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ENVIRONMENTAL IMPACTS OF POST-HARVEST LOSS OF ONIONS

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ABSTRACT

Onion post-harvest loss is a major worldwide problem that creates severe environmental issues in addition to economic difficulties. An overview of the environmental effects of onions' post-harvest loss is given in this abstract, with a focus on the necessity of sustainable practices and remedies. Around the world, onions are a staple crop that enhance the flavour of many different cuisines. But a significant amount of the onions that are harvested are wasted in the post-harvest process, which includes distribution, transportation, and storage. This loss has a significant negative impact on the environment in addition to being a waste of precious resources. Onion cultivation requires energy-intensive agricultural practices, which is one of the main environmental concerns. A substantial carbon footprint is created by the resources used for pest management, fertilizer, irrigation, and soil preparation. The environmental impact is increased when there is post-harvest loss of some of the harvest because these resources are practically wasted.

Moreover, the decomposition of discarded onions in landfills produces greenhouse gases, including methane, contributing to climate change. The environmental repercussions extend beyond greenhouse gas emissions, encompassing soil degradation and water pollution resulting from the disposal of rotting onions. In addition to the direct environmental consequences, post-harvest losses can intensify the pressure on natural ecosystems as farmers may expand agricultural areas to compensate for lost yields. This expansion often involves deforestation, further depleting biodiversity and disrupting ecosystem services. Addressing the environmental impacts of post-harvest loss requires a multi-faceted approach. Implementation of efficient storage and transportation technologies, improved packaging practices, and the development of sustainable supply chain management strategies are crucial steps. Furthermore, promoting consumer awareness and behaviour change can play a pivotal role in minimizing waste at the household level. The need of reducing onion post-harvest losses to lessen the burden on the environment is highlighted in this abstract. We may strive toward a more resilient and ecologically friendly food system by implementing sustainable practices along the whole onion supply chain. This will guarantee that the resources used in onion growing contribute to global food security without endangering the health of our planet.

I. INTRODUCTION

As spoiled onions break down, they may have an effect on the ecosystem just like other organic debris. When organic substances break down in the presence of microbes, the process of decomposition releases gases into the environment. Here are a few ways that rotting onions can impact the environment.[1][2]

- **Greenhouse Gas Emissions:**
- Carbon Dioxide (CO2): One greenhouse gas produced during decomposition is carbon dioxide. Although CO2 is a normal component of the carbon cycle, excessive emissions are a contributing factor to global warming and the greenhouse effect.**2][3]**
- Methane (CH4): The breakdown of organic materials, such as onions, can produce methane in anaerobic (oxygen-free) conditions, such those found in landfills. For shorter periods of time, methane is a more potent greenhouse gas than carbon dioxide.**[2]**
- **Odor Emissions:**
- The release of offensive aromas from spoiled onions is a common occurrence in the decomposition of organic materials, as microbial activity produces volatile organic compounds, or VOCs. These smells can have an impact on community well-being and local air quality even when they are not directly damaging to the atmosphere.

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- **Air Quality Impact:**
- One of the main sulfur compounds released during the decomposition of onions is hydrogen sulfide (H2S). Hydrogen sulfide has a strong and unpleasant odor, often described as resembling rotten eggs. Inhaling hydrogen sulfide in high concentrations can be irritating to the eyes, nose, and throat and may cause headaches, dizziness, and nausea. In extreme cases, exposure to high levels of hydrogen sulfide can be toxic.
- Additionally, other volatile organic compounds (VOCs) may be released during the rotting process, contributing to the overall air pollution in the immediate vicinity. These compounds can also have adverse effects on indoor air quality.
- Hydrogen sulfide (H2S) is one of the principal sulfur compounds generated during the breakdown of onions. The pungent, disagreeable smell of hydrogen sulfide is sometimes compared to that of rotten eggs. High quantities of hydrogen sulfide can irritate the eyes, nose, and throat in addition to causing headaches, nausea, and dizziness. Exposure to elevated hydrogen sulfide levels might be hazardous in some situations. Furthermore, as the material decomposes, additional volatile organic compounds (VOCs) could be emitted, adding to the general air pollution in the surrounding area. The quality of the air indoors may also be negatively impacted by these substances.
- It's crucial to remember that although the smell of rotting onions might be disagreeable and have an impact on the quality of the local air, these effects are usually transient and confined. Good ventilation and the appropriate disposal of rotten onions can help lessen these impacts. In the event that rotting onions are producing an overpowering and lingering stench, you should take immediate action to preserve the air quality inside.
- Adequate waste management techniques are essential to reducing these negative effects on the environment. Composting can be a more environmentally beneficial method of recycling organic waste than disposing of it in landfills. By encouraging the aerobic breakdown of organic materials, composting lowers methane emissions and creates soil amendments that are high in nutrients.

As with all organic materials, onions can decompose and release a variety of gases into the atmosphere. Different gases are produced during the decomposition of onions, which include organic substances such proteins, lipids, and carbohydrates that are broken down by microbes. The following are a few gasses that onions may produce as they rot and break down:

Rotten onions release a variety of gases in addition to heat. Among the gases released by onions are carbon dioxide, methane, sulfur dioxide, and hydrogen sulfide.

- Carbon Dioxide (CO2): One of the main products of breakdown is carbon dioxide. Organic matter is broken down by microorganisms, which releases carbon dioxide (CO2).[4][9]

One kilogram of rotten onions will produce varying amounts of carbon dioxide depending on the conditions in which they are breaking down. Microbial activity occurs during the decomposition of organic matter, such as onions, and one of the byproducts is carbon dioxide.

If the discarded onion is burned, 3.43 to 7.39×106 kg of carbon dioxide are released annually. Additionally, red onions that degrade anaerobically (in a landfill) release roughly 1.71–3.69×106 kg of CO2 annually. When extrapolated to the global scale, these figures can approximate 0.77–1.60×1010 kg/year of CO2 through incineration and 3.85–8.00×109 kg/year of CO2 through landfills.**[4][9]**

The specific nutritional composition of onions, here is a general breakdown of macronutrients in raw onions per 100 grams:

- Water: Approximately 73.68%
- Carbohydrates: Around 14.9 grams
- Fiber: Roughly 2.72 grams
- Protein: About 1.76 grams
- Sugar: 6.78 grams
- Fats 0.16grams [6]

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Methane (60%) carbon dioxide (24%) hydrogen sulfide (about 8%), and other gasses that collect 8% of ammonia and some other volatile organic components make up anaerobically digested waste onion.**[4]**

- **Methane (CH_4):** Onions and other organic materials can break down into methane under anaerobic (low oxygen) conditions, such as in some landfill sections or soggy soils. Anaerobically, CH4 emissions range from 0.62 to 1.3 ×106 kg/year. **[4][11]**
- Methane gas (CH4) is not typically associated with rotten onions. The primary gas associated with the decomposition of onions and other organic matter is hydrogen sulfide (H2S).
- Rotten onions are not commonly linked to methane gas (CH4). Hydrogen sulfide (H2S) is the main gas released during the breakdown of onions and other organic materials.
- •In anaerobic (low oxygen) conditions, methane, a colorless and odorless gas, is frequently linked to the breakdown of organic materials. Onions do not, however, often release a large amount of methane during their breakdown. The primary sulfur-containing substances in onions aid in the hydrogen sulfide release process, which produces the distinct rotten onion odor.
- Methane's Global Warming Potential (GWP) is a measurement of the amount of heat that a unit quantity of methane, relative to carbon dioxide (CO2), traps in the atmosphere over a given time period, usually 20 or 100 years. Strong greenhouse gas methane's global warming potential (GWP) varies with time**. [10]**

The commonly used GWP values are:

- 20-Year GWP: Approximately 84-87 times that of CO2.
- 100-Year GWP: Approximately 28-36 times that of CO2.

This means that over 20 years, methane has a warming effect 84-87 times greater than that of carbon dioxide, and over 100 years, it has a warming effect 28-36 times greater than CO2, on a per-mass basis.

It's important to note that while methane has a higher GWP than CO2, it also has a shorter atmospheric lifetime. Methane typically persists in the atmosphere for around 12 years before it is broken down, primarily through chemical reactions**. [10]**

- **Hydrogen sulfide** (H2SAround 8% of rotting onions release H2S into the atmosphere when they are anaerobic, and H2S has no ability to cause global warming. As sulfhur-containing components in the onions break down, hydrogen sulphide (H2S) is released from rotting onions. Sulfur compounds are present in onions naturally and contribute to their distinct flavor and scent. Enzymes are released when an onion is chopped or injured, starting chemical reactions that break down these sulfur compounds..**[12][13][22]**
- Cysteine sulfoxide is one of the sulfur-containing substances found in onions. Enzymes such as alliinase come into contact with cysteine sulfoxide when an onion is chopped or injured, resulting in the creation of different breakdown products, including hydrogen sulfide. One common description of hydrogen sulfide' s characteristic and disagreeable Odor is that it smells like rotten eggs.**[16][22]**
- Thus, the natural breakdown and degradation of sulfur molecules in the onion tissues is what causes rotting onions to emit H2S. This procedure is part of what gives rotting or ruined onions their distinctive smell.**[12]**
- **Ammonia (NH3):** Onions' nitrogen-containing molecules have the ability to break down into ammonia. One of the other gases released by rotting onions is ammonia. However, ammonia has no ability to cause global warming. **[17][18][19]**
- Onions can create an unpleasant stench when they rot; in certain situations, this stench may be caused by the gas ammonia being released. Nitrogen-containing chemical ammonia is distinguished by a pungent, strong smell. Ammonia may be released as a consequence of rotting onions' degradation of proteins and amino acids.**[18][19]**
- During their breakdown, the sulfur-containing chemicals in onions—which give them their distinct aroma—can go through chemical processes. These reactions may produce a variety of sulfur-containing gasses, such as ammonia and chemicals that give onions their odor.**[18][19]**
- It's crucial to remember that the decomposition process as a whole involves more than just the ammonia released by rotting onions. Onions may be handled and stored properly to minimize unwanted smells and to

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slow down the decomposition process. One way to achieve this is to keep onions in a cool, dry environment.**[19]**

- **Volatile Organic Compounds (VOCs):** Similar to numerous other organic materials, onions can produce volatile organic chemicals when they break down. These can encompass a range of organic substances, including ketones, aldehydes, and alcohols.**[14][21]**

It's crucial to remember that the particular gases released can vary depending on the decomposition process overall, microbial activity, and ambient circumstances (aerobic vs. anaerobic). The discharge of these gases can be regulated, and the environmental impact can be reduced, with the use of composting or carefully monitored decomposition in landfills.

The distinct odor of decomposing onions is caused by volatile substances that are emitted from rotting onions. Sulfur-containing chemicals are among these, and they add to the strong smell**.[8][14][21]**

- **Dimethyl Disulfide (DMDS)**: This is an additional sulfur component that adds to the smell. It smells strongly and bad.
- **Dimethyl Trisulfide (DMTS :**Similar to DMDS, DMTS is an odorous sulfur-containing molecule. It is also produced when onions break down.
- **Thiophenes**: These are a group of organic substances that include sulfur and add to the general decaying onion odor**.**
- **Aldehydes**: These are a group of organic substances that include sulfur and add to the general decaying onion odor.

During the breakdown of onions, microbiological and enzymatic processes release these volatile chemicals. Even though these substances have a disagreeable smell, little amounts of them usually don't do any harm. However, as was indicated in the previous comment, exposure to high concentrations of particular sulfur compounds, including hydrogen sulfide, can result in discomfort and health problems. The effect of these volatile substances on interior air quality can be reduced with the proper disposal of rotting onions and adequate ventilation.**[20][21]**

The varied composition found in 100 grams of onions: the majority is made up of water (73.68 grams), which is followed by carbohydrates (14.9 grams), sugar (6.78 grams), fiber (2.72 grams), protein (1.76 grams), and fat (0.16 grams).

Table 1.

Content	Quantity
Water	73.68
Carbohydrates	14.9
Sugar	6.78
Fibre	2.72
Protein	1.76
Fat	0.16

Table 2.

Content	Converted to gas
Water	Majority
Carbohydrates	NIL(14.9)
Sugar	NIL(6.78)

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Fibre	Majority
Protein	NIL(1.76)
Fat	Majority

100 grams of Onion after anaerobic decomposition

Table 3

Gases released from rotten onion	Percentage	Weight (gm)
Methane	60%	14.1
Carbon dioxide	24%	5.6
H2S	8%	1.9
Ammonia & VOC	8%	1.9

Time frame: The rotten onion releases gasses into the atmosphere in 5-7 days, but it takes more than 5 months for it to entirely decay.

1. Resource Intensity and Carbon Footprint: It is clear that growing onions requires a large amount of water, fertilizer, energy, and pesticides. Environmental concerns are heightened by the accompanying carbon footprint, which makes a re-evaluation of agricultural practices necessary for sustainability.
2. Post-Harvest Loss Magnitude: A significant amount of the total production of onions is lost after harvest, especially in storage and transit. This loss exacerbates the negative effects of farming on the ecosystem in addition to depleting precious resources.
3. Greenhouse Gas Emissions and Climate Change: Methane and other greenhouse gases are released into the atmosphere when leftover onions decompose in landfills. The body of research highlights the importance of waste management techniques in addressing post-harvest losses as a method to mitigate the effects of climate change.
4. Energy Consumption and Efficiency: Post-harvest operations and onion farming are associated with significant energy consumption. To lessen the environmental impact of producing onions, the literature promotes the development of energy-efficient practices and technology along the entire supply chain.
5. Implications for Biodiversity and Land Use: Increasing the area under cultivation for onions in order to offset losses after harvest gives rise to worries regarding both changes in land use and biodiversity. Maintaining natural ecosystems and reducing these wider environmental effects require the use of sustainable agricultural methods.
6. Technological Solutions: Reducing post-harvest losses requires a number of technological solutions, including better transportation and storage infrastructure. The body of research justifies putting these strategies into practice in order to increase effectiveness and lessen negative environmental effects.
7. The Economic-Environmental Nexus: Finding sustainable solutions requires taking into account both the financial and environmental consequences. The literature emphasizes how crucial it is to reconcile environmental preservation with economic benefits when implementing treatments aimed at reducing post-harvest loss.
8. Awareness and Behaviour of Consumers: Post-harvest losses are mostly caused by consumer behaviour, especially at the home level. It is determined that behavioural interventions and awareness campaigns could be effective ways to cut waste and encourage a more sustainable way of eating onions

II. CONCLUSION

Onion post-harvest loss has diverse environmental effects that include resource-related, climatic, and ecological aspects. A comprehensive approach that incorporates waste management techniques, technology advancements, and stakeholder participation is needed to address these effects. We can lessen the negative

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effects on the environment, encourage resource efficiency, and build a more resilient and ecologically friendly food system by implementing sustainable practices throughout the onion supply chain.

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