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Fatty acid profile of edible oils and fats consumed in India

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ABSTRACT

A total 320 samples of edible oils and fats (Oils-236; Vanaspati- 45; Ghee-39) were sampled from 107 sampling sites in India and were evaluated for their fatty acid profile. This is the first comprehensive report on fatty acids profile of fats & oil commonly consumed in India. Every variety of edible oil showed its own unique fatty acid profile with significant variation within each individual fatty acid. Pure safflower oil exhibited the highest total TPUFA (76.78%) while the highest TSFA was noticed for coconut oil (90.84%). High level of erucic acid in the range of 48.5 to 54.2% was observed in mustard oil.. Groundnut and rice bran oils showed TPUFA/TSFA ratio closer to WHO recommended value. Several vanaspati samples exhibited trans fatty acid beyond the permitted limit while trace amount of the same was also detected in ghee.

1. Introduction

Edible vegetable oils and fats are vital part of human diet, not only due to its sensory attributes but also for providing essential fatty acids and energy. In addition, they serve as carrier for fat soluble vitamins, and precursor for steroid hormones and prostaglandins synthesis (Li, Kong, Shi, & Shen, 2016). Worldwide, edible oil consumption has been rising steadily. Several factors are associated with increased oil & fat consumption, such as increase in per capita income, urbanization and shift to obesogenic diets observed around the world (Kojima, Parcell, & Cain, 2016).

Edible fats and oils are composed of glycerin esters and fatty acids (>90%) which are differentiated by triglycerol structure (chain length, position of double bond and *cis*/*trans* orientation) as well as the relative proportion of saturated fatty acids and unsaturated fatty acids (number and position of double bonds) (O'brien, 2008). Vegetable oils and fats having the fatty acids in *cis* configuration which are nutritionally important while during partially hydrogenation of fats and oil some *cis* form of fatty acids are converted into *trans* form which are reported to have adverse affect on human serum lipoproteins and increase the risk of coronary heart disease (Aro, Becker, & Pedersen, 2006; Allison, 1995). The chemistry, metabolism, quantity and quality of the fatty acids in the diet play a critical role in health and disease. Fatty acids can be classified into short chain (2–8); medium chain (8–12) and long chain (13–24) or into saturated, monounsaturated and polyunsaturated fatty acids (SFA, MUFA and PUFA, respectively) depending upon presence or absence of double bonds (Kostik, Memeti, & Bauer, 2013). PUFA namely linoleic acid (*cis*-9,12-Octadecadienoic acid, C18:2n6c) and α-linolenic acid (cis-9,12,15-octadecatrienoic, C18:3n3) are 'essential fatty acids', as they cannot be synthesized by human body and need to be solely supplied through the diet. The principal sources of lipids in human diet are edible oils, fats, meat, dairy products, fish and nuts.

Dietary fatty acids play a major role in cholesterol metabolism and thus may be associated with cardiovascular diseases (CVD) (Aro et al., 1995; Willett et al., 1993). According to health statistics, gazetted by the World Health Organisation (WHO, 2015), non-communicable diseases (NCDs) will be causing more than three quarters of global deaths by the year 2030. Globally, an estimated 17.5 million deaths (31% of global deaths) in the year 2011 were attributed to CVD and the projections show a staggering 23.3 million by the year 2030 (WHO, 2014). India is a vast country with a population of 1.32 billion and undergoing epidemiologic transition, whereby the burden of communicable diseases is declining slowly, but non-communicable diseases (NCD) is rising rapidly (Krishnan et al., 2016). The changing dietary patterns and the changes in lifestyle are attributed to the rise in disease burden around the world including India.

Oilseeds play a key role in Indian economy (Jha et al., 2012) being the 5th largest edible oil economy after USA, China, Brazil and Argentina. In India, total nine oil seed crops are grown, among them, seven are categorized under the edible oils, including soybean, rapeseed (mustard), sunflower, safflower, groundnut, sesame and niger, while castor and linseed are categorized as non-edible

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oil seed. Besides these, considerable amount of edible oil is also extracted from rice bran, cottonseeds and corn germ. The per capita average oil consumption in India was 14.3 kg/year (2012–13), far behind the global per capita consumption of 24 kg/year (2012–13) (Jha et al., 2012).

Considering the importance of edible oils and fats in the Indian diet and significance of their fatty acids composition on nutrition and health, the present investigation was carried out to evaluate the fatty acid profile of commonly consumed edible oils and fats available in the Indian market.

2. Materials and methods

2.1. Sample collection

All varieties and brands of edible oil samples (coconut; sunflower; ground nut; palmolein; gingelly; soyabean; mustard; safflower-blended and pure; rice bran; corn germ; cottonseed oil) available in the market were collected from 107 sampling sites across India, according to the sample design and procedure laid out for the Indian food composition tables (Longvah, Ananthan, Bhaskarachary, & Venkaiah, 2017). Edible oils and fats including ghee (Clarified butter) and vanaspati (partially hydrogenated vegetable oil) were collected considering that only the highly preferred brands used in the region are available in those outlets. A total of 320 samples (Edible oils, 236), vanaspati (45) and ghee (39) were collected for the study. The number of edible oil and fat samples collected in each region across the country are provided in Table 1.

2.2. Reagents and chemicals

The fatty acid standards were procured from Nu-Chek, USA. The other chemicals, regents used were of HPLC grade. Milli-Q water was used in analysis, where required.

2.3. Determination of fatty acid profile by GC-FID

The fatty acid profile of edible oils and fats were determined according to method of O'Fallon, Busboom, Nelson, and Gaskins (2007) and AOAC official method 996.06 (AOAC Official Method of Analysis, 1995). Fatty acid methyl esters (FAMEs) were prepared from the oils and fat samples by direct *trans*-esterification using 2% sulphuric acid in methanol. FAMEs were separated and quantified by Gas Chromatography coupled with flame ionisation detector (FID) (Agilent Series, 7890 Series, USA). Briefly, 40 μl of the edible oil or 50 mg of fat sample was weighed in a screw capped Pyrex culture tube and 1 ml of C_{17} (1 mg/ml; Heptadecanoic acid; Sigma H3500) was added as internal standard. Potassium hydroxide (0.7 ml) and 5.3 ml of methanol with 0.05% of butylated hydroxyl toluene (BHT) were added to the tube and incubated in a boiling water bath set at 55 °C for 90 min with vigorous shaking of 20 s for every 20 min. After incubation, the tubes were cooled under tap water followed by addition of 2% sulphuric acid and incubation at 55 °C for 90 min. Further, *n*-Hexane (3 ml) was added to the tube, vortexed and centrifuged for 5 min at 2000 rpm. The *n*-Hexane layer was collected in a 5 ml test tube having 0.1 g of sodium sulphate. The tubes were again vortexed and the solvent was evaporated under a gentle stream of nitrogen. 1.5 ml of dichloromethane was added to the tube and mixed thoroughly. 0.5 ml of the dichloromethane with FAME was filtered through 0.22 μm PVDF syringe filter and injected to the gas chromatograph. SP 2560 (75 m x 0.18 mm x 0.14 μm) column was used for the gas chromatographic separation with following instrumental conditions: Injector temperature : 250 °C; Carrier gas : Hydrogen @ 0.6 ml/minute; Split Ratio : 1:100; Oven Program : 140 °C (Hold 1.5 min) to 220 °C @ 3 °C (Hold 1.0 min) to 230 °C (Hold 3 min); Detector : Flame Ionization Detector; Temperature : 260 °C; H_2: 40 ml/minute; Zero Air : 400 ml/min; Injection Volume : 1 μl. The fatty acids present in the samples were quantified by area percentage calculation using Supelco 37 FAME Mixture (Sigma Cat. No. 47885-U) as reference standard. Results were expressed as % fatty acids of fat/oil. Internal standard as well as Standard Reference Material (SRM)-1544 was used for analytical quality assurance.

2.4. Data analysis

Each sample was analyzed in duplicate and the mean values were reported with ±Standard Deviation. All results of each particular fat and oil were pooled and average values were taken to represents the fatty acid profile of the particular oil or fat type. The minimum and maximum values of each fatty acid are represented as a measure of range and regional variations in the fatty acid content.

3. Results and discussion

3.1. Availability and sampling of oil across India

Total 320 edible oils (236) and fats (84) samples were collected from different region of India (Table 1) including Central (41), East (36), North (47), North East (22), South (53) and West (37). The distribution of oil and fat samples in different region of India was diverse and may reflect upon consumption pattern (preference), availability and production of particular oil seed in a region. Data revealed that the highest number of oil samples collected was mustard followed by soybean and sunflower while only one sample of corn oil was collected from Central India, due to non-availability in other sampling site. Vanaspati (45) and ghee (39) samples were also collected; the highest numbers of both were collected in North India which may be due to its preferential consumption in North India. Groundnut oil was distributed almost

Table 1
Number of oils and fat samples collected across different regions of India.

Regions/ Oil /Fat	Groundnut Oil	Sunflower Oil	Mustard Oil	Corn oil	Cotton seed Oil	Palmolein	Soyabean Oil	Rice Bran Oil	Gingelly Oil	Safflower Oil		Coconut Oil	Ghee	Vanaspati
										Blended	Pure			
Central	03	07	07	01	Nil	05	14	02	02	Nil	Nil	Nil	05	06
East	01	06	10	Nil	Nil	07	05	02	03	03	Nil	Nil	03	10
North	04	06	18	Nil	Nil	Nil	11	02	05	01	Nil	Nil	11	09
Northeast	Nil	06	09	Nil	Nil	Nil	06	Nil	01	Nil	Nil	Nil	03	05
South	04	09	07	Nil	Nil	05	03	04	09	03	04	5	10	08
West	04	05	08	Nil	02	03	07	02	04	01	Nil	Nil	07	07
Total Number of Samples	16	39	59	01	02	20	46	12	24	08	04	05	39	45