



Diversion of Used Cooking Oil into the Food Stream

A Study of Four Indian Cities

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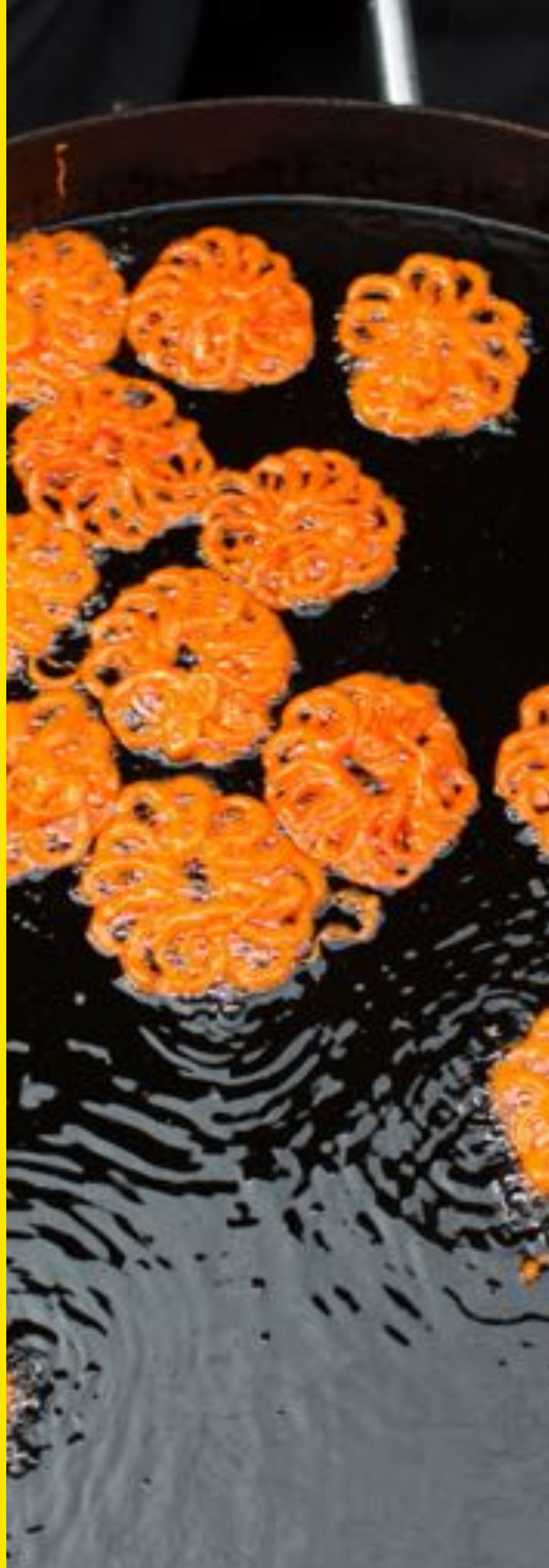
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Executive Summary



Introduction

With India's per capita edible oil consumption nearly doubling in the last decade, so has its generation of Used Cooking Oil (UCO). UCO is the leftover oil from frying and cooking that is produced both in homes and in commercial food manufacturing and service businesses. Repeated use of UCO has been linked by extensive scientific and medical research to a number of non-communicable diseases, including cancer, heart disease, and organ damage. Consumption of UCO in any form is regulated in many

countries, including India, due to its adverse health impact. However, through home and commercial reuse, almost 60 percent of the UCO produced in India makes its way back into the food chain.

The Repurpose Used Cooking Oil (RUCO) initiative was started by India's food-safety regulator, the Food and Safety Standards Authority of India (FSSAI), to combat the growing diversion of UCO back into food supply. The goal is to develop a legal and regulatory framework to shift UCO away from the food chain and towards other waste-to-wealth industries including bio-fuels, soaps, and oleo-chemicals. However,

this initiative has had limited impact due to policy gaps like those that allow topping up UCO with fresh edible oils, compounded by low levels of societal awareness, poor compliance among UCO generators, and ineffective ground-level implementation by the FSSAI and state-level food safety authorities.

Objectives of the Study

The present study looks to fill the gaps in literature that explore the public health impacts of UCO consumption in India by examining the extent, trends and processes through which UCO is diverted into the commercial food stream. By examining the behavioural practices of food business operators (FBOs) across four Indian metros—Delhi, Mumbai, Kolkata, and Chennai—the study focuses on the following trends:

- Edible oil consumption by type and location of FBOs;
- UCO generation by type and location of FBOs;
- UCO consumption by type and location of FBOs;
- UCO disposal by type and location of FBOs; and

- Awareness of food safety laws and the RUCO initiative by type and location of the FBOs.

The study also looks into how changes in the prices of edible oils, awareness levels of FBOs, and development of waste collection infrastructure, affect compliance with food safety guidelines and regulations of the RUCO initiative.

Methodology

The study employs a mixed-methods approach, combining an extensive literature review, expert and stakeholder interviews, and statistical and econometric analysis of primary data to examine the landscape of commercial UCO generation, consumption, and diversion into the food stream. It surveys 507 (101 large and 406 small) FBOs across four metros in India—i.e., Mumbai, Delhi, Chennai, and Kolkata.

Results

The study seeks to fill current knowledge gaps in identifying UCO consumers and producers among FBOs in India, estimating the volumes of UCO consumption among these businesses,

pinpointing the drivers of UCO sale and consumption, and the impact of state regulation and enforcement on the ecosystem. The following are key findings of the survey:

- **Smaller eateries buy cheaper cooking oils but spend more on oils as a percentage of their costs:** In comparison to large restaurants, small eateries typically pay far less for their cooking oil purchases. Thus, small restaurants are more likely to buy cooking oils of poor quality or sold 'loose' (not packaged), which may be mixed with UCO. Smaller restaurants in cities spend, on average, 15 to 25 percent of their daily budget on cooking oils.
- **Large eateries under-report volumes of UCO generation:** Out of a total of 101 large restaurants surveyed, all but eight reported daily UCO generation below 10 litres. With 70 percent of the large eateries' total daily consumption of cooking oil exceeding 50 litres, it is possible that some of them are grossly under-reporting their UCO generation. (The FSSAI guidelines are only applicable to FBOs consuming

more than 50 litres of cooking oil per day.)

- **Eateries continue to reuse UCO till the last drop:** The majority of large eateries across the four cities self-reported that cooking oil for frying was changed daily. However, among small eateries, especially in Delhi and Kolkata, respondents claimed that they cooked with UCO till the last drop. Similarly, respondents in Mumbai and Chennai claimed low volumes of leftover UCO, indicating a high prevalence of UCO self-utilisation.
- **UCO disposal is a challenge for large eateries:** Among large eateries in Delhi, Mumbai, and Kolkata, 53 percent claimed that they dispose of UCO in drains. This figure is significantly lower for Chennai where a larger proportion of eateries sell UCO to accredited collectors and aggregators. This claim of UCO being disposed of in drains has been challenged by experts and stakeholders who argue that it is a cover-up for continued UCO utilisation as well as resale to unauthorised traders, and the volume discarded in drains is minimal.

Small eateries do not face any issues disposing of UCO since they acknowledge that they reuse their cooking oils till the last drop.

- **Price incentives drive UCO sale:** Eateries, especially in Chennai, reported that better prices were the key drivers for not reusing UCO and selling the waste oils to aggregators and collectors.
- **Infrastructural support by local government bodies helps in UCO collection:** Chennai's local government bodies assist eateries in storage and disposal of UCO. There is no such support in the other three cities. This has led to more eateries in Chennai segregating and selling UCO to designated collectors and aggregators, helping ensure that UCO is removed from the food stream.
- **Awareness of regulations drives better compliance:** Awareness of the RUCO initiative is low, with the exception of respondents in Chennai. Chennai had a larger proportion of large and small eateries that do not reuse UCO and dispose of it through

designated collectors and aggregators. Awareness of food safety rules is even lower across small eateries than large ones, especially in Delhi and Kolkata. Small eateries freely reutilise UCO in their cooking. The linear regression model devised for this study indicates that for both large and small eateries, higher levels of awareness will reduce the likelihood of them reusing cooking oil by as much as 98 percent.

Policy Recommendations

India can do a lot more to address the challenge of UCO diversion into the food stream. The strategy will need a combined effort by all stakeholders including the government and the FBO sector, networks of doctors and nutritionists, as well as consumer rights groups. This report makes the following policy recommendations:

- **Harmonise UCO regulations:** The practice of topping up UCO with fresh oil, allowed by the FSSAI so far due to implementation capacity gaps, needs to be stopped. The guidelines should be expanded to account for all possible avenues through which

UCO could re-enter the food stream, including animal feed and household consumption. The FSSAI should also explore the feasibility of expanding RUCO compliance to eateries consuming less than 50 litres of oil per day.

- **Improve enforcement capabilities:** State-level food safety authorities that enforce UCO management rules are often short on personnel, ill-equipped, and poorly funded. The FSSAI must build institutional capacity from the ground up.
- **Promote awareness about the health impacts of UCO reuse:** The FSSAI needs to engage with other critical stakeholders in the ecosystem, including food industry associations, consumer groups, industry bodies, public health experts, doctors and nutritionists, to launch impactful and persistent awareness campaigns targeting FBOs. It needs to run awareness campaigns for consumers highlighting the risks of UCO consumption while providing actionable inputs on UCO disposal at the household level.
- **Improve industry self-regulation:** Stakeholders of the food manufacturing and services industries need to take on a more proactive role in ensuring compliance with food safety standards and regulations of their constituent members.
- **Develop infrastructure for UCO collection:** This present survey showed that compliance depends upon the presence of supporting infrastructure, including serviceability and access to UCO collectors and aggregators. The FSSAI can leverage the efficiency of the private sector as well as drive greater public-private collaboration with local self-government bodies to improve the physical infrastructure for UCO storage, collection, and disposal.
- **Promote principles of circular economy:** Since UCO has significant demand from non-food sectors including bio-fuels, soap and oleo-chemicals, there is scope to create an alternative structure to divert UCO out of the food stream through a market-driven incentive system. This will help drive circular-economy principles while also delivering positive health outcomes.

Introduction



India's consumption of edible oils has grown in recent years, alongside its overall consumption growth. Other factors have also driven the rise, including urbanisation, changes in tastes and preferences, and rising purchasing power largely attributed to per capita income growth. Various studies have found evidence of these patterns, including one in 2015 by the Observer Research Foundation (ORF).¹

Over the past five years, though India's production of edible oil seeds has increased by more than 44 percent, it barely meets 40 percent of the country's demand. The

annual consumption demand for edible oil is 25 million tonnes, of which 60 percent comes from households and 40 percent from the commercial sector (i.e., food manufacturing, hotels, restaurants, and other entities that serve food—together known as food business operators or FBOs).² Of the 25 million tonnes, only 10.5 million tonnes come from domestic production.³ The remaining 58 percent is imported, of which 86 percent consists of palm oil and soya oil. This high import dependence translates to high volatility in prices of edible oils in the domestic market, which rose to an 11-year high in early 2021 following disruptions in global edible oil supplies.⁴

With the rise in consumption of edible oils from 11.2 litres per capita in 2005–06 to 19.5 litres in 2015–16, there has been a corresponding increase in the generation of used cooking oil (UCO).⁵ UCO is classified as waste edible fats and oils of animal or vegetable origin, which is the residual by-product of cooking food, particularly frying at higher temperatures.⁶ The primary generators of UCO are households and FBOs.

There is overwhelming evidence that repeated consumption of UCO increases the risk of contracting many non-communicable diseases, including cancers and cardiovascular diseases, and can lead to organ damage.^{7,8} Yet, 60 percent of the UCO generated in India finds its way back into the food stream through domestic and commercial reuse.⁹

In 2018, India's food safety regulator, the Food Safety and Standards Authority of India (FSSAI) issued guidelines seeking safety standards for edible oil use and UCO disposal. Subsequently, the Repurpose Used Cooking Oil (RUCO) initiative was launched in 2018 to create a regulatory mechanism to promote sustainable and non-hazardous disposal of UCO into

biodiesel manufacturing. More recently, the ambit of the RUCO initiative has been expanded to include disposal of UCO by using it in the manufacture of soap and lubricants as well.¹⁰ The initiative also launched a number of public awareness campaigns about the health risks of consuming UCO and appropriate disposal methods. These initiatives are premised on the fact that UCO could be better diverted to other sectors—such as biodiesels and oleo-chemicals—and could thereby promote principles of circular economy and sustainability instead of negatively impacting public health. However, the initiative has fallen short of its goals: societal awareness remains low, there is poor ground-level implementation, and UCO generators often do not comply.

Though the FSSAI rules came into force on 1 July 2018, compliance levels across the food manufacturing and business sectors have been low.¹¹ Additionally, since the regulations of the RUCO initiative only apply to FBOs that consume more than 50 litres of edible oil per day, a large majority of small food business operators escape any regulatory oversight.¹² Consequently, waste oil

generated in the commercial sector finds its way back into the food stream through reuse, or is sold to roadside food vendors. According to media reports,¹³ pricing plays an important role in reinforcing the “substitution effect”, with loose UCOs sold at a much lower price than branded and packaged edible oils.

While there are existing studies establishing the health risks of UCO consumption, these have critical gaps in understanding the full scope of the challenge in India. For instance, while the studies have documented the various genotoxic and carcinogenic risks associated with UCO consumption, they do not explain the socio-economic dynamics of UCO consumption, nor the environmental challenges, public-health outcomes, and impact on health expenditure and productivity of communities.¹⁴

This study is an attempt to fill the knowledge gap, from a commercial perspective, on how UCO gets diverted into the food stream. It does not engage with the issue of UCO consumption at the household level. It examines edible oil consumption and UCO generation

practices of commercial food service establishments across four cities in India—i.e., Delhi, Mumbai, Kolkata, and Chennai. The results will provide greater clarity on UCO generation and management at the commercial level, identify triggers for reuse of UCO in commercial food preparation, and offer lessons that can help enhance policy and improve the regulatory and enforcement regime for UCO management in the country.

Methodology of the Study

The report has four sections. Following the Introduction, Section II examines existing literature on the health implications of UCO consumption. Section III outlines the global and national trends in UCO consumption as well as the overall UCO ecosystem, and most importantly, attempts to identify global best practices in UCO management and repurposing. Section IV presents the findings of a quantitative and qualitative analysis of the patterns and triggers of commercial UCO generation, consumption and disposal across the four metros. It also presents results from interviews with medical and nutrition

professionals. The report concludes with a set of recommendations towards better management of the UCO ecosystem in India, particularly in commercial establishments.

The first step was identifying existing gaps in the literature on UCO consumption and management in India. The authors referred to academic literature, media reports, and consumer knowledge products such as press releases, advertisements, and pamphlets. Once the gaps were identified, a primary survey was designed to enable a quantitative and qualitative analysis of the UCO ecosystems in India. The primary survey consisted of two phases: a structured survey across the four metro cities,¹⁵ and interviews with medical practitioners and nutritionists.

The first phase of the primary survey entailed interviews based on a structured questionnaire administered to proprietors of 507 commercial FBOs across the four cities. The questionnaire sought to fill current knowledge gaps in identifying UCO consumers and producers among FBOs, their volume of UCO consumption,

the drivers of UCO sale and consumption, and the impact of state regulation and enforcement on the ecosystem. The sample was drawn from two segments: large eateries, comprising dine-in restaurants, quick-service restaurants, canteens in commercial establishments, and marriage and banquet halls with more than 50 litres of average daily consumption of cooking oil; and small eateries, such as roadside eateries, food carts, and fritters stalls. Using descriptive statistics and econometric methods, the study tries to understand the associative and causal relationships between variables impacting UCO reuse, sales, and compliance with regulations. The study also maps the spatial divergences of FBO behavioural practices across the four cities.

The second phase involved a series of expert interviews with 32 doctors and nutritionists to estimate levels of awareness and knowledge about UCO consumption and its ill-effects among patients and the scientific community.

While the research team exerted their best efforts to ensure the quality and

robustness of the methods of analysis, the study admits to the following limitations:

1. It does not attempt to map the complete UCO supply chain in India.
2. While it discusses, to some extent, the health implications of UCO consumption and how it could worsen the country's disease burden, it does not specifically examine household-level UCO consumption.
3. Most of the questions posed to the commercial establishments in the first phase of the survey, particularly those related to the operations of UCO markets, are about practices that are legally disallowed, but which nonetheless continue. The responses thus needed to be contextualised while reporting them.
4. Both phases of the survey were conducted while the COVID-19 pandemic was still causing high numbers of infections across the country; the research team admits to operational difficulties in the study.

Endnotes

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Health Risks of UCO Consumption: A Literature Survey

Used Cooking Oil (UCO), the residual by-product of cooking and frying food, is categorised as a hazardous waste. UCO comprises mainly edible oils used for frying at high temperatures and edible fats discarded with kitchen waste.¹ Households, restaurants and eateries, and food processing industries are the primary generators of UCO.

Repeatedly heating cooking oil creates lipid peroxidation products and excess polar compounds, which are known to be hazardous to health and can lead to or

aggravate co-morbidities. Repeated UCO heating and consumption is also a high-risk factor for various cancers.² It reduces the nutritional quality of foods, as the process of re-heating cooking oil causes essential tocopherols, amino acids, and fatty acids to decompose.³

This section reviews the scientific evidence related to UCO consumption and its hazards. It also outlines the initiatives of the Food Safety and Standards Authority of India (FSSAI) to tackle the reuse and diversion of UCO into the food stream.

Health Impacts of UCO Consumption

Reusing cooking oil till it gets over is a common practice across commercial eateries and households in India. Such repeated heating, especially more than four times, generates compounds and free radicals, including polycyclic aromatic hydrocarbons (PAHs). The composition of oils, and the foods cooked in used oils, are dependent on various factors such as the duration and temperature of frying, frying method (deep/shallow/stir), oil type (sunflower, soya bean, coconut, or others), saturation ratio of oil, and the presence of a catalyst or antioxidant.⁴ Therefore, PAHs too, change remarkably with the varying

characteristics of the cooking oil being used. Some of these PAHs are reported to possess massive genotoxic, mutagenic and carcinogenic potential contributing to the development of gastro-intestinal tract cancers.⁵⁶ Moreover, the more UCO is used for frying, the protein content in food decreases, and fat and fatty acid content increases. After two or three frying cycles, the quality of food starts declining.⁷ Research on coconut oil, commonly used in India's southern regions for cooking, has found that PAH content of UCO was up to five times higher than that of fresh cooking oil and about 2.5 times higher than that of single-heated oil.⁸ Table 2.1 summarises the studies that document the adverse impacts of UCO consumption on health.

Table 2.1: Literature Survey: Health impacts of UCO consumption

Authors	Source	Findings
Manchanda and Passi (2015)	<i>Indian Heart Journal</i>	The quality/quantity of dietary fat and trans fatty acids (TFA) intake has significantly elevated associations with coronary heart disease, a leading cause of mortality in India.
Ganesan et al. (2016)	<i>Critical Reviews in Food Science and Nutrition</i>	Reheated cooking oil and its fumes can pose health hazards associated with malignancies, including lung, colorectal, breast, and prostate cancers.
Rajendrana et al. (2020)	<i>Critical Reviews in Food Science and Nutrition</i>	Acute exposure to certain PHAs causes mutations and aberrations to the BRCA1 gene, seriously heightening the risk of breast cancer in women.

Authors	Source	Findings
Lamboni et al. (1999)	<i>Bulletin of the Chemical Society of Ethiopia</i>	When fed used cooking oil, rats developed enlarged livers, dermatitis, hair loss, and significant changes in their metabolism and platelet functions, resulting in clotting.
Saleh et al. (2015)	<i>International Journal of Advanced Research</i>	Researchers observed considerable weight loss in experimental animals fed with UCO due to decreased protein and albumin and increased glucose and creatinine.
Ng et al. (2014)	<i>Vascular Pharmacology</i>	After three frying cycles, cancer risk values of oil exceeded acceptable risk norms. Long-term consumption of repeatedly heated oil tends to increase blood pressure and total cholesterol, and cause vascular inflammation, atherosclerosis, and hypertension.
LodoviciDe et al. (2009)	<i>Food Additives & Contaminants</i>	Exposure to PAH due to heat processing of oils at high temperatures is an element of cancer risk. Reheated edible oil, along with meat and cereals, is a significant non-occupational source of PAH for non-smokers.
S. Ima-Nirwana et al (2007)	<i>Singapore Medical Journal</i>	Reheating edible oils can lead to bone osteoporosis in the long run. It is also associated with illnesses of cognitive decline such as Alzheimer's, Parkinson's Disease, and dementia.
Adam et al. (2008)	<i>McGill Journal of Medicine</i>	Palm oil, when reheated several times, increases total cholesterol and serum levels of thiobarbituric acid reactive substances, which predispose bodies to atherosclerosis. It affects, to varying degrees, the levels of estrogen, especially in post-menopausal women.
Gul Ambreen et al., (2020)	<i>Lipids in Health and Disease</i>	Prolonged consumption of food cooked in repeatedly heated edible oils can lead to hepatic diseases. It can impair liver and kidney function and destroy histological structure significantly through fat accumulation and oxidative stress.
Cahill (2014)	<i>The American Journal of Clinical Nutrition</i>	Frequent consumption of fried food increases the risk of Type 2 diabetes and coronary artery disease. Using repeatedly heated oil to deep fry can exacerbate existing co-morbidities.

Benefits of Removing and Recycling UCO

Removing UCO from the food streams has immediate and long-term health benefits. Increasing awareness levels,

and ensuring regulatory compliance with food safety laws, is vital to limiting exposure to food prepared in UCO. When UCO is reused or not appropriately stored, it can develop bacteria that causes food poisoning.⁹

Box 2.1: Benefits of removing and recycling UCO

Employment generation and economic benefits

The collection of UCO not only prevents it from re-entering the food stream, but also enables its more productive use in the biodiesel, soap, and oleo-chemicals sector. This can expand these sectors beyond their current nascent levels and create more employment.

Cleaner environment through reduced carbon footprint

Direct disposal of UCO into drains can clog the sewerage system. Proper collection and management of UCO can be a crucial step towards facilitating a cleaner environment in two ways: (i) reducing its improper disposal into drains; and (ii) processing it into bio-fuels, whose greenhouse gas emissions are 86-percent lower than those of fossil fuels.

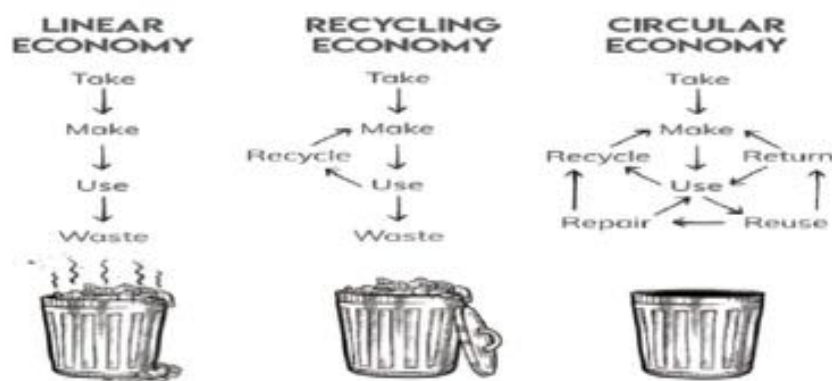
Reduction of import dependency

Diverting UCO into the bio-diesel sector can facilitate reduction in crude imports by decreasing dependency on traditional fuel sources, albeit to a limited extent.

Promoting a shift towards a circular economy

Compared to a linear or a simple recycling economy, the circular economy model aims to create additional value from waste materials that have significant spill-over benefits. Figure 2.1 shows how the model uses sustainable waste as a resource. The FSSAI's RUCO initiative envisions the creation and implementation of a resilient circular economy in India.

Figure 2.1: Circular Economy Model



Source: RUCO Booklet, FSSAI

The UCO Ecosystem in India

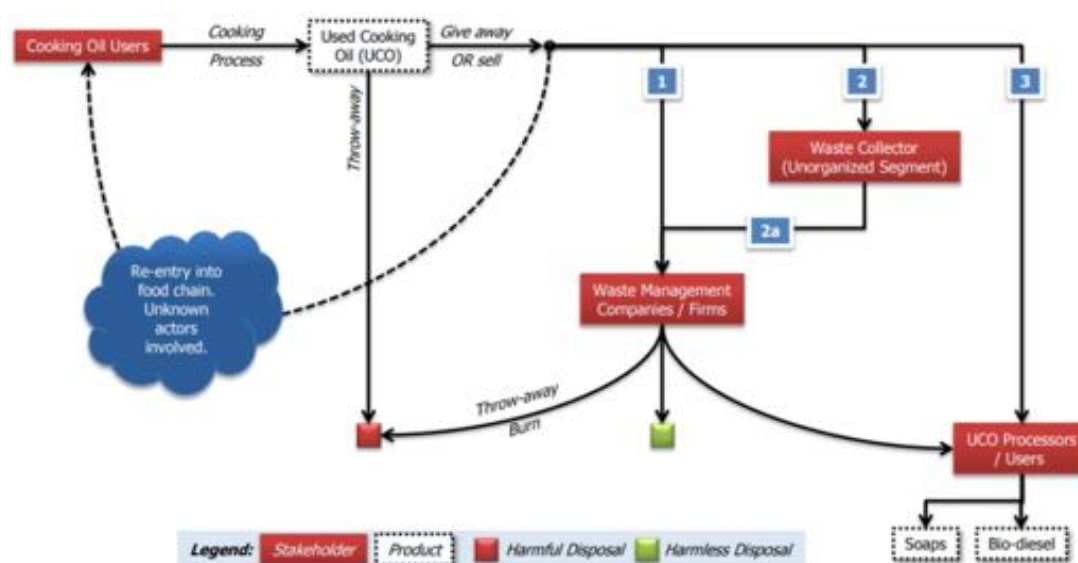
Generation of UCO

In India, households consume nearly 60 percent of all edible vegetable oil. The food processing and services industry—which includes hotels, restaurants, cafes, street food vendors, and food manufacturing entities, collectively known as food business operators (FBOs)—uses the rest.¹⁰ By source, therefore, the market for UCO can be classified into two sectors: household and commercial. Households remain a significant source of UCO generation, but due to their unstructured nature, concrete data on how much UCO they generate or consume is not available. The challenge of UCO collection from homes

is aggravated by low awareness of the detrimental effects of UCO consumption.

There are estimates, however. It has been estimated that the potential for UCO collection from urban centres in India (households and FBOs) is 1,697 kilotonnes a year.¹¹ Of this, the collection potential from homes is relatively small, at 117 kilotonnes per year. Only 13–19 percent is currently being collected. Other countries in the region collect far more: China (60–80 percent); Indonesia (25–37 percent); Japan (21–37 percent); and Malaysia (30–45 percent).¹² In the absence of a mechanism for collection, the bulk of the used oil is disposed of in harmful ways such as re-consumption, open disposal, and discarding in drains.

Figure 2.2: Ecosystem for production, use and disposal of UCO



Source: FSSAI¹³

Figure 2.2 outlines the processes of UCO generation, consumption, and disposal in India.

The FSSAI has also estimated the potential availability of UCO after considering patterns of production and consumption. Table 2.2 shows the availability and potential generation of UCO in India.

The initial estimate for UCO generation and collection potential from the commercial sector stands at 15 percent and from the household sector, at 5 percent. FSSAI norms require FBOs to discard edible oils which have been reheated four times consecutively or when their total polar compound (TPC) levels reach 25.

Table 2.2: UCO Generation in India

Source	Availability (crore litres)	Potential generation (%)
UCO commercial	148.00	15%
UCO household	74.00	5%
Total	222.00	

Source: RUCO Booklet, FSSAI

The FSSAI rules were announced on 1 July 2018. However, their on-ground implementation remains weak. FBOs are not disposing of UCO in the volumes they are supposed to. The FSSAI's own estimate concluded that 3 million tonnes of UCO are generated annually across the country, of which around 60 percent returns to the food stream.¹⁴ The UCO norms apply only to FBOs consuming 50 litres or more edible oil per day. Some FBOs allegedly under-report their use as below 50 litres in order to bypass the rules.¹⁵

A 2020 survey across large and small eateries in Bengaluru revealed that, on average, 29 percent of UCO is left over from overall oil consumption.¹⁶ It found that nearly 5-10 percent of UCO was thrown away in drains, while the remaining was either collected by

workers/ waste-collecting agents or used again for cooking.

UCO Consumption in India

Edible oil wastes such as UCO can be optimally utilised in other industries as raw material. To mitigate the risks involved in improper handling and disposal of UCO, countries around the world have explored sustainable solutions through UCO consuming sectors. Apart from food, the UCO consumption market consists of soaps and oleo, animal feed, and auxiliary fuels. Synthesising renewable fuel to decompose UCO holds promise as a cost-effective solution. Diverting UCO for the production of biofuels not only increases the lifecycle of the product and prevents contamination, but also enables recovery of valuable energy content.¹⁷ Table 2.3

Table 2.3: UCO Consumption Sectors

	Availability (crore litres)	Current consumption (%)
Food	133.20	60%
Soaps & Oleo	33.30	15%
Misc. (including biofuels)	22.20	10%
Animal feed	33.30	15%
Total	222.00	100%

Source: RUCO Booklet, FSSAI

depicts the broad patterns of current consumption.

The FSSAI estimates that there is potential for recovering nearly 3 million metric tonnes of UCO annually for the production of biodiesel, much of which is being diverted back into the food stream.¹⁸ Ideally, UCO utilisation should be directed towards sustainable alternatives like biodiesel, soap, and oleos.

transferring it to UCO processors; and (c) transferring it to waste collectors or waste management companies. While selling to UCO aggregators or waste management agents would be ideal, the bulk of UCO from households and commercial enterprises in India is either mixed with fresh oil and reused, or thrown away. The first adulterates essential food value chains, while the second causes significant environmental damage.

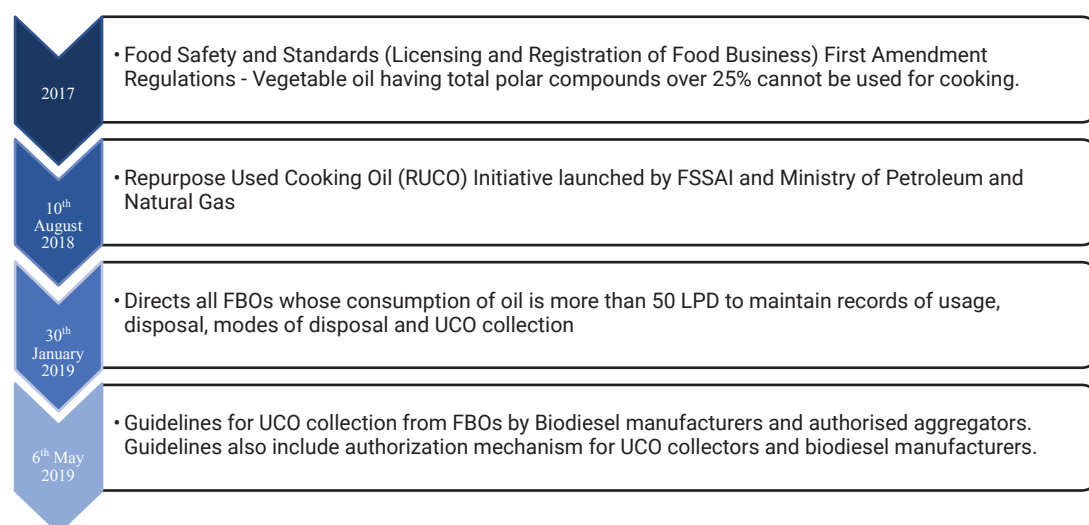
UCO Disposal

At present, UCO is disposed of in three ways: (a) pouring it into drains, on the ground or in water bodies; (b)

UCO Regulation and Management in India

The FSSAI is tasked with ensuring the removal of UCO from the food stream.¹⁹

Figure 2.3: FSSAI Timeline of UCO use, collection and management notifications



Over the past few years, it has taken multiple initiatives to ensure improved UCO management and disposal. Figure 2.3 depicts the timeline of UCO-related regulations launched by the FSSAI.

The RUCO Initiative²⁰

The RUCO initiative aims to remove UCO from the food stream and make it available as feedstock for biodiesel manufacturing. The following are the main drivers of the RUCO initiative:

- Health benefits of removing UCO from the food stream;
- Environmental benefits of proper disposal of UCO;
- Recognition of UCO as potential feedstock for biodiesel manufacturing in the National Bio-fuels Policy, 2018. The policy seeks to achieve 5-percent biodiesel blending by 2030. The current blending rate is only 0.16 percent;
- Reduced import dependency (on palm stearin); and
- Push towards a circular economy.

The RUCO initiative is being implemented through a strategy of 'Education, Enforcement and Ecosystem' (EEE).

- **Education:** Guidelines/standard operating procedures have been issued to FBOs for proper UCO management. Efforts are underway to educate customers.

- **Enforcement:** The agencies responsible are state food and drugs administrations (FDAs) and Food Safety Commissioners. They have to ensure that FBOs consuming more than 50 litres per day of edible oil dispose of their UCO to recognised UCO collectors.

- **Ecosystem:** Systems are being set up to track real-time data on UCO collection and disposal. The authorities are also working with stakeholders to provide FBOs accreditation and compliance certification.

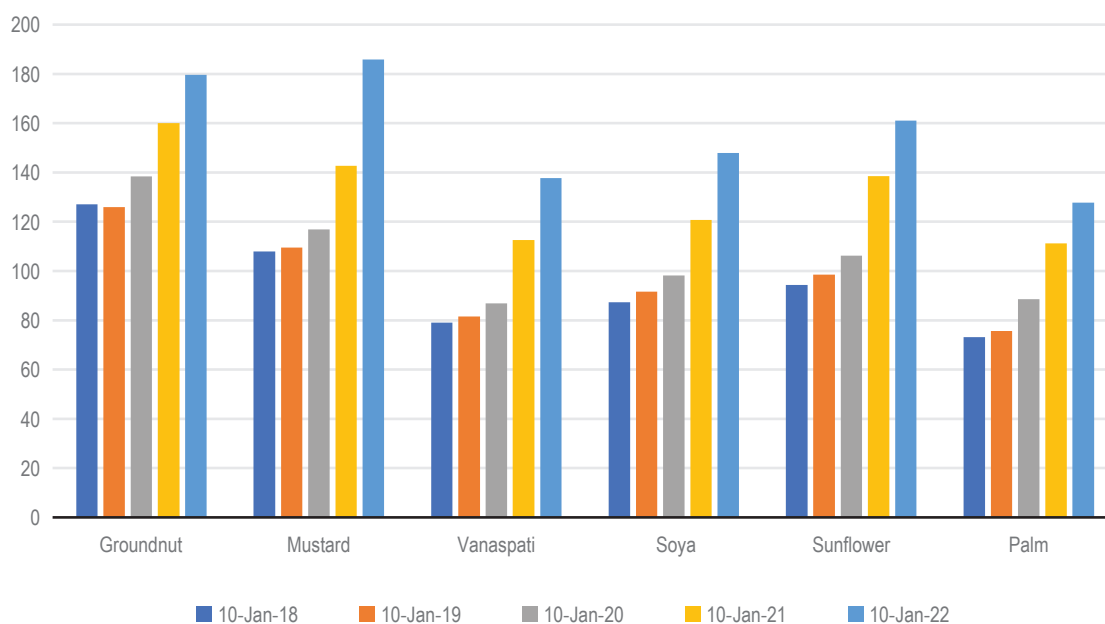
Impact of Re-entry of UCO in the Food Stream

The FSSAI's recent guidelines permitting the topping up of UCO with fresh oil legitimises the continued use of UCO by FBOs.²¹ Studies have shown that in India, the reuse of UCO is mostly deliberate and not unintentional.²²

Poor disposal practices and the lower cost of UCO are the main reasons driving the deliberate re-entry of UCO into food streams. Smaller eateries or street-side vendors may well be purchasing repackaged, cheaper oils from unregulated markets, unaware of their poor quality. UCO is available online at prices ranging from INR 35–52 per litre.²³ The price difference with fresh cooking oil is key to the proliferation of UCO back into the food chain. Smaller FBOs also often do not know how to differentiate between clean and used oil in terms of Total Polar Compound (TPC) levels.

Since 2018, the retail price of every kind of edible oil—groundnut, mustard, vanaspati, soya, sunflower, and palm—has increased substantially, more so since the COVID-19 outbreak in 2020 (see Figure 2.4). Further, following Russia’s invasion of Ukraine in February 2022, edible oil prices have been soaring, specifically for sunflower oil. Community surveys have found that prices jumped from 25–40 percent within 45 days of the invasion. It has led to depleted savings in households and efforts to cut down expenses by using inferior-quality oils.²⁴

Figure 2.4: National average retail prices of different edible oils (in INR per Kg)



* Country average of daily prices on 10 January for each year are taken.

Source: Department of Consumer Affairs, Government of India

This may well drive more UCO into the food chain. If prices increase further, there will be more economic incentive for the smaller enterprises to buy UCO from the bigger FBOs.

In India, the consumption of edible oils has increased steadily in recent years. Domestic production is unable to meet the demand and the gap is met by imports. In 2019–20, imports constituted around 56 percent of the country's total availability of edible oils. Supply chain bottlenecks caused by the COVID-19 pandemic and the Russia-Ukraine crisis have sharply increased the global prices of edible oils in recent months.²⁵

The short-run impact of this rise is that it may increase the trend of the smaller food operators, roadside vendors and eateries buying UCO in search of cheap alternatives. It is widely acknowledged that big hotels and FBOs are the principal generators of UCO, and they sell it—mostly bypassing existing norms—to retrieve a part of their production costs, and that small eateries buy it because it is cheaper than fresh packaged oil. But this is not always true, nor does it convey the full picture. Different stakeholders have

varied motivations for utilising UCO. Though law enforcement agencies often apprehend illegal operations of UCO, the network gets rebuilt as demand for UCO is steep. The pandemic has worsened the situation as UCO-based biodiesel producers are now facing shortages of UCO—their primary feedstock—leading to many of them shutting production, which implies that more UCO is flowing back into the food stream.²⁶

Gaps in the Literature

While the generation, consumption and management of UCO are widely explored themes, there are gaps in the literature which the current study intends to fill. Various scientific studies have investigated the health impacts of UCO through different methodologies. However, few studies have focused on aggregate UCO generation potential in the Indian context. Moreover, the local UCO supply value chain, and its links with various economic agents in the country, also remains unexplored. Thus, little information is available on what the FBOs and restaurants in India do with the generated UCO and how the current regulation has impacted

its disposal. There are also few studies exploring the role of UCO collectors and aggregators, and big industries that absorb UCO for further value creation in India. At the individual or household level, the literature does not provide clear information on the breakdown of UCO consumption across socio-economic communities.

The present study investigates some of the gaps in the literature on UCO generation, consumption, awareness, and regulatory compliance in India.

Specifically, it analyses the spatial differences across India's four largest metros in these four areas. It also tries to map occupational behaviour differences among large and small eateries with regard to the drivers of regulatory compliance and sustainable management of UCO. An analysis of the results of the primary survey, as well as lessons from global best practices, have been distilled to provide policy recommendations for public and private stakeholders to address the UCO consumption challenge in India.

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III.

UCO Generation, Consumption, and Regulation: Global Trends

Global Consumption and Disposal Trends

While developed countries have more efficient mechanisms in place for the management of waste cooking oil, those in the Global South are beginning to acknowledge the need for remedies. Countries in South Asia and Southeast Asia, in particular, are struggling with the re-entry of used cooking oils (UCO) into their food systems in the absence of concrete regulation, compounded by poor public awareness.

A decade ago, China was facing similar difficulties in regulating the use of UCO (also known as 'gutter oil') in the food industry and initiated a crackdown. At that time, estimates pegged the country's annual consumption of gutter oil at nearly 20 million tonnes.¹ In Malaysia, meanwhile, a household-level survey in 2013 found that there was abysmal knowledge on the proper disposal of used cooking oil: only 12 percent of the surveyed households recycled UCO. The study also found that it is the cost factor that primarily drives the repeated use of cooking oils.² After multiple uses, much of these reheated cooking oils were then

being poured down drains, kitchen sinks, or into waste bins and polluting the environment.³

In Iran, about 72 percent of waste oil from households is thrown either in garbage or into sewers.⁴ Some of it is also utilised for poultry feeding, without first refining it, again risking entry into human bodies and long-term damage to population health.⁵ For its part, Indonesia's community-level management of UCO is also led by throwing almost 40–50 percent of it into drains or directly into the ground.⁶ The problem exists in Africa too: in Nigeria, for example, repeated use of cooking oil due to price factors and lack of consumer and producer awareness, is prevalent.⁷

In 2014, a “used oil scandal” erupted in Taiwan: media investigators found that used oil from leather factories and food waste were being mixed with fresh oil and sold to the public. Authorities had to order the withdrawal of food items from market shelves in Hong Kong and Macau.⁸ This incident drove Taiwan in 2015 to recognise UCO as a mandatory recyclable waste and, with help from private collectors and recyclers, there was an almost 687-percent increase in

waste oil collection from households by 2017.⁹ The government made policy changes to channel UCO towards biodiesel and oleo products.¹⁰ These efforts, coupled with robust implementation, are today bearing results in terms of prevention of diversion of UCO into the food chain, and biodiesel production is often supplemented by imports of UCO from other countries to achieve scale. Moreover, other Asian countries such as China, Singapore, Thailand, and Indonesia have also started engaging in waste UCO collection and recycling.

In many countries in the West, the generation and recycling of UCO is governed by strict regulatory systems that have been in place for the past decade or so. These countries have stringent regulations for UCO that promote efficient collection systems and generate greater demand for UCO as fuel pathways. The European Union (EU) and the United States (US) now import UCO, largely for use as biodiesel feedstock: within just five years (2011–2016), there was a 360-percent increase in the use of UCO in biodiesel from 0.68 million tonnes to 2.44 million tonnes. Low-cost renewable fuel and effective usage

promotion policies mainly drove this shift. A large part of these imports are from China, Indonesia, and Malaysia. In 2018, the EU imported more than 500,000 tonnes of UCO from these countries.¹¹ However, the production of bio-fuels in Asia remains weak at less than 5 percent of all the transport fuels.¹²

At present, there is no global import or export standard for UCO based on any international consensus. This is an important impetus to the future export potential for UCO, mainly for biodiesel production. The emerging market for UCO in the EU resulted in a rise in prices, and this has also led to increased reported UCO theft in countries such as the UK.¹³

Box 3.1: UCO: In Search of Universal Definitions

Countries use different parameters, including frying temperature, acid value, smoke point, polar compounds and polymers, to classify the safety of used cooking oil. The most widely adopted indicator to classify whether the edible oil is safe for human consumption is the 'Total Polar Compound' (TPC) level of the oil.

Countries such as France, Italy, Germany, and Spain legally classify oils with a TPC exceeding 25 percent to be unsafe for human consumption. Similarly, Germany and Brazil recommend the TPC levels for cooking oils to be below 24 and 25 percent, respectively. In 2019, the FSSAI, India's food safety regulator, defined edible oils with TPC higher than 25 percent to be unsafe for human consumption.

Box 3.2: Regulations and Management Practices

Evolution and changes in UCO regulations

UCO management and collection practices have been in place in several OECD countries since 1990. Regulations affecting UCO management have undergone changes shadowing emerging scientific findings on the risk factor of UCO consumption. For instance, UCO was widely used in the preparation of animal feed in the UK and the EU up to around 2004, when the practice was banned to safeguard animal and human health.

UCO collection and promoting a shift to renewable fuels in the UK

Under the UK's Environmental Protection Act, 1990, catering businesses are obligated to ensure proper storage and collection of UCO by an authorised collector. Household-generated UCO is collected separately at oil banks in recycling centres for further treatment and processing. Moreover, through the annual 'Renewable Transport Fuel Obligation' (RTFO) guidance, the UK mandates fuel suppliers to progressively increase their targets of transport fuel generated from sustainable renewable sources.

Management practices in the EU

In the EU, UCO collectors and waste management firms ensure UCO recovery from commercial establishments. However, UCO collection from households is only operational in some member countries, including Austria, Belgium and Netherlands. In Finland, households are advised to dispose of UCO in sealed packages in mixed waste bins. Subsequently, these waste products, which are deemed unsuitable for recycling, are converted to electricity at waste-to-energy plants.

Regulation and collection of UCO in the US

In 2007, the US Environment Protection Agency prohibited the discharge of any fats, oils, and grease (FOG) from food service establishments (FSE) into publicly owned sewage treatment works. The FSEs are advised to collect the UCO and schedule its pickup by authorised collectors for resale and reuse in non-food sectors such as animal feed manufacturers and bio-fuels.

UCO Management: Best Practices

The circular-economy model for UCO collection and recycling has been in place in many countries across the globe, both for household and commercially generated waste oil. One of the earliest waste oil management models was initiated in Kyoto in Japan, where UCO collection from households began in 1997.¹⁴ By 2006, the city had collected 1.5 million litres of UCO from households and commercial establishments combined. In 2004, Kyoto started operating a waste oil recycling facility that had the capacity to process over 5,000 litres of UCO every day for manufacturing biodiesel. The produced bio-fuel was utilised to power the city's garbage trucks and buses. Kyoto also pioneered in setting quality standards in production, well before the national government did.

In the US, various public UCO collection programmes are in place across certain states. One such programme has been implemented in a number of counties across North Carolina since 2011, where the waste oil can either be dropped at locally available convenience centres

or collected by local aggregators.¹⁵ UCO collection companies, including in-state biodiesel producers, provide containers and collection services at no cost to participating restaurants, in addition to paying for the UCO.

As countries look for alternatives to replace conventional fuel sources to reduce dependence, the biodiesel manufacturing industry has seen considerable growth in private investments. Manufacturers of renewable fuel enter into circular-economy partnerships with restaurants, collectors, and municipal corporations across the US and Europe to materialise its waste-as-a-resource method. For example, Neste, a Finnish company, collects UCO and other waste oils from over 110 restaurants in Oakland through a partnership with the local government.¹⁶ The project collected 750,000 litres of UCO within just the first three months of implementation. The UCO is then converted to renewable diesel, which powers the city's public transport and equipment.

The waste oils are also used to process sustainable aviation fuel (SAF) for the San Francisco International Airport.

Similarly, Neste has also partnered with Hesburger and McDonald's in Finland and the Netherlands, respectively, to recycle UCO from outlets across the country.^{17,18} The collected UCO is then supplied to the company's refinery where it is processed into renewable diesel. The generated fuel is used to power the logistics of the partners and aggregators, reducing their overall carbon footprint.

In recent years, similar circular-economy partnerships have also emerged in other parts of the world. Taiwan has implemented one of the most successful regulations to tackle the waste cooking oil problem in its region. In 2015, the Taiwanese Environmental Protection Administration (EPA) made it mandatory for both households and commercial establishments to recycle UCO.¹⁹ To improve UCO collection, the EPA established a four-in-one recycling programme that enhanced cooperation among three key stakeholders: community residents, collectors and recyclers, and local governments. Further, a recycling fund was created to subsidise the costs of collection for UCO aggregators and the municipal corporation. Today, over 60

percent of the generated UCO is recycled into energy sources or chemical products (i.e., soaps, stearic acid), while the rest is used for manufacturing animal feed.

Meanwhile, Bali in Indonesia, a popular tourist destination, initiated in 2015 a project to collect UCO from participating hotels and restaurants for processing high-quality biodiesel.²⁰ Waste oil was collected by plant operator Lengis Hijau (a non-profit UCO recycling company) at hotels and restaurants or was brought to the processing plant directly by the generators. In India, Ananda Oil Corporation (AOC) was designated as an authorised UCO aggregator in Kanchipuram, Tamil Nadu.²¹ The firm tied up with FSSAI as part of the latter's Repurpose Used Cooking Oil (RUCO) initiative to facilitate and support the collection of used cooking oils and its conversion into biodiesel. Previously, AOC had also collaborated with FSSAI for UCO collection in Madurai district in the same state. By 2020, AOC had collected over 30 metric tonnes of UCO from Madurai, of which 20 metric tonnes had been sent to a biodiesel manufacturer to be converted into bio-fuel.

Box 3.3: Global best practices on UCO management: Lessons for India

Harmonisation of UCO reuse regulations across all food sectors

Regulations on UCO management across the globe explicitly state that waste oils cannot be further topped with fresh oil to prolong its use. However, in 2022, the FSSAI has allowed food manufacturing entities and operators to continue this practice on account of a lack of regulatory capacity to enforce the laws. This move by the FSSAI negates past efforts undertaken through the RUCO initiative to remove UCO from the food stream. It legitimises practices that could have grave consequences for public health.

UCO management rules cover all waste-oil generators

Similarly, UCO regulations in other parts of the globe cover not only commercial operations but also household waste oil generation. In India, close to 60 percent of edible oil is consumed at the household level, where there is poor consumer awareness of the health risks of UCO consumption and limited knowledge of UCO management and disposal. Moreover, there is also significant scope to include small FBOs within the ambit of regulations to improve compliance and promote better food safety practices.

The intersection of UCO regulations and public policy imperatives

Globally, attempts to remove UCO from the food stream have also aligned themselves with other public programmes to promote energy security and sustainability, and to drive principles of a circular economy.

Driving public-private collaboration to manage UCO

Initiatives across the globe, particularly in Finland, Netherlands and Taiwan, have demonstrated the positive effects of public-private collaboration in UCO management. In addition to building resilient practices to remove UCO from the food stream, these collaborations also build incentives for large UCO generators to comply with regulations, such as providing biofuel for transport.

Strengthening local self-government bodies to regulate and manage UCO

UCO management and disposal often falls under the ambit of local self-government bodies like municipalities and federal governments. As evident in the examples of Kyoto (Japan) and North Carolina (US), political will and robust regulatory compliance at the state level have created efficient regulatory processes to ensure that UCO is diverted to non-food sectors.

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IV.

City-Level Data Analysis

Basic Characteristics of the Study Sample

To explore the gaps identified in the literature survey, this study collected data from four large Indian cities, surveying 507 small and large eateries.¹ Most of these smaller eateries operate within the large informal sector and not all of them can be found in an exhaustive census. It was for this reason that the authors did not employ any specific methodology in sampling. Each city was divided into different zones and interviewers were assigned a mix of

residential marketplaces and commercial areas. The interviewers conducted purposive sampling within these clusters and contacted respondents who matched the required profile. A pilot was conducted in all four cities to streamline the data collection process and strengthen the instrument.

There are some essential characteristics common to the sample, primarily relating to the scale of business operations. These, correlated with their magnitude of oil consumption, their related transaction costs, and share in total expenditure, helped the research

team gauge their propensity to divert UCO into the food stream. A total of 101 large eateries were surveyed across four cities: 26 in Mumbai and 25 each in Delhi, Chennai, and Kolkata (see Appendix 1.1 for details). The number of small eateries in the sample was 406: 101 in Delhi, 100 in Mumbai, 104 in Chennai, and 101 in Kolkata (see Appendix 1.2 for details).

Most of the large eateries had been operating for more than five years at the time of the survey. All 25 in Delhi, 23 (out of 25) in Kolkata, 21 (out of 26) in Mumbai, and 18 (out of 25) in Chennai fall under this category. Of the total 406 small eateries, 303 (nearly 75 percent) have been operating for more than five years and could be considered as “stable”. This large proportion enhances the reliability and general applicability of the observations presented in this report.

In terms of scale of operations, large eateries in Delhi and Kolkata operate with smaller numbers of workers (11 to 20); those in Mumbai and Chennai employ more than 20. Of the 25 large eateries in Delhi, 21 operate with 11 to 20

workers (see Appendix 1.3). Around 300 of the surveyed small eateries operate with more than 10 workers. However, a sizeable number of 86 small eateries are run only by one person, i.e., the owners themselves – of which, 46 are in Chennai and 21 are in Kolkata and the remaining in Mumbai and Delhi (see Appendix 1.4).

The number of workers employed across these eateries is consistent with the number of orders they sell daily. In Mumbai and Chennai, large eateries serve more orders (both on weekdays and weekends) than those in Delhi and Kolkata. In terms of oil consumption, 69 of the 101 large eateries reported consuming more than 50 litres of different kinds of cooking oil, butter, and ghee daily. Therefore, roughly 70 percent of the large eateries surveyed for this study fall under the UCO norms prescribed by the FSSAI. For small eateries, the daily average number of orders varies widely within and across the cities over the week. Notably, more small eateries in Mumbai and Chennai serve more than 100 orders daily, on average, compared to those in Delhi and Kolkata.

Tracking Expenditures on Refined Oils

The literature survey suggests that small eateries, on average, purchase cooking oils at significantly lower prices compared to the large eateries. The literature correlates this low purchase price of cooking oils with two consumption trends among the small eateries. First, they are more prone to purchasing low quality cooking oils; second, they are more likely to purchase 'loose' cooking oils (not packed), which are often adulterated with UCO. This is also corroborated by our survey results.

Across the four metro cities, the average purchase price of refined oil reported by

the large eateries was higher than that reported by the small eateries. Except in the case of Delhi, these differences are statistically significant at 5 percent level of significance (see Table 4.1).

Of the 406 small eateries, as many as 376 used cooking oil priced below INR 150 per litre. Additionally, small eateries also spend on other cooking mediums such as ghee, vanaspati and butter, though only a small share of their total expenditure. While small eateries in Kolkata and Chennai spend relatively less on oil and other cooking mediums (less than INR 500 daily), more Mumbai and Delhi small eateries spend between INR 500 and INR 900 daily (see Figure 4.1). The average daily expenditure on cooking mediums,

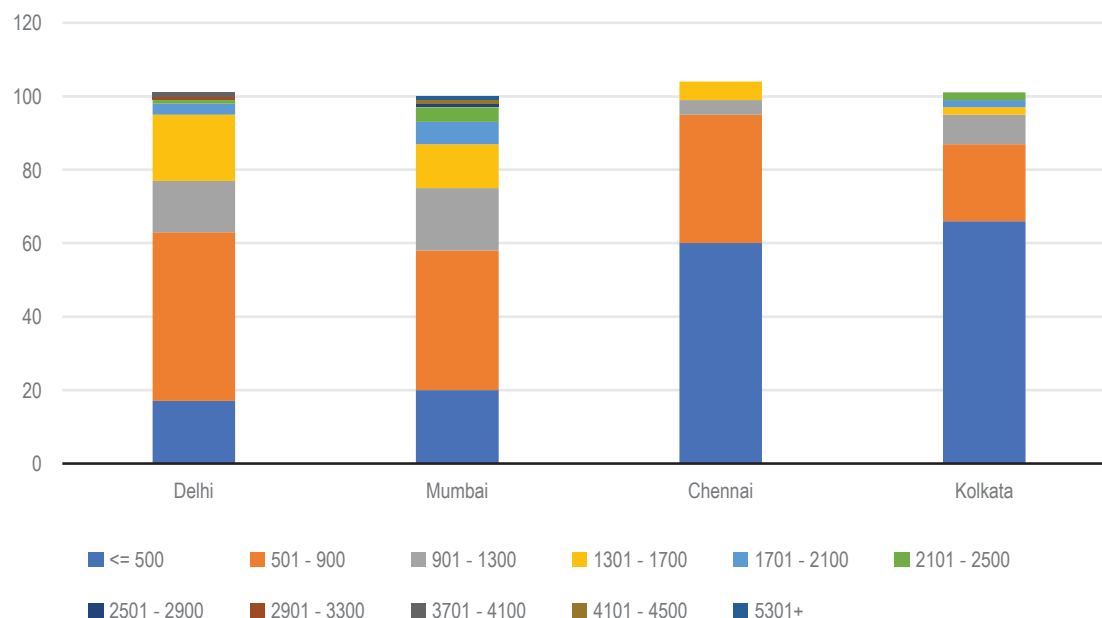
TABLE 4.1: Average Purchase Price of Refined Oil (per litre, in INR)

City	Large Eateries	Small Eateries	Difference
Delhi	138.72	137.27	1.45
Mumbai	158.35	149.30	9.05*
Chennai	153.00	139.59	13.41*
Kolkata	149.88	135.52	14.36*

* Significant at 5 percent level of significance

Source: Authors' own

FIGURE 4.1: Small Eateries – Daily total expenditure on oil and other cooking mediums (in INR)



correlated with the scale of business operations, can be a useful indicator of the recharge/reuse propensity of cooking oils and UCO diversion into the food stream.

In the case of Chennai, the low daily expenditure on oil, despite higher volume of orders and relatively higher average purchase price of cooking oil, may be driven by easy availability of low-priced alternative cooking mediums (like palm oil sold through the public distribution system). For the small eateries in Kolkata, the reported average purchase price of refined oil is the lowest among the four

cities. Moreover, the number of orders (particularly during weekdays) is relatively lower across Kolkata's small eateries. Both factors, taken together, could be the reason for relatively low expenditure on oil compared to other cities.

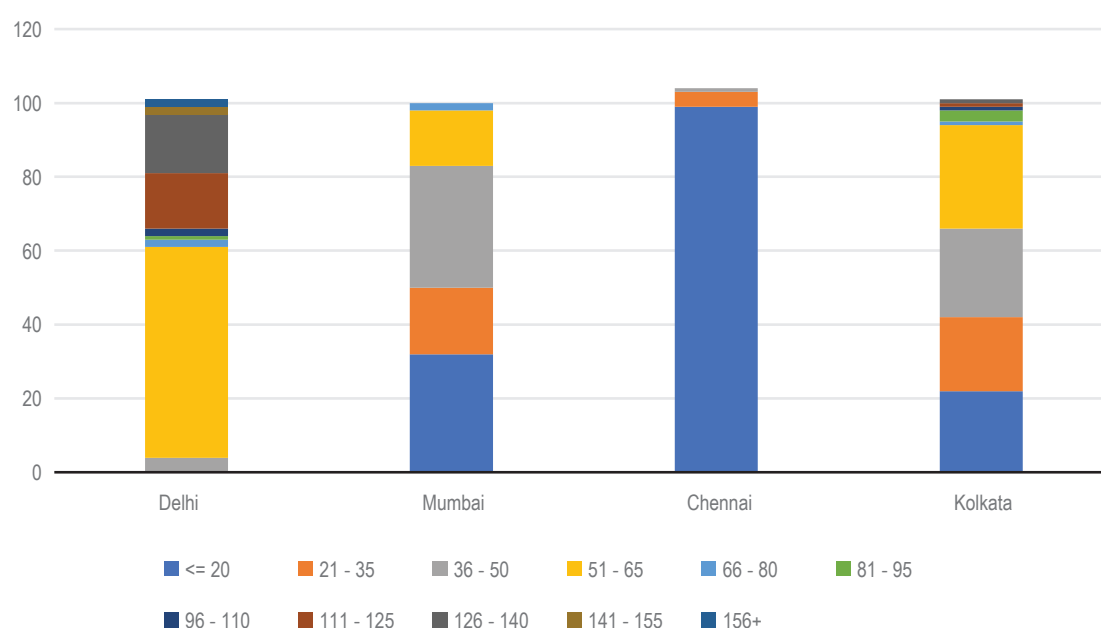
A third possibility could be that small eateries in Kolkata and Chennai recharge their cooking oils with UCO more often compared to their counterparts in the other two cities. However, due to the limitations of the primary survey, it is difficult to clearly indicate the exact reason behind this phenomenon.

The reported price rise over the last two years in cooking oil in Chennai is the lowest: 99 out of 100 large eateries experienced less than INR 20 per litre price rise in oil and other cooking mediums. In the other three metro cities, increases in oil and cooking medium prices are larger (see Figure 4.2). In Tamil Nadu, packed palmolein oil is sold at a subsidised price through the public distribution system (PDS).² It is now mandatory to sell palm oil in packets through the PDS in Tamil

Nadu.³ This was enforced to minimise adulteration of refined oils.

Primarily impacting the availability of cooking oil in Chennai, this will keep edible oil prices low even in the open market and increase their sales. Due to availability of palm oil through the PDS, the rise in oil prices is also expected to be the least in Chennai, as can be observed in the primary survey data.

FIGURE 4.2: Small Eateries – Overall increase in prices of oil and other cooking mediums (in INR)



It is not surprising, therefore, that 99 percent of Chennai's small eateries source their cooking oil from wholesalers in fresh packaged form. The majority of Delhi eateries buy loose fresh oil from wholesalers; Kolkata eateries buy packed fresh oil largely from grocery stores; and those in Mumbai source packed fresh cooking oil from both wholesalers and grocery stores (see Figure 4.3).

Finally, among small eateries across the sample cities, the average daily expenditure on cooking oils as a proportion of their total daily expenditure is the highest at 25 percent

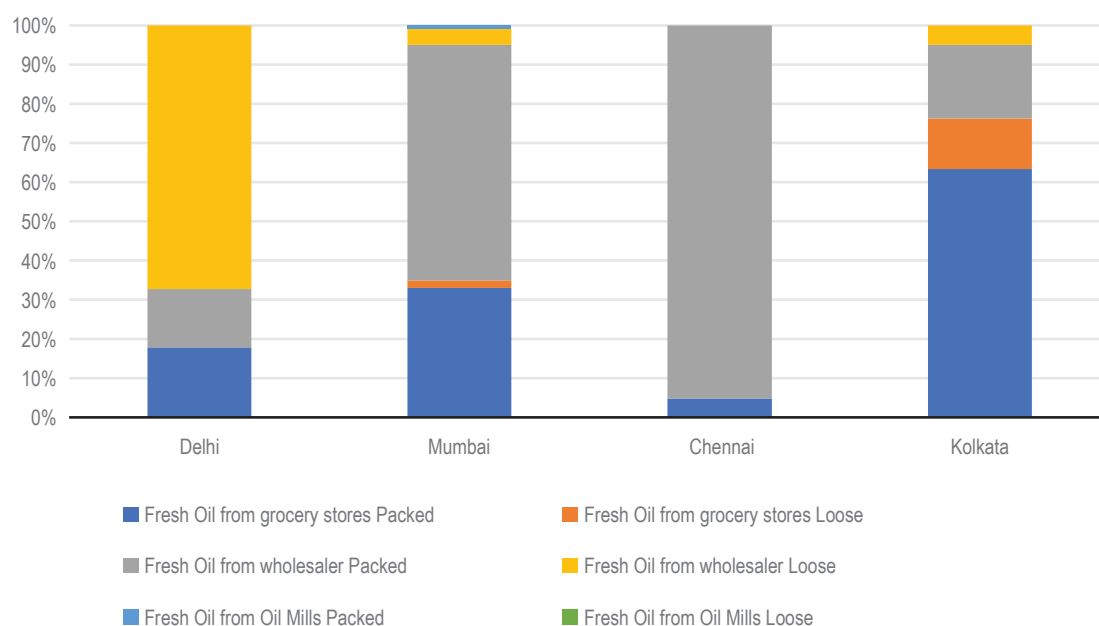
for Mumbai. On average, Chennai spends the lowest share of total expenditure (15 percent) on cooking oils (see Table 4.2). The low spending shares of cooking oil

TABLE 4.2: Average Share of Daily Expenditure on Cooking Oils

City	Small Eateries
Delhi	21%
Mumbai	25%
Chennai	15%
Kolkata	20%

Source: Authors' own

FIGURE 4.3: Small Eateries – Sources of cooking oil



may possibly act as an incentive for the eateries in Chennai to practice less reuse of cooking oils.

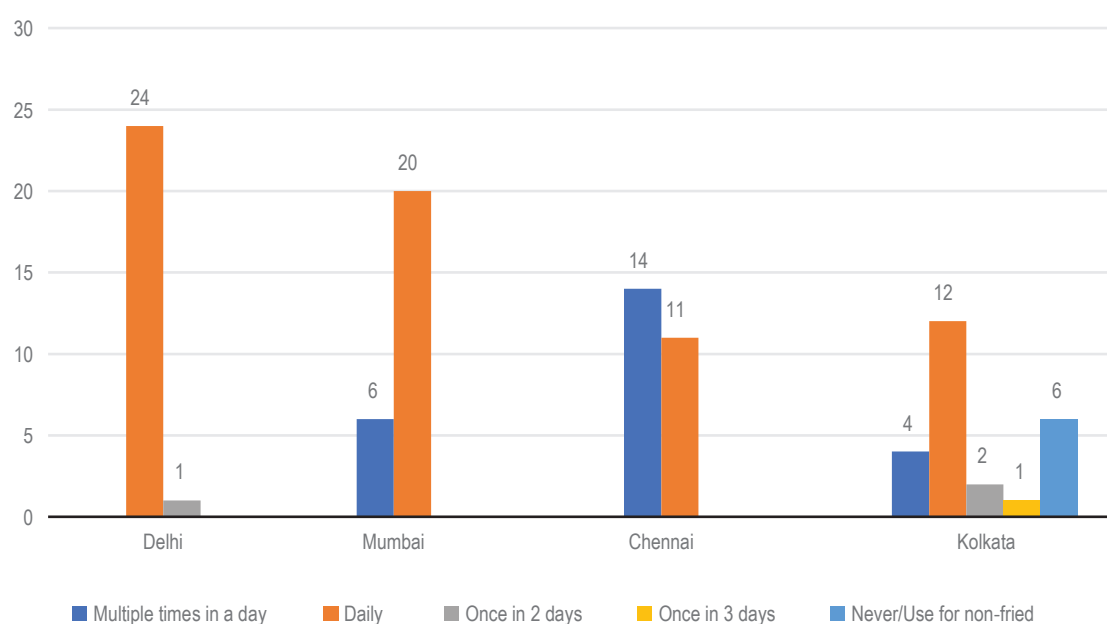
Patterns in Waste Oil Generation

The majority (66.3 percent) of large eateries across the four cities self-reported that cooking oil for frying is changed daily. In Chennai, 14 eateries (out of 25) reported that cooking oil is changed multiple times a day. This was the highest among all four (see Figure

4.4). Indeed, successive parameters, as will be seen later in this section, confirm that UCO-related awareness is highest in Chennai. This could be the primary reason for Chennai large eateries tending to change cooking oil more often.

About 92 percent of the large eateries surveyed across the four cities reported daily waste oil generation below 10 litres only. While daily total consumption of cooking mediums exceeded 50 litres for 70 percent of the entire sample (primarily constituting of refined oil), the estimates

FIGURE 4.4: Large Eateries – How often do you change the cooking oil used for frying?



of waste oil generation look conservative (see Figure 4.5) – indicating that much of the cooking oil is reused until exhaustion or diverted into the food stream in other forms.

In Delhi, Mumbai, and Kolkata, most of the surveyed large eateries reported being unaware about other restaurant/eateries using UCO for cooking. However, most large eateries in Chennai reported that whilst they themselves do not reuse UCO, they were aware of many other restaurants that buy and utilise UCO for cooking and frying (see Figure 4.6).

In Mumbai, Chennai and Kolkata, the majority of the surveyed small eateries reported daily changing of cooking oil for frying. In Delhi, 96 percent of small eateries reported using up cooking oil till the last drop for preparation of fried and non-fried meals. In Kolkata, 38 percent of the small eateries reported the same. Overall, only 58 percent of the small eateries surveyed indicated changing their cooking oily on a daily basis, while majority of them (74 percent) also reported no waste oil generation on a daily basis. Both findings, in conjunction, indicate that while using oil till the

FIGURE 4.5: Large Eateries – How much of waste oil is generated every day in your Restaurant?

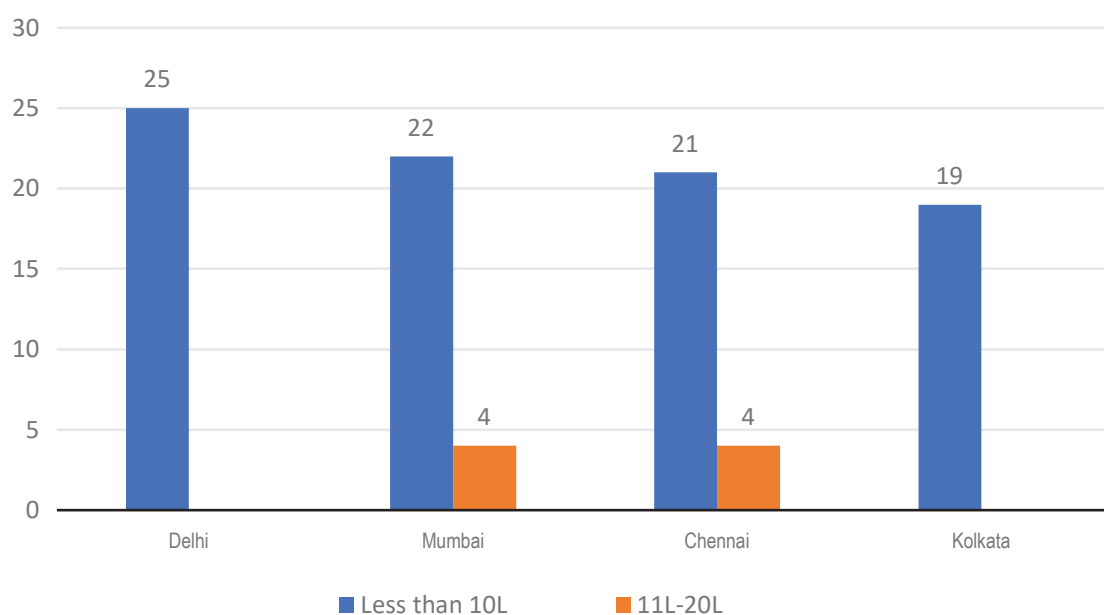
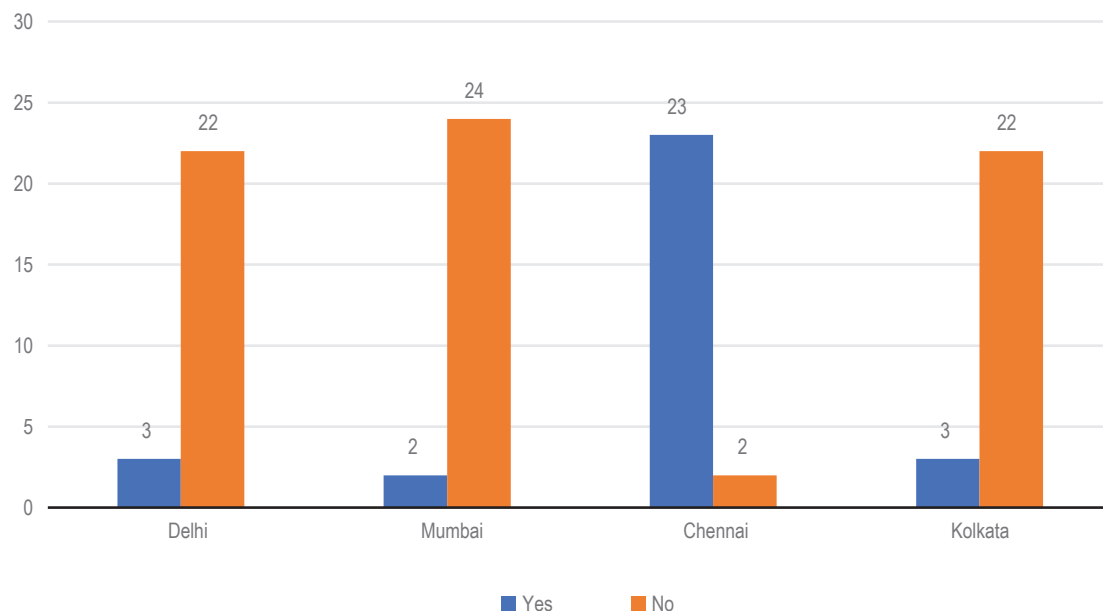


FIGURE 4.6: Large Eateries – Are you aware of other restaurants / eateries using “Reused oil” for cooking?



last drop seems to be a reality in small eateries, most of it is exhausted by the

end of day, prompting a daily change of frying oil (see Figures 4.7 and 4.8).

FIGURE 4.7: Small Eateries – How often do you change the cooking oil used for frying?

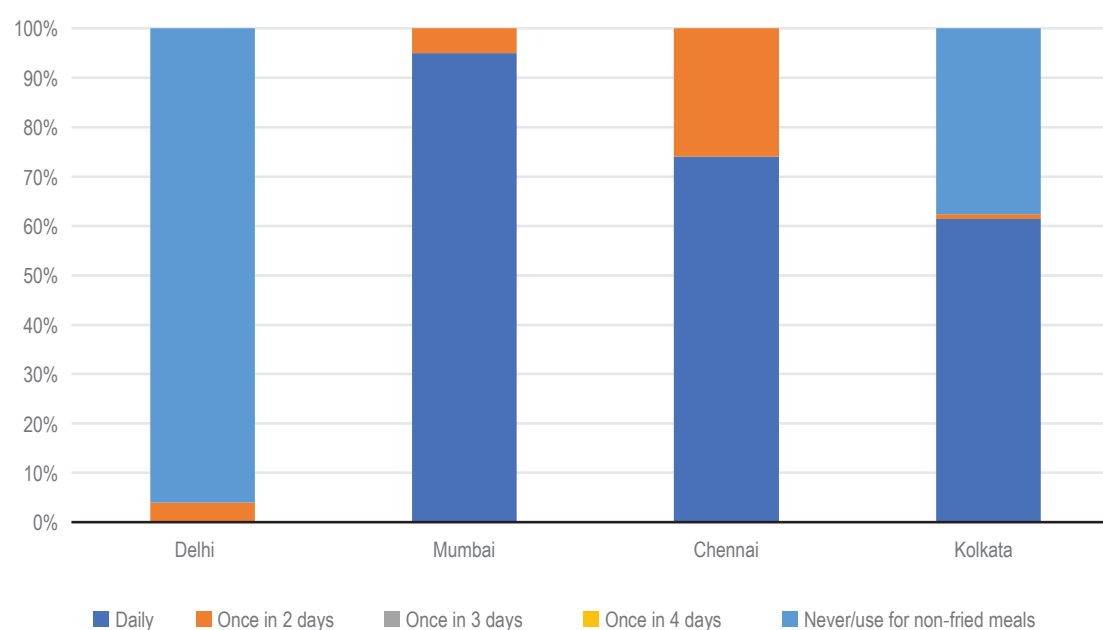
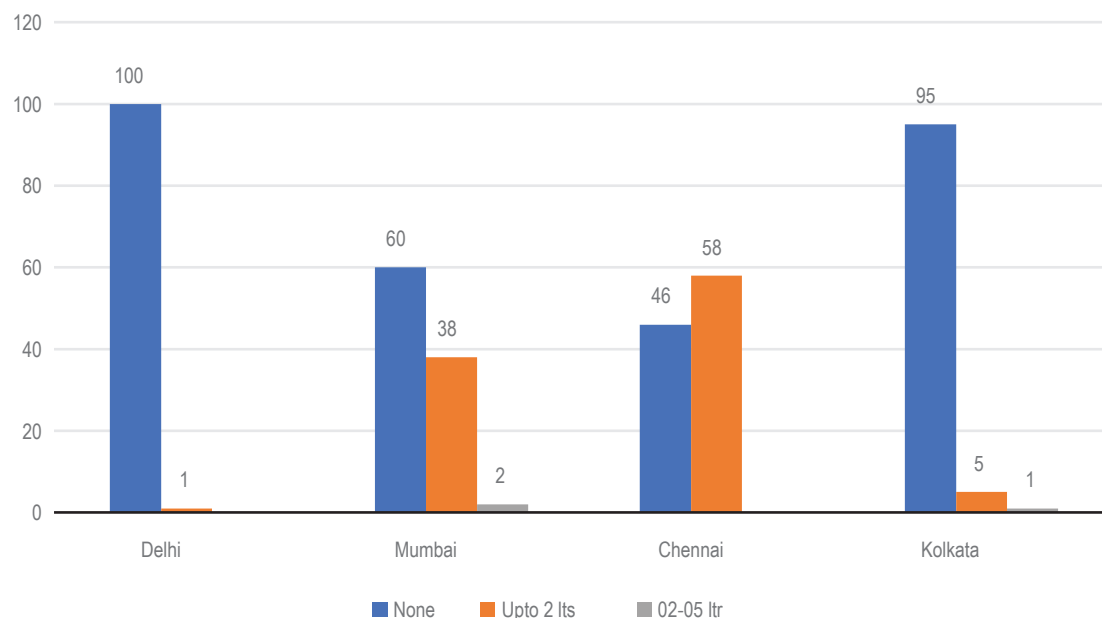


FIGURE 4.8: Small Eateries – How much of waste oil is generated every day by your shop / Stall?



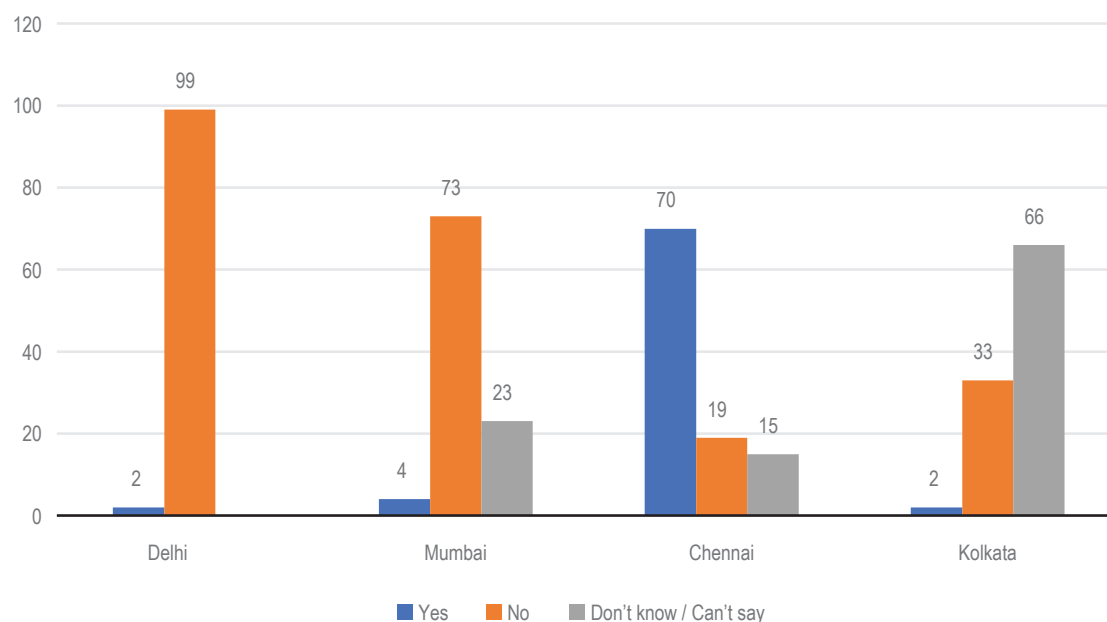
Just like the large eateries, small eateries across Delhi, Mumbai, and Kolkata reported not being aware of others using UCO. The respondents from small eateries in Chennai said they were aware of the use of UCO in other eateries in the vicinity.

In Delhi and Kolkata, almost all small eateries reported not generating waste oil. This is consistent with their earlier reporting of using cooking oil till the last drop. In Chennai, 58 eateries (out

of 104) reported generating up to two litres of waste oil daily; in Mumbai, 38 eateries (out of 100) reported the same (see Figure 4.8).

Most of the Delhi, Mumbai, and Kolkata small eateries, like their large counterparts, also did not comment on other eateries using UCO for cooking. The majority of the Chennai small eateries reported usage of UCO in neighbourhood eateries (see Figure 4.9).

FIGURE 4.9: Small Eateries – Do you think the other eateries in your neighbourhood also use “used cooking oil”?



Disposal of Used Cooking Oil

More than 50 percent (53 out of 101) of large eateries surveyed across the four cities reported that they discard some part of the UCO they generate in drains

(see Table 4.3). This shows low awareness of the harmful clogging effect of UCO in the sewage system. In Chennai, more eateries sell UCO to different collectors and aggregators, and a relatively smaller number discard it in drains.

Table 4.3: Methods of UCO Disposal among Large Eateries (in %)

Methods	Delhi	Mumbai	Chennai	Kolkata
Reuse the oil till it gets over	0	0	0	24
Sell to small eateries	8	0	0	4
Sell it to used cooking oil collectors / aggregator	0	8	64	12
Sell it to waste management firms/ agents	0	8	0	0
Discard in drains	92	58	36	44
Workers / Staff take the UCO home for reuse	0	27	0	16

A caveat, though, is in order about these responses on discarding UCO in drains. First, in the survey, ‘discarding UCO in drains’ was given as one of the possible methods of UCO disposal, but there was no further question about quantities. This means that the tally of respondents who practice disposing UCO in drains include those who dispose of smaller amounts (say, one or two litres). The exact amount of UCO disposed in drains has not been recorded, thus making it difficult to verify the magnitude of this particular problem within the scope of the present study. Second, there could be a large number of statistical outliers on this issue: some eateries could be contributing significantly to the problem with large amounts of disposal, while those of others remain negligible. Lastly, some respondents might have tried to hide the practice of selling UCO by choosing this option in the survey question.⁴ Therefore, these responses should be considered with caution and qualitative discretion applied.

Only 6 percent of the large eateries responded to the question about the difference between UCO selling prices during pre-COVID and post-COVID

times. Queries about buyers of UCO from large eateries elicited no responses, except in Chennai. The large eateries pointed to two main factors that they consider for UCO selling: compliance with government guidelines, and prices.

In Delhi and Kolkata, respondents from the large eateries reported that local municipal authorities generally do not provide support for the storage, management, and disposal of UCO. In Mumbai, there are only five large eateries (out of 26) which reported receiving local Brihanmumbai Municipal Corporation (BMC) support in UCO management and disposal. A significantly higher share of large eateries in Chennai said that they receive support from municipal authorities (see Figure 4.10).

Survey respondents—particularly in Delhi and Kolkata large eateries—reported not being aware of either government or private collectors that convert UCO to biodiesel, soap, or other products. Mumbai does moderately better on this count, and Chennai has the largest presence of such collectors of UCO – according to the large eateries in the city (see Figure 4.11). Respondents in

FIGURE 4.10: Large Eateries – Do local municipal authorities provide support to store, manage, and dispose of UCO?

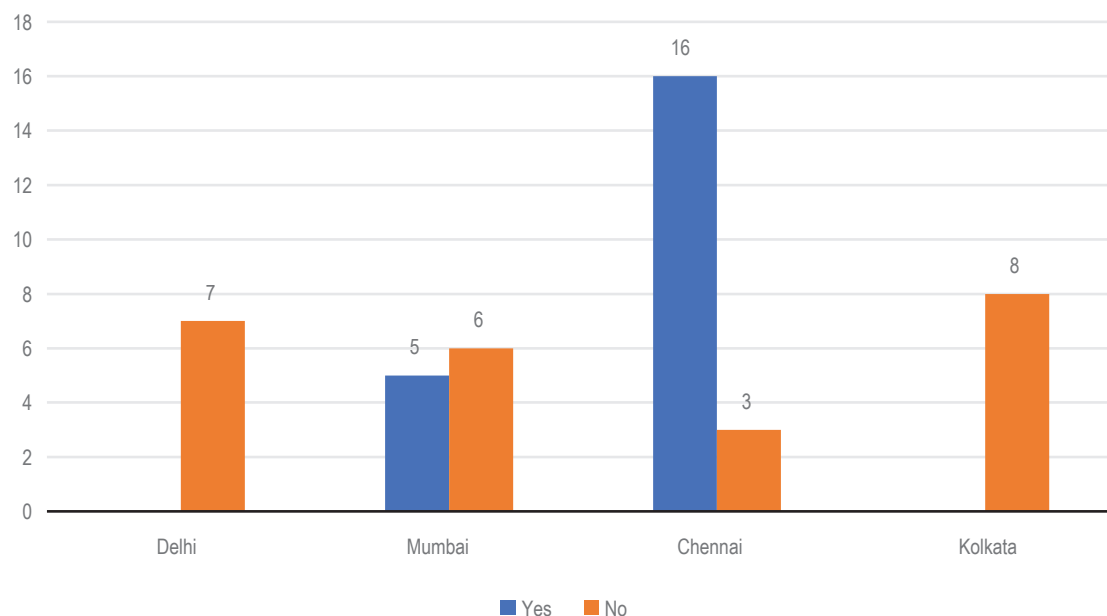
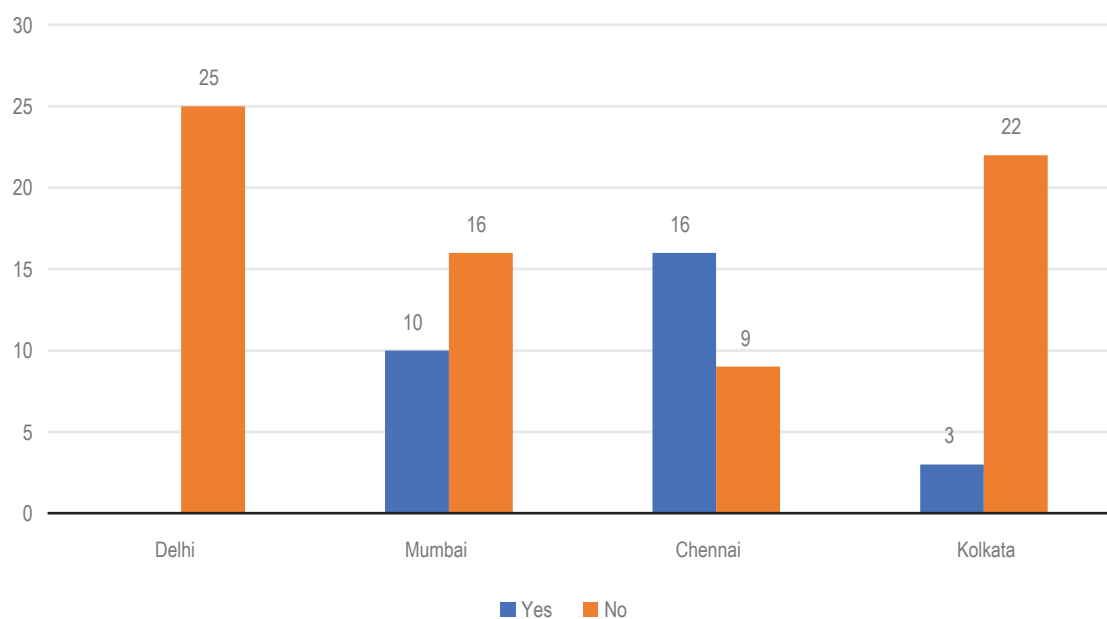


FIGURE 4.11: Large Eateries – Is there any government or private entity collecting UCO in the neighbourhood to convert it into any other product?



Chennai confirmed that the Repurpose Used Cooking Oil (RUCO) initiative of the government for the collection of UCO in the city was operational. In Mumbai, the large eateries said that the BMC conducts UCO collection in the city. Respondents from Delhi and Kolkata were unable to confirm the presence of UCO collectors in their cities.

Among the small eateries, responses repeatedly indicated a high propensity to use cooking oil till the last drop—often by topping it up with fresh oil (see Table 4.4). This is substantiated by the responses to questions related to methods they employ in disposing of UCO. Small eateries in Delhi and Kolkata reuse cooking oil until it is finished. In

Mumbai and Chennai, the small eateries that do not use it till it gets over simply discard UCO in drains, trash bins, or in other open areas.

Small eateries across the four cities do not consider UCO disposal a difficult task. The unanimous responses show that awareness about UCO disposal remains low across the four cities (see Figure 4.12).

Moreover, respondents from small eateries reported that there was almost no presence of any government or private entity collecting waste oil to convert it into any other products, including biodiesel (see Figure 4.13).

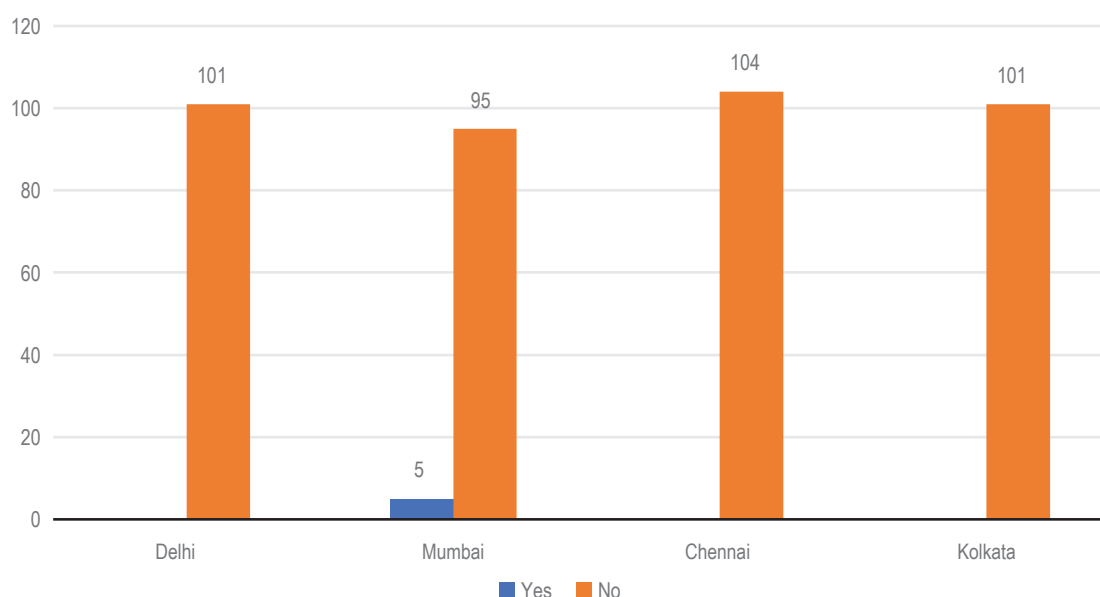
Table 4.4: Methods of UCO Disposal among Small Eateries (in %)

Methods	Delhi	Mumbai	Chennai	Kolkata
Reuse the oil till it gets over	99	60	44	94
Sell to other vendors	0	5	0	1
Sell it to used cooking oil collectors / aggregator	0	1	0	0
Discard in drains	1	20	43	3
Dispose in open place or dustbin	0	0	16	0
Preparing masala	0	3	0	2
Workers/Staff take the UCO home for reuse	0	11	0	2

FIGURE 4.12: Small Eateries – Is finding ways to dispose UCO a difficult task?



FIGURE 4.13: Small Eateries – Is there any government or private entity collecting UCO in the neighbourhood to convert it into any other product?



* Out of 5 respondents from Mumbai that said government or private entities collect UCO to convert into biodiesel or other products, 2 named BMC and 1 named central government department as collectors; the other 2 did not know the name of the collector.

Disposal, Collection, and Impacts of UCO: Awareness across Cities

In all four cities—Delhi, Mumbai, Chennai, and Kolkata—a number of questions were posed to proprietors across large and small eateries to record their level of awareness of proper collection and disposal of UCO, and the impact of UCO on public health and the environment. Their responses were used to generate a general awareness score for

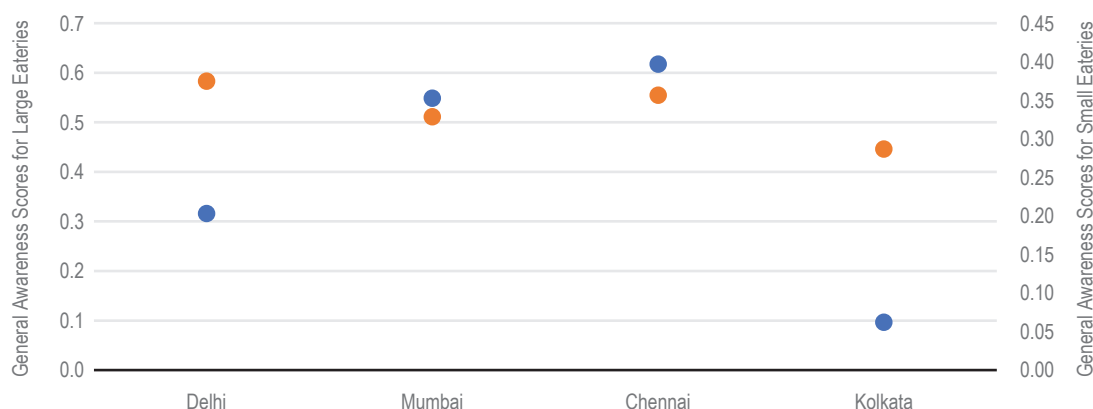
all eateries across cities. Each positive response was assigned a score of 1, while each negative response was assigned nil (a zero). For each respondent, the total score was assigned using an equally weighted average of all the scores. The city-level general awareness score is a simple average of the scores obtained by all respondents for that city, across both groups of large and small eateries. The average scores for large and small eateries were then compared across the four cities.

TABLE 4.5: General Awareness about Used Cooking Oil Stream

City	Large Eateries	Small Eateries
Delhi	0.39	0.20
Mumbai	0.60	0.35
Chennai	0.77	0.40
Kolkata	0.33	0.06

Source: Authors' own

FIGURE 4.14: General Awareness about Used Cooking Oil Stream among Large and Small Eateries (By City)



Source: Authors' own

Analysis

Comparing awareness scores for large and small eateries across cities, the following trends have been observed:

1. Among the four cities, small eateries in Chennai are the most aware about the possible impacts of UCO in the food stream and the suitable methods of disposal or collection; they are closely followed by the small eateries in Mumbai, and then, Delhi. The average score for small eateries in Kolkata is significantly lower than all the three other cities, implying the need for suitable institutional interventions (see Appendix 2.1).
2. For the large eateries, Chennai represents the highest levels of awareness about UCO implications and disposal among the four metros. The large eateries in Mumbai also do significantly well compared to those in Delhi and Kolkata. Among large eateries in Delhi and Kolkata, the average scores for awareness vary only marginally, with the difference not being statistically significant (see Appendix 2.2).
3. Across all four cities, the general awareness of the implications of UCO consumption and disposal/ collection is higher among the large eateries than the small eateries. The difference is statistically significant at 1 percent level of significance (see Appendix 2.3).

A majority of small eateries in Chennai, Mumbai, and Delhi are aware that discarding UCO in drains can clog the sewerage system. Almost all small eateries in these four cities are of the view that municipal authorities are lacking in efforts to collect and dispose of UCO. Small eateries in all four cities reported low awareness of the government's RUCO initiative. Respondents reported that no government agencies like the FSSAI or municipal authorities have ever reached out to them with information on RUCO.

The overall levels of awareness, compliance requirements, and greater engagement with the FSSAI among the large eateries across cities imply that they are sufficiently aware of proper methods of UCO disposal and collection. Yet, awareness of the RUCO initiative is relatively low even among the large eateries in all cities, except for Chennai.

In terms of efforts towards awareness creation, most large eateries in Chennai have seen their local government authorities conduct educational campaigns on UCO. Such campaigns are largely absent in Delhi and Kolkata. While Mumbai has held these campaigns, they have not been to the extent of those in Chennai. Large eateries are generally aware of the FSSAI guidelines on reused cooking oil. Kolkata is the only city where this awareness is relatively low (10 out of a total of 25 respondents were not aware of the guidelines). Consistent with the preceding comparisons, awareness about FSSAI guidelines is poor among small eateries in Delhi and Kolkata. Mumbai's small eateries have the highest awareness, followed by those in Chennai. This may be due to lack of targeted consumer awareness campaigns about the implications of UCO consumption.

The original 2018 FSSAI guidelines on UCO prohibited the topping-up of used cooking oil having Total Polar Compounds (TPC) of more than 25 percent. In January 2022, FSSAI removed

this provision through a new order, citing issues related to availability of testing protocols and enforcement. The order acknowledged problems in strictly implementing the UCO ban. In all four cities, the large eateries had only moderate knowledge of this recent change in FSSAI guidelines; Chennai eateries were largely unaware.

Consumer awareness campaigns follow the same pattern across these cities, according to the large eateries. Chennai has significant consumer awareness, followed by Mumbai. These campaigns have not been undertaken in Delhi and Kolkata. The awareness of UCO's negative health effects is high among the large eateries in Chennai, Mumbai, and Delhi. Those in Kolkata are less aware. In another illustration of the varied survey responses, small eateries in Delhi, Mumbai, and Chennai reported being strongly aware of the negative health effects of reusing cooking oil. But around 94 percent of respondents in Kolkata (95 out of total 101) said they were not aware of these negative health effects.

Why do eateries reuse cooking oil?

In the survey, no respondent (small or large eateries) reported buying used cooking oil from markets, but a few large eateries reported selling used cooking oil in secondary markets at relatively low prices indicating operational markets for used cooking oils. Moreover, a large number of large and small eateries across the four cities admitted to reusing cooking oil until it gets over. Others just reported that they discard the leftover oil in drains as against other suitable methods of disposal.

Among the small eateries, as many as 74 percent reported reusing cooking oil until it gets over. This share is considerably lower for the large eateries, across all the four cities, taken together (only 6 percent). Considering the massive health implications of consumption of UCO, it is necessary to explore the drivers

of reuse, rather than proper disposal. Identification of these driving forces can create learnings for policymakers to address specific issues with regard to the UCO stream.

The authors explore the likelihood of eateries (both large and small) reusing their cooking oils till complete exhaustion, rather than disposing it. The reference is their level of awareness of the implications of UCO consumption and disposal, and the cost of purchasing fresh cooking oil. A logistic regression model has been used to estimate the difference in likelihood of eateries reusing their cooking oil as opposed to resorting to any other means of disposal, with variations in awareness scores and the reported purchase price of fresh cooking oil (see Appendix 2.5 for model specification and results).

The results (summarised in Table 4.6) indicate the following:

TABLE 4.6: Summary Results for Likelihood Estimation

Indicator	Difference in odds in favour of reusing cooking oil (in %)	
	Large Eateries	Small Eateries
Awareness Scores	-98*	-98**
Price of fresh cooking oil	0	2**

*: Statistically significant at 5 percent level of significance

**: Statistically significant at 1 percent level of significance

Source: Authors' own

1. For both large and small eateries, higher levels of awareness reduce the likelihood of UCO reuse by 98 percent.
2. Increases in prices of fresh cooking oils raise the propensity of small eateries to reuse cooking oil by only 2 percent. For large eateries, the results indicate that rise in prices does not increase the likelihood of reuse of cooking oils, indicating purchase price of fresh cooking oil plays no role in determining reuse behaviour. However, the result for large eateries is not statistically significant and more evidence shall be required in this regard.

Comparing UCO-related compliance for large eateries across the cities

Across the four cities, most large eateries were aware of the Repurpose Used Cooking Oil (RUCO) initiative of the government and reported that they were taking steps to comply with the regulations. To assign scores to the large eateries on compliance-related issues, an aggregate of the number of steps undertaken to ensure compliance was used for large eateries across cities. The city-level compliance score is a simple average of the scores obtained by all respondents for the respective city. The authors then compare the average scores across the four cities.

TABLE 4.7: Compliance Scores related to Used Cooking Oil Stream

City	Large Eateries
Delhi	2.52
Mumbai	1.08
Chennai	5.12
Kolkata	2.56

Source: Authors' own

Analysis

Comparing compliance scores for large eateries across cities, the following trends have been observed:

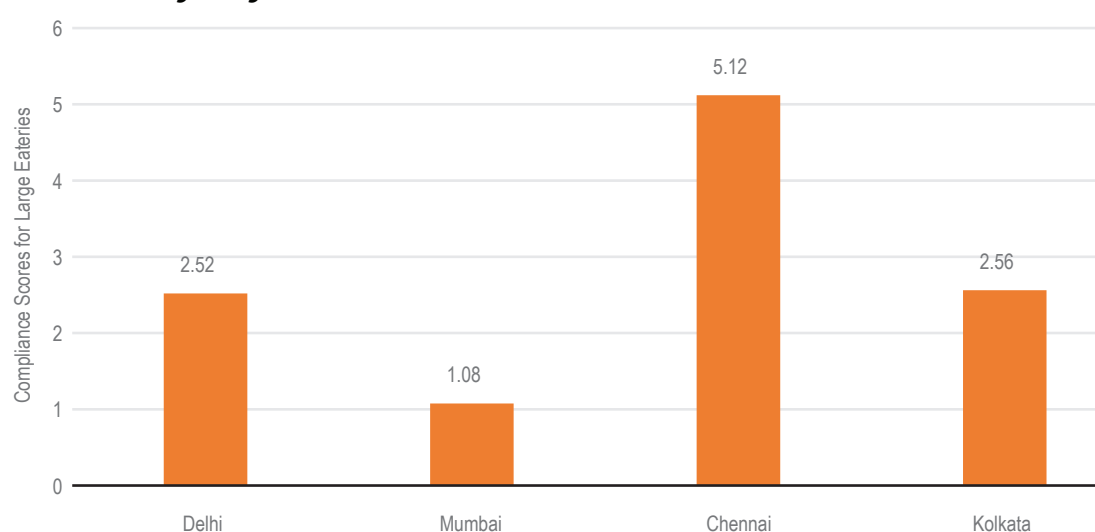
1. Out of a total of 101 respondents, about 40 percent of the large eateries across cities were not aware of the

RUCO initiative, and did not take any measures related to the RUCO's regulatory framework.

2. Comparing the average compliance scores for large eateries across all cities, Chennai does significantly better than the other three. Mumbai is at the bottom in this regard (see Appendix 2.4).

3. Although they reported general awareness on the implications of UCO, compliance is considerably low among the eateries in Mumbai. This shows that complementary efforts are required to raise awareness as well as prompt compliance.

FIGURE 4.15: Compliance with RUCO regulations among Large Eateries (By City)



Source: Authors' own

4. At least 20 large eateries (out of 25) in Chennai reported having detailed knowledge about how to comply with the RUCO initiative—the highest among the four cities. (see Figure 4.16).

Do higher levels of awareness always translate into compliance?

Both the literature review and the primary survey indicate that eateries with higher levels of awareness are more compliant with UCO regulations and monitoring. Yet, as discussed briefly

earlier, in the case of Mumbai, higher levels of average awareness have not translated into better compliance. The authors thus undertake a multiple linear regression analysis to explore if: (1) the variations in compliance scores for large eateries across cities in response to variations in awareness scores is positive and statistically significant; and (2) the marginal effect of awareness levels on compliance behaviour varies significantly across the four cities (see Appendix 2.6 for model specification and results).

The results (summarised in Table 4.8) highlight the following:

FIGURE 4.16: Large Eateries – How is the compliance with RUCO initiative ensured?

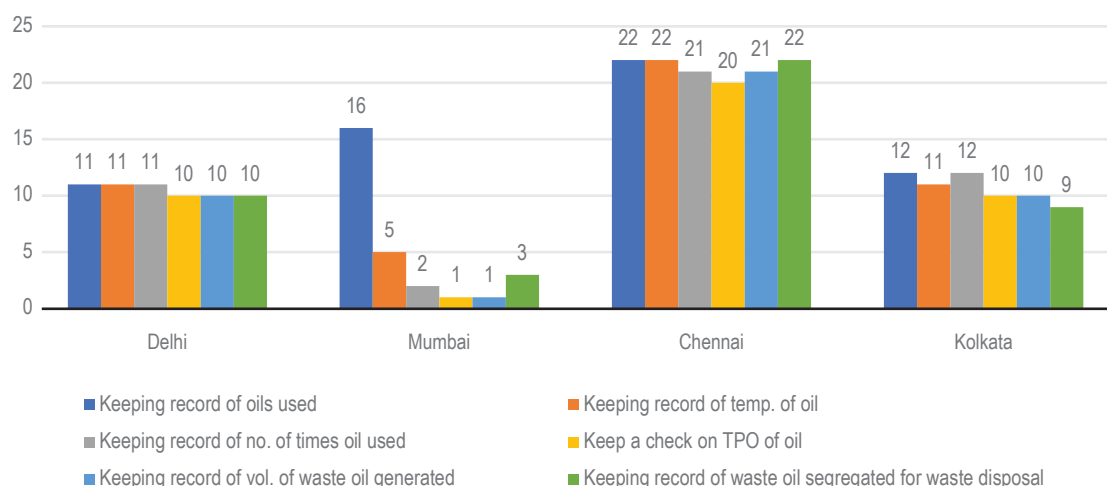


TABLE 4.8: Marginal Effect of Awareness on Compliance

City	Large Eateries
Delhi	6.44**
Mumbai	1.87**
Chennai	6.70
Kolkata	7.71

** : Statistically significant at 1 percent level of significance

Source: Authors' own

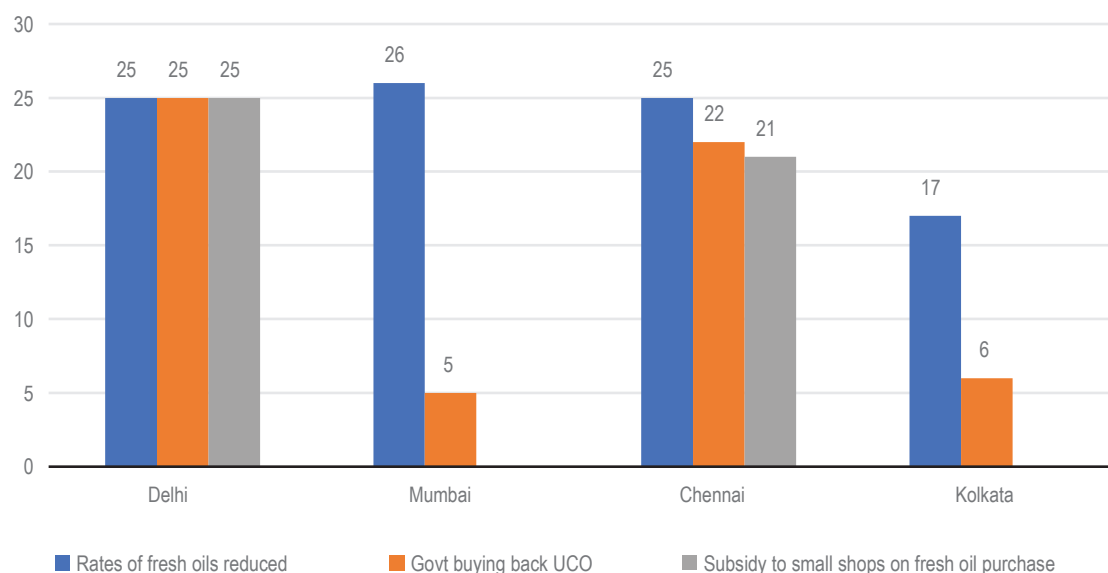
- 1) Levels of awareness do positively affect compliance behaviour (and are statistically significant). For a unit increase in awareness scores of the large eateries in Delhi, the compliance scores increase by 6.44 times.
- 2) The marginal effect of awareness levels on compliance behaviour of the large eateries in Chennai and Kolkata are not significantly different from those observed in Delhi.
- 3) For the large eateries in Mumbai, the marginal effect of awareness on

compliance is lower (and statistically significant). In this case, a unit increase in awareness scores leads to 1.87-times increase in compliance score. This indicates the importance of focusing on other institutional factors prompting either compliant or non-compliant behaviour among these eateries, in addition to raising awareness levels.

Incentivising a shift away from UCO consumption

The respondents, both large and small, were also asked about the best incentives that authorities or regulators can offer to encourage them to shift away from UCO consumption. All large eateries across the cities mentioned reduction in prices of fresh oils as most of them have been severely affected by the rise in cooking oil prices. In Delhi and Chennai, the respondents also sought subsidies for small shops for buying fresh oil and greater government role in buying-back UCO (see Figure 4.17).

FIGURE 4.17: Large Eateries – What can be done to shift away from using UCO?



On a similar note, asked to suggest measures to incentivise a shift away from UCO, small eateries responded in almost the same way as large eateries in the four cities. A reduction in oil prices the most favoured response, followed by the options of government buying-back UCO and providing subsidies to small eateries on fresh oil purchases (see Figure 4.18).

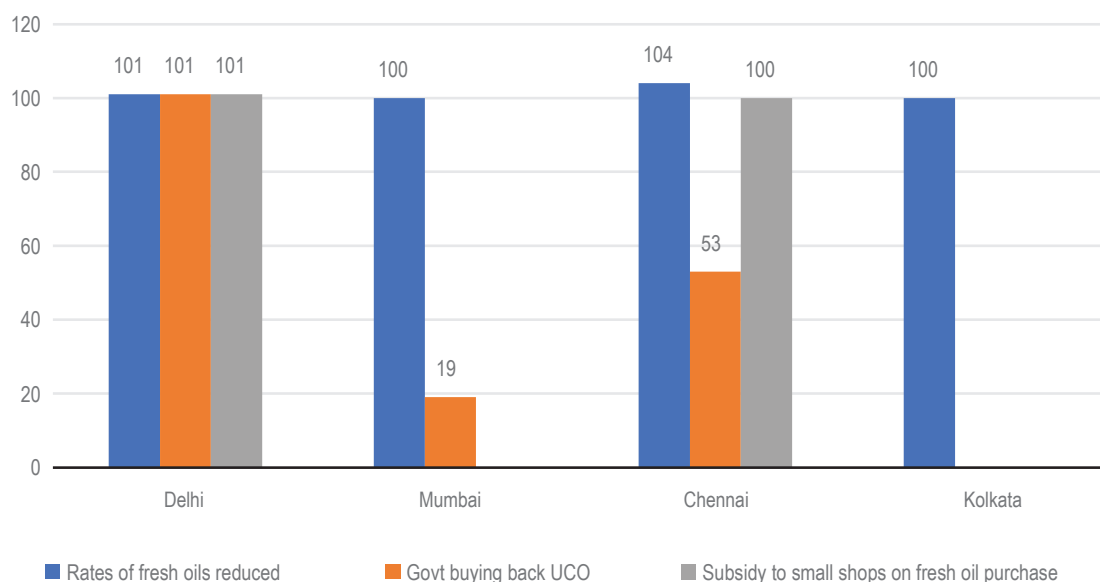
Summary of survey data analysis

- Most respondents reported that they do not use UCO. However, it is clear from other proxy survey

responses that broadly, large eateries across Delhi, Mumbai, Kolkata, and Chennai are generators and sellers of UCO while the small eateries are consumers. The generation is layered and difficult to quantify. Small eateries tend to top-up and utilise cooking oil till the last drop. This is significant because, in the absence of a monitoring mechanism, UCO generation and consumption by small eateries goes largely unnoticed.

- Among the four cities, small eateries in Chennai are most aware of UCO-related issues. At the bottom are the small eateries in Kolkata.

FIGURE 4.18: Small Eateries – What can be done to shift away from using UCO?



- For large eateries too, Chennai shows the highest levels of awareness of UCO effects, and need for its proper disposal. It is followed by large eateries in Mumbai.
 - Across all four cities, general awareness of the implications of UCO consumption and improper disposal/ collection is higher among large eateries than small eateries.
 - For both large and small eateries, higher levels of awareness reduce the likelihood of them reusing their cooking oil by 98 percent.
 - Rise in prices of fresh cooking oils increases the propensity of small eateries to reuse it by only 2 percent.
- For large eateries, however, no statistically significant relationship is observed.
- Comparing the city-level compliance scores for large eateries, Chennai does significantly better than the other three. Mumbai is least compliant.
 - While Mumbai scores well in general awareness on the implications of UCO, compliance remains low.
 - Apart from Chennai and to some extent, Mumbai, municipal and government authorities do not provide any assistance in storing, managing or discarding UCO. Consumer awareness campaigns are largely absent.

- Chennai and Mumbai have government and private UCO collectors and aggregators who convert UCO into other products, including biodiesel. There is no active engagement of such entities in the other two cities.
- The January 2022 FSSAI order lifted the earlier prohibition on topping up UCO having TPC of more than 25 percent, citing monitoring and enforcement issues. This can further incentivise UCO consumption.

Perspectives from Indian medical and nutritional practitioners

The authors of this report conducted interviews (online) with medical and nutritional practitioners in the country who could share their insights on the subject of the present study. The medical professionals were selected across the areas of cardiology, oncology, gastroenterology, hepatology, as well as general medicine, from online listings where email addresses were available. Nutrition professionals were contacted through professional and personal networks, as online databases are

not as freely available as for medical professionals. More than 100 such email requests were sent, and 32–13 medical professionals and 19 nutrition professionals—sent their detailed responses. The questions focused on general awareness of the health impacts of UCO in the food stream, as well as on the government initiatives among the professionals.

The responses indicated that there is high awareness in the nutrition and medical communities about the harmful effects of used cooking oil. Slightly more than half of the respondents (51.6 percent) said that the consumption of used cooking oil was “*very harmful*” and 48.4 percent said it was “*harmful*”. Not one of the 32 claimed that UCO consumption was not harmful or that they were not aware of the harmful effects. The experts linked UCO consumption to cardiovascular diseases, cancers, and gastrointestinal diseases. Indeed, a number of them reported that they advise their clients to avoid reusing cooking oil, specifically for frying, and utilise oil once used for frying for other uses in the kitchen that ensure direct consumption. For example, oil once used for frying can be used for

“tadka”, a method widely used in the South Asian region in which powdered spices are heated in hot oil and the mix added to a dish to enhance taste.

A high 71.9 percent of the medical and nutrition experts said that while there is scientific literature on UCO’s health impacts in the Indian context, the subject remains under-explored. Only 18.8 percent of them felt that *sufficient evidence* already existed. Put in another way, more than 80 percent of healthcare and nutrition experts consulted said that there was insufficient evidence in the Indian context to clearly link UCO consumption and health.

Two-thirds of the experts knew about the Eat Right India movement, and about two-thirds were not aware of the RUCO initiative. Only 15.6 percent said that a government agency had ever shared information or advocacy material on the harmful effects of reused cooking oil with them. A majority (53.1 percent) maintained that their medical/nutrition curriculum while they were training did not cover the harmful effects of UCO consumption. There was unanimous agreement that the government should

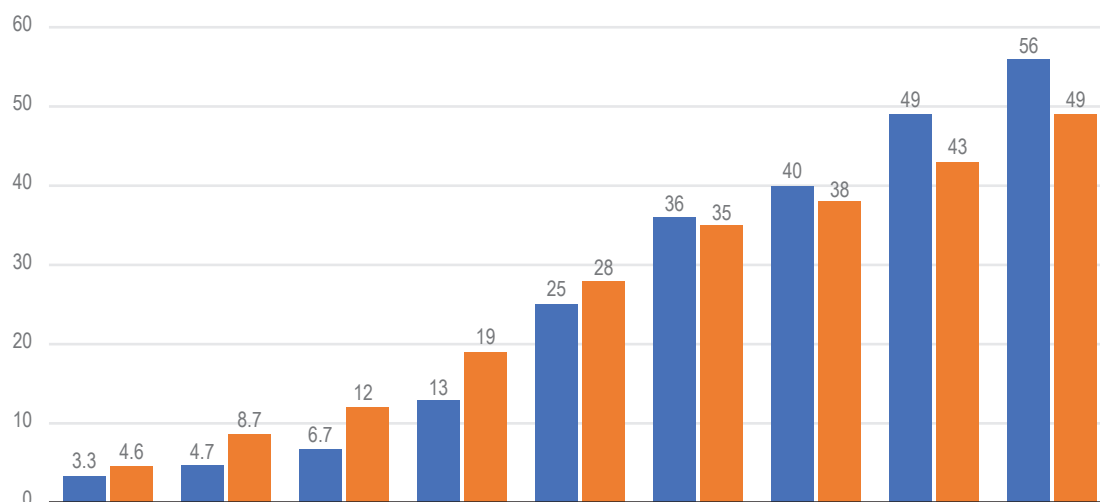
give greater policy attention to UCO consumption.

More than nine of every 10 of the experts (90.3 percent) said that UCO consumption is an important public health issue for India. Nearly 84 percent reported that they advise their clients or patients about the negative health effects of reusing cooking oil.

The experts agreed that any strategy to tackle UCO consumption must include public communication campaigns that focus on households, school children, and eateries. Some of the policy suggestions from the experts include effective monitoring, strict implementation of existing laws, incentivising UCO collection, visual warnings about the harm of UCO consumption on oil packets, and appropriate labels as well as advertisements.

Another policy incentive is the promotion of awareness of the harmful effects of UCO consumption. As data shows, India is witnessing heightening challenges related to non-communicable diseases. Obesity, for instance, is a risk factor for many diseases that is amplified by UCO consumption.

Figure 4.19: Prevalence of Hypertension by Age and Sex in India (2019-21)



Source: NFHS-5 National Report (<https://dhsprogram.com/publications/publication-FR374-DHS-Final-Reports.cfm>)

Latest data from the National Family Health Survey 2019-21 (NFHS-5), confirms earlier trends that show a parallel slow decline in under-nutrition and rapid increase in obesity. The proportion of overweight or obese women (15-49) increased from 13 to 24 percent, and men from nine to 23 percent, between 2005-06 and 2019-21. Moreover, there has been an increase in the mean body mass index (BMI) from 20.5 in 2005-06 to 21.9 in 2019-21.⁵

NFHS-5 also found that 21 percent of women and 24 percent of men above the age of 15 in India have hypertension; 39 percent of women and 49 percent

of men above 15 are pre-hypertensive. Furthermore, 12 percent of women and 14 percent of men above 15 have random blood glucose levels higher than 140 mg/dl.⁶ Available evidence indicates that diabetes doubles the chances of having heart disease or stroke in the general population.⁷ About one percent of the Indian population above 15 years of age is currently taking anti-hypertensive medicine, according to NFHS-5. These huge proportions of at-risk populations amount to hundreds of millions of people. Many of these risks are amplified by UCO consumption. The imperative is to build awareness around UCO, and to conduct India-specific studies quantifying particular disease risks.

Endnotes

- 1 Large eateries comprise dine-in restaurants, quick-service restaurants, canteens in commercial establishments, and wedding and banquet halls, where the average daily consumption of cooking oil was above 50 litres. The study proposed to survey 100 large eateries, distributed equally across the four cities. However, the final sample size considered for analysis is 101 (25 each for Chennai, Delhi and Kolkata; 26 for Mumbai). Small eateries are roadside eateries, food carts, fritters stalls, and the like. The intent was to survey 400 small eateries, with equal representation from all four metro cities. The final sample size for this segment is 406 (101 from Delhi; 100 from Mumbai; 104 from Chennai; and 101 from Kolkata). The final samples are slightly larger than planned since additional responses that qualified quality back-checks were not selectively dropped to avoid inferential biases.
- 2 Tamilnadu Civil Supplies Corporation, “Public Distribution System”, Government of Tamil Nadu, <https://www.tncsc.tn.gov.in/en/PDS.html>
- 3 The New Indian Express, “PDS shops eye FSSAI licence in Tamil Nadu”, July 7, 2022, <https://www.newindianexpress.com/states/tamil-nadu/2022/jul/07/pds-shops-eye-fssai-licence-in-tamil-nadu-to-supply-toor-dal-in-packets-2473799.html>
- 4 This point was made by domain experts who reviewed the study during a validation event.
- 5 India Demographic and Health Survey (DHS) Report 2019-21, <https://dhsprogram.com/publications/publication-FR374-DHS-Final-Reports.cfm>
- 6 India Demographic and Health Survey (DHS) Report 2019-21
- 7 “Diabetes and Your Heart”, Centers for Disease Control and Prevention, <https://www.cdc.gov/diabetes/library/features/diabetes-and-heart.html>

Conclusion

There is pervasive reuse and diversion of UCO across the commercial food sector in India. However, the reasons for UCO reuse vary significantly based on the location, size, and type of cuisine prepared at the food service establishment. Operators' and workers' knowledge of food safety practices in these establishments also influences UCO reuse practices.

India's attempts to remove toxic wastes such as UCO from the food stream have had limited impact. Making matters worse, India's food safety regulator—the FSSAI—has permitted topping up of UCO with fresh oil, a practice that

is explicitly prohibited in many other countries. Legitimising the topping up of UCO with fresh oil effectively weakens measures that seek to prevent FBOs from continuing to use UCO. Critical gaps in the enforcement capacity of regulators such as the FSSAI and state food safety authorities also result in poor implementation and compliance with UCO regulations on the ground. Consequently, efforts such as the RUCO initiative have had limited impact in creating an alternative ecosystem for UCO removal from the food stream. Indian consumers are thus being exposed to significant health risks on account of continuous and unabated UCO consumption.

Key Recommendations

1. Harmonise UCO regulations

- **Retract the FSSAI notification permitting topping up of fresh oil with UCO:** The FSSAI's own regulations send contradictory messages regarding the utilisation of UCO. On one hand, they prohibit the use of edible oils having a TPC greater than 25 percent. On the other, they also permit the topping up of fresh oil with UCO. The FSSAI notified the latter regulation without any scientific assessment of the health risks of this process. By its own admission, it permitted this exemption owing to lack of enforcement capabilities.
- **Streamline the definition of food streams:** Current regulations only cover the use of UCO across commercial food streams, mainly food service and food manufacturing. There is urgent need to target all potential avenues of UCO re-entering the food stream, including the livestock feeds sector as well as household consumption.
- **Expand the scope of UCO compliance:** Enforcement guidelines on UCO

management are applicable only to entities that consume more than 50 litres of edible oil per day. This high level of consumption is achieved only by a small proportion of food service establishments in the organised sector. Moreover, edible oil purchases are undertaken through multiple vendors, masking actual consumption. Consequently, a large proportion of FBOs fall outside the regulatory purview of UCO management rules. The FSSAI needs to rationalise the extent and applicability of UCO management rules, in consultation with industry associations, to include a more significant proportion of FBOs.

2. Improve enforcement capabilities

- **Build Capacity within FSSAI:** State-level food safety agencies that enforce UCO management rules on the ground are often short on personnel, ill-equipped, and poorly funded. As India's leading food safety regulator, the FSSAI needs to build institutional capacity by focusing on the following:

- Training and up-skilling of field staff;
 - Developing mobile field-testing kits for staff;
 - Timely disbursement of funds to state and district units;
 - Enhancing the network of accredited laboratories and testing centres;
 - Developing a grievance redressal portal with timely and actionable interventions to deal with complaints of non-compliance with food safety regulations; and
 - Expanding the scope of edible oil tracking applications to monitor generation, management and disposal of UCO across FBOs.
- **Promote Awareness of the Health Impacts of UCO Reuse:** The survey results indicate that awareness levels around UCO rules and the health risks of UCO consumption drive behavioural patterns of reuse of UCO and compliance with regulations. Small food service establishments with lower levels of awareness repeatedly reuse UCO until it is used up fully. Larger food establishments, especially those in Chennai, which reported a better understanding of

UCO management rules, changed their edible oils frequently and reported a higher level of compliance with the RUCO initiative.

The last awareness campaign by the FSSAI on UCO management was conducted in 2018 without any follow-ups. To tackle this awareness gap, the FSSAI needs to engage with other critical stakeholders in the ecosystem, including food industry associations, consumer groups, industry bodies, public health experts, doctors and nutritionists, to launch impactful and continuous awareness campaigns targeting food business operators. It needs to create awareness campaigns aimed at consumers to communicate the risks associated with UCO consumption, while providing actionable inputs on UCO disposal at the household level. Such a campaign would align with larger initiatives launched by the FSSAI under the 'Eat Right India' initiative. The FSSAI can draw inspiration from other successful awareness campaigns, such as those against single-use plastics and food adulteration.

3. Promote self-regulation by the industry

Stakeholders in the food manufacturing and services industries need to take on a more proactive role in ensuring compliance with food safety standards and regulations of their constituent members. They need to actively engage with downstream waste collectors and aggregators to find sustainable and scalable incentive models that can ensure compliance with regulations as well as secure additional revenue streams for businesses.

4. Develop infrastructure for UCO collection

Our survey results indicate that compliance with UCO management rules is predicated on the development of supporting infrastructure, including serviceability of, and access to, UCO collectors and aggregators. As the regulatory authority in charge of UCO management and the RUCO initiative, the FSSAI needs to expand its activities beyond the accreditation of UCO collectors and aggregators. This should include:

- Leveraging the efficiency of the private sector:** India has seen many instances of successful public-private collaboration in various sectors, including infrastructure development, electricity supply and even waste collection and management. Government stakeholders, including the FSSAI, need to leverage the learnings from these experiences to build successful public-private collaborative models of UCO management that create the necessary infrastructure and efficient incentives for sustainable waste collection.
- Collaborating with local self-government bodies:** In India, local self-government bodies are tasked with managing UCO and other food wastes. However, they often lack the institutional capacity, finances, and dedicated knowledge resources to act on the challenges of UCO diversion into the food stream. Building local capabilities through intensive public-private collaborations and an infusion of best practices from global models of UCO management can help municipalities tackle the growing threat posed by UCO diversion into the food stream.

5. Promote Principles of Circular Economy

There is significant demand for UCO in non-food sectors, including oleo-chemicals and soap manufacturing along with the bio-fuels sector. Alongside India's efforts to mainstream circular-economy principles through programmes such as the Waste to Wealth Mission and the National Bio-fuels Policy, there is significant scope to

create an alternative structure to divert UCO out of the food stream through a market-driven incentive system. The processes required to develop such alternative structures, however, go well beyond the administrative mandate and authority of the FSSAI and require deeper collaboration with other line ministries, including the Ministry of Petroleum and Natural Gas, industry stakeholders, and municipal bodies.

Appendices

Appendix 1: Basic characteristics of the sample

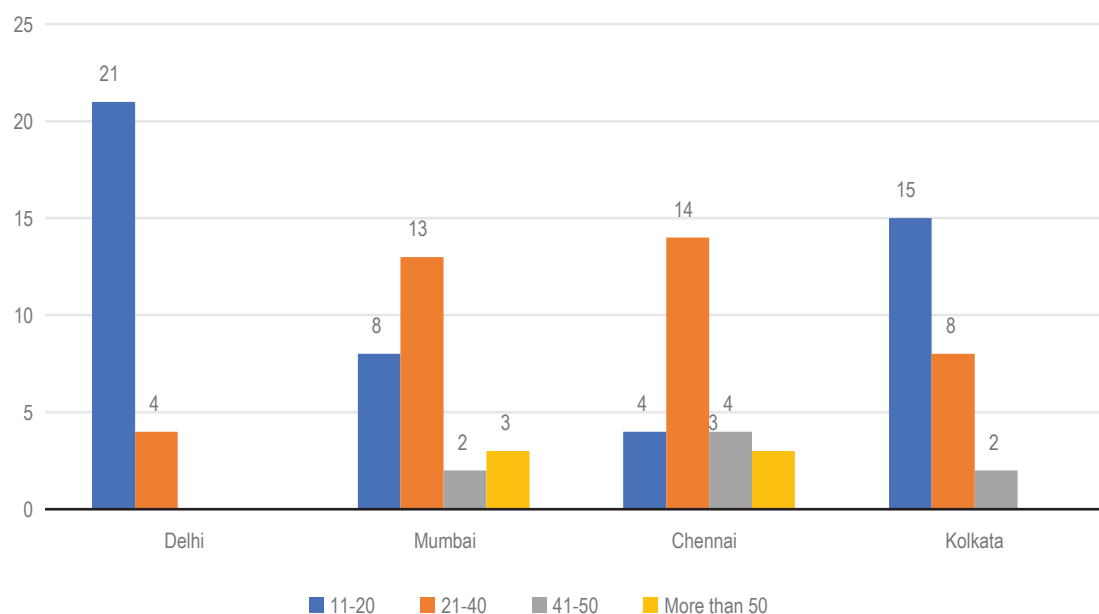
Appendix 1.1: Types of large eateries

	Delhi	Mumbai	Chennai	Kolkata
Dine-in restaurants	9	11	5	17
Quick service restaurants	9	6	8	7
Commercial canteens	3	4	5	-
Banquet/Marriage halls	4	5	7	1
TOTAL	25	26	25	25

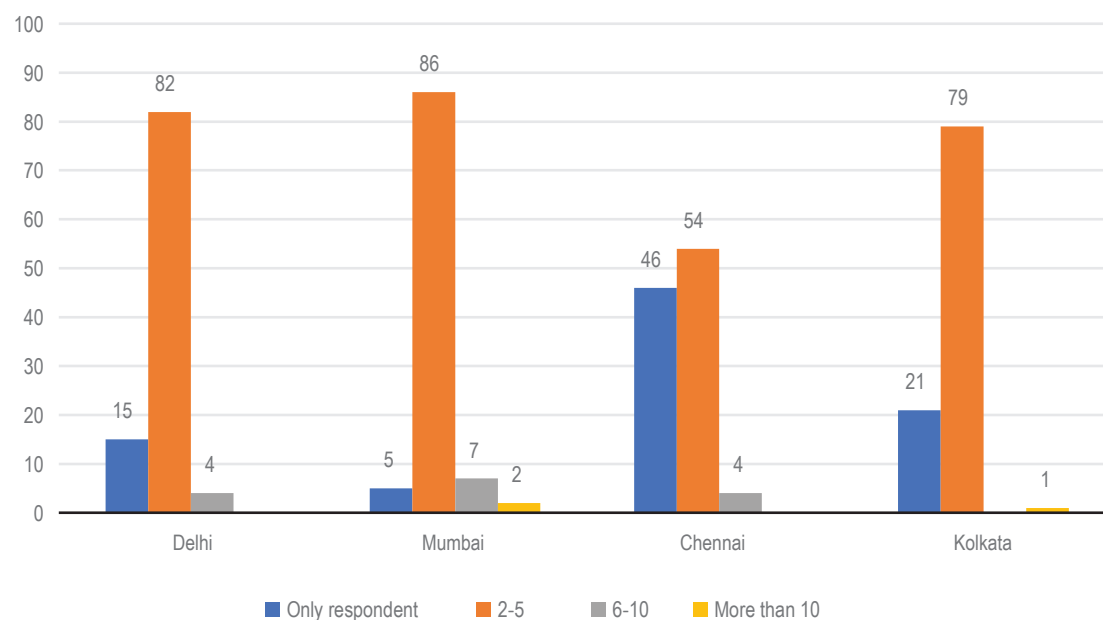
Appendix 1.2: Types of small eateries

	Delhi	Mumbai	Chennai	Kolkata
Very small/foot path (On a cart)	15	28	22	16
Roadside small eatery (no place of sitting)	20	36	37	43
Roadside small eatery (with a place for sitting)	37	23	22	41
Small Dhaba type eatery	22	10	18	1
Food Truck (Motorised)	7	3	5	-
Total	101	100	104	101

Appendix 1.3: Large Eateries: Number of workers in the establishment



Appendix 1.4: Small Eateries: Number of workers in the establishment



Appendix 2: Results and specifications

2.1. Comparing the General Awareness Scores for Small Eateries By city

t-test for Mean Comparison	Delhi	Mumbai	Chennai	Kolkata
Mean Score	0.20	0.35	0.40	0.06
Standard Deviation	0.11	0.19	0.21	0.07
Hypothesis 0: The average levels of awareness on UCO is same for small eateries across cities				
Hypothesis 1: The average levels of awareness on UCO is higher for small eateries in Chennai than all other cities	(0.000)**	(0.038)*		(0.000)**
Hypothesis 2: The average levels of awareness on UCO is higher for small eateries in Mumbai than Delhi and Kolkata	(0.000)**			(0.000)**
Hypothesis 3: The average levels of awareness on UCO is higher for small eateries in Delhi than Kolkata				(0.000)**

Figures in brackets () represent p-value for one-tailed t-test for mean comparison

* represents the null hypothesis can be rejected at 5% level of significance

** represents the null hypothesis can be rejected at 1% level of significance.

2.2. Comparing the General Awareness Scores for Large Eateries By city

t-test for Mean Comparison	Delhi	Mumbai	Chennai	Kolkata
Mean Score	0.39	0.60	0.77	0.33
Standard Deviation	0.19	0.21	0.19	0.22
Hypothesis 0: The average levels of awareness on UCO is same for large eateries across cities				

t-test for Mean Comparison	Delhi	Mumbai	Chennai	Kolkata
Hypothesis 1: The average levels of awareness on UCO is higher for large eateries in Chennai than all other cities	(0.000)**	(0.002)**		(0.000)**
Hypothesis 2: The average levels of awareness on UCO is higher for large eateries in Mumbai than Delhi and Kolkata	(0.000)**			(0.000)**
Hypothesis 3: The average levels of awareness on UCO is higher for large eateries in Delhi than Kolkata				(0.1537)

Figures in brackets () represent p-value for one-tailed t-test for mean comparison

* represents the null hypothesis can be rejected at 5% level of significance

** represents the null hypothesis can be rejected at 1% level of significance

2.3. Comparing the General Awareness Scores for Large and Small Eateries By city

t-test for Mean Comparison	Delhi	Mumbai	Chennai	Kolkata
Mean Score_Large Eateries	0.39	0.60	0.77	0.33
Standard Deviation_Large Eateries	0.19	0.21	0.19	0.22
Mean Score_Small Eateries	0.20	0.35	0.40	0.06
Standard Deviation_Small Eateries	0.11	0.19	0.21	0.07
Hypothesis 0: The average levels of awareness on UCO is same for large and small eateries in the city				
Hypothesis 1: The average levels of awareness on UCO is higher for large eateries than small eateries in the city	(0.000)**	(0.000)**	(0.000)**	(0.000)**

Figures in brackets () represent p-value for one-tailed t-test for mean comparison

* represents the null hypothesis can be rejected at 5% level of significance

** represents the null hypothesis can be rejected at 1% level of significance

2.4. Comparing the Compliance Scores for Large Eateries By city

t-test for Mean Comparison	Delhi	Mumbai	Chennai	Kolkata
Mean Score	2.52	1.08	5.12	2.56
Standard Deviation	2.96	1.38	2.03	2.87
Hypothesis 0: The average levels of compliance regarding UCO regulations is same for large eateries across cities				
Hypothesis 1: The average levels of compliance regarding UCO regulations is higher for large eateries in Chennai than all other cities	(0.000)**	(0.000)**		(0.000)**
Hypothesis 2: The average levels of compliance regarding UCO regulations is higher for large eateries in Kolkata than Delhi and Mumbai	(0.4808)	(0.013)*		
Hypothesis 3: The average levels of compliance regarding UCO regulations is higher for large eateries in Delhi than Mumbai		(0.017)*		

Figures in brackets () represent p-value for one-tailed t-test for mean comparison

* represents the null hypothesis can be rejected at 5% level of significance

** represents the null hypothesis can be rejected at 1% level of significance

2.5. Model Specification and Results for Logistic Regression

To study the impact of variations in levels of awareness and purchase price of fresh cooking oil on the reuse behaviour of large and small eateries across cities, we use a simple without-intercept logistic regression model (since, the dependent variable has only binary outcomes) as represented below:

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \alpha * Awarenessscores + \beta * Priceoffreshoil + \mu_{ij} \text{ ----- (1),}$$

Where,

$p_{ij} = P(\text{Reuseoil}_{ij} = 1 | X) = \text{Probability that Reuseoil}_{ij} \text{ is true, conditional on } X,$

where X captures the Awarenessscores and Priceoffreshoil;

$j = \text{typeofeatery}$ (large eatery is 1, small eatery is 0)

$\frac{p_{ij}}{1-p_{ij}}$ is the odds in favour of Reuseoil_{ij} is true

"ln" refers to the natural logarithmic scale

The statistical significance of the parameters is of interest here. The results of the regression are consistent with all post-estimation tests and robust standard errors and presented below:

```
. by Typeofeatery , sort : logistic Reuseoil Awarenessscores Priceoffreshoil, noconstant
```

```
-> Typeofeatery = 0
```

Logistic regression	Number of obs	=	406
	Wald chi2 (2)	=	101.85
Log likelihood = -212.16961	Prob > chi2	=	0.0000

Reuseoil	Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]	
Awarenessscores	.020389	.0124184	-6.39	0.000	.0061795	.0672731
Priceoffreshoil	1.015287	.0016066	9.59	0.000	1.012143	1.018441

```
-> Typeofeatery = 1
```

Logistic regression	Number of obs	=	101
	Wald chi2 (2)	=	33.82
Log likelihood = -21.01033	Prob > chi2	=	0.0000

Reuseoil	Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]	
Awarenessscores	.0193421	.0383789	-1.99	0.047	.0003959	.9450863
Priceoffreshoil	.9926874	.0051582	-1.41	0.158	.9826288	1.002849

.

2.6. Model Specification and Results for Multiple Regression

To study the impact of variations in levels of awareness on the compliance behaviour of large eateries across cities, we use a simple without-intercept multiple regression model with slope dummies for the three cities – Mumbai, Chennai and Kolkata (Delhi is considered the base case), as represented below:

$$Y_{ij} = \beta_1 * X_{ij} + \beta_2 * d_{i1}X_{ij} + \beta_3 * d_{i2}X_{ij} + \beta_4 * d_{i3}X_{ij} + \varepsilon_{ij} \text{----- (2),}$$

Where,

Y_{ij} = Compliance scores for the i th large eatery in j th city ,

X_{ij} = Awareness scores for the i th large eatery in j th city

j = city (Delhi , Mumbai, Chennai, Kolkata)

d_{i1} = dummy variable corresponding to j = Mumbai

d_{i2} = dummy variable corresponding to j = Chennai

d_{i3} = dummy variable corresponding to j = Kolkata

The statistical significance of the parameters is of interest here. The results of the regression are consistent with all post-estimation tests and robust standard errors and presented below:

```
. regress totalcompliancescoresy generalawarenessscoresonucox d1x d2x d3x, noconstant
```

Source	SS	df	MS	Number of obs	=	101
Model	1160.70561	4	290.176404	F(4, 97)	=	69.97
Residual	402.294385	97	4.1473648	Prob > F	=	0.0000
				R-squared	=	0.7426
				Adj R-squared	=	0.7320
Total	1563	101	15.4752475	Root MSE	=	2.0365

totalcompliancescoresy	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
generalawarenessscoresonucox	6.44204	.9284945	6.94	0.000	4.599236 8.284845
d1x	-4.571082	1.119281	-4.08	0.000	-6.792545 -2.349619
d2x	.2614601	1.062768	0.25	0.806	-1.847839 2.37076
d3x	1.271655	1.400711	0.91	0.366	-1.508369 4.051679

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