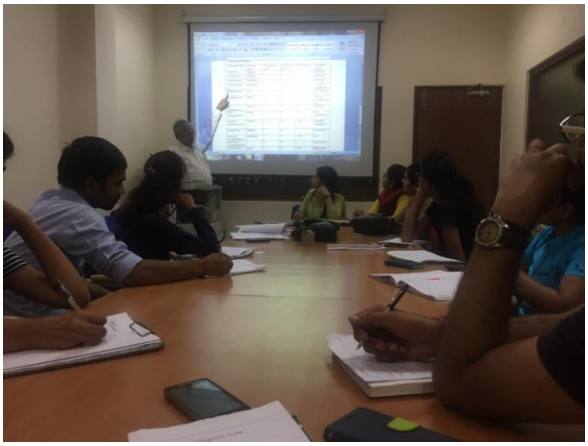


Conference Presentations etc.





Interaction with the Mentor



16. Annexure/Any other information:

Sample Details, Questionnaire for Survey

Annexure I: List of Oil Samples Used in Current Investigation

Oil Code	Oil Sample (INGRIDIENTS)
1	OLIVE OIL
2	refined Edible sunflower oil, refined edible rice bran oil, antioxidant(TBHQ)
3	soyabean oil , vit A, D ,E , dimethyl polysiloxane (900a)
4	sunflower oil,vitaminA 750mcgper 100g of oil,vitaminE 273mcg,vitamin D polysiloxane(900a)
5	Rice Bran Oil + Filtered Seasame Oil
6	refined soya bean oil, permitted antioxidant (E 319)
7	refined soyabean oil, antioxidants TERTIARY BUTYLHYDROQUINONE,vitA,VITD
8	mustard oil vitamin A & D2, antifoaming agent di methyl polysiloxane
9	extra virgin olive oil
10	80% refined olive oilL,20% extrasa virgin olive oil
11	85%refined pomace olive oil ,15%extra virgin olive oil
12	refined olive pomace oil , virgin olive oil
13	extra virgin olive oil
14	Olive oil
15	extra virgin olive oil
16	olive oil
17	refined rice bran oil,refined soya bean oil , permitted antioxidants (319 , 330), antifoaming agent (900a), vit E
18	physically refined rice bran oil , permitted antioxidants , antifoaming agents
19	refined rice bran oil , imported sunflower oil ,permitted antioxidants , antifoaming agents

Annexure II

Questionnaire on Consumer Perception towards Edible Oils

Instructions: The purpose of this study is to understand the buying and consumptions patterns for edible oils in Delhi. This study also aimed to examine factors influencing /affecting purchase decision of edible oils and some health related aspects. Please complete the following questions to reflect your opinions as accurately as possible and to answer factual questions to the best of your knowledge.Your information will be kept strictly confidential.

GENERAL INFORMATION:

A. Name:

B. Age:

C. Your Height:

D. Your Weight:

E. Hip-Waist Ratio:

F. Gender: Male / Female

G. Address:

H. Occupation:

I. Father's occupation:

J. Mother's occupation:

K. Type of family (Please Tick):: Joint/Nuclear

L. Number of family members (Please Tick):

a) 1-2

b) 3-4

c) 5-6

d) 6 or more

M. What is the monthly family income of your family (Please Tick):

a) Below 10 thousands

b) 10-20 thousands

c) 20-35 thousands

d) 35-50 thousands

e) 50-75 thousands

f) 75,000 and more

g) 1 lakh or more

1. Type of fat consumed:
a) Ghee
b) Dalda/Vanaspati
c) Oil (any oil like refined/mustard etc.)
d) Both (for different purposes)

2. What type of edible oil do you prefer:
a) Branded
b) Non- branded
c) No preference
d) whatever is available in the nearby shop/store

3. Why do you prefer branded / Non- branded:
a) Price
b) Surety about quality
c) Packaging
d) Ease of availability

4. Monthly consumption of edible oil by family (in litres):
a) 0-2
b) 2-4
c) 4-6
d) 6-8
e) 8-10

5. Age group of family members:

S.No	**Age group**	**Number of individuals**
a)	0-15	
b)	15-25	
c)	25-35	
d)	35-45	
e)	45 or more	

6. Educational background of family: Tick mark the column(s):

		1 person	2 persons	3 persons	4 persons	5 persons	6 persons
a)	12^{th} or below						
b)	Graduation						
c)	Post-graduation						
d)	Diploma						
e)	Ph.D./AnyTechnical Degree(Mention)						

7. How important do you think the choice of edible oil is for your health:
a) Very much
b) Somewhat
c) Not at all
d) I am unaware

8. Brand consumed/ preferred:
a) Borges
b) Dalda
c) Delmonte
d) Dhara
e) Figaro
f) Fortune
g) Gemini
h) Mahakosh
i) Saffola
j) Sundrop
k) Sweekar
l) Some other brand (please mention)
m) Whatever is available in the local shop (brand does not matter)

9. What are the factors which influence your decision while edible oil selection:

S.No	**Does this factor influence you selection**	**Yes**	**No**	**Order of preference**
1.	Advertisement			
2.	Brand			
3.	Easy availability (any would do)			
4.	Flavour			
5.	Habit (Parents/family have been using before)			
6.	Nutritional value			
7.	Packaging			

8.	Price			
9.	Source of oil			
10.	Taste			
11.	Viscosity/ Non-stickiness			
12.	Shelf Life/Best Before/Expiry			

10. How loyal are to you/your family to the brand which you use:
a) Very much
b) Somewhat
c) Not at all

11. Which edible oil brand does your family used 2 years ago:
a) Borges
b) Dalda
c) Delmonte
d) Dhara
e) Figaro
f) Fortune
g) Gemini
h) Mahakosh
i) Saffola
j) Sundrop
k) Sweekar
l) Some other brand (please mention)
m) Non-branded

12. Which edible oil brand does your family used 5 years ago:
a) Borges
b) Dalda
c) Delmonte
d) Dhara
e) Figaro
f) Fortune
g) Gemini
h) Mahakosh
i) Saffola
j) Sundrop
k) Sweekar
l) Some other brand (please mention)
m) Non-branded

13. How particular/specific are you about the **'source of edible oil'**(like someone might say'I would consume only mustard oil only, brand preference comes later'):
a) Very much
b) Somewhat
c) Not at all

14. Which plant source do you/your family prefer:
a) Mustard
b) Coconut
c) Soybean
d) Palm
e) Groundnut
f) Canola
g) Olive
h) Blended (mixture)
i) Others (please mention)

15. Do you use/consume olive oil for cooking? If yes, mention the brand used:
a) Bertolli
b) Borges
c) Del Monte
d) Farrell
e) Figaro
f) Gata
g) Leonardo
h) MIMI
i) Oleev
j) Olivo
k) Casarinaldi
l) Costa d' Oro
m) Pietro
n) GAIA
o) Fragata
p) Any other (please mention)

16. If you use olive oil for edible purposes, for what purpose:
a) Deep frying
b) Shallow frying
c) Pickling
d) Salad dressing/direct consumption
e) Tadka (in vegetable dishes)
f) Any other (please mention)

17. Do you know the actual difference between the various categories of olive oil:
(Yes/ No)
If yes, which is most preferred by you?
a) Pure Olive oil
b) Extra Virgin
c) Extra light
d) Pomace
e) Blend with other oils
f) Other(s)

18. How many times do you re-use the oil for deep frying purposes (Especially for Indian delicacies like Pakoras, Bhature, Potato Chips, Samosas & Puris):

a) Strictly Only Once

b) 2-3 times

c) 4-5 times

d) Till the oil is fully consumed

19. How often deep fried food is consumed in a month (Please tick):

Consumption/month	**At home**	**At Work Place**	**At Eating Joints (StreetVendors,Restaurants,Hotels)**
Nil			
1-2 times			
3-4 times			
5-6 times			
More than 6			

20. Do you use separate oil for frying/deep frying purposes (If Yes, then specify the brand used):

(Mention the brand Name)

21. Suppose 'source of oil is same' than which brand would you buy. What are the factors which make a certain brand more preferred over others? Number your order of preference.

a) Advertisements, Brand tagline
b) Price
c) Visual appeal of packaging
d) Information provided on packaging
e) Word-of mouth publicity (Influenced by friend/neighbour/colleagues choice)
f) Family history/traditional choice
g) Any other (please specify)

22. What type of packaging do you prefer:
a) Bottle
b) Plastic cans of various shapes
c) Pouches
d) Tetrapacks
e) Tin cans
f) Glass Jars/Bottles
g) Does not matter

23. How often do you make purchase of edible oil:
a) Once a week

b) Once in fifteen days
c) Once a month
d) Once in 2 months
e) Once in 6 months
f) Yearly

24. Which source of information influences your choice of edible oils, the most? **Number your order of preference**.

a) Television
b) Newspapers
c) Radio
d) Internet
e) Family
f) Friends
g) Others (please mention)

25. Do promotional schemes/offers influence your choice:
a) Always
b) Never
c) Sometimes

26. In your family, who makes the decision regarding choice of edible oil:
a) Grandmother
b) Grandfather
c) Mother
d) Father
e) Wife
f) Husband
g) Children
h) Servant/Cook

27. Are you aware of the positive/negative health effects related to the following (in relation to edible oil consumption):

S. no.	**Parameter**	**Yes**	**No**	**Has this factor affected your choice till date (Yes/No)**
a)	Saturated fats			
b)	Trans fats			
c)	Monounsaturated fat			
d)	Polyunsaturated fat			
e)	Cholesterol			
f)	Omega 3,6			
g)	Antioxidants			

h)	Losorb technology			
i)	Multiseed source			
j)	Nutrilock technology			
k)	Presence of oryzanol			
l)	Fortification with Vitamins A, D, E			
m)	Erucic acid			
n)	Smoke Point of Oils			
o)	Rancidity			
p)	Shelf Life/Best Before/Expiry			

30. According to you, have you made a healthy choice:

a) Yes
b) No
c) Don't know, never gave a thought

31. What do you think is the main reason for not paying attention to oil quality:

a) Lack of knowledge
b) Lack of interest
c) Monetary reasons
d) Never mattered. All seem similar to me.

32. Does anyone in your family suffer from/had any of the following disorders:

a) Hypertention (B.P.)
b) Coronary artery disease/ Heart Attack
c) Heart failure
d) Dyslipidemia (High cholesterol - Bad Lipid Profiles)
e) Diabetes
f) Fatty Liver
g) Stroke (Cerebro Vascular Accident)

33. Does the disease history of family member(s) influence your selection criteria of edible oil:

a) Sometimes
b) Always
c) Never
d) Depends upon the severity of condition

34. How many people are overweight* in your family out of total family members:

a) 1-2
b) 3-4
c) 5-6
d) 6 or more

***Note:** BMI =Weight in Kg /Height in $M^{2;}$**BMI Categories:** Underweight = <18.5, Normal weight = 18.5–24.9, Overweight = 25–29.9, Obesity = BMI of 30 or greater

UTILIZATION CERTIFICATE

Innovation Project 2015-16

SHC-310

Project Title: A comparative analysis of commercially available edible oils for their efficacy for human consumption, using defined parameters

Audited Financial Statement under Innovation Project scheme

College: Shivaji College

Project Investigators: Dr. Misha Yadav, Dr. Smita Tripathi, Dr. Deepika Yadav

Grant Sanctioned Rs	(In figures) Rs. 4,00,000 (In Words) Four lakh rupees only		
	Sanctioned	Spent	Unutilised Amount
Equipments/Consumables	1,80,000	1,79,276	724
Travel	25,000	25,000	-
Stipend	1,20,000	1,20,000	-
Honorarium	25,000	448	24,552
Stationery	20,000	19,998	2
Contingency	30,000	30,256	(256)
Total amount utilized Rs. (In figures and words)	3,74,978 (Three lakh seventy four thousand nine hundred seventy eight rupees)		
Amount remaining Rs. (In figures and words)	25,022 (Twenty five thousand twenty two rupees)		

Certified that out of **Rs. 4,00,000 (Four lakh)** (In figures and words)

Sanctioned to Innovation Project Code **SHC-310**, Rs 3,74,978 has been utilized during the period of the project. The remaining amount Rs. 25,022 (Twenty five thousand twenty two rupees) (In figures and words) is being returned back to the University.

Misha Smita (Dr. Smita Tripathi) Deepika Yadav (Dr. Deepika Yadav)

(Dr. Misha Yadav)

Signature of Project Investigators

VIMAL DHAWAN & ASSOCIATES Chartered Accountants M. No. 518146 NEW DELHI

Financial Audit Clearance
and Stamp of Charted Accountant

Signature of Principal

University of Delhi

RC/2015/9435 31 August, 2015

The Principal,
Shivaji College
Ring Road, Raja Garden,
New Delhi-27

Subject: - **Innovation Projects 2015-16**

Dear Principal,

The University of Delhi is pleased to announce the third round of the undergraduate research initiative in colleges, Innovation Projects 2015-16. You will be glad to know that the following project submitted by your college has been selected for award

Project Code: SHC 310
Project Title: A Comparative Chemical Analysis Of Commercially Available Newer Brands Of Edible Oils For Their Highlighted Benefits For Human Consumption

The distribution of grant under different budget heads as below:

Sr. No.	Budget Head	Amount
1.	Equipment/Consumables	Rs 1,25,000/-
2.	Stipends	Rs. 1,20,000/- (1000x10x12)
3.	Travel	Rs 80,000/-
4.	Honorarium	Rs 25,000/-
5.	Stationery/Printing	Rs 20,000/
6.	Contingency	Rs 30,000/-
	Total	Rs 400,000/-
Rs 4 lakhs (Rupees four lakhs only)		
Amount to be released in first phase by Finance Branch- Rs 2,50,000/		

Budget head No. 1 and half of the remaining grant will be released as the first instalment. The second and final instalment will be released after submission of half-yearly report (by 15 February 2016), satisfactory review and recommendation of release of the second instalment.
Please refer to the detailed guidelines for implementation of the project. Any queries may be addressed to- innovationprojects1516@gmail.com.

With best wishes,

Yours sincerely,

Prof. Malashri Lal