

## **Use of Food Wastes for Industrial Purposes**

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### **Abstract**

The UN Food Waste Index Report 2021 highlights that one billion tons of food is wasted annually, with households accounting for 61% of the waste. This poses environmental challenges and requires interventions at various levels. Collaboration between governments, businesses, and consumers is necessary to achieve the UN's goal of reducing global food waste by 50% by 2030. Strategies such as incentivizing sustainable practices and promoting innovation can help transform the food sector towards sustainability. In India, addressing the disposal of industrial waste is crucial, and extracting bioactive compounds from organic waste can provide valuable resources. Using greener extraction techniques and conducting economic analyses can lead to commercial utilization of industrial waste, reducing environmental pollution. Converting composted food waste into biogas is an environmentally friendly approach that reduces greenhouse gas emissions while generating renewable energy. Ethylene, a gas released by fruits and vegetables, can be used as a biogas to replace methane, offering benefits in industrial and construction applications.

**Keywords:** Food waste, Oil extraction, Biogas, Bioactive compound, Environmentally friendly approach

### **Introduction**

The issue of food waste is a global problem that not only has an impact on the environment but also contributes to food security as well as economic stability. This means that food resources intended for human consumption have been lost or wasted. A large amount of food is being lost or wasted throughout the supply chain, contributing to depletion of natural resources and exacerbating hunger and poverty worldwide (FAO, 2019). Food

waste may occur at various stages, including agricultural production, processing, distribution, retail, and consumer level. Around one third of all food produced for human consumption is lost or wasted worldwide each year, according to FAO, amounting to approximately 1.3 billion tonnes of food wasted with an estimated value of around \$1 trillion (FAO, 2019).

There are substantial impacts on the environment from food waste. All resources used in the production of food, such as water, energy, and land, will also be lost when it is wasted. Methane, a potent greenhouse gas and contributing to climate change, is also generated by decomposing food waste in landfills. Moreover, biodiversity loss and degradation of the environment are resulting from deforestation and habitat destruction associated with food production (FAO, 2019). The wastefulness of resources that would have been used for feeding the hungry exacerbates food insecurity. The reduction of food waste is essential for the achievement of food security and ensuring that every person has access to quality, healthy foodstuffs (FAO, 2019).

On both a macro and micro level, food waste has significant economic consequences. At the macro level, wasted resources have an impact on the economy in terms of lost investments, jobs, and energy. At the micro level, businesses in the food industry are experiencing financial losses due to unused or expired products. Consumers are also affected by food waste by increasing the cost of food production and distribution, ultimately leading to higher food prices (FAO, 2019). Addressing food waste at every stage of the supply chain is crucial to reduce the environmental impact, enhance food security, and contribute towards a more equitable world. Action by individuals, industry initiatives, and supportive policies are essential to meet this challenge and create a future in which the value of food is appreciated, not wasted (FAO, 2019).

## **FOOD WASTE AT GLOBAL LEVEL**

The UN Environment Programme's Food Waste Index Report 2021 stated that nearly one billion tons of food is wasted each year (UNEP, 2021). Furthermore, the report highlights that 17% of global food production may go to waste (UNEP, 2021). According to the report, households are the main contributors to food waste at 61%, followed by food service at 26% and retail at 13% (UNEP, 2021). The report emphasizes that food waste leads to various environmental issues, including climate change, pollution, and biodiversity

loss (UNEP, 2021). Consequently, reducing food waste is crucial for achieving sustainable food systems and addressing global challenges related to food security and environmental sustainability (UNEP, 2021). The report recommends implementing interventions at the household, business, and policy levels as potential solutions to mitigate this problem (UNEP, 2021).

There are significant environmental, social, and economic benefits to reducing food waste, both at the consumer and domestic levels. This objective aligns with the United Nations' Sustainable Development Goal (SDG) 12.3, which sets a target for countries to reduce per capita global food waste at the retail and consumer levels by 50% by the year 2030 (United Nations, n.d.). Achieving this target necessitates a collaborative effort from all stakeholders, including governments, businesses, and consumers, to implement measures aimed at reducing food waste throughout the food supply chain. The reduction of food waste can contribute to the promotion of sustainable food systems, the alleviation of food insecurity.

The Food Waste Index is a groundbreaking report that provides valuable insights into the magnitude of global food waste (UNEP, 2021). In fact, the report indicates that the scale of the problem could be more than twice as large as earlier estimates (UNEP, 2021). Previous studies have often suggested that food waste at the consumer level was predominantly a concern in developed countries, while developing nations faced challenges related to production, storage, and transportation losses (Parfitt et al., 2010; FAO, 2011). However, the Food Waste Index report challenges this perception by highlighting the significant contribution of households in food waste globally (UNEP, 2021).

However, the report's findings reveal that household food waste per capita is similar across high-income, upper middle-income, and lower-middle-income countries (UNEP, 2021). It is worth noting that there was insufficient data on low-income countries, but the report's findings suggest that food waste is a global issue that necessitates a global solution. According to the Food and Agriculture Organization of the United Nations (FAO), 690 million people worldwide experienced hunger in 2019, and this number is projected to increase due to the impacts of the COVID-19 pandemic (FAO, 2020). The World Economic Forum's Incentivizing Food Systems Transformation report argues that such a transformation is necessary to address the multiple challenges facing the food system, including food waste, climate change, and malnutrition (WEF, 2021). Achieving

sustainable food systems will require collaborative efforts from various stakeholders, including policymakers, businesses, farmers, and consumers. The report suggests that incentivizing sustainable practices and promoting innovation in the food sector could help accelerate the transformation towards more sustainable food systems (WEF, 2021).

The World Economic Forum's report highlights the significant economic impact of food loss and waste, which it estimates costs the global economy \$936 billion per year. Furthermore, food systems incur significant health, economic, and environmental costs that amount to \$12 trillion, which is 20% more than the market value of food systems. To incentivize the transformation of food systems towards sustainability, the report outlines various strategies, including repurposing public investment and policies, redesigning business models, and setting higher standards for companies. The report suggests that investors can play a critical role in driving the transformation by encouraging companies to adopt more sustainable practices. Consumers can also contribute to this transformation by shifting their demand towards more socially-responsible products. Overall, a multi-stakeholder approach is necessary to transform the food system towards sustainability, and the report's recommendations provide a useful roadmap for achieving this objective.

### **Solution**

The Food Waste Index report recommends that governments use its methodology for measuring food waste to guide their national strategies for food waste prevention and track progress towards the 2030 goals (Food and Agriculture Organization of the United Nations [FAO], 2021). This can help to foster a more coordinated and effective approach to reducing food waste at all levels, including household, food service, and retail. Food-related businesses, such as supermarkets, can also play their part in reducing waste by ensuring the quality and safety of produce and using the least amount of energy possible (FAO, 2021). Innovative technologies, such as the Internet of Things, can be used to monitor storage temperatures and stock levels for food retailers, enabling them to make more informed decisions about managing their inventory and reducing waste (FAO, 2021). At the consumer or household level, there are many things that individuals can do to waste less food, as suggested by the FAO. For example, adopting a healthier diet, buying only what is needed, and storing food wisely can all help to reduce food waste (FAO, 2021). By taking small, practical steps towards reducing food waste, we can all play our part in building more sustainable and resilient food systems (FAO, 2021).

## FOOD WASTE SCENARIO IN INDIA

Food waste poses a significant challenge in India, where a considerable portion of the population faces food insecurity and malnutrition (Food and Agriculture Organization of the United Nations [FAO], 2021). Approximately 40% of the country's food production goes to waste, primarily due to inefficient supply chains, inadequate storage and transportation facilities, and improper handling and processing practices (FAO, 2021). Cultural norms, such as extravagant weddings and social events, also contribute to the wastage of large quantities of food (Ranganathan & Balachander, 2018). The Indian government has acknowledged this issue and has implemented measures to address it, such as improving cold storage infrastructure, promoting food processing and preservation techniques, and raising public awareness about food waste (Government of India, 2019). Non-governmental organizations and civil society groups are also actively involved in reducing food waste and redistributing excess food to those in need (Sikka, 2020). However, further efforts are necessary to effectively combat food waste in India and ensure improved food security for its population (FAO, 2021). In India, with large quantities of food being wasted at various stages of the food supply chain (Srinivasan et al., 2019). Here is an overview of the food waste scenario in India:

**Production and Harvesting:** Inadequate infrastructure and poor post-harvest management practices lead to substantial food losses on farms. Factors such as improper storage, lack of transportation facilities, and limited access to markets contribute to food waste during production and harvesting (Kader & Rolle, 2004).

**Processing and Distribution:** Inefficient processing facilities and inadequate cold storage infrastructure result in further food losses. Insufficient processing capabilities lead to spoilage and wastage of perishable food items. Inefficient distribution systems and long supply chains also contribute to food waste (Srinivasan et al., 2019).

**Retail Sector:** In India, the retail sector faces challenges related to food waste, including inefficient inventory management, inadequate storage facilities, and improper handling practices. These issues lead to the discarding of food that is still edible (Taneja et al., 2019).

## **Addressing Food Waste in India:**

The Indian government and various organizations are taking steps to address food waste:

**Infrastructure Development:** Efforts are being made to improve cold storage facilities, transportation infrastructure, and processing capabilities. Investments in better post-harvest management infrastructure aim to reduce food losses (Singh et al., 2020).

**Awareness and Education:** Public campaigns and initiatives are raising awareness about the importance of reducing food waste. Educational programs targeting consumers, farmers, and food businesses aim to promote responsible consumption and better management practices (Jha & Singh, 2018).

**Food Recovery and Redistribution:** NGOs and organizations are working to recover excess food from various sources and redistribute it to vulnerable populations. Food donation drives, community kitchens, and technology-based platforms for surplus food redistribution are being implemented (Gupta et al., 2020).

**Policy Interventions:** The Indian government has launched initiatives such as the National Food Security Mission and the Pradhan Mantri Kisan Sampada Yojana to address food waste and improve food security. Policies are being formulated to encourage food processing, reduce food losses, and promote sustainable practices (Singh et al., 2020).

Despite these efforts, more comprehensive measures are needed to tackle food waste effectively in India. Encouraging collaborations among government, industry, and civil society, improving supply chain efficiencies, promoting innovative food preservation techniques, and fostering a culture of responsible consumption are crucial to minimizing food waste and ensuring better food security in the country (Singh et al., 2020).

## **PROBLEMS RELATED TO FOOD WASTE**

Food waste is a significant global issue that has numerous negative consequences. Here are some problems related to food waste:

**Hunger and Food Insecurity:** According to the FAO, around 690 million people worldwide suffer from hunger (FAO, 2021). Food waste exacerbates this issue by diverting valuable resources away from those who need it most. Instead of being consumed, edible food is discarded, resulting in a lack of access to nutritious meals for many individuals.

FAO: Food and Agriculture Organization

**Economic Loss:** Food waste represents a substantial economic loss at various stages of the food supply chain. Farmers, retailers, and consumers all incur financial losses when food is wasted. This inefficiency impacts businesses' profitability, agricultural productivity, and overall economic growth (Parfitt et al., 2010).

**Resource Depletion:** Producing food requires valuable resources, including water, energy, and land. When food is wasted, these resources are wasted as well. For instance, water used for irrigation and food processing is squandered, exacerbating water scarcity in many regions. Conserving these resources by reducing food waste is crucial for sustainable resource management (Kummu et al., 2012).

**Food Production Impact:** Food waste places unnecessary pressure on the global food production system. The growing population and increasing demand for food make it imperative to utilize resources efficiently. By reducing food waste, fewer resources would be required to meet the demand, mitigating the strain on agricultural production and reducing the need for deforestation and excessive fertilizer use (FAO, 2013).

**Ethical Concerns:** The wastage of food raises ethical questions, considering the stark contrast between food abundance and food insecurity. Throwing away edible food while people go hungry is a moral dilemma that needs to be addressed. Promoting responsible consumption and minimizing food waste can help alleviate these ethical concerns (Gustavsson et al., 2011).

## **SOLUTIONS TO THESE FOOD WASTE PROBLEMS**

To address the problems related to food waste, several solutions can be implemented at various stages of the food supply chain. Here are some effective strategies:

**Consumer Education and Awareness:** Educating consumers about the impact of food waste and providing them with practical tips on food storage, meal planning, and portion control can help reduce household food waste. Campaigns, workshops, and online resources can raise awareness and promote behavior change (Quested et al., 2013).

**Improved Food Storage and Handling:** Proper storage and handling practices can extend the shelf life of food. This includes maintaining appropriate temperatures, using airtight containers, and organizing refrigerators and pantries effectively. Clear labeling and rotation systems can also help ensure that older food items are used first (WRAP, 2019).

**Donation and Food Recovery Programs:** Establishing partnerships between food retailers, restaurants, and food banks can facilitate the donation of surplus food that is still safe for consumption. Food recovery programs can collect excess food from businesses and distribute it to those in need, reducing food waste and addressing food insecurity simultaneously (Bellemare et al., 2017).

**Sustainable Food Packaging:** Innovative packaging solutions can help prolong the shelf life of perishable foods, reducing the likelihood of spoilage. Biodegradable and compostable packaging materials can also minimize environmental impact (González-Torre et al., 2018).

**Improved Supply Chain Management:** Efficient inventory management, accurate demand forecasting, and streamlined logistics can reduce food waste throughout the supply chain. Implementing technology, such as data analytics and inventory tracking systems, can help identify and address inefficiencies (Wang et al., 2018).

**Food Waste Recycling and Composting:** Establishing composting programs for food scraps can divert organic waste from landfills. Municipalities can implement centralized composting facilities, and individuals can compost at home to reduce the environmental impact of food waste (Parizeau et al., 2015).

**Policy and Regulation:** Governments can enact policies and regulations to encourage food waste reduction. This can include tax incentives for businesses that donate excess food, landfill diversion targets, and standardized date labeling to reduce confusion and unnecessary food discards (Kantor et al., 2015).

**Farming and Agricultural Practices:** Promoting sustainable agricultural practices, such as precision farming and reducing post-harvest losses, can minimize food waste at the production level. Efficient irrigation systems, improved harvesting techniques, and proper storage facilities can all contribute to reducing waste (Gustavsson et al., 2011).

By implementing these strategies and encouraging a shift towards a more sustainable and responsible approach to food consumption, we can significantly reduce food waste and address the associated problems effectively.



## **EXTRACTION OF OIL FROM FOOD WASTE**

The world is currently facing a pressing issue of increasing petroleum consumption, which has resulted in a fossil fuel crisis and an imminent energy problem, mainly due to rapid urbanization and industrialization (Pachauri et al., 2014). Historically, the energy crisis has been addressed by relying on fossil fuels, which are finite resources. However, the heightened demand for fossil fuels has led to rising fuel prices and significant environmental consequences, including global warming, acidification, deforestation, ozone depletion, eutrophication, and photochemical smog (IEA, 2018). Over the past few decades, global consumption of fossil fuel energy has doubled (IEA, 2021). Given the limited nature of fossil fuel reserves, there is an urgent requirement to explore alternative resources that are economically viable, socially equitable, and environmentally friendly (Di Lucia et al., 2016). Extracting valuable products from residues like food and organic waste is generally considered beneficial (Goswami et al., 2021). One valuable material that can be obtained from such waste is oil, often referred to as "bio-oil," which is present in a significant amount in various biological waste materials of both plant and animal origin (Deng et al., 2017). These waste materials can originate from different stages of the supply and processing chain, including field waste, food processing factories, abattoirs, leftover supermarket products, and food waste generated during food preparation and leftovers from catering services (Ahmad et al., 2021; Liu et al., 2018).

When dealing with food wastes, it becomes essential to have the capability to process a diverse array of materials, including those of animal or vegetable origin. These materials can be in various states, such as raw, partially cooked, or fully cooked, and may consist of a wide range of fats, proteins, cellulose, keratin fiber, and even bones (Sharma et al., 2019). For instance, waste from a catering establishment can comprise uncooked vegetable peelings, meat trimmings including excess fat and gristle, bones, as well as leftover cooked food. Each of these waste components possesses unique characteristics, offering different types and proportions of recoverable beneficial oil (Kumari et al., 2020).

Two highly environmentally friendly sources for biodiesel production are used cooking oil and waste grease. According to the EPA's Renewable Fuel Standards Program Regulatory Impact Analysis from February 2010, biodiesel derived from waste grease can lead to an impressive 86% reduction in greenhouse gas emissions compared to traditional petroleum-based diesel (EPA, 2010). Waste oil and grease can be broadly classified into two categories. The first category is used cooking oil, also known as waste vegetable oil or

used fryer oil. This type of oil is derived from edible sources and has been utilized multiple times in deep-fat fryers (Alves et al., 2021).

## **USE OF GASSES RELEASE DURING VEGETABLES AND FRUITS PROCESSING**

Vegetables and fruit produce ethylene gas which is produced during processing of vegetables and fruits. Ethylene is a gas released by fruits and vegetables; this gas cause's produce to ripen faster. Ethylene produced during certain stages of growth such as ripening of fruits, senescence of flowers, germination, ripening of fruits. Ethylene producers are apples, bananas, tomatoes, avocados, melons, pears, squash, and stone fruits such as mangos. Plants which do not produce ethylene are broccoli, cabbage, cauliflower, leafy greens, and lettuce. Ethylene as a biogas is a great approach due to its properties, the property which is useful for industrial and construction use is ethylene gas is highly flammable and can replace methane. Why are we replacing methane because of its harmful effects to humans? Ethylene  $C_2H_4$  is the simplest alkene with the chemical name ethylene. It is also called ethene or polyethylene or Etileno. Ethylene is a colorless gas which has a sweaty odor and taste.

**Ethylene gas is used for the following purposes:** Plant growth regulator, Seed germination, Shoot and root growth, Root development, Abscission of leaves.

**Industrial applications of ethylene gas:** Ethylene is used as oxy-fuel gas in metal cutting, Welding, High velocity thermal spraying, Ethylene is used as refrigerant, LNG liquefaction plants, Ethylene is used in the extraction of rubber, Used as a feedstock in the production of polymers and industrial chemicals.

### **Conclusion, future prospective and Limitations**

The utilization of food waste in industries can bring about numerous benefits, ranging from environmental sustainability to economic opportunities. By recognizing the value of food waste and implementing innovative strategies, we can effectively address the challenges posed by food waste while creating a more resilient and resource-efficient industrial sector. Firstly, redirecting food waste towards industrial applications can significantly reduce the environmental impact of waste disposal. Instead of ending up in landfills where it contributes to methane emissions and soil pollution, food waste can be diverted to

industries for various purposes. It can be used as a valuable resource for bioenergy production, such as anaerobic digestion or biofuel generation, reducing reliance on fossil fuels and mitigating greenhouse gas emissions (Li et al., 2019). Secondly, food waste can serve as a feedstock for the production of bioplastics and biochemicals. The organic matter present in food waste can be converted into biodegradable plastics, enzymes, organic acids, and other bio-based chemicals through advanced biotechnological processes. This promotes the development of sustainable alternatives to traditional petrochemical-based products, reducing our dependence on non-renewable resources and minimizing the carbon footprint of the plastics industry (Eriksson et al., 2020; Silva et al., 2020). These initiatives not only contribute to environmental sustainability but also present economic opportunities. The valorization of food waste in industrial sectors can lead to the creation of new markets, job opportunities, and revenue streams. Moreover, it can enhance resource efficiency and reduce production costs for industries by utilizing readily available waste streams (Molinos-Senante et al., 2019; Liu et al., 2020). In conclusion, the utilization of food waste in industries holds great potential for environmental, economic, and social benefits. By adopting sustainable practices and innovative technologies, we can transform food waste into valuable resources, reduce environmental impacts, and contribute to a more circular and sustainable economy. Additionally, food waste can be utilized in the production of animal feed and fertilizers. By properly processing and treating food waste, it can be transformed into nutritious animal feed, thus reducing the need for dedicated crops for livestock. This not only conserves land and water resources but also helps tackle the challenges of food security and animal nutrition (Mata-Alvarez et al., 2014; Yang et al., 2019). Moreover, food waste can be composted and converted into organic fertilizers, providing a natural and sustainable solution for enhancing soil fertility and crop productivity (Mukhtar et al., 2018; Sharma et al., 2019). Composting food waste helps divert organic waste from landfills and reduces the need for synthetic fertilizers, contributing to waste reduction and environmental sustainability.

Furthermore, the usage of food waste in industries can present economic opportunities and foster circular economy models. With appropriate infrastructure and technologies in place, food waste can be transformed into value-added products, generating revenue and creating employment opportunities (Biswas et al., 2019; Holm-Nielsen et al., 2019). This approach aligns with the principles of a circular economy, where waste materials are recycled and reintegrated into the production cycle, minimizing waste generation and maximizing

resource efficiency. In conclusion, harnessing the potential of food waste in industries allows us to tackle environmental, economic, and social challenges simultaneously. By adopting innovative approaches and collaborative efforts between the food sector, waste management systems, and industrial stakeholders, we can unlock the untapped potential of food waste and transition towards a more sustainable and resilient industrial landscape. Overall, the unborn perspective on food waste involves a holistic approach that combines technological advancements, behavioral changes, policy interventions, and innovative results to reduce food waste, promote sustainability, and produce a more effective and indifferent food system.

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