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CHANGES IN SMOKING TEMPERATURE OF OIL SUBJECTED TO REPEATED HEATING

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ABSTRACT

Deep fat frying is one of the oldest methods of food preparation. The turnover rate of oil, frying time and temperature affect the deterioration of oil during deep fat frying. The present study evaluated the changes in smoking temperature of four commonly used oils viz: Groundnut oil (GNO), Sunflower oil (SFO), Soybean oil (SBO) and Rice Bran oil (RBO), heated freshly and repeatedly reheated to fry potato chips. The initial smoking temperature of SFO was highest (242° C) and GNO the lowest (210°C). A progressive fall in smoke point was observed in all oils with increase in frying trials up to 11th trial of frying. Replenishing with fresh oil at the 12th trial reflected a slight increase in smoke point of all oils. A highly significant difference (p=0.00) between the changes in smoking temperatures of oils subjected to repeated heating in frying potato chips was observed. Paired sample analysis showed insignificant changes in smoke point of oils until third frying (p=.061) indicating the suitability of all oils until temperatures attained at third frying (198°C, 238°,238°,212° of GNO, SFO, SBO, RBO respectively). The smoke point is therefore an important characteristic for restaurants and housewives in deciding when to change the frying oil.

Keywords: Smoke point, Reheating, Replenishing, Deterioration.

INTRODUCTION

Frying is an old and traditional means to prepare food quickly and enjoy the preparation for culinary delight. Deep-fat frying seals the food by immersing it in the hot oil so that all flavors and the juices are retained by the crisp crust .During the frying process, the physical, chemical and sensory characteristics of foods are modified, despite, texture, color and oil content being the main quality parameters of fried foods (Amany et al .2009).

The use of good quality frying medium becomes obvious when one considers that some of

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the fat is absorbed by every piece of food in it. The choice of frying fat depends on many factors such as availability, price, frying performance, flavor and stability of product during storage.

Deep frying is the basis of a very large and expanding worldwide industry. Indian snack food industries use potatoes for producing products like potato chips, potato sticks, puffed potatoes, potato flakes and French fried potatoes.

Frying temperatures of 170°-190° degrees centigrade affect the stability and quality of vegetable oil in deep frying operations. In domestic use a cooking oil could be used up to 6-8 successive frying either in deep frying without replenishment or in pan frying with replenishment (Nicolas et al 2002).

The overuse of deep frying oil causes adverse effects on flavor, stability, color and texture of fried product and may be harmful to human health (Sukumar et al 2012).

Frying and reuse of oil for frying is a common household and commercial practice. In all the joints where the oil is allowed to cool during the night before reheating and reusing on the next day intermittent heating and cooling of oils is much more destructive, than continuous heating. Overused or highly abused oils contain oxidized and polymerized materials, which are harmful to human health (Anuprita et al. 2002).

Repeated using of frying oils can affect the food quality and promote the formation of compounds that can affect human health and cause the fried foods to have rather limited shelf life due to the development of rancidity in the frying oil taken up by the products (Fan et al. 2013).

The **smoke point** of an oil or fat is the temperature at which, under specific and defined conditions, oil begins to produce a continuous bluish smoke that becomes clearly visible (https://en.wikipedia.org/wiki/Smoke_point).

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A desirable characteristic of fats used for frying is a high smoking point. Fats which have been heated previously smoke at a low temperature because hydrolysis of some fat molecules has already occurred.

Comparative evaluation of oils commonly used for frying, reheating of oils and the quality changes resulting during the frying process has not been given much attention both at the household and commercial level. The objective of the study was to evaluate the changes in smoking temperature of oil subjected to repeated heating on frying of potato chips.

METHODOLOGY

The present research work was carried out to analyze the changes in smoking point of fresh and reheated oils in frying potato chips. Fresh potato chips from Manglaorean potatoes were used and several trials were conducted. The procedure was standardized using four different oils viz: Groundnut Oil (GNO), Sunflower Oil (SFO), Soybean Oil (SBO) and Rice Bran Oil (RBO). To determine smoking point fresh oil was taken in an iron kadhai and heated on a high flame, till it started smoking. The temperature at this point was noted down. The process was repeated with reheated oil before each cycle.

Fresh potatoes were peeled and submerged in water approximately for 5 minutes. Two liter of oil was taken in Kadai for frying potato chips. Potatoes were sliced using a slicer. The sliced potatoes were fried immediately. Chips were fried at 180°c for 7.5 min. Deep fat frying time and temperature were decided based on preliminary experiments carried out in the laboratory. After each frying cycle the oil was allowed to cool approximately for 1 hour and then the oil was heated again and a new frying cycle was started. Total thirteen frying cycles were carried out at a rate of 3 frying cycle / day. On 4^{th} day in 12^{th} frying 1 liter of fresh oil was added in already heated oil and same frying procedure was carried out for two more frying cycles. 50ml of fried oil sample were withdrawn

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after 1, 3, 5, 7, 9, 11, 12, & 13th frying for analysis of oils.

Data on smoking point of fresh and repeatedly heated different oils was compiled and tabulated. Means and standard deviations were derived for the parameters under study. The data was subjected to statistical analysis using SPSS version 20 package.

ANNOVA was applied to find out the differences in smoking temperature of oils on reheating and heating replenishing with fresh oil. Independent 't' test was applied to compare the differences between oils with respect to changes. Paired Comparison test was applied to study the changes between the frying trials.

RESULTS AND DISCUSSION

Foods that are fried at higher temperatures have a better texture and absorb much less fat than foods fried at lower temperatures (www.wisegeek.com/what-is-the-smoke-point.htm). Hence high smoking temperature of oil is an important characteristic in deep fat frying of foods.

Data on initial smoke point temperature and changes on reheating of oils during frying of potato chips is presented in **Table No. 1** and also reflected in **Figure No.1**

Observation from the table reveals that the smoke point temperatures of oils during the first frying was highest in SFO (242 °C), followed by SBO (240°C).The smoke point of RBO was 220°C and comparatively high to that of GNO (210°C). As the frying trials increased, a steady decrease in smoke point was observed in all the oils. Replenishing with fresh oil in the 12th frying reflected a slight increase in the smoking temperature of all the oils as compared to the temperatures noted after the eleventh frying (Figure 1). However, a decrease in smoking temperature was observed at the 13th frying which was comparable to the temperatures obtained at 9th frying. The decrease in smoke point observed after the eleventh frying was highest in GNO (32°C) and

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comparatively lower in SBO (20°C) and SFO (28°C) while RBO showed a value closer (30°C) to GNO.

Results of 'f' test applied between smoke point of oils and statistical data on independent sample 't' test are presented in **Tables 2** and **3** respectively.

Results of ANOVA test presented in **Table No. 2** reflects a highly significant difference (p = 0.00) between the smoke point temperature of the oils subjected to repeated heating in frying potato chips suggestive of changes irrespective of the oil.

Statistical data from **Table No. 3** shows independent comparison between the overall changes in smoking temperature of the four oils. Smoke point of GNO on repeated heating shows significant differences (p = 0.033) only at 5% level as compared to SFO, highly significant (p = 0.000) with SBO and insignificant with RBO (p = 0.122). The change in smoke point of SFO on repeated heating differs insignificantly from those observed in SBO (p = 0.109) and RBO (p = 0.258). However highly significant changes (p = 0.000) between smoke point of SBO and RBO is noted. Results reflect that amongst all oils the decrease in smoking temperature was observed to be lower in SBO as compared to GNO and RBO indicating its suitability as a frying medium..

Paired Sample statistics to ascertain the changes in smoking temperature of oils at each frying stage has been done. The results are presented in **Table No. 4**

Observations from the table show that changes in smoking temperature until the third frying are insignificant. However significant changes are evident in the smoking temperature between the first vs. fifth (0.23), third vs. seventh (0.11) and fifth vs. ninth (0.10) frying indicating the suitability of oils until the third frying in terms of the smoking temperature. Addition of fresh oil at the twelfth frying reflects an insignificant change in the smoking temperature of oil indicating that a further reduction in temperature does not result.

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However when compared to the smoking temperature of the first frying significant change is observed reflecting that in spite of adding fresh oil the smoking temperature does not improve significantly.

The smoke point is certainly an important characteristic for restaurants and housewives in deciding when to change the frying oil. **(Pantzeris 1998).**

A decrease in smoking point by 16°C & 22°C in soya & groundnut oils respectively in the fifth frying has been reported **(Roselyn et al. 2002).**

Fan, et al (2013) reported a progressive fall in the smoke point of RBO from 235^0 C to 188^0 C when the oil was used to fry French fries continuously for six hours a day up to five days.

CONCLUSION

Progressive and significant decrease in smoking temperature of all oils after third frying trial is indicative of changes in the frying medium. Replenishing with fresh oil may be an option to prevent further decrease in smoking temperatures after the third trial.

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Table No.1: Smoke Point Temperatures (°C) of Oil during Frying of Potato Chips

		Types of Oils			
Particulars		**GNO**	**SFO**	**SBO**	**RBO**
Frying Trials	1	210	242	240	220
	3	198	238	238	212
	5	192	220	234	196
	7	190	224	230	194
	9	186	218	226	186
	11	178	214	220	190
Addition of Fresh Oil	12	194	218	230	192
	13	184	217	218	194
Mean		**191.500**	**213.750**	**229.500**	**201.750**
SD		**9.724**	**24.783**	**7.910**	**14.675**
Range *		**210-178**	**242-214**	**240-218**	**220-186**

*Maximum to Minimum Range

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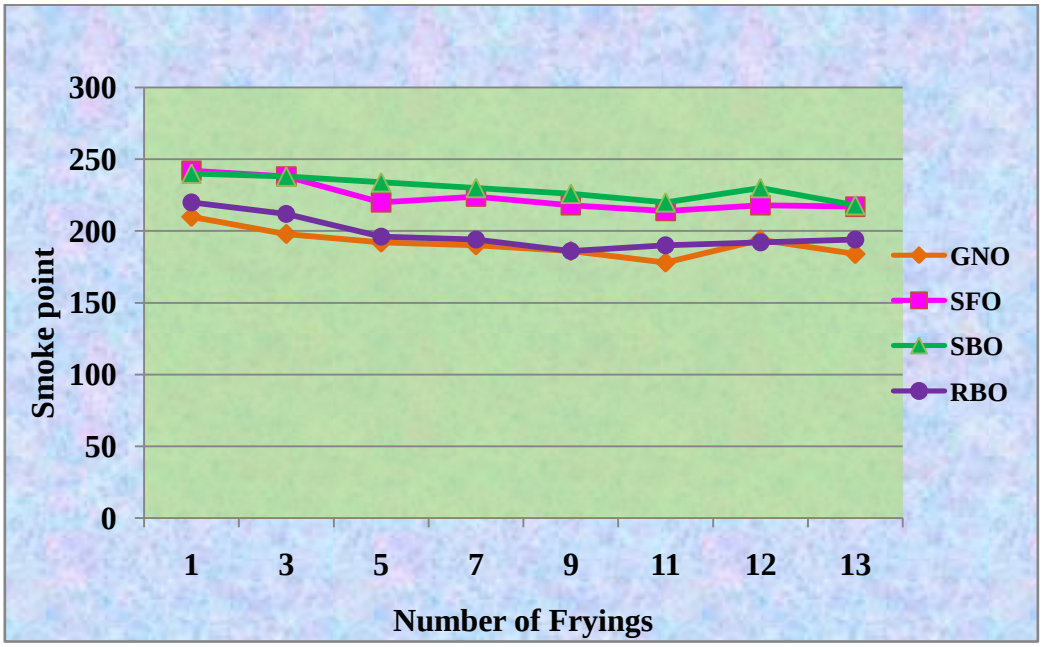

Figure No.1: Changes in Smoke Point Temperatures (°C) of Oil during Frying of Potato Chips

Table No.2 Results of ANNOVA for Smoke point of Oils

		Sum of Squares	df	F value	Significance
Smoke Point	Between Groups	6412.500	3	8.665	.000
	Within Groups	6907.000	28		
	Total	13319.500	31		

Table No. 3: Results of Independent Sample Test for Smoke Point of Oil

Sr. No	Oils	df	't' values	Significance
1	GNO vs. SFO	14	2.364	.033
2	GNO vs. SBO	14	8.57	.000
3	GNO vs. RBO	14	1.647	.122
4	SFO vs. SBO	14	1.712	.109
5	SFO vs. RBO	14	1.178	.258
6	SBO vs. RBO	14	4.708	.000

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Table No.1 (c): Paired Sample Test for Smoke Point of Oils on Repeated Heating

	t	df	Sig.(2 tailed)
Pair 1 first vs. third	2.931	3	.061
Pair 2 first vs. Fifth	4.341	3	.023
Pair 3 third vs. Seventh	5.599	3	.011
Pair 4 fifth vs..ninth	5.879	3	.010
Pair 5 first vs. eleventh	10.456	3	.002
Pair 6 eleventh vs. oil change	2.530	3	.085
Pair 7 eleventh vs. repeat change	1.616	3	.205
Pair 8 first vs.oil change	4.837	3	.017
Pair 9 oil change vs. repeat change	1.544	3	.220

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