PHYSICAL CHARACTERISTICS OF LOCAL BIOMASS MATERIALS SELECTED FOR USE AS BASE MATERIALS FOR HYDROPONIC FODDER PRODUCTION.

[1]*Azodo, N. L., [2]Odoemelam, V. U., [2]Obikaonu, H. O., [1]Olabode A. D., [2]Etuk, U. N. E., [2]Giwa, A. L., [2]Achonwa, C.C. and [2]Okoli, I. C.

Department Of Animal Production Technology, Federal College of Agriculture Ishiagu, Ebonyi State.
Department Of Animal Science and Technology, Federal University of Technology Owerri, Imo State.
*Corresponding author: azodononyel@gmail.com, +2348024944071

ABSTRACT

The selection of effective base materials is crucial for hydroponic fodder production, as these materials directly influence plant growth, water retention, and nutrient absorption. This study evaluated the physical characteristics of three locally sourced biomass materials—Banana Pseudo-Stem (BPS), Dry Banana Leaves (DBL), and Rice Hulls (RHL)—to assess their suitability as growing media. Parameters such as water holding capacity (WHC), bulk density (BD), specific gravity (SPG), oil absorption capacity (OAC), swelling capacity (SWC), and wettability were analyzed using standardized methods. The results revealed significant differences ($p < 0.05$) among the materials. BPS demonstrated the highest WHC (620.83%) and OAC (378.37%), making it highly effective for moisture and nutrient retention. DBL recorded the best SWC (799.10%) and wettability (492.00%), likely due to its cellulose-rich structure, enhancing its hydrophilicity and ability to swell in aqueous environments. In contrast, RHL exhibited the highest BD (0.52 g/ml) and SPG (0.55), indicating compactness but limited effectiveness in water retention and absorption. These findings align with previous studies emphasizing the importance of physical characteristics in determining the efficiency of hydroponic media. While BPS and DBL offer high potential for hydroponic systems, the lower air porosity associated with high WHC may impact root respiration, necessitating careful application. Conversely, the compact nature of RHL makes it more suitable for structural support.

Keywords: Hydroponic, Fodder production, Growing media, Biomass materials, Physical characteristics, Water retention

INTRODUCTION

Base materials used as growing media should be easy to handle and should provide an environment that is suitable for plant growth. The different organic and in-organic materials used as growing media, appropriate water holding capacity and correct balance of air to ensure adequate plant growth (Nair *et al.,* 2011; Olle *et al.,* 2012). The base materials are characterized by reproducible physical quality parameters, such as pore size, volumetric weight, and water retention potential (Gilmar and Betina 2022). This allows for precise cultivation practices needed to obtain high yields with the desired quality values in the products. In the hydroponic system, the base materials serve as stabilizer for the plant root system, while creating optimal conditions for water, and nutrient uptake. Ideally, the selection of the base material for a hydroponic system should be based on its different physical, and chemical properties as well as its stability. Physical characteristics are however, the major determinants of the capacity of the hydroponic media to efficiently produce fodder (Gunasekaran *et al*., 2019). The physical characteristics include the water holding capacity (WHC), bulk density (BD), air porosity (AP), specific gravity (SG), wettability and structure/ stability (S/S) (Etuk, 2023).

This study demonstrates the potential of local biomass materials as sustainable and effective base media for hydroponic fodder production.

MATERIALS AND METHODS

Banana/plantain pseudo stem, dry leaves and milled rice husk were sourced locally and used as base materials for the study. They were selected purposely due to their abundance and ease of collection. The banana pseudo-stem (BPS) was obtained from matured and harvested banana trees. The BPS were chopped into small pieces to ease drying. The pieces were sundried for 5 – 7 days during the dry season, and thereafter milled into coarse powder with a motorized grinder to form banana pseudo-stem meal (BPM) and stored in a polythene sack until needed. The dry banana or plantain leaves (DBL) were obtained from mature banana trees and were sundried further for 2 - 3 days until they become crispy. The leaves were sliced into small pieces and thereafter milled into coarse powder with a grinder and stored in a polythene sack until needed. The rice hull or husk (RHL) will be collected from a rice mill at Orji in Owerri North Local Government Area LGA of Imo State. A magnet was passed through the RHL to remove all metal fragments in it before further sorting to remove debris and other unwanted materials. It was stored in a polythene sack until needed. Thereafter, the physical characteristics of the base materials were determined in triplicates, using the methods described by AOAC international (2016).

RESULTS AND DISCUSSION

Table 1: Physical characteristics of base materials

Parameters	BPS	DBL	RHL	SEM
BD (g/ml)	0.32^{b}	0.24^{c}	0.52^{a}	0.04
SPG	0.34^{b}	0.26^{c}	0.55^{a}	0.04
WHC (%)	620.83^{a}	275.92^{b}	229.33^{c}	61.74
OAC (%)	378.37^{a}	290.61^{b}	206.01^{c}	24.88
SWC (%)	741.44^{b}	799.10^{a}	323.18^{c}	74.98
Wettability (%)	16.67^{c}	492.00^{a}	95.33^{c}	73.57

^{abc} Means with different superscript in a row are significantly different ($p<0.05$), BPS = Banana pseudo-stem,

DBL = Dry banana leaves, RHL = Rice hull

The physical characteristics of base materials are shown in Table 1.From the result it can be seen that rice hulls recorded significantly ($p<0.05$) lower water holding capacity, oil absorption capacity, swelling capacity & wettability when compared to others. The DBL recorded better swelling capacity and wettability than others indicating a greater ability to swell in aqueous environments, possibly due to the cellulose content. Studies on cellulose-rich residues, such as banana leaf, echo this observation (Gupta & Singh, 2021) and the high wettability indicates better hydrophilic properties, which may relate to its structural composition, while the bulk density (BD) and specific gravity (SPG) were however reduced significantly ($p<0.05$). This is in line with the study by Bloodnick (2022) who reported that Peat-based growing media have low bulk density and high-water holding capacity (Bulk density is generally affected by the particle size and will vary from year to year depending on the weather at the time of harvest. Some media materials such as peat and coconut coir are usually compacted into bales or cubes for ease of transportation. Therefore, the ability to regain the original volume depends on the moisture content, particle size and the degree of humidification of the material (Cattivello, 2013; Carlile *et al.,* 2015). The BPS recorded better water holding capacity and oil absorption capacity than others. Yaeger *et al.* (2007) suggested a water holding capacity of 25 to 35% in line with the specific use of the medium. Etuk (2023) reported a WHC of 744.02% for banana pseudo stem meal used in sorghum and fonio millet hydroponic fodder production. A growing medium having low WHC dries up quickly resulting in stress and damage to the plants, while those having high water holding capacity may also have lower air-filled porosity, which facilitate higher water retention may eventually lead to problems with root respiration (Larson, 1988; Anjum et al., 2003). Peat-based media for example have higher WHC (Bloodnick, 2022; Hydroponic Way, 2022a).

CONCLUSION

This study highlights the potential of locally sourced biomass—BPS, DBL, and RHL—as effective hydroponic growing media. BPS exhibited superior moisture and nutrient retention, DBL excelled in swelling capacity and wettability, while RHL's high density suggests structural benefits but limited moisture management. Optimizing these materials can enhance sustainable hydroponic fodder production.

REFERENCES

AOAC International (2016). Official methods of analysis of AOAC International, 20th edition. Association of Analytical Chemists, Rockville, Maryland, USA.

Bloodnick, E. (2022). Fundamentals of growing media. Promix. Retrieved on April 25, 2023, from https://www.pthorticulture.com/en/training-center/fundamentals-of-growingmedia.

Carlile, W. R., Costantino, C. & Zaccheo, P. (2015). Organic growing media: constituents and properties. *Soil Science Society of America*, Doi:10.2136/vzj2014.09.0125

Cattivello, C. (2013). Factors affecting the swelling capacity of peat-based substrates. *Acta Horticulturae,* 1013, 123 – 130.

Etuk, U.N.E. (2023). Effect of sprouting medium on the hydroponic production and nutrient composition of fodder from local seeds. PGD Thesis, Federal University of Technology Owerri, Nigeria.

Gilmar S. & Betina L. L. (2022). Physical and chemical characteristics and analysis of plant substrate. *Ornamental Horticulture*, 28(2):181-192. https://doi.org/10.1590/2447-536X.v28i2.2496

Gunasekaran, S., Bandeswaran, C. and Valli, C. (2019). Low-cost hydroponic fodder production technology for sustainable livestock farming during fodder scarcity. *Current Science*, 116(4), 526 - 526.

Gupta, P., & Singh, R. (2021). Swelling capacity in cellulose-rich residues. *Biotechnology Progress, 37*(1), e3140.

Hydroponic Way (2022). Physical properties of growing medium that affects quality. Hydroponicway.com>physical properties (accessed April 2023).

Kakar, A., Miano, T. F., Soomro, A. H., Yar, A., Memon, S. A. & Khan, B. (2022). Oil and water absorption capacity of wheat, rice, and gram flour powders. *International Journal of Ecosystems and Ecology Science*, 12 (2), 585 – 594.

Nair, A, Ngouajio, M. & Biernbaum, J. (2011). Alfalfa based organic amendment in peatcompost growing medium for organic tomato transplant production. *Horticultural Science*, 46, 253 - 259.

Olle, M., Ngouajio, M. &Siomos, A. (2012). Vegetable quality and productivity as influenced by growing medium: a review. *Žemdirbystė Agriculture*, 99(4), 399 - 408.

Yeager, T.H., Fare, D.C., Lea-Cox,J., Ruter,J., Bilderback,T.E. & Gilliam, C. H. (2007). Best management practices: Guide for producing container grown plants.2nd editionSouthern Nurserymen's Association, Marietta, GA.