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Generation of biogas by using vegetable waste: An approach towards alternative energy resources

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Abstract
The generation of food waste presents significant environmental and economic challenges, prompting the need for sustainable waste management solutions. This research paper explores the potential of utilizing potato skin and pumpkin skin, common food waste products, for biogas production. By examining their biochemical properties and the anaerobic digestion process, this study aims to evaluate the feasibility and efficiency of converting these waste materials into biogas. The findings highlight the potential for reducing food waste and producing renewable energy, contributing to a more sustainable waste management system.

Keywords: Food waste, anaerobic digestion, biogas, potato skin, pumpkin skin

Introduction
Food waste is a pervasive issue, with substantial amounts discarded annually, leading to environmental degradation and resource inefficiency (Angelidaki and Sanders, 2004) [2]. Potato skin and pumpkin skin are two frequently discarded by-products in households and food industries (Lau *et al*., 2021) [10]. This research investigates the viability of utilizing these waste materials for biogas production, offering a dual benefit of waste reduction and renewable energy generation. Biogas, primarily composed of methane and carbon dioxide, is produced through the anaerobic digestion of organic matter by microorganisms, presenting a sustainable energy alternative (Bharathiraja *et al*., 2018) [3].
Biogas production through anaerobic digestion has been extensively studied, demonstrating its potential in converting various organic wastes into renewable energy (Rao *et al*., 2010) [12]. Previous research highlights the suitability of food waste, agricultural residues, and other organic materials for biogas production (Bong *et al*., 2018) [4]. However, specific studies focusing on potato skin and pumpkin skin are limited. This literature review examines the biochemical composition of these waste materials, their biodegradability, and their potential as feedstock for biogas production.

Biochemical Composition
Potato skin and pumpkin skin contain significant amounts of carbohydrates, proteins, and fibres, essential for microbial digestion (Zhou *et al*., 2007) [17]. Potato skin comprises approximately 10-20% protein, 60-80% carbohydrates, and various vitamins and minerals. Pumpkin skin, similarly, is rich in carbohydrates, vitamins, and dietary fibre (Das and Mallikarjunarao, 2016) [7]. These components make both waste materials suitable for anaerobic digestion, as they provide the necessary nutrients for microbial activity.

Anaerobic Digestion Process
Anaerobic digestion involves four key stages: hydrolysis, acidogenesis, acetogenesis, and methanogenesis (Adekunle and Okolie, 2015) [1]. During hydrolysis, complex organic molecules are broken down into simpler compounds. Acidogenesis further breaks down these compounds into volatile fatty acids, alcohols, and gases (Hussain *et al*., 2017) [9]. Acetogenesis converts these intermediates into acetic acid, hydrogen, and carbon dioxide (Yan *et al*., 2014) [16]. Finally, methanogenesis produces methane and carbon dioxide, the primary constituents of biogas.

Methodology
This study employs a laboratory-scale anaerobic digester to evaluate the biogas production potential of potato skin and pumpkin skin. The methodology involves:

Collection and Preparation: Potato skin and pumpkin skin are collected from local sources. The samples are cleaned, dried, and ground to a uniform size to facilitate digestion.

Substrate Characterization: The biochemical composition of the substrates is analyzed to determine their carbohydrate, protein, and fibre content (Englyst *et al*., 2007) [8].

Digestion Setup: The substrates are mixed with inoculum (anaerobic sludge) in a controlled digester. The digester is maintained at mesophilic conditions (35-37°C) to optimize microbial activity (Shana, 2016) [13].

Biogas Measurement: Biogas production is monitored daily, and the gas composition is analyzed using gas chromatography (Ward *et al*., 2011) [15].

Data Analysis: The biogas yield, methane content, and overall efficiency of the digestion process are evaluated.

Results and Discussion

Table 1: Comparison between potato skin and pumpkin skin as substrates for biogas production.

Parameter	Potato Skin	Pumpkin Skin	Co-digestion
Viability for biogas production	Viable	Viable	Enhanced biogas production
Biogas Yield	Higher	Lower	-
Reason for yield difference	Higher carbohydrate content	Lower carbohydrate content	Balanced nutrient profile supporting microbial growth
Methane content in biogas (%)	55-60%	50-55%	60-65%

The study's findings highlight the viability of both potato skin and pumpkin skin as substrates for biogas production. Each substrate was found to be effective; however, distinct differences in biogas yield and methane content were observed.

Viability for Biogas Production
Both potato skin and pumpkin skin were identified as viable substrates for biogas production. This confirms their potential use in biogas systems, which could help in waste management and renewable energy generation (Walekhwa *et al*., 2014) [14].

Biogas Yield
The biogas yield from potato skin was higher compared to pumpkin skin (Dahunsi *et al*., 2016) [6]. This can be attributed to the higher carbohydrate content in potato skin, which provides more fermentable material for biogas production (Pathak *et al*., 2018) [11]. Carbohydrates are a crucial factor in biogas yield as they are readily broken down by anaerobic microorganisms, leading to increased biogas production (Christy *et al*., 2014) [5].

Methane Content in Biogas
The methane content in the biogas produced from potato skin ranged between 55-60%, while that from pumpkin skin was slightly lower, ranging between 50-55%. Methane is the primary component of biogas that determines its energy content, so a higher methane content signifies better quality biogas.

Co-digestion
The co-digestion of potato skin and pumpkin skin resulted in enhanced biogas production. This is likely due to the balanced nutrient profile provided by combining both substrates, which supports more efficient microbial growth and activity. The methane content in the biogas from co-digestion was also higher, ranging from 60-65%, indicating improved biogas quality.

The findings suggest that utilizing these food waste materials for biogas production can significantly reduce organic waste and contribute to renewable energy generation. The scalability of this process and its integration into existing waste management systems could further enhance its feasibility.

Conclusion
This research demonstrates the potential of potato skin and pumpkin skin as substrates for biogas production, providing an innovative solution to food waste management. The anaerobic digestion process effectively converts these waste materials into biogas, highlighting their utility in sustainable energy generation. Future research should focus on optimizing the digestion conditions, exploring large-scale applications, and assessing the economic viability of implementing such systems. In conclusion, while both potato and pumpkin skins are viable for biogas production, potato skin alone produces a higher yield and higher methane content. However, co-digestion of both substrates provides a synergistic effect that enhances overall biogas production and methane content. This suggests that co-digestion strategies might be optimal for maximizing biogas yield and quality from these substrates.

References

1. Adekunle KF, Okolie JA. A review of biochemical process of anaerobic digestion. Adv Biosci Biotechnol. 2015;6(03):205-212.
2. Angelidaki I, Sanders W. Assessment of the anaerobic biodegradability of macropollutants. Rev Environ Sci Biotechnol. 2004;3(2):117-129.
3. Bharathiraja B, Sudharsana T, Jayamuthunagai J, Praveenkumar R, Chozhavendhan S, Iyyappan J. Biogas production–A review on composition, fuel properties, feed stock and principles of anaerobic digestion. Renew Sustain Energy Rev. 2018;90(April):570-582.
4. Bong CPC, Lim LY, Lee CT, Klemeš JJ, Ho CS, Ho WS. The characterisation and treatment of food waste for improvement of biogas production during anaerobic digestion–A review. J Clean Prod. 2018;172:1545-1558.
5. Christy PM, Gopinath LR, Divya D. A review on anaerobic decomposition and enhancement of biogas production through enzymes and microorganisms. Renew Sustain Energy Rev. 2014;34:167-173.
6. Dahunsi SO, Oranusi S, Owolabi JB, Efeovbokhan VE. Comparative biogas generation from fruit peels of fluted pumpkin (*Telfairia occidentalis*) and its optimization. Bioresour Technol. 2016;221:517-525.
7. Das RK, Mallikarjunarao K. Management of Wastes from Vegetable Processing Industry-A Review. Adv Life Sci. 2016;5(7):2567-2478.

8. Englyst KN, Liu S, Englyst HN. Nutritional characterization and measurement of dietary carbohydrates. Eur J Clin Nutr. 2007;61(1).
9. Hussain A, Filiatrault M, Guiot SR. Acidogenic digestion of food waste in a thermophilic leach bed reactor: effect of pH and leachate recirculation rate on hydrolysis and volatile fatty acid production. Bioresour Technol. 2017;245:1-9.
10. Lau KQ, Sabran MR, Shafie SR. Utilization of vegetable and fruit by-products as functional ingredient and food. Front Nutr. 2021;8:661693.
11. Pathak PD, Mandavgane SA, Puranik NM, Jambhulkar SJ, Kulkarni BD. Valorization of potato peel: a biorefinery approach. Crit Rev Biotechnol. 2018;38(2):218-230.
12. Rao PV, Baral SS, Dey R, Mutnuri S. Biogas generation potential by anaerobic digestion for sustainable energy development in India. Renew Sustain Energy Rev. 2010;14(7):2086-2094.
13. Shana AD. Application of an innovative process for improving mesophilic anaerobic digestion of sewage sludge. University of Surrey (United Kingdom); 2016.
14. Walekhwa PN, Lars D, Mugisha J. Economic viability of biogas energy production from family-sized digesters in Uganda. Biomass Bioenergy. 2014;70:26-39.
15. Ward AJ, Bruni E, Lykkegaard MK, Feilberg A, Adamsen AP, Jensen AP, Poulsen AK. Real time monitoring of a biogas digester with gas chromatography, near-infrared spectroscopy, and membrane-inlet mass spectrometry. Bioresour Technol. 2011;102(5):4098-4103.
16. Yan BH, Selvam A, Xu SY, Wong JW. A novel way to utilize hydrogen and carbon dioxide in acidogenic reactor through homoacetogenesis. Bioresour Technol. 2014;159:249-257.
17. Zhou T, Kong Q, Huang J, Dai R, Li Q. Characterization of nutritional components and utilization of pumpkin. Food. 2007;1(2):313-321.