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CIRCULAR ECONOMY: A SOLUTION TO SOLID WASTE MANAGEMENT IN AFRICA AS AN ALTERNATIVE TO LANDFILLING

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Introduction: Rapid urbanization and population growth in Africa have resulted in a continuous increase in solid waste output, causing serious environmental, health, and economic issues. In 2016, the continent generated approximately 174 million tonnes of solid waste, a figure projected to reach 516 million tonnes per year by 2050 [1]. Traditional waste management methods, such as landfilling and open dumping, have proven ineffective, leading to pollution, greenhouse gas emissions, and resource depletion. As waste volumes continue to rise, there is an urgent need to transition toward a more sustainable approach that emphasizes resource efficiency, waste reduction, and economic opportunities. Studies suggest that implementing advanced waste management strategies such as recycling and composting can significantly mitigate these challenges. This research suggests several methods under the circular economy framework, including Windrow composting, Microbial-Induced Carbonation (MIC) for construction waste recycling, brewery spent grain (BSG) upcycling into alternative protein sources, and the production of biodegradable soap from fruit peels. By adopting these circular economy strategies, Africa can reduce waste, minimize environmental impact, and create economic opportunities. A collective effort from policymakers, industries, and communities is essential to drive this transition toward a sustainable and resilient future.

Circular economy is a waste management strategy that promotes sustainability by extending the lifecycle of materials through reuse, recycling, and innovative waste transformation methods. Unlike the traditional linear model, which focuses on disposal, the circular economy seeks to extract value from waste while reducing environmental harm. This study explores key circular economy strategies applicable to Africa

The Main Part: One promising method within the circular economy framework is windrow composting, which facilitates the natural decomposition of organic waste such as food scraps and agricultural residues. This technique involves arranging waste into long rows, or "windrows," which are periodically turned to enhance aerobic decomposition. The result is nutrient-rich compost that can be used to improve soil fertility, boosting agricultural productivity while simultaneously reducing methane emissions from organic waste decay. This method is both practical and cost-effective, as it does not require sophisticated equipment and can be implemented at various scales, from small community composting initiatives to large industrial composting operations. Many African countries have abundant agricultural activities, making windrow composting highly feasible, as farmers can directly benefit from the compost to enhance crop yields. However, challenges such as limited public awareness, insufficient waste separation at the source, and potential odor issues in densely populated areas must be addressed through education, proper site selection, and effective waste management policies.

Another innovative approach is the closed-loop recycling of construction waste using microbialinduced carbonation. The MIC process utilizes microorganisms to accelerate the carbonation of recycled concrete, enhancing its strength and enabling its reuse in new construction projects. Concrete production is one of the largest contributors to carbon dioxide emissions worldwide, and MIC presents an opportunity to both reduce emissions and repurpose construction waste. The process involves introducing specific bacteria, such as *Sporosarcina pasteurii*, which induce the precipitation of calcium carbonate, binding the particles of recycled concrete together and increasing its structural integrity. This method not only reduces waste disposal but also provides an environmentally friendly alternative to conventional concrete production. The feasibility of MIC depends on factors such as the availability of bacterial cultures,

research and development support, and infrastructure to collect and process construction waste efficiently. Given the rapid expansion of African cities and increasing demand for affordable housing, MIC can be a game-changer in sustainable construction. However, challenges such as scaling up microbial carbonation technology, regulatory approvals, and public acceptance must be addressed to ensure successful adoption.

Beyond solid waste recycling, the conversion of brewery spent grain into edible protein-rich snacks is an innovative method to repurpose organic waste. BSG, a byproduct of beer production, is often discarded despite its rich protein and fibre content. In many African countries, food insecurity and malnutrition remain significant concerns, making this approach highly relevant. The fermentation of BSG enhances its digestibility and nutritional value, making it a viable ingredient for plant-based food products. However, widespread adoption will require investment in food processing technologies, regulatory approvals for new food products, and consumer awareness campaigns to drive acceptance of BSG-derived protein.

Another noteworthy application of circular economy principles is the production of bathing soap from plantain and orange peels. These fruit peels, which are typically treated as waste, contain essential oils and beneficial compounds that can be processed into biodegradable soap. The extraction of natural oils and active ingredients from fruit peels is a straightforward process that involves drying, grinding, and mixing with natural bases such as sodium hydroxide. This innovation not only promotes waste valorisation by transforming food waste into valuable consumer products but also reduces dependency on synthetic chemicals in personal care items. Africa has a strong tradition of using natural ingredients for skincare, which enhances the feasibility of this method. Small-scale entrepreneurs can leverage this opportunity to develop eco-friendly soap brands, creating employment and reducing reliance on imported chemical-based soaps. However, challenges such as quality control, access to consistent raw materials, and market penetration must be addressed through proper training, funding support, and consumer education.

Conclusions: Findings from this research indicate that implementing circular economy practices in solid waste management can result in a significant reduction of waste output by up to 40%, while also mitigating environmental degradation and unlocking economic opportunities through resource recovery. The adoption of these methods leads to a reduction in pollution, enhanced job creation, and the development of sustainable agricultural and industrial systems. As such, the transition from a linear to a circular economy is crucial for ensuring sustainable development in Africa. Achieving this requires the collaborative effort of policymakers, industries, and communities to implement innovative waste management solutions and promote best practices. **References**

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