A SURVEY ON REUSING COOKING OIL PRACTICES FOR FRYING AMONG LOCAL FOOD OUTLETS IN SONIPAT, HARYANA.

[1] Poornima [2] Dr. Nutan

[1]Research scholar, [2]Assistant Professor

[1]Department of Food and Nutrition

[1]BPSM University, Khanpur Kalan, Sonipat, Haryana, India

ABSTRACT

Deep fat fried foods are prevalent food due to their one of a kind quality attributes. The procedure depends on the drenching food at high temperatures, contingent upon the crude materials, in this way prompting physical and synthetic changes, for example, starch gelatinization, protein denaturation cooking, and outside layer development. So as to get an item with a low fat substance, it is basic to comprehend the components required amid the broiling procedure so oil movement into a food item can be limited. Reusing cooking oil in food arrangement, particularly amid deep-fricasseeing, is a typical practice to spare expenses. Continued warming of the oil quickens oxidative corruption of lipids, framing risky reactive oxygen species and exhausting the regular antioxidant substance of the cooking oil. Long haul ingestion of foods arranged utilizing warmed oil could seriously bargain one's antioxidant protection organize, prompting pathologies, for example, hypertension, diabetes and vascular irritation. The hindering impacts of warmed oil utilization stretch out past minor oxidative ambush to cell antioxidant shield. In this Article, we used a survey method to analyze reusing cooking oil practices for frying among local food outlets in Sonepat, Haryana.

Keywords: Fatty Acids, Reusing, Cooking Oil, Fat Frying, Deep Frying.

I. INTRODUCTION

Snacks-the foods eaten in the middle of dinners have turned into a vital piece of weight control plans because of changing dietary and way of life rehearses in every one of the nations, regardless of whether created or creating. Frequently these snacks are deep-fried and are generally accessible at little and medium measured vendors. The nature of these snacks relies upon the oil/fat utilized for broiling [1]. The consumption of these deep-fried snacks has expanded the fat and all out vitality admission levels which assume an imperative job in wellbeing and disease. India represents 10% of the world's eatable oil consumption. Exorbitant consumption of fats in eating regimen raises blood cholesterol, which is then in charge of atherosclerosis, prompting cardio-vascular diseases (CVDs) and other related disorders. CVDs are right now one of the biggest supporters of interminable disease load in India. Improving dietary admissions is an essential modifiable risk factor for cardiovascular diseases.

The wellsprings of Trans fatty acids (TFA) in human diets incorporate creature sources (for example dairy items and ruminant meats), yet most are provided side-effects containing modernly produced partially hydrogenated vegetable oils (PHVOs; for example margarines, shortenings around the world, vanaspati in India). These mostly hydrogenated vegetable oils are normally utilized in families and by vendors in India particularly for deep singing purposes or as shortening. Different metabolic and epidemiological investigations have detailed that consumption of Trans fatty acids presents expanded risk of coronary heart disease (CHD) because of changes in blood lipid levels and unsettling in other physiological pathways adding to the expanded risk.

1.1 HEATING PROCESS OF VEGETABLE OIL

Amid the frying procedure, cooking oil is presented to an amazingly high temperature within the sight of air and dampness. Under such conditions, an intricate arrangement of chemical reactions happens, bringing about loss of both quality and healthy benefits of the cooking oil. More than once warming the cooking oils starts a progression of chemical reactions, adjusting the fat constituents of cooking oil through oxidation, hydrolysis, polymerization, and isomerization, in the end bringing about lipid peroxidation, Lipid peroxidation creates a wide range of unstable or non-unpredictable parts, including free fatty acids, alcohols, aldehydes, ketones, hydrocarbons, trans isomers, cyclic and epoxy mixes. Accordingly, when a similar cooking oil is reused too much, the chemical reactions upgrade frothing, obscuring of oil shading, expanded consistency, and off-enhance. Thus, continued warming of the oil can prompt corruption of the cooking oil, both chemically and physically [2].

Despite the fact that the chemical reactions incited by warm treatment are perplexing, they communicate with and influence one another. Presentation to oxygen at high temperatures prompts oxidation of triacylglycerides, which creates hydroperoxides. Hydroperoxides are shaky intermediates and quickly stall into reactive free radicals to start autoxidation, by and large through a three-stage process (inception, engendering and end). Autoxidation is along these lines proposed to be a primary component of lipid peroxidation. The extraordinary warmth amid frying is the fundamental initiator for autoxidation, notwithstanding different factors, for example, photonic operators, ionizing radiation, free radicals and chemical effects.

1.2 FRYING PROCESS

The real innovation of frying is professed to have started and been created close to the Mediterranean territory because of the impact of olive oil. Fried food items produce billions of dollars. In the United States alone, in excess of 500,000 business eateries utilize one million metric tons (MMT) or 2.0 x 109 lb. of frying fats and oils every year. Frying is such a prominent procedure because of the attributes of the foods that are created. Frying is a highly intricate procedure where a progression of wonders happens all the while all through the whole procedure. All the more explicitly, there is synchronous warmth, dampness, and oil exchange occurring between the item and the heating medium (frying oil). There is additionally the arrangement of a hull layer. To muddle the issue significantly further, the sythesis of the oil is relentlessly changing all through the procedure. It is critical to have a comprehension of what's going on amid the frying procedure to such an extent that enhancement of the procedure can be accomplished [3].

1.3 DEEP FAT FRYING OR IMMERSION FRYING

Deep fat frying is one of the most seasoned techniques for cooking that presumably began from the Mediterranean. Foods are fried fundamentally to cook and to make them increasingly alluring, agreeable, and edible. Frying is a procedure that includes synchronous warmth and mass exchange, in which frying oil is the medium of warmth move into the food, while dampness moves out and oil is assimilated into the food. Ordinarily, foods to be fried are submerged in hot oil at a temperature extend somewhere in the range of 120 and 180°C, contingent upon the crude material and the last item wanted. Numerous physicochemical changes occur amid frying, for example, starch gelatinization described by swelling of starch granules; protein denaturation; cooking; hull arrangement, which creates because of drying out of the outside of the fried item; enhance part development that portrays fried foods; shrinkage; and swelling. These physical and chemical changes lead to basic changes at both the macro and micro dimension. Mass move wonders in frying include the outflow of dampness and interruption of fat brought about by exchange of warmth vitality to the item and its surface attributes amid and in the wake of frying, despite the fact that the procedure is as yet not obviously comprehended. Amid deep-fat frying, heat is exchanged by convection from the oil to the outside of the food and afterward into the center by conduction [4].

1.4 ADVANTAGES OF DEEP FAT FRYING

(1) Maintains micro-supplements.

(2) Consistency of cooked item;

(3) Adds color, flavor and fresh surface;

(4) Speed of cooking;

(5) Energy proficiency and economy;

Reusing cooking oil is a typical practice in Haryana. Oxidation and hydrolysis happen when oil is warmed over and again because of warm decay. It had been proposed that consumption of over and again warmed oil could be a health peril. It is in this manner fascinating to quantify the mindfulness level among Sonipat inhabitants with respect to the utilization of over and over warmed cooking oil. A cross-sectional examination was led to evaluate the dimension of mindfulness dependent on information, frame of mind and work on in regards to the utilization of over and over warmed cooking oil [5].

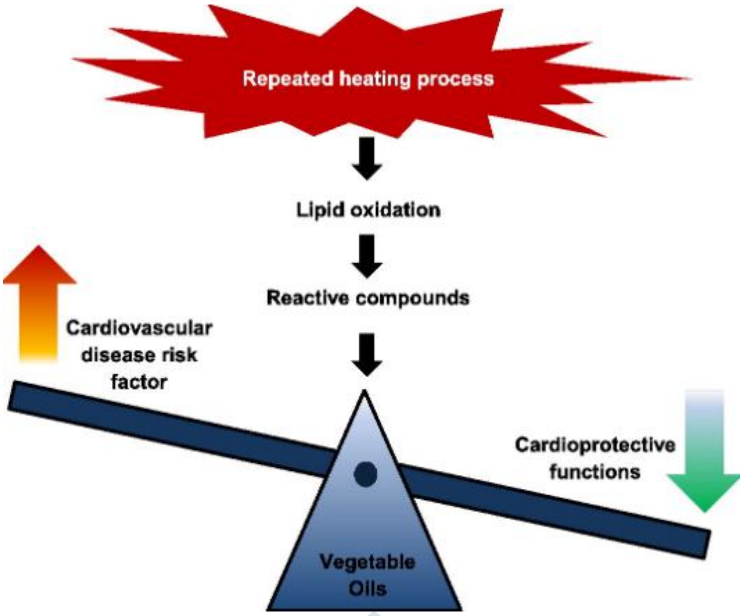

Figure 1: Effects of Repeated Heated Oil

1.5 EFFECT OF REHEATED VEGETABLE OILS ON ANTIOXIDANT ACTIVITY

Exorbitant age of reactive oxygen species (ROS), combined with a diminished accessibility of antioxidants, inclines the cells to a condition of oxidative stress. ROS are highly reactive and insecure in nature. Antioxidants present in oil hinder oxidative decay in vegetable oils amid the frying procedure and rummage free radicals and ROS. Vegetable oils are in this way imperative in the practical and tactile part of food items. The oil goes about as a medium for heat transfer and as a bearer for the fat-solvent nutrients A, D, E, and K. Frying stays as a standout amongst the most well-known culinary techniques universally, for both modern and residential food planning methodology. Organoleptic and sensorial properties of fried food items, for example, succulent taste, decent flavor, crispy surface and brownish color, are generally wanted and savored by purchasers [6]. In any case, reheating of the vegetable oil at high temperatures prompts oxidation, which produces malodorous smell and flavor. Consequently, the oxidation procedure lessens both the dietary benefit just as the wellbeing of fried food items through the development of optional items because of peroxidation of polyunsaturated fatty acids (PUFAs).

Expanding the heating temperature and term may modify the antioxidant action in the vegetable oils [7]. Heating causes changes in the physical and chemical attributes of the oils. More than once heating the oil prompts the corruption in the oil quality, with development of progressively immersed mixes, for example, hydroperoxides, monomers, dimers, trimers and high-sub-atomic weight mixes alongside less extent of unsaturated fats. Lipid peroxidation might be at first forestalled by antioxidants. Be that as it may, continued heating inevitably diminishes the antioxidant substance of the oil. As an outcome, the staying drained antioxidants in the oil won't be equipped for applying any defensive impact against free radicals and oxidative harm.

1.6 EFFECT OF REHEATED VEGETABLE OILS ON LIPID PEROXIDATION

Intemperate free radicals cause modifications in the redox condition of human body, prompting lipid peroxidation. Despite the fact that lipid peroxidation is a characteristic procedure, unabated, it is a pivotal advance in essential deteriorative instruments that incorporate cell damage, catalyst harm and nucleic corrosive mutagenesis. Lipid peroxidation is one of the key systems causing oxidative adjustment of physiologically vital lipids in cell films. Lipids, especially PUFAs, are key focuses of this change since they contain oxidizable twofold bonds. The reason for this is the hydrogen clinging to the carbon particle between two contiguous twofold bonds is the weakest bond in the fatty corrosive, which makes it powerless to oxidative assault. Temperamental free radicals promptly balance out themselves by abstracting electrons from layer lipids to start a self-engendering chain response [8]. Basic improvement of the lipids results and the rate of security cleavage is extraordinarily expanded until the atom is balanced out. Oxidative harm to lipid models can at last lead to complication and brokenness of, just as harm to films, chemicals and proteins. Along these lines, lipid peroxidation debilitates the film capacities, inactivates layer bound receptors or compounds, and bothers particles penetrability and ease, which in the long run prompts layer crack. In addition, reactive electrophilic final results of such lipid peroxidation reactions, to be specific α-and β-aldehydes are likewise adverse to cell practicality. Lipid peroxidation incites modification in quality articulation and immunologic reactions. Oxidative harm may gather after some time, subsequently adding to cell damage and pathologies, including cardiovascular diseases and provocative disorders.

1.7 EFFECT OF REHEATED VEGETABLE OILS ON ENDOTHELIAL FUNCTION

Notwithstanding being the physical boundary between vessel divider and the blood, the endothelium is a critical structure that has both endocrine and paracrine functions. Besides, the endothelial cell can react to physical and chemical flags that direct vascular tone, cellular adhesion, platelet aggregation, smooth muscle cell multiplication and irritation. Vasomotion by the endothelium is in charge of the parity of tissue oxygen supply and metabolic interest by guideline of vascular tone and width, notwithstanding being associated with the renovating of vascular structure and long haul organ perfusion [9]. Estimation of endothelial function has turned into an essential way to identify blood vessel variations from the norm and speaks to an early marker of cardiovascular diseases. At the point when presented to deep-frying temperatures, fatty acids in the vegetable cooking oil experience chemical configurationally changes from cis to Trans isomers. Also, age of oxidized items because of the reheating procedure prompts a harmful impact on the vascular function. Past research discoveries in our lab obviously demonstrated that over and over heated palm oil and soybean oil cause impedance in endothelium-subordinate vaso-relaxations and growth of contractile reactions in grown-up male Sprague-Dawley rodents. Correspondingly, it has been reported that long haul admission of thermally oxidized palm oil modifies the function of aorta segregated from the rodent. This shows an expansion in vascular reactivity, which would add to expanding vascular tone, in the long run lifts blood pressure levels. So also, admission of over and again heated oil was seen to create hurtful consequences for endothelial function in typical youthful healthy volunteers when they were given heated olive, soybean or palm oils that had experienced either 10 or 20 deep-frying rounds [10].

II. REVIEW OF LITERATURE

Bhagwan et al. (2011) [11] likewise considered the impact of hydrocolloid (HPMC, CMC, guargum, and xanthum gum) in packaging of samosas on decrease of oil uptake. Among every one of the hydrocolloids learned at various levels for readiness of samosas, it tends to be reasoned that samosas arranged with the expansion of thickener at 1.5% were factually noteworthy over every other hydrocolloid in oil uptake with ideal tactile quality attributes.

Lee et al (2012) [12] additionally considered the physical properties of wheat flour composites dry-covered with micro articulated soybean hulls and rice flour and their utilization low-fat donut readiness. The report further demonstrates that wheat flour composites arranged by hybridization with micro articulated rice flour (up to 30%) and/or soybean hulls (up to 10%) displayed one of a kind physical properties and were powerful in lessening fat uptake amid frying. Moreover, the composite development in which wheat flour was dry covered with rice flour or soybean hulls showed critical consequences for the physical properties of the deep-fat fried doughnuts arranged with composite flours.

Tabibloghmany et al (2013) [13] led an exploration examine on impact of linseed (Linum usitatissimum) hydrocolloid as palatable covering in diminishing oil retention in potato chips amid deep-fat frying. The aftereffect of this analysis demonstrated that use of linseed as covering hydrocolloid in arrangement of potato chips caused diminished oil uptake, corrosiveness, and peroxide estimation of removed oil and expanded dampness substance of potato chips without any adjustments in surface contrasted with clear treatment. The examination further uncovered that 1.5% linseed was the best in the previously mentioned cases. Thusly, linseed hydrocolloid as an eatable covering is satisfactory for diminishing oil uptake potato chips for both healthful and conservative angles

Parang et al (2015) [14] revealed the impact of a few hydrocolloids (guar, carboxymethylcellulose, gelatin) covering on decreasing oil uptake and quality elements of aged doughnuts at various focus. The report further demonstrates that the utilization of hydrocolloids diminishes the oil retention in doughnuts; besides the tried coatings or hydrocolloid coatings diminished the fat uptake yet in addition diminished the water decrease amid frying item.

Norizzah et al. (2016) [15] revealed the impacts of thickener and carrageenan on the oil uptake and agreeableness of banana (Musa taper) fritters amid rehashed deep-fat frying. The report further demonstrates that there was huge decrease in oil substance of banana fritters dunked in player containing thickener contrasted with carrageenan and control. Be that as it may, 1% thickener was successful in lessening oil retention of banana fritters without influencing the by and large tangible agreeableness.

III. OBJECTIVES OF THE STUDY

The main objective of the study is to analyze the criteria for choosing cooking oils and find out the reusing cooking oil practices and to keep the fried oil in storage and ways for maintaining the quality of the re-used cooking oil in the Local Food Outlets in Sonepat District, Haryana.

IV. METHODOLOGY

For the research work, we followed a survey method. We analyzed the 38 Local Food Outlets in the Sonepat District, Haryana to find out the desired results of the research.

V. RESULTS AND DISCUSSIONS

5.1 MOST DEMANDING /LIKED SNACK BY COSTUMERS IN SHOPS

According to the respondents, significant numbers of respondent (31.6%) said most demanding or liked snack by costumers in shop is bread pakora followed by cholabhatura (3.2%). Few costumers or students like chips & Samosa (10.5%) as well followed by Namkeen 7.9%. Items like Jalebi (5.3%), Mathri (2.6%), pavbhaji (2.6%) are also being liked by costumers in shop .

Table 1: Percentage of Most Liked Snacks

Most demanding /liked snack by costumers in shops? Specify the name of snack	Count	%
BREAD PAKODA	12	31.6%
CHIPS(LAYS)	4	10.5%
CHIPS, SAMOSE	3	7.9%
CHOLA BHATURA	5	13.2%
JALEBI, SAMOSA	2	5.3%
MATTHI, SAMOSA	1	2.6%
Namkeen	3	7.9%
NO DEMAND	1	2.6%
PavBhaji	1	2.6%
SAMOSA, BREAD PAKODA	4	10.5%
SAMOSA, FRENCH FRIES	2	5.3%
Grand Total	**38**	**100%**

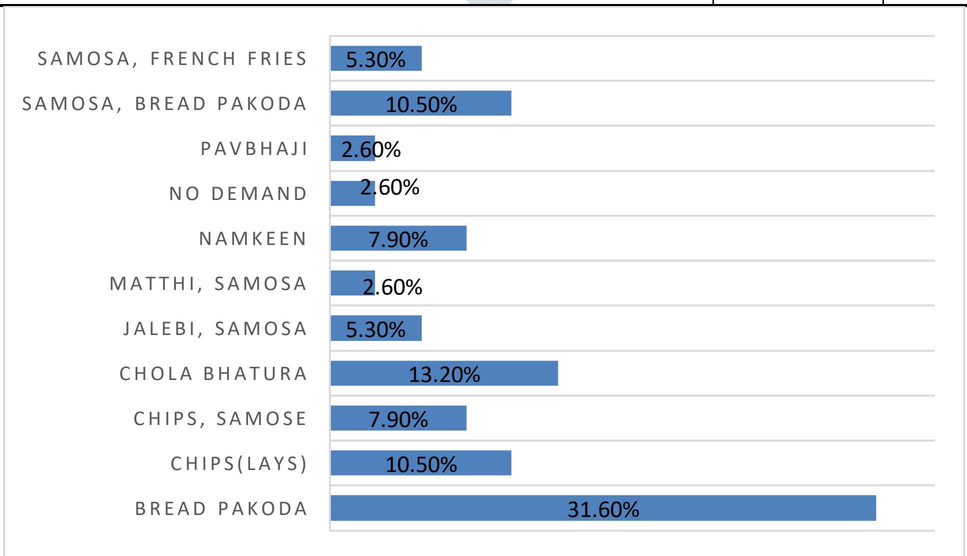

Figure 2: Graph on Percentage of Most Liked Snacks

5.2 USE OF COOKING OIL REPEATEDLY FOR FRYING

According to the respondents, significant numbers of respondent (50.0%) said yes for using cooking oil repeatedly for frying followed by 31.6% of the respondents who said sometime they use cooking oil repeatedly for frying. Only 18.4% of the respondents said they don't use cooking oil repeatedly for frying.

Table 2: Percentage of Repeated Use of Cooking Oil for Frying

Use of Cooking Oil Repeatedly for Frying	Count	%
NO	7	18.4%
Sometimes	12	31.6%
Yes	19	50.0%
Grand Total	**38**	**100%**

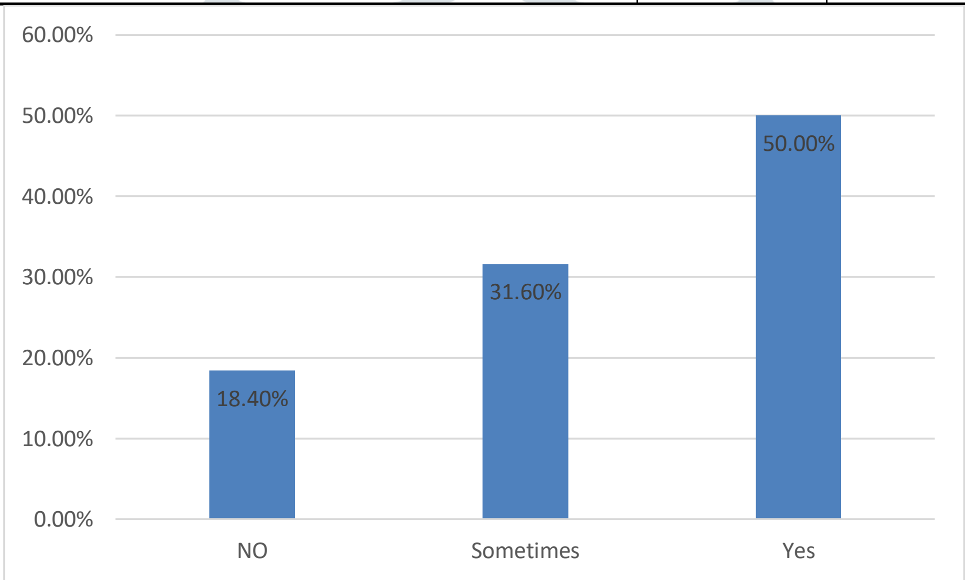

Figure 3: Graph on Use of Cooking Oil Repeatedly for Frying % cont.

5.3 TIMES OF USING THE SAME COOKING OIL REPEATEDLY FOR FRYING

According to the respondents, significant numbers of respondent (52.6%) said they use the same cooking oil repeatedly for frying next day followed by the 26.3% respondents who use the same cooking oil repeatedly for frying in a single use per day. 7.9% of the respondents use the same cooking oil repeatedly for frying for more than three days or until the until the color of the oil change. 5.3% of the respondents usage the same cooking oil repeatedly for frying for next three days only.

Table 3: No. of Times for using same Repeated Cooking Oil

Times of using the same cooking oil repeatedly for frying	Count	%
More than three days	3	7.9%
Next Day	20	52.6%
Single use per day	10	26.3%
Use for three days	2	5.3%
Use until the colour becomes dark	3	7.9%
Grand Total	**38**	**100%**

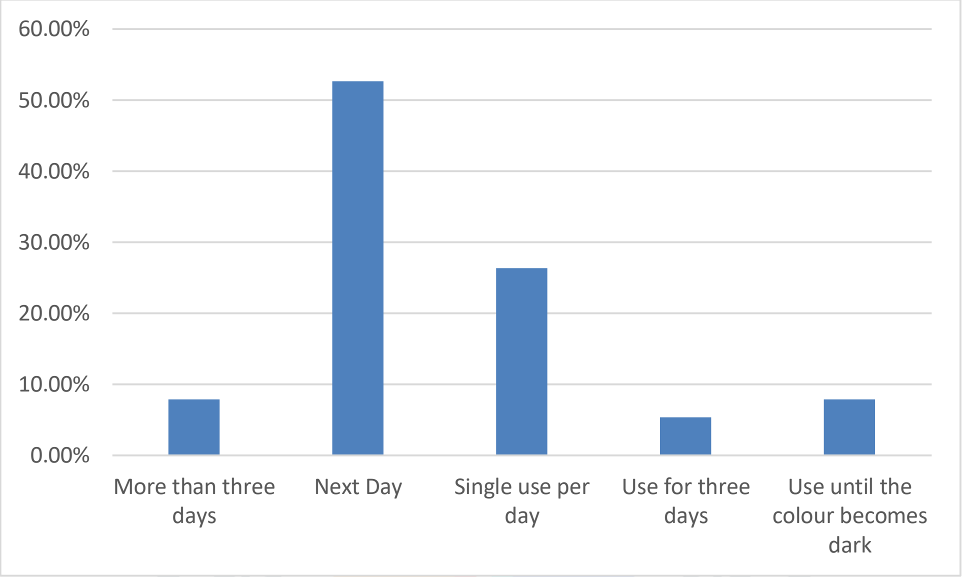

Figure 4: Graph on No. of Times for using same Repeated Cooking Oil

5.4 CRITERIA FOR CHOOSING COOKING OIL

According to the respondents, significant numbers of respondent (34.2%) said there criteria for choosing cooking oil is easily available followed by 31.6% of the respondents said cheap price and 26.3% of the respondents said good healthily eating attributes. Only 7.9% of the respondents said that the flavor of the oil is there criteria for choosing cooking oil.

Table 4: Reason for the Preference of the Cooking Oil

Criteria for Choosing Cooking Oil	Count	%
Cheap Price	12	31.6%
Easily Valuable Available	13	34.2%
Flavor of the Oil	3	7.9%
Good Healthy Eating Attributes	10	26.3%
Grand Total	38	100%

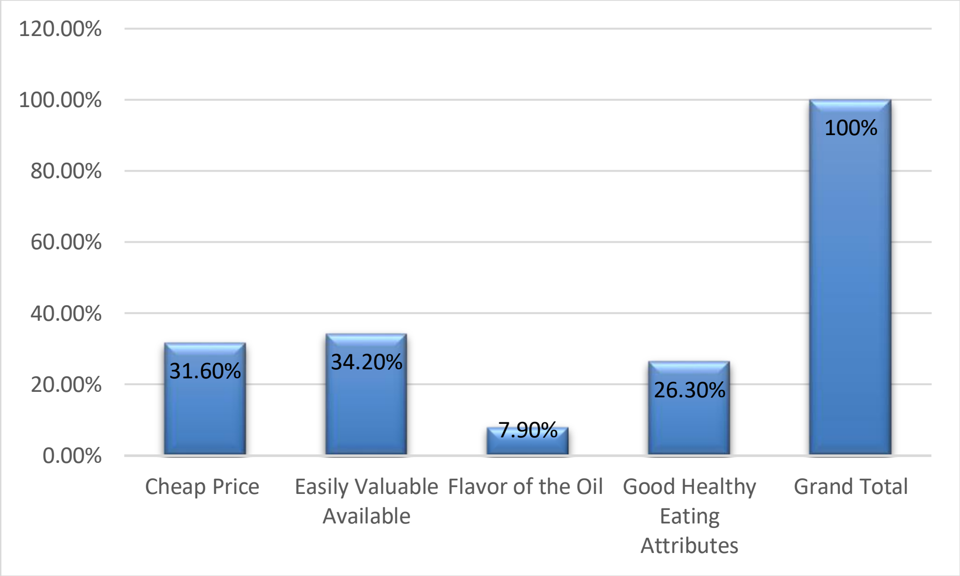

Figure 5: Graph on Reason for the Preference of the Cooking Oil

5.5 REPEATED FRIED OIL IS KEPT STORED

According to the respondents, significant numbers of respondent (63.2%) said that they keep repeated fried Oil stored only for 1 day. 21.1% of the respondents said they keep repeated fried Oil stored only for 3 days. Whereas 7.9% of the respondents said they keep repeated fried Oil stored only for 2 days.

Table 5: Percentage of the Time Duration of Stored Cooking Oil

Repeated fried Oil is kept stored	Count	%
For 1 Day	24	63.2%
For 2 Days	3	7.9%
For 3 Days	8	21.1%
More Upon The Customers	3	7.9%
Grand Total	**38**	**100%**

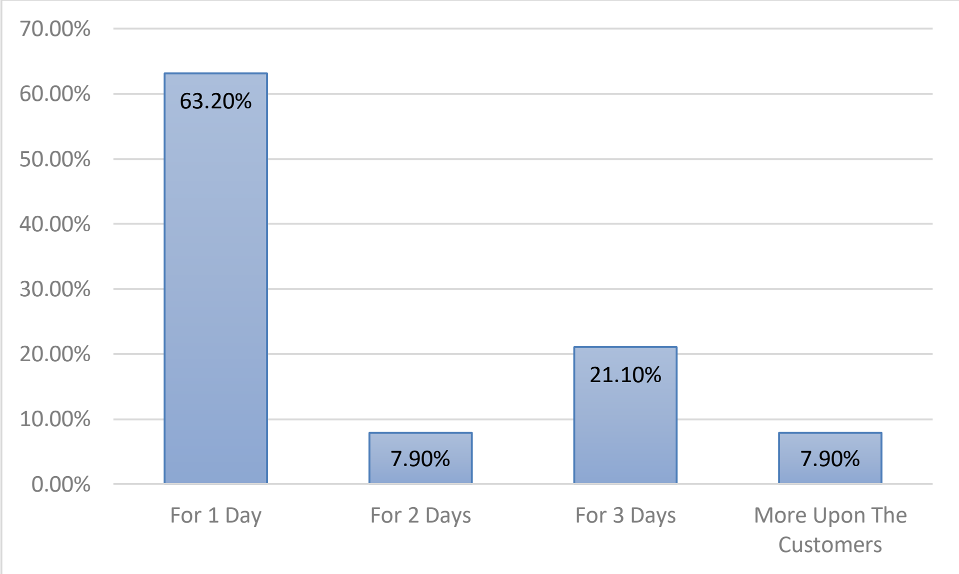

Figure 6: Graph on Percentage of the Time Duration of Stored Cooking Oil

5.6 REUSING OIL PRACTICES

According to the respondents, significant numbers of respondent (68.4%) said that they reuse oil practices for "Top up existing used oil with fresh unused oil", 71.1% of the respondents said that they reuse oil practices for "Used next day in other product frying", 21.1% of the respondents said that they reuse oil practices for "After frying dispose of used oil and refill with completely fresh oil after every batch", 47.4% of the respondents said that they reuse oil practices for "Filter used oil and top up with fresh unused oil".

Table 6: Percentage of Reusing oil practices

Reusing oil practices	Yes	%	No	%
Top up existing used oil with fresh unused oil	26	68.4%	12	31.6%
Used next day in other product frying	27	71.1%	11	28.9%
After frying dispose of used oil and refill with completely fresh oil after every batch	8	21.1%	30	78.9%
Filter used oil and top up with fresh unused oil	18	47.4%	20	52.6%

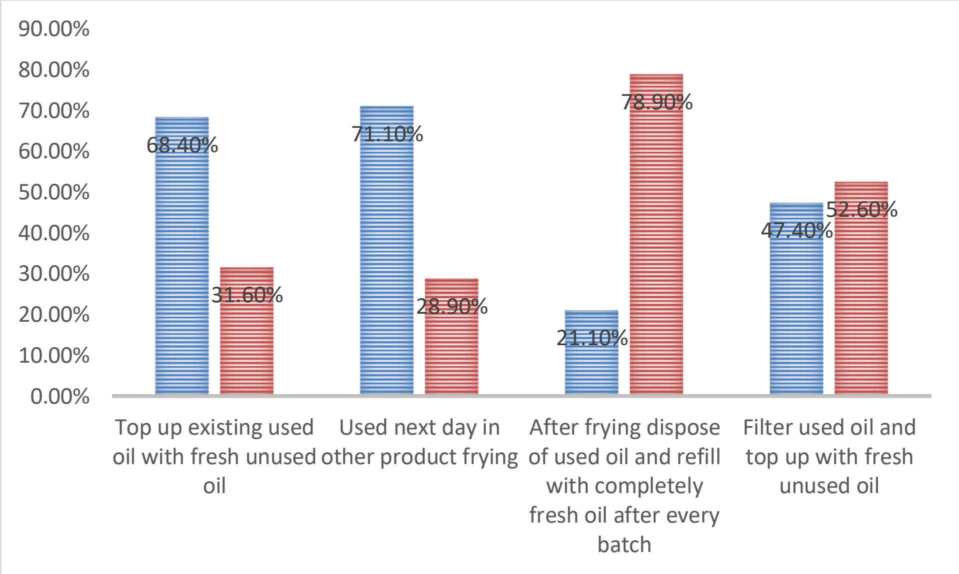

Figure 7: Graph on Percentage of Reusing oil practices

5.7 STOREAGE OF RE-USED OIL

According to the respondents, significant numbers of respondent (13.2%) said that they store reuse oil for "In the same container as fresh unused oil", 52.6% of the respondents said that they store reuse oil for "In a container specifically for used oil" and 10.5% of the respondents said that they store reuse oil for "Used oil is not stored and is disposed of immediately".

Table 7: Percentage of the Preferences to Reused Oil Storage

How to store re-used oil	Yes	%	No	%
In the same container as fresh unused oil	5	13.2%	33	86.8%
In a container specifically for used oil	20	52.6%	18	47.4%
Used oil is not stored and is disposed of immediately	4	10.5%	34	89.5%

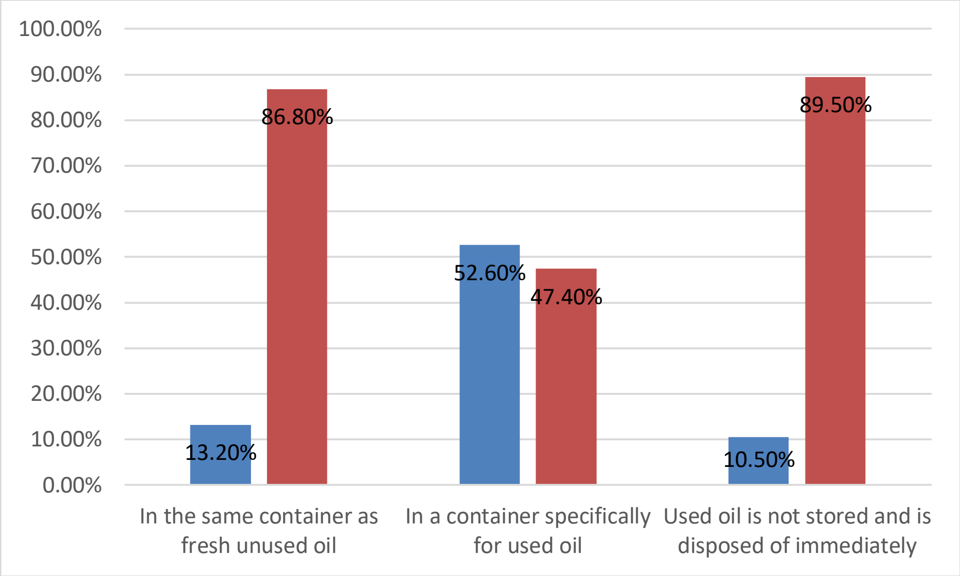

Figure 8: Graph on Percentage of the Preferences to Reused Oil Storage

5.8 METHODS ATTEMPTED IN ORDER TO MAINTAIN THE QUALITY OF COOKING OIL

According to the respondents, significant numbers of respondent (57.9%) said that they in order to maintain the quality of cooking oil the method they attempt is "Using fresh oil for frying every time", 52.6% of the respondents said that they in order to maintain the quality of cooking oil the method they attempt for "Maintaining a small flame while frying", 31.6% of the respondents said that they in order to maintain the quality of cooking oil the method they attempt for "Using stainless steel frying utensils", 55.3% of the respondents said that they in order to maintain the quality of cooking oil the method they attempt for "Storing oil in stainless steel or glass container after use" and 52.6.9% of the respondents said that they in order to maintain the quality of cooking oil the method they attempt for "Filtering the oil to catch any food particles or foreign matter".

Table 8: Percentage of Adopted Methods for Quality Maintenance of Cooking Oils

Methods attempted in order to maintain the quality of cooking oil	Yes	%	No	%
Using fresh oil for frying every time	22	57.9%	16	42.1%
Maintaining a small flame while frying	20	52.6%	18	47.4%
Using stainless steel frying utensils	12	31.6%	26	68.4%
Storing oil in stainless steel or glass container after use	21	55.3%	17	44.7%
Filtering the oil to catch any food particles or foreign matter	25	65.8%	13	34.2%

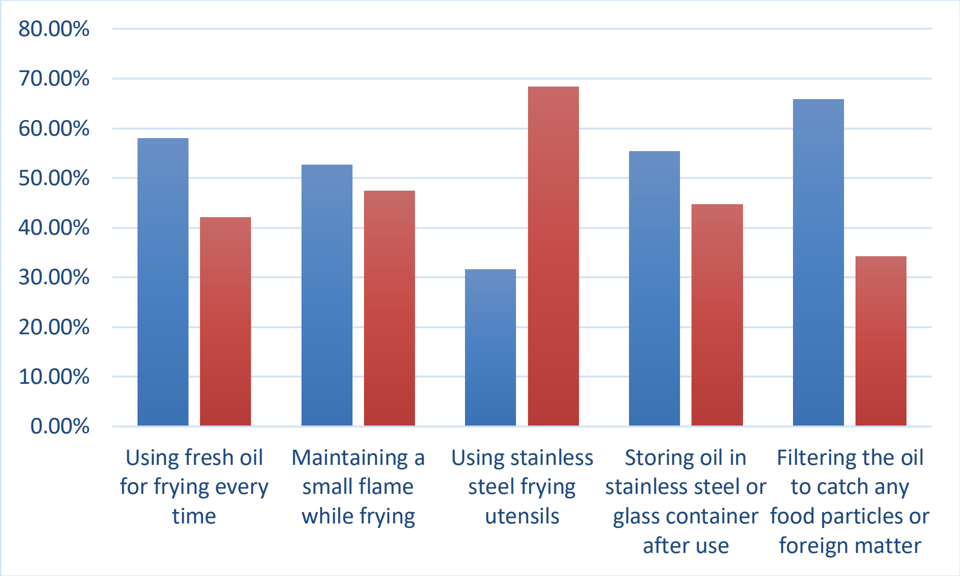

Figure 9: Graph on Percentage of Adopted Methods for Quality Maintenance of Cooking Oils

VI. CONCLUSION

The survey was done on the Local Food Outlets of Pune City. To be concluded, mostly the respondents liked Pakora as their favorite snack. Half of the Respondents agreed to use cooking oil repeatedly for frying. Quarter to half Respondents agreed to choose cooking oil on the basis of the price. 63.2% respondents agreed to use store the oil for one day whereas others agreed to store it for longer period. They described various practices for the reusing of cooking oil, and the practices to store it. Various Methods adopted used by the Respondents are also stated by them. Long haul admission of diet including reheated vegetable oil prompts endothelial dysfunction. Over and over heated dietary vegetable oil advances oxidative stress, bringing about NO inactivation and diminished bioavailability. In addition, antioxidant impact of crisp vegetable oil against free radicals might be diminished slowly as the oil is more than once heated. Generation of free radicals and decrease of antioxidant and nutrient levels in the long run lead to oxidative stress. Oxidative stress and endothelial dysfunction assume critical jobs in the pathogenesis of cardiovascular diseases, which might be constrained by diet alteration. Ingestion of over and again heated vegetable oil ought to be confined because of the unfavorable outcomes on health.

REFERENCES

[1]. Fellow P, Hilmi M. Selling Street and snack foods.Diversification Booklet No. 18. Rural Infrastructure and Agro- Industries Division. Food and Agriculture Organization of the United Nations. Rome; 2011. http://www.fao.org/docrep/015/i2474e/i2474e00.pdf

[2]. Corsini MS, Jorge N. Oxidative stability of vegetable oils used in frying of frozen cassava.Journal of Food Science and Technology (Campinas). 2016. 26 (1): 27- 32. Available from: http://dx.doi.org/10.1590/S0101-20612006000100005.

[3]. FreirePCM, LoboLCB, FreitasGS, FerreiraTAPC. Quality of deep frying oils and fats used in street- fairs in Goiania, Brazil. Journal of Food Science and Technology (Campinas). 2013; 33 (3): 569- 576.

[4]. ISSN 2249-8516Osawa CC, Gonclaves IAG, Mendes FM. Evaluation of oils and fats frying commercial establishments of the city Campinas/ SP: Good practices are frying being served?; Alimentos e Nutricao, Araraquara. 2010; 21 (1):47- 55.

[5]. Leong XF, Najib MN, Das S, Mustafa MR, Jaarin K. Intake of repeatedly heated palm oil causes elevation in blood pressure with impaired vasorelaxation in rats. Tohoku J Exp Med. 2009; 219: 71-78.

[6]. Lobo V, Patil A, Phatak A, Chandra N. Free radicals, antioxidants and functional foods: Impact on human health. Pharmacogn Rev. 2010; 4: 118- 126.

[7]. Choe E, Min DB. Chemistry of deep-fat frying oils. J Food Sci. 2007; 72: R77-86.

[8]. Leong XF, Salimon J, Mustafa MR, Jaarin K. Effect of repeatedly heated palm olein on blood pressure-regulating enzymes activity and lipid peroxidation in rats. Malays J Med Sci. 2012; 19: 20-29.

[9]. Esper RJ, Nordaby RA, Vilariño JO, Paragano A, Cacharrón JL, Machado RA. Endothelial dysfunction: a comprehensive appraisal. Cardiovasc Diabetol. 2006; 5: 4.

[10]. Rueda-Clausen CF, Silva FA, Lindarte MA, Villa-Roel C, Gomez E, Gutierrez R, et al. Olive, soybean and palm oils intake have a similar acute detrimental effect over the endothelial function in healthy young subjects. Nutr Metab Cardiovasc Dis. 2007; 17: 50-57.

[11]. Bhagwan, K. S., Jyosna, B. B., Vitthalrao, D. P., & Suryabhan, L.S (2011). Effect of hydrocolloids incorporation in causing samosa on reduction of oil uptake. Journal of Food Science and Technology, 48(6), 769–772.

[12]. Lee, H. G., & Lee, S. (2011). Effect of hydrocolloid coatings on the heat transfer and oil uptake during frying of potato strips. Journal of Food Engineering, 102, 317–320. doi:10.1016/j.jfoodeng.2010.09.005

[13]. Tabibloghmany, F., Hojjatoleslamy, M., Farhadian, F., & Ehsandoost, E. (2013). Effect of linseed (Linum Usitatissimum L.) hydrocolloid as edible coating on decreasing oil absorption in potato chips during deep-fat frying. International Journal of Agriculture and Crop Sciences, 6(2), 63–69.

[14]. Parang, Y., Babak, G. T., & Maryam, G. (2015). Effect of some hydrocolloids on reducing oil uptake and quality factors of fermented donots. Journal of Biodiversity and Environmental Sciences, 6(2), 233–241.

[15]. Norizzah, A. R., Junaida, A. R., & Maryam Afifah, A. L. (2016). Effect of repeated frying and hydrocolloids on the oil absorption and acceptability of banana (Musa acuminate) fritters. International Food Research Journal, 23(2), 694–699.