Quality and Safety of the Frying oils used in small- or medium-sized Food Enterprises

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ABSTRACT

The present study investigates the cooking practices and oil used in small and medium sized street food vendors/kiosks in the west zone of Delhi, India. Information on vendor cooking practices and oil quality was analyzed using different physio-chemical parameters. The study revealed that the oil samples collected from the participating vendors displayed varied values of %FFA (free fatty acid) content (0.16±0.00 to 0.60±0.01), acid value (0.225±0.00 to 1.030±0.01), peroxide values (9.12±0.02 to 32.45±0.49) and iodine value (61.57±0.19 to 79.08±0.07) indicating poor quality of the oils used for the preparation of snacks. Study revealed that the majority of the vendors re-use oils and practice adulteration with hydrogenated fats which can significantly deteriorate the quality of oil and henceforth the health of the consumers.

Keywords: Fats and oils, Physico-chemical properties, Quality of oils, Street foods, Indian snacks, Oil usage practices.

INTRODUCTION

Snacks are the foods consumed between meals that have become a part of diets in all countries, whether developed or developing, due to lifestyle changes leading to corresponding altered dietary habits[1]. Majority of these popular snacks are deep-fried and are easily available from the street side vendors. Safety and quality of these snacks depends upon the type of fat or oil used to fry them[2]. There is an increasing trend in the consumption of these deep-fried snacks which on the other side leads to increased oil and calorie intake that can significantly cause deterioration of health[3]. Cardio-vascular diseases (CVDs) and other conditions such as atherosclerosis occur due to the high blood cholesterol if the dietary intake of fat is high. Currently, CVDs are among India's main contributors to the burden of chronic diseases. Improving the dietary intakes is an important variable factor to reduce the risk of onset of CVDs[4]. Animal products (e.g., milk products and ruminant meats) are the major reasons of the trans- fatty acids (TFA) present in our diets, but the remainder are provided by products which contain partially hydrogenated vegetable oils (PHVOs) that are industrially manufactured

in India, e.g., margarines, shortenings, vanaspati. These PHVOs are widely used for deep frying or shortening purposes by the street food vendors in India. Various metabolic and epidemiological studies have indicated that TFA intake can increase the risk of cardio-vascular diseases as it enhances the lipid levels in blood thereby affecting other physiological pathways[3,5,6]. Apart from the hydrogenation of vegetable oils, prolonged heating and repeated usage of used oil have shown to be associated with an increased TFA formation in oils. After thermal treatment, different geometric and positional isomers are produced from fatty acids[7,8,9], but only temperatures above 180-190^{o}C can result in the development of TFA in fats and oils[10]. Deep frying involves high temperatures(between 160°C and 180°C), leading to rise in TFA level in the frying oils[11,12] and fried products[12,13]. Further, the process of frying occurs in the presence of moisture and air resulting in chemical and physical degradation of these frying oils and fats that affects frying efficacy and the storage stability of the fried products[14]. Furthermore, the street food vendors in India commonly practice repeated heating and reuse of oils which warrants further study as there is an increasing trend of consumption of street foods and also highlights the need of well-defined policies along with strict guidelines for the vendors.

Keeping in view the above scenario, this study was carried out to understand the perceptions and practices pertaining to use of cooking oils by the street food vendors/kiosks (small and medium-sized) in West Delhi, India, and also evaluate the physico-chemical quality of the oil samples collected from these vendors.

MATERIAL AND METHOD

Selection of respondents for the study

A cross sectional study was carried out in the market area of West Delhi, India as per the standard procedure[15]. The study sites were selected randomly, based on the listing by Municipal Corporation of Delhi (MCD) of the West Delhi. Small to medium eateries and roadside kiosks selling ready to eat (RTE) fried food snacks were mapped within the selected areas from which 30 respondents were willing to participate in the study by providing details of cooking methods and oil samples. This number of respondents presents a good sample size to see the impact on the entire population of the area.

Survey analysis

The participating respondents were provided with a questionnaire prior to the collection of the oil sample to gather information pertaining to the type of fried snacks sold, their popularity, the type of fat/oil used for deep frying food and shortening, their selection parameters, the nature of cookware and utensil used for frying, the reuse practices of fats/oils and determination of the right temperatures for frying.

Oil sample collection

Oil samples used by the participating respondents for frying of snacks were collected in clean capped glass containers. Samples collected were analyzed for their physico-chemical properties.

Physico-chemical analysis of oil samples

Oil samples collected were tested for their Peroxide Value (PV), Iodine Value (IV), %Free Fatty Acid Content (FFA) and Acid Value (AV) following the standard AOAC methods[16]. PV was estimated by standard iodometric titration method whereas the FFA and AV were determined by titration against dilute NaOH. Iodine values of oil samples were conducted following Wijs method. The volume and weight of oils collected were measured using a pycnometer and weighing balance from which the specific gravity was calculated. All analyses were conducted in triplicates for each sample.

Statistical Analysis

All the tests in this study have been performed in triplicates. The statistical study involves a one-way variance analysis (ANOVA) and a test by Duncan. The commercial statistical packages (SPSS, Inc, Chicago, IL, USA) have been used for analyzing the results and $p \leq 0.05$ were considered statistically significant.

RESULTS AND DISCUSSION

The objective of this study was to analyze the perceptions and practices of street food vendors in West Delhi, India pertaining to the cooking oils used for deep frying the snacks sold by them and to evaluate the quality of the oil samples used by the participating respondents.

Survey analysis

Participating respondents majorly comprise of shop/kiosk/vendor owners (approximately 75%) whereas the remaining 25% included employees/ workers in the shop or at the kiosk. The mean number of surveyed employees in the shops/kiosks (n=15) were 5. Depending on the hour of the day and items sold at the shop/kiosk, number of buyers were also in varied strength, although roughly 70% vendors had nearly 50-100 buyers each day. The oils/fats were mostly bought from the local retailers which were used for frying the snacks by these establishments. A little more than a third of the sellers sold 1 to 2 fried snacks which were freshly prepared through their outlet. The total number of snacks these vendors sold ranged from 1-10. Samosa was the most often sold snack, as stated by the respondents. (69.4%) followed by bread pakora (67.7%) and kachori (35.5%). Other popular snacks included gol gappe, dahi bhalla, papdi chat, aloo chat, paneer pakora, jalebi, momos, chowmein, etc. Above 80% of the establishments under the study declared the usage of vanaspati as shortening in three snacks, namely, kachori, papdi and samosa.

Variety of fats/oil used for snacks frying

The details of the type of oils/ fats used by the respondents are displayed in Table 1. The participating respondents declared usage of one or more varieties of oils/fats for frying or shortening of the snacks prepared. Refined soyabean oil was observed to be the most popular variety used by almost 61% of the respondents followed by mustard oil (22%) and hydrogenated oil (11%).

Table 1: Types of fats/oil used for snacks frying (as declared by vendor)

Type of oils/fat used	Number	%
Refined soya bean oil	11	61.1
Mustard oil	4	22.2
Vanaspati/Hydrogenated oil	2	11.1
Sunflower oil	1	5.5

Frying practices

The common frying practices followed by the respondents are demonstrated in Table 2. The vendors either used utensils made of cast iron, steel, aluminum or more than one type for frying.

Table 2: Practices pertaining to frying amongst vendors

Practices	Details	Number (n)	Percentages (%)
Type of cookware	Steel	9	60
(utensil used)used in	Aluminium	-	-
frying	Cast iron	5	33
Average oil consumption	Upto 5 liters	4	27
	5-10 liters	10	67
	>10 liters	1	7
Refilling or adding the fresh oil	Yes	12	80
amount after first usage	No	3	20
Left over oil	Use it elsewhere/ household cooking	2-3	15-20
	Throw it/ sell it	4-5	30

9 respondents used utensils made of steel (60%) while 6 respondents declared using utensils of cast iron (25%). Only 1 of 15 respondents consumed more than 10 L of oil for preparing the snacks whereas majority used up to 10 L for the same purpose depending upon the size of consumers per day. More than half of the 15 respondents declared (n=12; 80%) the habit of adding or mixing fresh oil in the leftover oil as soon as the frying oil content reduced to half the quantity initially used. Most of the respondents (almost 50%) declared to continue using of the leftover oils/ fats in the following day for preparing the snacks whereas 15-20% reported to use the leftover oils/ fats for other purposes like household cooking. The remaining 30% were reported to either discard the leftover oils/ fats or otherwise sold the same at very low prices to economically weaker section of the population.

Physico-chemical properties

Table 3 the mean values of the physico-chemical properties of oil samples collected from the 15 participating vendors of west Delhi area.

Table 3: Physico Chemical Properties of Selected Oil Samples

Vendor code	Type of oil used	%FFA	Acid value	Iodine value	Peroxide value (mEq/kg)	Specific Gravity
A	Refined Soyabean oil	0.39±0.00	0.552±0.00	68.52±0.52	13.20±0.30	0.92±0.00
B	Refined Soyabean oil	0.40±0.00	0.567±0.01	61.57±0.19	14.95±0.10	0.92±0.00
C	Refined Soyabean oil	0.29±0.01	0.416±0.02	76.74±0.25	10.48±0.06	0.93±0.00
D	Refined Soyabean oil	0.28±0.00	0.398±0.00	79.08±0.07	9.49±0.06	0.87±0.00
E	Refined Soyabean oil	0.34±0.01	0.482±0.01	62.45±0.12	11.91±0.11	0.91±0.01
F	Hydrogenated oil	0.40±0.01	0.561±0.02	69.72±0.08	12.05±0.06	0.91±0.01
G	Mustard oil Mixed with hydrogenated oil	0.50±0.01	0.900±0.01	73.85±0.25	17.39±0.10	0.93±0.00
H	Mustard oil	0.33±0.00	0.599±0.00	75.06±0.05	13.34±0.06	0.90±0.01
I	Refined Soyabean oil	0.60±0.01	0.863±0.01	78.10±0.01	32.45±0.49	0.92±0.00
J	Refined Soyabean oil	0.55±0.01	0.789±0.01	69.56±0.04	27.44±0.08	0.91±0.01
K	Mustard oil	0.57±0.00	1.030±0.01	71.89±0.12	29.37±0.55	0.92±0.00
L	Sunflower oil	0.16±0.00	0.225±0.00	70.21±0.01	9.12±0.02	0.92±0.00
M	Mustard oil	0.23±0.01	0.411±0.01	71.01±0.03	15.07±0.07	0.91±0.01
N	Refined Soyabean oil	0.37±0.00	0.529±0.00	72.76±0.21	13.52±0.16	0.92±0.00
O	Refined Soyabean oil	0.42±0.00	0.595±0.01	72.35±0.21	17.87±0.07	0.92±0.00

Values are Mean±SD

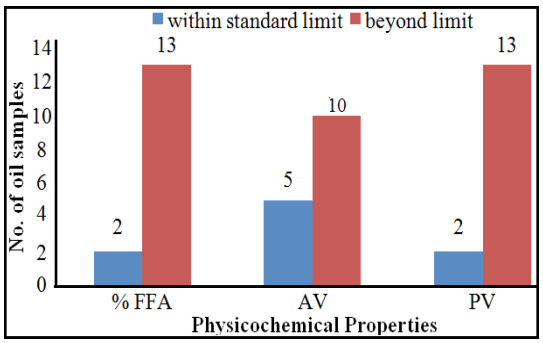

Fig. 1. Number of oil samples exceeding the FSSAI standard limits for quality

The %FFA values of oil samples ranged from 0.16±0.00 to 0.60±0.01 and acid values of 0.225±0.00 to 1.030±0.01. The peroxide values ranged from 9.12±0.02 to 32.45±0.49 whereas the iodine value rand specific gravity ranged from 61.57±0.19 to 79.08±0.07 and 0.87±0.00 to 0.93±0.00, respectively. From Table 3 and Fig. 1, it is concluded that most of the oil samples used by the respondents for preparing the snacks have exceeded the standard limits laid down by the FSSAI. Fig. 1 demonstrates that only the oil used for in-house frying and one more procured after single frying showed desirable values, i.e., 0.16±0.00 and 0.23±0.01. High values of most of collected %FFA and AV observed in the oil samples collected may be attributed to the behavioral habits of replenishing or reusing of oils subjecting to hydrolytic rancidity[17]. Table 4 represents the FSSAI specifications for the different types of oils used by the vendors.

The heating of oils/fats having high levels of unsaturated fatty acids can result in the formation of certain products detrimental to health[18]. In addition, the prolonged practice of frying the foods for a long period of time releases water into the oil which leads to hydrolytic degradation results in decreased stability of oil to autooxidation. Further, continuous reheating of oils also results in the formation of TFAs and cyclic polar compounds which adversely impact not only the quality of fried products but also the biological parameters such as lipid profiles, high cholesterol levels leading to an increased risk of CVDs in the consumers[19].

Table 4: Standard values of different fats/oils as per FSSAI regulations[24]

Standards Oil Type	%FFA	AV	PV	IV	SG
Soya bean oil	0.25 max	0.5 max	Less than 10mEq/kg	120-140	0.91-0.92
Mustard oil Vanaspati/	0.25 max	0.5 max	Less than 10mEq/kg	96-112	0.91-0.92
Hydrogenated oil	0.25 max	0.5 max	Less than 10mEq/kg	Below 70 number	Less than 0.905 at
Sunflower oil	0.5 max	0.5 max	Less than 10mEq/kg	78-90	0.91-0.92 at 25°C

In a similar note, the PV of the majority of the oil samples collected were observed to exceed the permissible limit (less than 10 mEq/kg). However, it is difficult to provide certain guidelines relating PV to rancidity as these values are not static[20]. Man and Hussain[21] have stated that generally PV is not a very reliable parameter to identify the deterioration in cooking oils. Similarly, Marinova *et al.,*[22] have also showed that the changes that are occurring in oil samples during storage can lead to increase in PV. Nonetheless, oils with very high value of more than 30mEq/kg does indicate rancid fat or oil but moderate values may be a result of breakdown of peroxides after attaining a high concentration[23]. However, in the current study, except for two samples, most values were below 20mEq/kg and even, the sunflower oil used by vendor L showed a value of less than standard limits (PV=9.12±0.02 mEq/kg) indicating good quality oil.

Further, it was observed that the iodine values of oil samples were not falling within the range of specific oils as specified by FSSAI pointing out the possibility of adulteration, e.g., mixing with fats with high saturated content like vanaspati as commonly practiced by Indian vendors. All these findings indicate that the oils used were either adulterated or have been extensive used and have become unfit for human consumption[19].

CONCLUSION

The present study was done to assess the practices pertaining to oil usage and the quality of oils and fats used in street foods for deep frying in West Delhi. The outcomes are of interest to the food safety authorities, as there is a need to create awareness and educate about compliance strategies to promote healthier practices in both small and medium-sized vendors. Further, our findings also highlight the need for research about the suitability of suitable substitutes to reduce trans fats in the food which may otherwise compromise long-term health of the consumers.

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Conflicts of Interest

The authors declare no conflict of interest.

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