IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
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"Natural Cooling Methods for Healthier Food Storage: Terra Cool Review"

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Abstract:

This research proposes the development and implementation of a novel clay sheet device designed to improve the efficiency of outdoor air conditioner condenser units, thereby reducing carbon emissions and contributing to global environmental sustainability. The device will be strategically placed in front of the condenser unit to enhance heat dissipation and airflow, optimizing the system's performance. Through experimental testing and simulations, the effectiveness of the clay sheet device will be evaluated in terms of its ability to mitigate heat transfer losses and improve energy efficiency. The project aims to provide a cost-effective and environmentally friendly solution to enhance the operation of air conditioning systems while simultaneously reducing their carbon footprint. Maintaining the freshness and nutritional quality of perishable foods is a critical challenge in food storage, especially in regions with limited access to electricity and refrigeration. Natural cooling methods, such as clay-based cooling systems, offer a sustainable and eco-friendly alternative to conventional refrigeration. This review focuses on the Terra Cool clay cooling system, evaluating its effectiveness in preserving food freshness, extending shelf life, and maintaining nutritional value. By utilizing the natural evaporative cooling properties of clay, Terra Cool provides a chemical-free, energy-efficient solution that supports healthier food storage practices. The system's impact on reducing food spoilage and promoting food safety is examined, alongside its potential benefits for reducing food waste and supporting food security in off-grid and low-resource settings. This review highlights the importance of integrating traditional cooling techniques with modern innovations to promote sustainable and health-conscious food preservation.

Keywords: Global warming, Carbon emissions, Air conditioner, Environment, Air Quality, Green initiative.

1. Introduction.

Global warming is primarily caused by the increase in greenhouse gases, such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), in the Earth's atmosphere. Human activities, including the burning of fossil fuels for energy, deforestation, industrial processes, and agriculture, release these gases, trapping heat and leading to a rise in global temperatures. This enhanced greenhouse effect disrupts the Earth's climate system, resulting in more frequent and intense heatwaves, melting polar ice caps, rising sea levels, and other adverse environmental impacts.

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Air conditioners contribute to global warming primarily through their energy consumption and refrigerant emissions. The electricity required to power air conditioning units often comes from fossil fuel combustion, releasing carbon dioxide and other greenhouse gases into the atmosphere. Additionally, many air conditioners use refrigerants with high global warming potential (GWP), which can leak during operation or disposal. These refrigerants, such as hydrofluorocarbons (HFCs), trap heat in the atmosphere, exacerbating the greenhouse effect. The combined effects of energy consumption and refrigerant emissions make air conditioners significant contributors to global warming, highlighting the importance of improving efficiency and transitioning to environmentally friendly alternatives.

By using natural materials like clay, we can help reduce our carbon footprint and lessen the impact of global warming on nature. Clay has excellent insulating properties, which can help regulate indoor temperatures and reduce the need for heating and cooling systems that contribute to greenhouse gas emissions. Additionally, clay is a sustainable material that is abundant in nature and can be easily sourced without causing harm to the environment.

Overall, using natural materials like clay can play a significant role in reducing the impact of global warming on nature and creating a more sustainable future for generations to come.

2. Effects on Global Warming by ACs

Air conditioning has several significant effects on global warming and climate change due to its energy consumption and the refrigerants used in cooling systems.

Air conditioning is responsible for about 4% of global greenhouse gas emissions. This is twice as much as the aviation industry.

Here are some key points to consider:

1. Energy Consumption: Air conditioning units consume a significant amount of electricity, especially during hot summer months when demand for cooling is high. This high energy consumption leads to increased greenhouse gas emissions, primarily from the burning of fossil fuels to generate electricity. These emissions contribute to global warming and climate change.

2. Refrigerants: Traditional air conditioning units use refrigerants that are potent greenhouse gases, such as hydrofluorocarbons (HFCs). When released into the atmosphere, these refrigerants can trap heat and contribute to global warming. The production, use, and disposal of these refrigerants have a significant impact on the environment.

3. Urban Heat Island Effect: The widespread use of air conditioning in urban areas can contribute to the urban heat island effect, where cities become significantly warmer than surrounding rural areas due to human activities and infrastructure. This effect can further exacerbate global warming and impact local climate patterns.

4. Increased Demand: As global temperatures rise due to climate change, the demand for air conditioning is expected to increase, especially in regions experiencing more frequent and intense

heatwaves. This increased demand for cooling can further strain electricity grids, increase energy consumption, and contribute to higher greenhouse gas emissions.

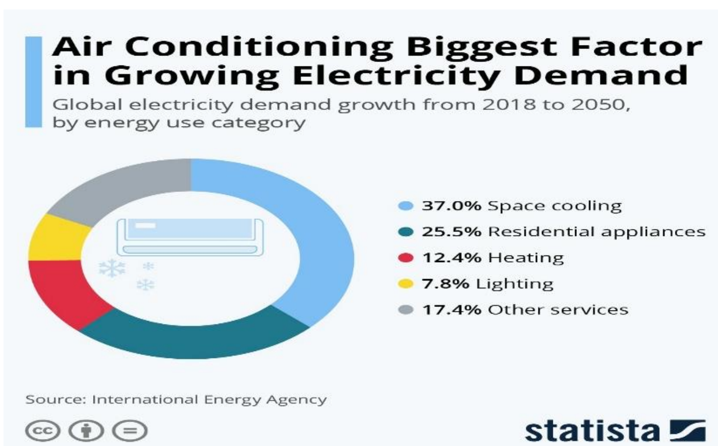
In daily life, air conditioning has become a common feature in homes, offices, and public spaces, providing comfort and relief from hot weather. However, it is essential to consider the environmental impact of air conditioning and take steps to reduce its carbon footprint. This can include using energy-efficient cooling systems, setting temperature controls wisely, improving building insulation, and transitioning to more sustainable refrigerants.

By raising awareness about the effects of air conditioning on global warming and adopting more environmentally friendly cooling practices, individuals and communities can help mitigate the environmental impact of cooling systems and work towards a more sustainable future.

Emerging economies in the tropics and the subtropics, such as India, China, Brazil, and Indonesia, are expected to see a fivefold increase in demand for cooling in the next three decades.

If these demand projections hold true and AC energy efficiency continues to improve at its 50-year historical rate, residential air conditioning alone could lead to a 0.5ºC increase in global temperature by 2100, completely derailing our Paris goals to stay below a 2ºC global increase.

Air conditioners impact the climate in two main ways: direct emissions from refrigerants and indirect emissions from electricity use. Refrigerants leak into the atmosphere throughout the lifespan of the air conditioner and are thousands of times more potent than carbon dioxide. However, refrigerants account for only 20–30 percent of air conditioners' climate impact. The other 70–80 percent is due to electricity use from the grids. If nothing is done, by 2050 residential ACs globally could use more than all the electricity that the United States and Germany use today combined.



Air conditioning (AC) has emerged as a significant factor driving the growing demand for electricity worldwide. As global temperatures rise due to climate change, the need for cooling solutions has become increasingly critical, leading to a surge in the adoption of AC units in both residential and commercial sectors.

One of the primary reasons for AC's disproportionate contribution to electricity demand is its energy-intensive operation. Compared to other electrical appliances, such as refrigerators or washing machines, AC units consume a substantial amount of electricity, especially during peak cooling periods. This high energy consumption is primarily attributed to the continuous operation of compressors and fans needed to cool indoor spaces efficiently.

As a result, AC units are responsible for a significant portion of electricity consumption in many regions, particularly during hot summer months. In some areas, the demand for electricity spikes dramatically during heatwaves, straining electrical grids and necessitating additional generation capacity to meet peak loads.

The extensive use of electricity by AC units has serious implications for global warming. The majority of electricity generation still relies on fossil fuels, such as coal, natural gas, and oil, which release carbon dioxide (CO2) and other greenhouse gases when burned. These emissions contribute to the greenhouse effect, trapping heat in the Earth's atmosphere and leading to global warming and climate change.

Furthermore, the refrigerants used in AC systems, particularly hydrofluorocarbons (HFCs), are potent greenhouse gases with a high global warming potential. When leaked or improperly disposed of, HFCs can contribute significantly to climate change, further exacerbating the environmental impact of AC usage. In summary, the extensive use of electricity by air conditioning systems is a significant driver of global warming. From the high energy consumption of AC units to the emissions associated with electricity generation and refrigerant leakage, AC's environmental footprint is substantial. Addressing this challenge requires a multi-faceted approach, including promoting energy-efficient cooling technologies, transitioning to renewable energy sources, and phasing out the use of high-global-warming-potential refrigerants. By taking proactive measures to mitigate the environmental impact of AC usage, we can work towards a more sustainable and climate-resilient future

3. Material Research:

Table 1 Advantages and limitations of Clay with respect to cooling.

Sr. No	Material	Advantages	Limitations	Cooling ability
1	**Clay**	Clay possesses advantageous cooling properties due to its natural ability to retain moisture and release it slowly over time. This slow release of moisture helps regulate temperature, creating a cooling effect in its surroundings. Additionally, clay's dense composition provides thermal mass, absorbing heat during the day and	While clay offers effective cooling properties, it also has limitations, particularly in humid environments where it can struggle to evaporate moisture efficiently, hindering its cooling effect. Additionally, clay's effectiveness in cooling may diminish over time due to factors such as weathering and	-----

		releasing it gradually at night, further contributing to its cooling capabilities	accumulation of dirt or debris on its surface, reducing its ability to regulate temperature effectively.	
2	**Terracotta Clay**	Terracotta, as a type of clay, shares many advantages with traditional clay in terms of cooling. It retains moisture effectively and releases it gradually, providing a natural cooling effect in its surroundings. Additionally, terracotta's dense composition offers thermal mass, absorbing heat during the day and releasing it slowly at night, contributing to its cooling properties.	Terracotta, a type of clay, shares similar limitations with traditional clay in terms of cooling. In humid conditions, terracotta may struggle to evaporate moisture efficiently, affecting its ability to provide effective cooling. Additionally, like clay, terracotta can lose its cooling effectiveness over time due to factors such as weathering and accumulation of dirt or debris, diminishing its capacity to regulate temperature.	Moderate
3	**Bentonite Clay**	One advantage of bentonite clay for cooling purposes is its exceptional ability to absorb and retain moisture. This property allows it to effectively trap moisture from the surrounding environment and release it slowly, creating a cooling sensation. Additionally, bentonite clay's high thermal conductivity enables it to dissipate heat quickly, contributing to its cooling effect. Overall, these characteristics make bentonite clay a valuable natural material for maintaining cooler temperatures in various applications, from skincare products to construction materials.	One limitation of bentonite clay in terms of cooling is its tendency to become less effective in highly humid environments. In such conditions, the clay may struggle to absorb moisture from the air, reducing its cooling capacity. Additionally, over time, bentonite clay can become compacted or contaminated, diminishing its ability to retain moisture and regulate temperature effectively, thereby limiting its cooling potential..	High
4	**Earthenware Clay**	Earthenware clay offers the advantage of being readily available and relatively inexpensive compared to other types of clay. Its porous nature facilitates efficient evaporation of moisture, which can enhance its cooling effect, especially in dry climates. Additionally, earthenware clay is often lighter in weight and easier to work with, making it suitable for a	Earthenware clay's limitation in cooling lies in its porous nature, which can lead to faster evaporation of moisture compared to denser clays. In humid conditions, this rapid moisture loss may reduce its effectiveness in providing sustained cooling. Additionally, earthenware clay may not possess the same level of thermal mass as denser clays, which could limit its ability to	Low

		wide range of cooling applications, such as pottery and construction materials.	absorb and retain heat for gradual release, affecting its overall cooling properties.	

4.Research and Methodology:

Based on the information provided in the search results, the use of certain clay minerals, such as smectite, has been shown to have the potential to sequester carbon over millions of years. These clay minerals are effective at trapping organic carbon, thereby preventing it from being consumed by microbes and expelled back into the atmosphere as carbon dioxide. Consequently, they may have a cooling effect on the entire planet, contributing to the modulation of global temperatures and potentially offsetting some of the carbon emissions that have been released into the atmosphere.

Research Objective

The primary objective of this research is to evaluate the effectiveness of the Terra Cool clay cooling system as a natural method for healthier food storage. The study aims to assess the system's ability to preserve food freshness, extend shelf life, maintain nutritional quality, and promote food safety without relying on conventional refrigeration.

Research Design

This study adopts a mixed-methods approach, combining experimental evaluation with qualitative analysis. It involves both laboratory testing of the Terra Cool system's cooling performance and user feedback collected through surveys and interviews.

Data Collection Methods

1. **Experimental Testing:**

- **Sample Selection:** Common perishable food items such as fruits (e.g., tomatoes, apples), vegetables (e.g., leafy greens), and dairy products are selected for the study.
- **Storage Conditions:** Foods are stored under three different conditions for comparison:
    - Terra Cool clay cooling system
    - Conventional refrigeration
    - Ambient room temperature
- **Parameters Monitored:** Temperature inside the storage units, humidity levels, and food quality indicators including weight loss, color retention, texture, microbial growth, and nutrient content (vitamins and minerals) over a period of 7-14 days.
- **Measurement Tools:** Digital thermometers, hygrometers, spectrophotometers for color analysis, microbial testing kits, and standard nutritional assays.

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2. **Qualitative Data:**

- **User Surveys and Interviews:** Participants from rural and urban households using Terra Cool are surveyed to gather insights on ease of use, perceived effectiveness, impact on food waste, and health benefits.
- **Focus Groups:** Discussions with nutritionists and food safety experts to evaluate the system's impact on food quality and health outcomes.

Data Analysis

- **Quantitative Data:** Statistical analysis using software such as SPSS or Excel to compare temperature regulation, microbial growth rates, and nutrient retention across different storage methods. Analysis of variance (ANOVA) tests to determine significance.
- **Qualitative Data:** Thematic analysis of survey responses and interview transcripts to identify common patterns and user perceptions related to health and nutrition benefits.

Ethical Considerations

Participants' consent will be obtained prior to surveys and interviews. Data confidentiality and anonymity will be maintained throughout the study.

Limitations

The study may face constraints related to seasonal variations in ambient temperature and humidity, which could affect cooling efficiency. The sample size for user feedback may also be limited by geographic and demographic factors.

The research suggests that these clay minerals, particularly smectite, could be intentionally harnessed to further mitigate global warming. For example, they could be applied to regions of permafrost to prevent exposed carbon from escaping into the atmosphere and contributing to further warming. Furthermore, the findings emphasize the importance of understanding natural processes at a mineral and grain scale to uncover potential solutions for addressing the climatic challenges posed by global warming.

Utilizing clay as a shield to absorb and reduce carbon emissions presents a promising avenue for combating global warming. By coating surfaces prone to emitting carbon dioxide, such as industrial exhausts or power plant chimneys, with clay-based materials, carbon capture and storage can be enhanced. Clay's porous structure provides an ideal medium for trapping carbon dioxide molecules, preventing their release into the atmosphere. Moreover, clay minerals possess chemical properties that facilitate carbon dioxide adsorption and conversion into stable compounds. Harnessing clay as a shield in carbon capture processes offers a cost-effective and scalable approach to reducing emissions and mitigating climate change, contributing to a more sustainable future.

5. Conclusion:

In conclusion, the clay sheet device, strategically placed behind air conditioner condenser units, presents a sustainable and cost-effective solution for addressing global and local temperature rise. Harnessing clay's innate cooling properties, it acts as a thermal barrier, effectively reducing heat transfer and alleviating the urban heat island effect. This environmentally friendly approach not only minimizes energy consumption but also contributes to long-term climate resilience. Its affordability and scalability make it accessible for widespread implementation, particularly in areas where conventional cooling technologies are limited. By improving community well-being and mitigating heat-related health risks, the clay sheet device demonstrates significant potential in the fight against climate change and the creation of more sustainable urban environments. Overall, its innovative design and practical benefits position it as a promising tool in the pursuit of a cooler, greener future.

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