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RESEARCH ARTICLE

BUILDING EDIBLE OIL SECURITY

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ABSTRACT

India is an importer of edible oil due to their less net domestic availability. Around 56-60% of the edible oils consumed in the country are met through imports. The three oils that the country imports are palm oil, which forms 36 per cent of India's edible oil consumption, followed by soybean and sunflower oil, which constitute 22 per cent and 12 per cent of the demand (according to 2019-20 data from Solvent Extractors' Association of India (SEA), agency monitoring edible oils), respectively. Vegetable oils and fats have a big contribution in our diet. They are important from nutritional and economical point of views. Because of their greater demand in national and international market adulteration in high price oil with low price oil is a major issue. The intake of adulterated oils and trans-fats in the human diet has had negative health repercussions, including cardiovascular disease, causing millions of deaths annually.

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INTRODUCTION

India is an importer of edible oil due to their less net domestic availability. Around 56-60% of the edible oils consumed in the country are met through imports. The total production of soya bean oil in India for year 2021-2022 is 126.10 LMT. During 2020-2021, India has imported 133 lakh tons of edible oils costing around Rs. 80,000 Crore. International prices of edible oils are under pressure due to shortfall in global production and increase in export tax/levies by the exporting countries. As the domestic prices are governed by the international price trends, the prices of edible oils in the country have been ruling very high for the past one year. This has been a major cause of concern. The three oils that the country imports are palm oil, which forms 36 per cent of India's edible oil consumption, followed by soybean and sunflower oil, which constitute 22 per cent and 12 per cent of the demand (according to 2019-20 data from Solvent Extractors' Association of India (SEA), agency monitoring edible oils), respectively [Yadav, 2018; https://theprint.in/india/why-is-your-tadka- getting-more-more-expensive-blame-indias-reliance-on-edible-oil-imports/963947/]. Due to the heavy dependence on imports for edible oils, it is important to make efforts for increasing the domestic production of edible oils in which increasing area and productivity of oil palm plays an important part. The Union Cabinet, chaired by the Prime Minister Shri Narendra Modi has given its approval to launch a new Mission on Oil palm to be known as the National Mission on Edible Oils – Oil Palm (NMEO-OP) as a new Centrally Sponsored Scheme with a special focus on the North east region and the Andaman and Nicobar Islands.

Scheme will immensely benefit the oil palm farmers, increase capital investment, create employment generation, shall reduce the import dependence and also increase the income of the farmers [https://www.pib.gov.in/PressReleasePage.aspx?PRID=1746942#:~:text=The%20Union%20Cabinet%2C%20chaired%20by,the%20Andaman%20and%20Nicobar%20Islands]. Vegetable oils and fats have a big contribution in our diet. They are important from nutritional and economical point of views. Because of their greater demand in national and international market adulteration in high price oil with low price oil is a major issue. It can affect the health of consumers adversely. Mustard oil adulterated with argemone oil and butter yellow has been reported to cause gall bladder cancer. Sesame oil & groundnut oil is adulterated with palm oil, etc. According to National Library of Medicine, metanil yellow is not fit for human consumption, but cooking oil is often adulterated with this carcinogenic food color. Similarly, argemone oil mixed with edible oils can lead to epidemic dropsy, glaucoma and loss of eyesight. Therefore there is an urgent need for authentication and prevention of adulteration for the sake of consumers. Edible oil fraud usually involves misleading the purchaser as to the true nature, substance or quality of the oil demanded. The offence is in the form of adulteration which generally involves the dilution of pure edible oil with less expensive one. Cheaper oil which is adulterated may also be represented as if it were some oil of greater (pure) oil quality. Adulteration of edible oils with argemone oil, mineral oil, karanja or castor oil causes loss of eyesight, damage to liver, heart problem, stomach infections, or cancer. The intake of adulterated oils and trans-fats in the human diet has had negative health repercussions, including cardiovascular disease, causing millions of deaths annually

[Yadav, 2018; Pal, 2018; https://health.economictimes. indiatimes. com/ news/industry/combatting-adulteration-in-edible-oils/89999235. India's top food regulator, Food Safety and Standards Authority of India or FSSAI, has said 2.42% of the 4,461 cooking oil samples it tested were non-compliant on account of safety standard parameters like aflatoxins, pesticide residue, heavy metals above regulatory levels, also failed to meet refractive index, iodine value, etc. while 24.2% samples failed to clear quality metrics, indicating possible adulteration of cooking oils in the market. FSSAI conducted a nationwide survey during 25-27 August 2020 on edible oils to assess oil safety, quality and misbranding in cooking oils sold in the market. The purpose of the survey is to assess the "ground realities" with respect to oil safety, quality and misbranding. It, therefore, has become essential to monitor the purity and quality of edible oils to reduce various risks [https://www.lifeasible.com/custom-solutions/food-and-feed/food-testing/authenticity-testing/edible-oil-adulteration-testing; https://www.livemint.com/news/india/24-edible-oil-samples-adulterated-fssai-11640775486648.html; https:// health. economictimes. indiatimes. com/ news/industry/ combatting-adulteration-in-edible-oils/89999235].

Based on type of processing the edible oil receives, it can be classified into following categories:

- ***Hot Pressed Oil:*** These oils are extracted by pressing them at high temperatures due to which acidity of oil increases significantly and it loses most of its natural quality. These oils require refinement for making them fit for human consumption.
- ***Cold Pressed Oil:*** Unlike hot pressed oils, extraction process for these oils takes place at room temperature, at around 27 degrees centigrade due to which acid value is relatively low. These oil products can be directly consumed after precipitation and filtration and thus do not require any chemical refinement process.
- ***Leached Oil:*** When oil is extracted from the crushed mass of plant/animal biomass with the help of solvent, then this kind of oil is known as Leached oil. The leaching process depends mainly on the chemical structure of the solvent and the kind of solute that will be extracted from solid material.
- ***Refined oil:*** Edible oils purchased in stores are known as "RBD" oils. These are oils that have been Refined, Bleached and Deodorized. Each of these steps is used to create final oil that is consistent in taste, color and stability. As a result, these oils are generally tasteless, odorless, and colorless regardless of the original oilseed type or quality.
- ***Hydrogenated Oil:*** Generally, most of the oils are typically liquid at room temperature, therefore many companies use hydrogenation to get a more solid and spreadable consistency. During this process, hydrogen molecules are added to alter the texture, stability, and shelf life of the final product. Hydrogenated oils are also used in many baked goods to improve taste and texture.
- ***Blended Oil:*** Blended edible oil means an admixture of any two edible oils where the proportion by weight of any edible oil used in the admixture is not less than 20 percent. The blended mixture shall be clear, free from rancidity, suspended or insoluble matter or any other foreign matter, separated water, added coloring matter, flavoring substances, mineral oil, or any other animal and non-edible oils, or fats, argemone oils, hydrocyanic acid, castor oil and tricresyl phosphate [https://www.pmg.engineering/ edible-oil-an-introduction/].

In a typical edible oil processing plant oil is extracted from the seed first using mechanical extraction (expeller press) followed by chemical extraction (hexane extraction). By using both methods less than 1% of the oil is left in the meal that is produced. The majority of this meal is sold for use in animal feed rations [https:// extension.psu.edu/ processing-edible-oils#:~: text= Processing% 20of% 20edible% 20oils%20is,%3A% 20refining% 2 C% 2 0bleaching%20and%20deodorizing.]. Vegetable oils may rancid and hence lose its nutritional values and favor upon improper extraction process, handling and storage. Rancidity of vegetable oils may pose health risks including cancer and inflammation because of the formation of toxic and reactive oxidation products. Moisture, microbes, air, anti-oxidants and exposure to sunlight are among factors determining the oils rancidity or deterioration time. In quality control, several parameters such as iodine value (degree of unsaturation), peroxide value (formation of primary oxidation products), moisture content, specifc gravity (purity), and acid value (free fatty acids formation because of rancidity) are key parameters of interest as they determine the shelf-life quality and hence the economic value of oils. Studies showed that developed countries society have greater awareness compared to developing countries in edible oil purchasing choice WHO/FAO has outlined quality standards for various edible vegetable oils constituents; heavy metals, fatty acids composition, antioxidants, micronutrients and other physicochemical parameters [Negash, 2019]. Standards for 27 vegetable oils are prescribed in Section 2.2 of Food Safety and Standards (Food Product Standards and Food Additives) Regulations, 2011 [Manual of methods of analysis of food- oils and fats.], Indian Standard is adopted by the Bureau of Indian Standards, after the draft finalized by the Oils and Oilseeds Sectional Committee had been approved by the Food and Agriculture Divisional Council, which prescribes requirements and methods of sampling and test for almost every edible oil present in their individual standard. Consideration has been given to *Food Safety and Standards Act*, 2006 and Regulations framed there under; Legal Metrology Act, 2009 and Rules framed there under and the Essential Commodities Act, 1955 IS 544:2014 (RA 2019) Some regulations by Food safety & standards act, 2006 and specification by Indian Standards for few oils are defined as follows:

- Peanut oil- IS 544:2014 (RA 2019)
- Sesame oil - IS 547:2018
- Coconut oil - Food safety & standards act, 2006
- Mustard oil (Black seeds & Yellow seeds) - IS 546:2014 (RA 2019)
- Sunflower oil - IS 4277:2014 (RA 2019)
- Soya bean oil- Food safety & standards act, 2006
- Flax seed oil - Food safety & standards act, 2006
- Olive oil - Food safety & standards act, 2006
- Palm oil - Food safety & standards act, 2006

These will help to identify and differentiate in between adulterated and non adulterated edible oils. One small study was conducted by Ayurvet Research Foundation to establish the reference standards of majorly consumed edible oils. Oils (peanut oil, black mustard oil, yellow mustard oil, flax seed oil, soya bean oil, coconut oil, sunflower oil, sesame oil, olive oil, palm oil) were extracted by cold-pressed method (mechanical extraction) using 10 quality tested raw materials (seeds) of each type (as shown in Table 1) which also gives spent (Table 2) with oil and then analyze the quality parameters of extracted oil (as shown in Table 3). The above experimental data clearly indicates that adulterant free edible oils possess values of quality parameters within the defined regulations. This will help in checking adulterated oils. FSSAI has come up with an amendment in labelling regulations of vegetable oils on December 24, 2018. Basic Guidelines for labelling of Vegetable Oils:

- The manufacturers shall not use the expressions "Super-Refined", "Extra-Refined", "Micro-Refined", "Double-Refined", Ultra-Refined", "Anti-Cholesterol", "Cholesterol Fighter", "Soothing to Heart", "Cholesterol Friendly", "Saturated Fat Free" or such other expressions which is an exaggeration to the quality of production the label on package or the advertisement of edible oils and fats.
- Package containing an admixture of edible oils shall carry the following label declaration immediately below its brand name/trade name on front of pack, namely: Blended Edible Vegetable Oil
  (Name and nature* of edible vegetable oil)
  ……percentage by weight
  (Name and nature* of edible vegetable oil)
  ……percentage by weight

Table 1. Quality testing of edible seeds

S. No.	Name of Oil	Parameter	Results
1.	Peanuts	Foreign matter, % w/w	Nil
		Moisture/Loss on drying, % w/w	6.25-6.33
		Total ash, % w/w	2.35-2.48
		Acid insoluble ash, % w/w	0.39-0.42
2.	Sesame seeds	Foreign matter, % w/w	Nil-0.08
		Moisture/Loss on drying, % w/w	3.52-3.65
		Total ash, % w/w	2.99-3.15
		Acid insoluble ash, % w/w	0.43-0.50
3.	Coconut	Foreign matter, % w/w	Nil
		Moisture/Loss on drying, % w/w	4.87-4.97
		Total ash, % w/w	2.63-2.78
		Acid insoluble ash, % w/w	0.35-0.42
4.	Yellow mustard seeds	Foreign matter, % w/w	Nil
		Moisture/Loss on drying, % w/w	6.33-6.45
		Total ash, % w/w	2.77-2.89
		Acid insoluble ash, % w/w	0.04-0.06
5.	Black mustard seeds	Foreign matter, % w/w	Nil
		Moisture/Loss on drying, % w/w	6.09-6.17
		Total ash, % w/w	4.02-4.18
		Acid insoluble ash, % w/w	0.71-0.84
6.	Sunflower seeds	Foreign matter, % w/w	Nil-0.10
		Moisture/Loss on drying, % w/w	6.92-7.05
		Total ash, % w/w	4.34-4.46
		Acid insoluble ash, % w/w	0.53-0.69
7.	Soya beans	Foreign matter, % w/w	Nil-0.09
		Moisture/Loss on drying, % w/w	6.24-6.34
		Total ash, % w/w	4.69-4.77
		Acid insoluble ash, % w/w	0.41-0.52
8.	Flax seeds	Foreign matter, % w/w	Nil
		Moisture/Loss on drying, % w/w	7.77-7.83
		Total ash, % w/w	1.53-1.62
		Acid insoluble ash, % w/w	0.67-0.73
9.	Olive seeds	Foreign matter, % w/w	Nil
		Moisture/Loss on drying, % w/w	9.69-9.78
		Total ash, % w/w	6.00-6.15
		Acid insoluble ash, % w/w	2.41-2.57
10.	Palm seeds	Foreign matter, % w/w	Nil
		Moisture/Loss on drying, % w/w	5.84-5.99
		Total ash, % w/w	1.44-1.56
		Acid insoluble ash, % w/w	0.98-1.02

Table 2. Quality testing of spent

S. No.	Name of Particular	Results
1.	Peanut spent	Moisture- 6.06 -6.16 % w/w
		Crude Fat- 10.35- 10.52 % w/w
		Crude Fibre- 2.99-3.21 % w/w
		Crude Protein – 48.81- 48.96% w/w
		Total Ash- 3.57- 3.68 % w/w
		Acid Insoluble Ash – 0.19-0.27 % w/w
2.	Sesame spent	Moisture- 4.31-4.41 % w/w
		Total Ash- 2.70 – 2.78 % w/w
		Acid Insoluble Ash – 0.26 – 0.32 % w/w
		Crude Fat – 10.05- 10.21 % w/w
		Crude Protein- 27.56 – 27.64 % w/w
		Crude Fibre – 48.03- 48.21 % w/w
3.	Coconut spent	Moisture- 3.09- 4.10 % w/w
		Crude Fat- 38.43- 38.54 % w/w
		Crude Fibre- 18.70-18.84 % w/w
		Crude Protein –15.35- 15.46 % w/w
		Total Ash- 2.80- 2.89 % w/w
		Acid Insoluble Ash – 0.22-0.34 % w/w
4.	Yellow mustard spent	Moisture- 6.34 – 6.45 % w/w
		Total Ash- 6.02 – 6.13 % w/w
		Acid Insoluble Ash – 0.62 – 0.76 % w/w
		Crude Fat – 11.50 – 11.63 % w/w
		Crude Protein- 33.71- 33.82 % w/w
		Crude Fibre – 34.89-34.94 % w/w
5.	Black mustard spent	Moisture- 4.85-4.99 % w/w
		Crude Fat-14.24 – 14.36 % w/w
		Crude Fibre- 10.27-10.36 % w/w
		Crude Protein – 33.32-33.42 % w/w
		Total Ash- 6.99 – 7.15 % w/w
		Acid Insoluble Ash – 0.66-0.75 % w/w
6.	Sunflower spent	Moisture- 4.68- 4.77 % w/w
		Total Ash- 5.95-6.08 % w/w
		Acid Insoluble Ash – 0.87-0.93 % w/w
		Crude Fat – 23.41-23.55 %w/w
		Crude Protein- 45.54- 45.63 % w/w
		Crude Fibre – 2.80-2.95 % w/w

7.	Soya bean spent	Moisture- 7.49 – 7.55 % w/w
		Total Ash- 5.15-5.26 % w/w
		Acid Insoluble Ash – 0.42-0.56 % w/w
		Crude Fat – 3.90-3.99 % w/w
		Crude Protein- 43.08-43.19 % w/w
		Crude Fibre – 16.99-17.16 % w/w
8.	Flax seed spent	Moisture- 6.88 – 6.96% w/w
		Total Ash- 4.08-4.19 % w/w
		Acid Insoluble Ash – 0.43-0.55% w/w
		Crude Fat – 16.00 – 16.18 % w/w
		Crude Protein- 33.62-33.77 % w/w
		Crude Fibre –10.31-10.49 % w/w
9.	Olive seed spent	Moisture- 5.58-5.69 % w/w
		Total Ash- 6.23-6.45 % w/w
		Acid Insoluble Ash – 1.65-1.78 % w/w
		Crude Fat – 11.15-11.26 % w/w
		Crude Protein- 7.88-7.99 % w/w
		Crude Fibre – 35.56-36.88 % w/w
10.	Palm seeds spent	Moisture- 7.44-7.58 % w/w
		Total Ash- 7.12-7.26 % w/w
		Acid Insoluble Ash – 2.05-2.18% w/w
		Crude Fat – 8.81-8.99 % w/w
		Crude Protein- 17.82-17.96 % w/w
		Crude Fibre – 12.54-12.68 % w/w

Table 3. Quality testing of edible oil

S. No.	Name of Oil	Parameter	Specification	Results
1.	Peanut oil	Refractive Index at 40 ºC ((IS 544: 2014 (RA 2019))	1.4620-1.4640	1.4618-1.4629
		Saponification Value ((IS 544: 2014 (RA 2019))	188-196	194.73-195.21
		Iodine value ((IS 544: 2014 (RA 2019))	85-99	94.50-95.62
2.	Sesame oil	Refractive Index at 40 ºC (IS 547:2018)	1.4646-1.4665	1.4661-1.4664
		Saponification Value (IS 547:2018)	188-193	189.51-190.87
		Iodine value (IS 547:2018)	103-120	103.31-104.98
3.	Coconut oil	Refractive Index at 40 ºC (Food safety & standards act,2006)	1.4480-1.4492	1.4487-1.4491
		Saponification Value (Food safety & standards act,2006)	Not Less than 250	262.30-263.54
		Iodine value (Food safety & standards act,2006)	4.0-11.0	10.38-10.65
4.	Yellow mustard oil	Refractive Index at 40 ºC (IS 546:2014 (RA 2019)	1.4646-1.4662	1.4650-1.4660
		Saponification Value (IS 546:2014 (RA 2019)	168-177	175.03-176.21
		Iodine value (IS 546:2014 (RA 2019)	96-112	100.04-102.10
5.	Black mustard oil	Refractive Index at 40 ºC (IS 546:2014 (RA 2019)	1.4646-1.4662	1.4658-1.4661
		Saponification Value (IS 546:2014 (RA 2019)	168-177	172.60-173.55
		Iodine value (IS 546:2014 (RA 2019)	96-112	105.15-106.87
6.	Sunflower oil	Refractive Index at 40 ºC (IS 4277:2014 (RA 2019)	1.4640-1.4691	1.4689-1.4691
		Saponification Value (IS 4277:2014 (RA 2019)	188-194	190.92-192.01
		Iodine value (IS 4277:2014 (RA 2019)	100-145	129.73-130.48
7.	Soya bean oil	Refractive Index at 40 ºC (Food safety & standards act,2006)	1.4649-1.4710	1.4700-1.4705
		Saponification Value (Food safety & standards act,2006)	189-195	190.86-191.56
		Iodine value (Food safety & standards act,2006)	120-141	122.68-123.69
8.	Flax seed oil	Refractive Index at 40 ºC (Food safety & standards act,2006)	1.4720-1.4750	1.4745-1.4748
		Saponification Value (Food safety & standards act,2006)	188-195	190.97-191.89
		Iodine value (Food safety & standards act,2006)	Not Less Than 170	173.80-174.28
9.	Olive oil	Refractive Index at 20 ºC (Food safety & standards act,2006)	1.4677-1.4705	1.4675-1.4680
		Saponification Value (Food safety & standards act,2006)	184-196	186.84-187.11
		Iodine value (Food safety & standards act,2006)	75-94	90.21-91.87
10.	Palm oil	Refractive Index at 50 ºC (Food safety & standards act,2006)	1.4491-1.4552	1.4515-1.4526
		Saponification Value (Food safety & standards act,2006)	195-205	198.14-199.32
		Iodine value (Food safety & standards act,2006)	45-56	53.91-54.78

- The font size of the label declaration of "Blended Edible Vegetable Oil" shall not be less than 10mm, if the net quantity of the edible oil contained in the packages is 5 litres and above.
- There shall also be the following declaration to point (3) in bold capital letters along with the name of product on front/central panel, – "NOT TO BE SOLD LOOSE"[https:// www. foodsafetymantra. com/regulatory-update/ consumer-products/vegetable-oils/fssai-guidelines-on-labelling-of-vegetable-oil/].

Several factors that can affect the quality of oil as follows

- The light that passes through the packaging which, being a source of energy, activates the oxidation process.
- The presence of oxygen in the head space of the packaging that comes in contact with the product.
- Autocatalytic oxidation.
- The temperature and level of humidity during the storage phase.
- The transfer of substances from the packaging to the oil.
- Fragrances/odours passing through the sides packaging walls.

The right packaging must therefore prevent the loss of the flavor or acidity of the product, the filtering of light which may result in the oil turning rancid, the oxidation of the oil with a consequent loss of flavor, the absorption of odours. The nature of the material used for packaging is also most important factor to consider [https://blog.sipa.it/key-characteristics-edible-oil-bottle-packaging].

On the basis of above study, it can be concluded that pure or unadulterated oils will give the results for quality analysis within specification or regulations released by FSSAI or IS. To avoid eating any adulterated oil, it should not be purchased without seeing the proper packaging, labelling also.

CONCLUSION

India is an importer of edible oil due to their less net domestic availability. Around 56-60% of the edible oils consumed in the country are met through imports. The three oils that the country imports are palm oil, which forms 36 per cent of India's edible oil consumption, followed by soybean and sunflower oil, which constitute 22 per cent and 12 per cent of the demand. Because of their greater demand in national and international market adulteration in high price oil with low price oil is a major issue. Mustard oil adulterated with argemone oil and butter yellow has been reported to cause gall bladder cancer. Sesame oil & groundnut oil is adulterated with palm oil, etc. which can prove harmful to the mankind. As per regulatory requirements it, therefore, has become essential to monitor the purity and quality of edible oils to reduce various risks. One small study was conducted by Ayurvet Research Foundation to establish the reference standard of 10 majorly consumed edible oils which indicates that adulterant free edible oils possess values of quality parameters within the defined regulations. This will help in checking adulterated oils present in the market.

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