SUMMARY AND CONCLUSION

CHAPTER 6

SUMMARY AND CONCLUSIONS

Fats and oils are recognized as essential nutrients in human diets and are the most concentrated source of energy. Vegetable oils and fats are principal sources of fat in the diet. However, excessive consumption of fats in diet, derived from plant sources, elevates LDL cholesterol, which is one of the culprits responsible for cardiovascular diseases. Therefore there has been a resurgence of interest in the role that fats play in health and disease. Deep fat frying is an important, common and highly versatile process, for which oils and fats has been used from antiquity to cook a wide variety of products. Repeated frying results in changes in chemical and physical properties of oil, thus reduce the quality of oil. Consumption of such oils has been documented to adversely affect the health of individuals in many ways. Thus the present study was undertaken to assess the edible oil and fried food intake and its association with prevalence of NCDs in Gujarati housewives of urban Vadodara. The thermal stability of two popular edible oils (Cottonseed and Groundnut oil) used for frying french fries and bhajias was also studied in terms of their fatty acid profile, total polar components, peroxide value, p-anisidine value, acid value, iodine value, refractive index and color. The sensory quality of french fries and bhajias fried in these oils intermittently, was studied with respect to various organoleptic attributes and finally the frying practices and other food safety practices of a railway food outlet was determined. IEC material for safe frying practice was also developed. The results of the study are summarized and concluded as follows:

6.1 PHASE I

Consumption of edible oil in Gujarati diet is considered very high as compared to other states of India. This phase was designed to study the practices on type of oil used for cooking. The survey was specifically aimed at

collecting information from Gujarati housewives on the consumption pattern of popularly consumed deep fried and shallow fried foods and deep fried sweets prepared at home and purchased from market. Consumption of these foods was correlated with prevalence of NCDs. The association between the knowledge level on *trans* fats and the education level of the subjects was also determined.

6.1.1 Salient features of Phase I

- Most of the subjects belong to middle income group and about 57.5% housewives were graduate.
- Deep fried products prepared at home were consumed by 5% of households on daily basis and 55% and 60% households consumed fried foods on a weekly and fortnightly basis.
- Shallow fried foods were consumed by 43% of households on daily basis and 49% and 44% consumed shallow fried foods weekly and fortnightly basis. None of the households consumed deep fried sweets on daily basis. Most of the surveyed subjects were vegetarian and resorted to roasting as most popular cooking method.
- 58.8% of Gujarati housewives were obese and 25.2% were overweight. Other co-morbidities related to obesity such as hypertension and diabetes were present in 16% and 8% housewives respectively. Significant association was seen between diabetes and obesity.
- Consumption of homemade shallow fried foods significantly correlated with prevalence of diabetes.
- Fried food purchased from market fortnightly and its consumption showed a significant association with prevalence of GI problems.
- Eating out in restaurants/ parties on a weekly basis was preferred by 22% Gujarati housewives and 7% never preferred eating out. However, no association was found between prevalence of NCDs, GI problems and eating out frequency.

- Many families reported daily use of saturated fats such as *vanaspati* (26%), ghee (100%) and butter (76%). Use of *vanaspati* showed a significant association ($p<0.001$) with prevalence of hypertension. However, consumption of butter did not show association with prevalence of NCDs and GI problems.
- Awareness on recommended daily intake of vegetable oils was reviewed, 58.8% do not know about the daily intake allowances of oil.
- Knowledge on *trans* fats was assessed and it was found that only 34.8% know about the *trans* fats, and 31.2% know the sources of trans fat.
- Only 15.6 % house wives answered correctly that oil blends are the combination of different oils and only 25.2 % of house wives were aware of oil blends.

From the results of phase I, it can be concluded that saturated fats and ready-to-eat foods are consumed on daily basis which may be a significant contributor of high prevalence of obesity and other co-morbidities. Most subjects did not have knowledge on recommended daily intake of oils, oil blends and *trans* fats. Hence education on correct amount of oil intake, oil blends and *trans* fats is suggested to reduce prevalence of NCDs.

6.2 PHASE II

This phase was aimed to assess the sensory quality of french fries and bhajias intermittently fried (0, 6, 11, 16 and 21 h) in cottonseed oil (CSO) and groundnut oil (GNO).

6.2.1 Salient Features of Phase II

6.2.1.1 Sensory quality of french fries intermittently fried in CSO and GNO

- Appearance, color, crispness, greasiness and taste of french fries fried intermittently in CSO and GNO showed no significant change.
- Significant reduction ($p<0.05$) in flavor, odor and overall acceptability scores was noticed as the duration of frying in GNO increased from 6-

21 h, whereas these scores reduced significantly ($p<0.05$) for CSO from 16-21 h.

- With regards to taste, odor and overall acceptability GNO fried french fries were significantly ($p<0.05$) more acceptable as compared to CSO fried fries at initial hours of frying.
- Oil uptake during intermittent frying of french fries was 12% in GNO and 11.5% in CSO.

6.2.1.2 Sensory quality of bhajias intermittently fried in CSO and GNO

- As the duration of frying increased from 0-21 h a non significant change was observed in all sensory qualities of bhajias.
- The crispness scores of bhajias improved as the duration of frying increased although this increase was not statistically significant.
- During intermittent bhajias frying oil uptake was higher in GNO (19.65%) as compared to CSO (15.6%).

To conclude, the sensory qualities of CSO prepared french fries does alter when fried intermittently in repeatedly heated oil. Overall acceptability of french fries fried in GNO was more than CSO prepared fries. Bhajias showed no change in the sensory qualities up to 21 h of intermittent frying. However, both french fries and bhajias were acceptable as per the hedonic rating scale.

6.3 PHASE III

6.3.1 Salient Features of Phase III

In this phase of the study thermal stability of refined and double filtered CSO and GNO respectively was studied by intermittent frying of french fries and bhajias up to 25 h with respect to fatty acid profile, total polar components, peroxide value, p-anisidine value, acid value, iodine value, refractive index and color.

6.3.1.1 Chemical changes in CSO and GNO used for intermittent frying of french fries

- Intermittent frying of french fries in CSO and GNO results significant ($p<0.05$) change in chemical properties of both the oils.
- The peroxide value, p-anisidine value and totox value increased significantly ($p<0.001$) when french fries were fried intermittently up to 25 h. Though CSO showed significantly lower ($p<0.001$) stability than GNO.
- Positive correlation was found between peroxide value and p-anisidine value of both the oils with duration of frying.
- Iodine value, indicator of unsaturation in oil showed a significant decrease ($p<0.01$) in CSO (14.45%) and GNO (17.64%) as the frying duration of french fries increased.
- Significant increase ($p<0.01$) in acid value and total polar components (indicator of hydrolysis) was observed when french fries were fried intermittently up to 25 h.
- Intermittent french fries frying in CSO and GNO up to 25 h showed a significant change in fatty acid profile of both the oils. Palmitic acid (saturated fatty acid) increased by 16.4% and 11.8% in CSO and GNO respectively.
- Monounsaturated fatty acid/monoene i.e. oleic acid increased by 4.4% in GNO and 9.2% in CSO when french fried were intermittently fried up to 25 h.
- Linoleic acid decreased by 12.7% in CSO and 26% in GNO. The other polyunsaturated fatty acid i.e. linolenic acid was totally missing after 15 h intermittent frying of french fries in GNO.
- Significant decrease ($p<0.01$) in linoleic/palmitic ratio was seen in CSO (25%) and GNO (33.8%).

6.3.1.2 *Changes in physical parameters of CSO and GNO used for intermittent frying of french fries*

- Color and refractive index of CSO and GNO increased significantly ($p<0.001$) with the increase in frying duration.

6.3.1.3 *Chemical changes in CSO and GNO used for intermittent frying of bhajias*

- Bhajias frying result in significant increase ($p<0.001$) in peroxide value, p-anisidine value and totox value of CSO and GNO during the intermittent frying of 25 h. CSO showed lesser oxidative stability than GNO and no correlation was found between peroxide value and duration of frying.
- Significant decrease ($p<0.05$) in iodine value of bhajias fried CSO was observed. However, iodine value of GNO was not altered during 25 h of intermittent frying.
- Strong correlation (GNO $r^2=0.98$ and CSO $r^2=0.93$) and significant increase ($p<0.001$) in acid value of bhajias fried CSO and GNO was seen.
- At 25 h of intermittent frying total polar components of CSO and GNO was increased from 4 to 14.3 and 3.12 to 7.58 respectively.
- The saturated fatty acid content (palmitic and stearic acid) of GNO increased significantly ($p<0.05$) with the increase in frying hours. Stearic acid of CSO did not alter significantly.
- Oleic acid of CSO and GNO increased significantly ($p<0.05$) at 15 h of intermittent frying.
- The linolenic fatty acid of CSO was not significantly changed while the linolenic fatty acid of GNO was not detected at 15 and 25 h of intermittent frying.
- The linoleic acid to palmitic acid ratio (18:2/16:0) decreased significantly ($p<0.01$) in CSO whereas GNO 18:2/16:0 ratio showed no significant reduction during 25 h intermittent frying.

6.3.1.4 Changes in physical parameters of CSO and GNO used for intermittent frying of bhajias

- Refractive index and color of bhajias fried oils increased as frying duration increased.

Present phase concludes that frying of french fries and bhajias bring considerable thermal-oxidation of CSO and GNO at 5 h of intermittent frying and continued up to 25 h of intermittent frying as indicated by rise in chemical and physical properties of oil. Decrease in 18:2/16:0 ratio was greater in CSO than GNO when french fries and bhajias were intermittently fried for 25 h. Hence, it can be concluded that CSO is less stable than GNO when used for intermittent frying for 25 h.

6.4 PHASE IV

6.4.1 Salient Features of Phase IV

Safe food is one of the three essentials for maintenance of life and health. Therefore, present phase was designed to determine the current food safety practices prevailing at the Government run food outlet Jan aahar at Vadodara railway station particularly with respect of use of oils.

6.4.1.1 Case study on prevailing food safety and frying practices in Jan aahar- a government run food outlet at Vadodara railway station

- Jan aahar, a catering outlet is situated at western zone railway station-Baroda. Of the total of 10 kitchen staff members only 4 members had under gone the food safety training program.
- Food hygiene knowledge scores of Jan aahar kitchen staff was 75% and it ranged from good to excellent. Supervisor, manager and head cook scored maximum for food hygiene. However, correct way to manage leftover food was known by only 52% of kitchen staff.
- Knowledge scores on nutrition and health of kitchen staff ranged from poor to good (40.78%). Waiters and assistant cook obtained lowest

scores 22-27% (poor) on nutrition and health respectively as compared to other staff with manager scoring the highest (69%).

- The personal hygiene knowledge scores for the kitchen staff ranged from 50% for a cleaner to 100% for most staff.
- Infrastructural facilities like clean cloth, moping cloth for tables, counters, geyser for washing utensils, separate store for raw materials etc. were lacking.
- Both the cooks did not know about the correct frying temperature. Although cooks had good knowledge about the deterioration of oil quality during frying. Also the cooks followed the practice of discarding the oil for frying purpose at the end of day and used fresh batch of oil each day.

Hence this phase concludes that the food hygiene and personal hygiene practice scores of Jan aahar was good to excellent. However, the infrastructure facilities were lacking. Their frying practices were also found to be good. Food safety training can further improve the knowledge level of the staff and further enhance the good manufacturing practices (GMP).