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A Formulation and Evaluation of Alternative Starch-Based Culture Media for Microbial Growth

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ABSTRACT

This study explores the development of alternative starch-based culture media using locally available materials; rice (*Oryza sativa*), corn (*Zea mays*), and sweet potato (*Ipomoea batatas*). The objective was to formulate cost-effective, sustainable culture media and compare their efficacy with conventional agar-based media in supporting microbial growth. Microbial isolates of *Staphylococcus aureus*, *Escherichia coli* and *Candida albicans* were inoculated into the prepared media and their growth assessed and compared to the conventional media. Results showed that rice starch + potato starch medium provided optimal microbial proliferation while potato starch alone had limited growth-supporting capabilities. Standard nutrient agar exhibited the highest microbial growth, indicating its superior nutrient composition. Despite this, alternative starch-based media demonstrated potential for cost-effective and sustainable microbial cultivation, particularly in resource-limited settings like Nigeria.

Keywords: Culture media, Microbial growth, Starch-based media, Rice starch, Corn starch.

INTRODUCTION

The cultivation of microorganisms, particularly bacteria and fungi are a cornerstone of microbiology research and applications (Madigan *et al.,* 2021). It requires suitable nutrients and environmental conditions for growth. The traditional culture media for bacteria and fungi often rely on complex and expensive ingredients such as peptones, tryptones and yeast extracts (Singh, 2020). A medium may be formulated as either permissive with the intent of allowing the growth of whatever organisms are present, or restricted or selective with the intent of only selecting for growth only a particular subset of those organism (Ryan and Ray, 1994).

Likewise, some may be undefined media made from natural product and containing an unknown combination of very many organic molecules, while defined media can be precisely tailored to select organisms with very properties (3). The ingredients used in the formulation can be derived from animal byproducts, posing ethical concerns (Oliver, 2005) and contributing to environmental issues (Atlas, 2018).

Moreover, such media is usually costly, particularly in resource-limited settings like the developing countries, causing a significant barrier for research and diagnostic laboratories, particularly learning institutions (Patel and Sharma 2022). Therefore, this study seeks to formulate alternative culture media for bacterial and fungal growth using corn starch, rice starch and sweet potato starch. These plant-derived ingredients have shown potential as cost-effective and environmentally friendly alternatives (Kumar and Singh 2018; Sagar 2022).

MATERIALS AND METHODS

Collection of Raw Materials

Rice, corn and sweet potatoes were purchased from local markets. They were identified by taxonomist in the Department of Biological Sciences Northwest University, Kano.

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Preparation of the starch

The produce was sorted, cleaned, soaked and milled. The starch extraction was carried out by sieving with a muslin clothe and subsequent dehydration of the starch in a solar dryer. The obtained starch was transferred to airtight containers for storage.

Preparation of Alternative Culture Media

Sweet Potato Starch-based Media: 2.5g of sweet potato starch and 0.5g of agar-agar were dissolved in 10mL distilled water, heated until dissolved, autoclaved and poured in to sterile Petri dishes.

Corn Starch-based Media: 2.5g of corn starch, 2.5g of potato starch, and 0.5g of agar-agar were dissolved in 20mL distilled water, gently heated until thickened, autoclaved and poured in to sterile Petri dishes.

Rice Starch-based Media: 2.5g of rice starch, 2.5g of potato starch, and 0.5g of agar-agar were dissolved in 20mL distilled water, slowly heated until fully dissolved, autoclaved and poured in to sterile petri dish.

Microbial Analysis

Staphylococcus aureus, *Escherichia coli* and *Candida albicans* isolates were obtained from Aminu Kano Teaching Hospitals, Kano and sub-cultured. Serial dilution was done according to the standard method to get a final bacterial inoculum concentration of 1.0×10^6 cell/ml. Then 0.1 ml microbial suspension was taken using a sterile pipette. The bacterial cultures were incubated at 37°C for 24 hours, while fungal cultures were incubated at 28°C for 48-72 hours. Growth on alternative media was compared to standard nutrient agar (NA) and Sabouraud dextrose agar (SDA).

Proximate Analysis

The rice starch, corn starch and potato starch were analyzed for percentage moisture, ash, protein, fat and crude fibre according to AOAC, (1984).

RESULTS AND DISCUSSION

Table 1 presents the microbial growth observed on different starch-based culture media compared to the standard control. The results indicate significant variations in growth, with the control medium supporting the highest microbial proliferation. Among the alternative media, the rice starch + potato starch medium showed the best microbial growth while potato starch alone had the lowest. The results indicate no significant differences (P> 0.05) in microbial growth on various starch – based media.

Table 1: Viable Counts (Log_{10}CFU/ML) of Microorganisms Inoculated the Formulated Media

Microorganisms	Rice starch + potato starch	Corn starch + potato starch	Potato starch	Control (Nutrient Agar)	F-value	p-value
Candida albicans	7.92	7.68	6.85	8.30	45.23	**0.001**
Escherichia coli	7.51	7.64	6.48	7.94	38.76	**0.001**
Staphylococcus aureus	7.90	7.58	0.00	8.03	52.14	**0.001**

Table 2 showed the proximate analyses of the various starches. Rice starch had the highest carbohydrate content, while potato starch had the highest moisture and ash content.

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Table 2: Proximate Composition (%) of the Formulated Media

Components	Rice starch	Corn starch	Potato starch	F-value	P-value
Moisture	11	12	15	15.2	0.002
Ash	0.3	0.2	0.5	10.5	0.005
Protein	0.3	0.4	0.2	8.7	0.010
Fat	0.2	0.2	0.1	5.3	0.025
Crude fiber	0.3	0.3	0.3	0.0	1.000
Carbohydrate	88	87	84	12.8	0.001

The findings of this study demonstrate that the effectiveness of alternative starch-based media varies significantly depending on their composition. The combination of rice starch and potato starch provided the most favorable conditions for microbial growth. This can be attributed to the higher carbohydrate content of rice starch which serves as an essential energy source for microbial metabolism. Additionally, the presence of potato starch likely contributed to a better retention, creating an environment conducive to microbial proliferation. This observation aligns with the understanding that starch composition and its interaction with water availability are critical factors in microbial culture media (Patel and Sharma 2022; Sagar, 2022).

Corn starch, when combined with potato starch, also showed moderate support for microbial growth. Corn starch is known for its balanced carbohydrate and moisture content, which may have contributed to the observed growth. However, the results indicate that the growth-promoting effects of corn starch were not as pronounced as those of rice starch, suggesting that rice starch provides superior energy availability for microorganisms.

This difference could also be related to the varying amylose and amylopectin ratios in different starches, which can influence their digestibility and utilization by microbes. Similarly, Abalaki *et al.,* 2012, found a higher microbial count in guinea corn agar when compared with maize agar and suggest higher nutritional content of the guinea corn when compared with maize extract.

The poor growth observed in plain potato starch media suggests that it lacks key nutrients required for robust microbial proliferation. Potato starch is high in moisture but relatively low in available carbohydrates, which may have limited microbial metabolic activity. Furthermore, potato starch may be deficient in other essential nutrients, such as nitrogen and certain minerals, necessary for microbial growth. These findings align with the study conducted by Patel & Sharma (2019), which reported that combining starch sources significantly enhances microbial growth by improving nutrient composition.

Standard nutrient agar demonstrated the highest microbial growth across all tested organisms, reinforcing its well-established efficacy as a culture medium, which could be due to its enrichment with nutrients like the proteins, peptides, amino acids, energy source like carbohydrate and essential minerals like the micro and macro (Uthayasooriyan *et al*., 2016; Lipps, 2023). The superior performance of nutrient agar compared to alternative media suggests that while starch-based media can support microbial growth, they may require additional supplementation to achieve similar effectiveness. This result is in line with the work of Abalaka *et al.,* 2012, who obtained a higher microbial count in the commercially prepared nutrient agar than the locally prepared nutrient agar but with a little significant difference.

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The findings also highlight the potential for further refinement of starch-based media formulations. Supplementing these media with additional nutrients, such as nitrogen sources or trace elements, could enhance their ability to support better microbial proliferation.

CONCLUSION

This study demonstrates that locally sourced starch-based culture media can serve as cost-effective alternatives to conventional media. While standard nutrient agar remains the most effective, rice starch + potato starch media showed promising results.

Further optimization through nutrient supplementation and formulation refinement could enhance microbial growth-supporting capabilities. Also, there is a need to conduct broader trials on a wider range of microorganisms. We also hope to collaborate with industries to refine the formulations and explore large-scale production feasibility for commercial applications.

REFERENCES

1. Abalaka, M.E., Daniyan, S.Y., Adeyemo, S.O., Okolo, M.O., Abdulsalam, R. (2013). Evaluation of Locally Sourced Raw Materials for use as A Microbiological Media. J. Biol. Today's World (1):1-4. doi:10.15412/J.JBTW. 01020101
2. Madigan M. T., Bender K.S, Buckley D H., Sattley W. M., Stahl D. *A* (2021). *Biology of Microorganisms*. 16th ed Person Education; London, UK.
3. Madigan, M.T., Martinko, J.M., Parker J, Brock, T.D. (1997). Biology of microorganisms: Prentice Hall Upper Saddle River, NJ.
4. Singh, A. (2020). Corn starch-based medium for Aspergillus niger growth. *Journal of Environmental Science and Health,* Part B, 55, 1-8.
5. Oliver J.D. The viable but non-culturable state in bacteria. *J. Microbiol*. 2005; 43:93–100. - PubMed
6. Atlas, R. M., & Parks, L. C. (2018*). Handbook of microbiological media*. CRC Press.
7. Patel, K., & Sharma, R. (2019). Development of alternative microbial growth media using plant-based starch sources. *Journal of Applied Microbiology, 125*(4), 931-938.
8. Kumar, P., &Singh, R. (2018). Rice starch-based medium for Escherichia coli growth. *Journal of Applied Microbiology,* 125(4), 931-938.
9. Lipps, W.C., Braun-Howland, E.B., Baxter, T.E. (2023). *Standard methods for the Examination of Water and Wastewater,* 24th ed. Washington DC: APHA Press.
10. Sagar, A. (2022); *Factors affecting the growth of Micro-organisms in food*. Ed, Sanjogta Thapa Magar.
11. Official Methods of Analysis of Association of Official Analytical Chemists, Vol1 15th Edition, 1990.
12. Uthayasooriyan, M., Pathmanathan, S., Ravimannan, N., & Sathyaruban, S. (2016). Formulation of alternative culture media for bacterial and fungal growth. *Der Pharmacia Lettre*, 8(1), 431-436.
13. Ryan, K. J., Ray, C. G (1994). *Medical microbiology*. Appleton & Lange, Norwalk, Connecticut.