KAVAKA 61(3): 55-60 (2025) DOI: 10.36460/Kavaka/61/3/2025/55-60

Influence of Various Carbon and Nitrogen Sources on the Growth and Biomass Production of Some Field Fungi

Lincy Varghese*

Department of Microbiology, Bishop Kurialacherry College for Women, Amalagiri, Kottayam - 686 561, Kerala, India

**Corresponding author Email: svlincy45@gmail.com*

(Submitted on June 1, 2025; Accepted on July 05, 2025)

ABSTRACT

This study investigated the effects of different carbon and nitrogen sources on the mycelial growth and biomass production of four field fungi: *Penicillium* sp., *Aspergillus flavus*, *Aspergillus niger*, and *Fusarium* sp. Dextrose in Sabouraud's Dextrose Broth was individually replaced with sucrose and fructose, while peptone was substituted with ammonium nitrate and glycine. Fungi were incubated for 11 days, and biomass was measured by dry weight analysis. Results showed species-specific responses: *Fusarium* sp. grew best with sucrose (1.651 g/100 ml), *A. flavus* with fructose (2.976 g/100 ml), and *A. niger* with dextrose (1.036 g/100 ml). Peptone supported the highest biomass across all fungi, particularly for *A. flavus* and *A. niger*, while ammonium nitrate inhibited growth in *A. niger*. This study highlights the differential influence of carbon and nitrogen sources on fungal biomass production, offering potential applications in fungal biotechnology and industrial cultivation.

Keywords: Fungi, Carbon sources, Nitrogen sources, Fungal growth, Biomass, Dry weight

INTRODUCTION

Molds are renowned for their remarkable adaptability in colonizing diverse ecological niches, owing to their capacity to utilize a wide spectrum of nutrients, whether simple or complex in nature. Unlike autotrophic plants, which derive carbon and energy from carbon dioxide and sunlight, fungi obtain these essential resources by assimilating organic matter from their surroundings. The nutritional requirements of many saprophytic fungi have been systematically investigated using synthetic media with defined chemical compositions.

Nitrogen and carbon sources are particularly influential in regulating fungal growth and metabolite production. Itoo and Reshi (2022) identified diammonium hydrogen orthophosphate as the most effective nitrogen source for the growth of certain ectomycorrhizal fungi, while nitrate salts were found to inhibit growth. Among carbon sources, glucose outperformed trehalose, sucrose, and malic acid. Similarly, Hashem et al. (2017) demonstrated that *Aspergillus carbonarius* exhibit enhanced biomass accumulation when cultured with glucose, fructose, or sucrose, and nitrogen sources such as yeast extract and ammonium nitrate.

In a comparative study, *Fusarium aethiopicum* achieved high biomass while using maltose and succinic acid as carbon sources and L-lysine, L-tyrosine, and L-aspartic acid as nitrogen sources. However, *Fusarium culmorum* favoured L-sorbose, D-mannitol, D-lactose, and D-xylose, along with potassium nitrate and L-tyrosine as the carbon and nirogen sources, repectively. Mulik *et al*. (2020) reported maltose and calcium nitrate as optimal for growth and sporulation in *Aspergillus niger*, *A. flavus*, and *A. terreus*. Righelato *et al*. (1968) found that low glucose concentrations suppressed vegetative growth but stimulated conidiation in *Penicillium* sp. Recent studies on *Fusarium oxysporum* f. sp. *lini* and f. sp. *capsici* have further highlighted that carbon sources such as fructose and glucose and nitrogen sources including potassium nitrate and calcium nitrate significantly influence fungal biomass production (Singh *et al*., 2023). These findings underscore the importance of optimizing nutrient composition to enhance fungal growth and productivity in industrial and agricultural contexts.

Given the considerable influence of carbon and nitrogen sources on fungal growth, it is essential to understand their specific roles in supporting fungal biomass development. The present study was undertaken to study the influence of various carbon and nitrogen sources on the growth of common field fungi and to comparatively analyze the effect of these sources on the development of fungal biomass.

MATERIALS AND METHODS

Fungal Strains used

In the present study four fungal species viz., *Fusarium* sp., *Penicilium* sp*., Aspergillus flavus* and *Aspergillus niger* were used to study the effect of different carbon and nitrogen sources on their mycelia growth. These fungal species had been isolated in the lab by air exposure and identified by macroscopic and microscopic features. The fungi were maintained on Potato Dextrose Agar.

Utilization of different Carbon and Nitrogen Sources

The utilization of three different carbon and nitrogen sources were tested for each of the test fungi. Sabouraud's Dextrose Broth (SDB) was used as the base medium. To study carbon utilization, dextrose (D-glucose) in the base medium was replaced separately with sucrose and fructose, and to study nitrogen source utilization, peptone in the base medium was replaced separately with ammonium nitrate and glycine. The experiments were performed in duplicates.

Cultivation of Fungi

Pure cultures of the test fungi, maintained on PDA, were used for inoculation of the assay media. SDB itself, or other carbon or nitrogen replaced broth were inoculated with a single plug of fungi grown on PDA for five says. The plugs containing fungal mycelia were removed using a gel borer of diameter 10 mm and were inoculated into sterile broth under aseptic conditions. Each set of fungi were incubated at room temperature for a period of 11 days.

Dry Weight analysis

Mycelial growth was evaluated by dry weight determination. The fungi in broth culture were harvested after an incubation period of 11 days. The contents were filtered through pre-weighed pieces of filter paper. The fungal biomass, along with the filter paper, was oven dried at 55 °C for three days and the dry weights measured using an electronic weighing balance. The dry weight of the fungal biomass was calculated by deducing the weight of the filter paper from the total weight of the fungal biomass and filter paper together.

Statistical Analysis

The average dry weight of mycelial biomass was calculated for each treatment group (carbon or nitrogen source) based on triplicate measurements. Standard deviation (SD) was computed to assess the variability of fungal biomass across different treatments using Microsoft Excel and results are presented as mean ± SD.

RESULTS

The present study was undertaken to study the effects of different carbon and nitrogen sources on mycelia growth and biomass production of four different field fungi viz. *Penicillium* sp., *Fusarium* sp., *Aspergillus flavus* and *Aspergillus niger*. To find out the most suitable carbon source for mycelia growth of these fungi, two different carbon sources such as sucrose and fructose were supplemented individually, instead of glucose, in Sabouraud's Dextrose Broth (SDB) which was used as the base media.

The dry weight of mycelial biomass varied notably among the fungal isolates depending on the carbon source provided (Table 1). Distinct patterns of carbon source utilization were observed, with certain fungi exhibiting preferential growth on specific sugars. Among the tested fungi, *A. flavus* showed markedly enhanced biomass production on fructose, while *Fusarium* sp. demonstrated optimal growth on sucrose. In contrast, *A. niger* exhibited the highest mycelial yield with dextrose. Overall, sucrose and fructose supported higher biomass accumulation in most species compared to dextrose. The variation in mycelial dry weight across treatments was substantial, as reflected by a SD of ±0.670 g, indicating differential metabolic responses to the carbon sources provided.

Table 1: Average dry weight of mycelia biomass of four field fungi obtained after the utilization of different carbon sources

Fungi	Average dry weight of mycelia in g/100ml with utilization of carbon sources		
	Dextrose	**Sucrose**	**Fructose**
Penicillium sp.	0.323	1.082	1.012
Aspergillus niger	1.036	0.491	0.691
Aspergillus flavus	0.834	0.703	2.796
Fusarium sp.	0.271	1.651	0.448
Mean	0.945 g		
SD	±0.670 g		

To investigate the effect of different nitrogen sources on mycelia growth of the test fungi, they were cultivated in SDB where peptone in the base medium was replaced by glycine and ammonium nitrate individually. The type of nitrogen source significantly influenced the mycelial biomass production among the tested fungal species (Table 2). Peptone consistently supported higher biomass yields across all isolates compared to glycine and ammonium nitrate. Growth was markedly reduced in media supplemented with glycine or ammonium nitrate, particularly in *Aspergillus niger*, where biomass production was minimal under both conditions. Despite interspecies variability, a general trend of enhanced growth with organic nitrogen (peptone) over inorganic forms was evident. The overall mean biomass yield was relatively low, with considerable variability among treatments as indicated by the SD of ±0.288 g.

Table 2: Average dry weight of mycelia biomass of four field fungi obtained after the utilization of different nitrogen sources

Fungi	Average dry weight of mycelia in g/100ml with utilization of nitrogen sources		
	Peptone	Glycine	Ammonium nitrate
Penicillium sp.	0.323	0.156	0.296
Aspergillus niger	1.036	0.074	0.054
Aspergillus flavus	0.834	0.250	0.279
Fusarium sp.	0.271	0.101	0.269
Mean	0.328 g		
SD	±0.288 g		

DISCUSSION

The nutritional requirements of fungi play a critical role in their cultivation, with carbon serving as the primary source of energy, as well as contributing to the provision of hydrogen and oxygen. Media components significantly influence both mycelial growth and sporulation (Karmakar *et al*., 2017). While saprophytic fungi are capable of utilizing a wide variety of nutrient sources, the mass production of fungal biomass for commercial purposes often relies on simple and cost-effective media (Shah and Butt, 2005). Essential macroelements such as carbon, hydrogen, oxygen, sulfur, phosphorus, and nitrogen are indispensable for fungal growth and development, forming the structural backbone of carbohydrates, nucleic acids, and proteins.

In the current study, the effects of three carbon and three nitrogen sources on the mycelial growth and biomass production of four commonly encountered field fungi *Aspergillus flavus*, *Aspergillus niger*, *Penicillium* sp., and *Fusarium* sp., were assessed. The carbon sources tested included dextrose, sucrose, and fructose, with sucrose and fructose substituted individually in place of dextrose in Sabouraud's Dextrose Broth. Peptone, glycine, and ammonium nitrate were the nitrogen sources used, where peptone was replaced similarly by the other two.

The results of the study indicated differential utilization of carbon sources by the test fungi. *A. niger* showed the highest growth with dextrose (1.036 g/100 ml), while *Fusarium* sp. and *A. flavus* showed a preference for sucrose and fructose, respectively. These findings align with those of Medina *et al*. (2007), who identified sucrose and glucose as favourable carbon sources for optimal growth of *Aspergillus* sp., including *A. ochraceus* and *A. carbonarius*. Conversely, Hashem *et al*. (2015) reported no significant differences in the use of fructose, sucrose, and glucose for *A. carbonarius*. Karmakar *et al*. (2017) has also observed variable effects of carbon and nitrogen sources on *Fusarium sporotrichioides*, reporting lactose and sucrose as optimal. The present study findings corroborate this, as the *Fusarium* isolate exhibited highest biomass (1.651 g/100 ml) when sucrose was used, while fructose resulted in significantly lower growth (0.448 g/100 ml), similar to previous reports.

It has been suggested that fungi generally favour organic nitrogen sources like peptone and yeast extract over inorganic ones, as the former offer essential vitamins, micronutrients, and metabolic intermediates that support optimal growth (Brzonkalik *et al*., 2012; Kapetanakou *et al*., 2012; Oueslati *et al*., 2010). In the current study, the organic nitrogen source, peptone, concordantly and markedly enhanced the growth of all the four test fungi, as was also reported earlier for *A. carbonarius* (Hashem *et al*., 2015; Astoreca *et al*., 2009). Unlike previous findings of Hashem *et al*. (2015) where ammonium nitrate supported the growth of *A. carbonarius*, in the current study, it was less effective for *A. niger* and showed minimal biomass accumulation (0.054 g/100 ml) and glycine (0.074 g/100 ml). Inorganic nitrogen sources such as ammonium salts and urea may alter the pH of the medium and potentially exert inhibitory effects on fungal physiology. In contrast, Mulik *et al*. (2020) has found calcium nitrate to be very effective nitrogen source for the growth and sporulation of *Asergillus niger, Aspergillus flavus* and *Aspergillus terreus*.

In a recent study on the effects of various carbon and nitrogen sources on the growth of *Fusarium oxysporum* f. sp. *lini*, the pathogen responsible for linseed wilt, fructose supported the highest mycelial growth among carbon sources, followed by D-glactose, mannitol, and glucose, while potassium nitrate was the most effective followed by ammonium acetate, with all the seven tested nitrogen sources (Singh et al., 2023). Similar studies on *Fusarium oxysporum* f. sp. *capsici*, a prominent pathogen in chilli cultivation, has found glucose and dextrose supporting the highest growth as carbon sources and potassium nitrate, calcium nitrate, and urea as nitrogen sources. Similar studies on *Fusarium oxysporum* f. sp. *capsici*, a major pathogen affecting chilli cultivation, have demonstrated glucose and dextrose as the most effective carbon sources for supporting fungal growth and potassium nitrate, calcium nitrate, and urea as the favourable nitrogen sources. (Menge *et al*, 2021).

The growth response of *Fusarium* to peptone (0.271 g/100 ml) and ammonium nitrate (0.296 g/100 ml) was comparable, aligning with the findings of Karmakar *et al*. (2017). Consistent with these results, Khilare and Ahmed (2011) also demonstrated that amino acid-based organic nitrogen sources were more effective in promoting fungal growth than inorganic nitrogen compounds. Shilpa *et al*. (2015) has also noted enhanced biomass accumulation in *Fusarium aethiopicum* and *Fusarium culmorum* when cultured with organic nitrogen. In contrast, certain inorganic nitrogen compounds such as potassium nitrate, ammonium acetate, calcium nitrate, and urea, have been shown to support the growth of pathogenic *Fusarium oxysporum* strains favourably (Singh *et al*., 2023; Menge *et al*., 2021). These findings collectively suggest that the nitrogen source significantly influences *Fusarium* growth, with organic forms generally promoting higher biomass, although specific inorganic compounds may selectively enhance the proliferation of pathogenic variants.

The *Penicillium* isolate followed a similar pattern, exhibiting utmost biomass production with peptone (0.323 g/100 ml), followed by ammonium nitrate (0.296 g/100 ml) and glycine (0.156 g/100 ml). These results corroborates with the earlier reports on *Penicillium italicum* by Yong (1992) and the findings on the effects of nutrients on conidiophore and conidia formation in *Penicillium* sp. by Gutierréz-Rojas *et al*. (2015).

This study provides a comparative analysis of the role of individual carbon and nitrogen sources in the biomass production in selected field fungi. Significant variability was observed in the nutritional preferences among the isolates. The calculated standard deviations (0.670 g for carbon sources and 0.288 g for nitrogen sources) reflect substantial variability in biomass responses, particularly with carbon sources. This greater dispersion among carbon source treatments may be attributed to the broader range of metabolic pathways involved in carbohydrate breakdown and utilization, which can vary significantly between fungal taxa. The lower SD observed for nitrogen sources indicates a more consistent response among fungi to these treatments, albeit with generally lower biomass values, especially under inorganic nitrogen.

These findings align with previous reports indicating that carbon source availability and type can act as key modulators of fungal growth and biomass yield, often more variably than nitrogen sources. The observed standard deviation values underscore the importance of considering both the mean and the distribution of responses in evaluating nutrient utilization efficiency among fungal isolates. Overall, the data suggest that optimal biomass production in these fungi is highly dependent on nutrient type and species-specific metabolic capacities. Future studies incorporating additional nutrient combinations and molecular analyses may provide deeper insights into the regulatory mechanisms underlying carbon and nitrogen assimilation in soil fungi.

CONCLUSION

The present study highlights the significant influence of specific carbon and nitrogen sources on the mycelial growth and biomass production of field fungi such as *Penicillium* sp., *Aspergillus flavus*, *Aspergillus niger*, and *Fusarium* sp. Sucrose, fructose, and dextrose each demonstrated species-specific efficacy in promoting fungal growth, while peptone emerged as the most consistent nitrogen source across all tested fungi. These findings underscore the importance of targeted selection and regulation of carbon and nitrogen sources in culture media for optimizing fungal cultivation. The implications of this work extend beyond basic mycological research. Optimizing culture media compositions can enhance the efficiency of fungal biomass production for applications in biotechnology, agriculture, food fermentation, and pharmaceuticals. Moreover, understanding species-specific nutritional preferences helps in developing strategies for managing fungal contamination or for promoting beneficial fungi in environmental or industrial settings.

ACKNOWLEDGEMENTS

The author acknowledges Bishop Kurialacherry College for Women, Amalagiri, Kottayam, Kerala, for providing ncessary financial support and laboratory facilities.

REFERENCES

Astoreca, A., Barberis, C., Magnoli, C., *et al*. 2009. Ecophysiological factor effect on growth rate, lag phase and ochratoxin A production by *Aspergillus niger* aggregate strains on irradiated peanut seed. *International Journal of Food Microbiology*, **129(2)**:131-135; doi: 10.1016/j.ijfoodmicro.2008.11.002.

Brzonkalik, K., Hümmer, D., Syldatk C., *et al*. 2012. Influence of pH and carbon to nitrogen ratio on mycotoxin production by *Alternaria alternata* in submerged cultivation. *AMB Express*, **2(1)**:28; Doi: 10.1186/2191-0855-2-28.

Gutierréz-Rojas, I., Tibasosa-Rodríguez, G., Moreno-Sarmiento, N., *et al*. 2015. Carbon and nitrogen sources differently influence *Penicillium* sp. HC1 conidiation in solid and liquid culture. *African Journal of Microbiology Research*, **9(47)**:2290-2299; doi: 10.5897/AJMR2015. 7779.

Hashem, A., Fathi Abd-Allah, E., Sultan Al-Obeed, R., *et al*. 2015. Effect of carbon, nitrogen sources and water activity on growth and ochratoxin production of *Aspergillus carbonarius* (Bainier) Thom. *Jundishapur Journal of Microbiology*, **8(2)**:e17569; doi: 10.5812/jjm.17569.

Itoo, Z. A. and Reshi, Z. A. 2014. Effect of different nitrogen and carbon sources and concentrations on the mycelial growth of ectomycorrhizal fungi under in-vitro conditions. *Scandinavian Journal of Forest Research*, **29(7)**:619-628; doi: 10.1080/0282 7581.2014.964756.

Kapetanakou, A.E., Ampavi, A., Yanniotis, S., 2011. Development of a model describing the effect of temperature, water activity and (gel) structure on growth and ochratoxin A production by *Aspergillus carbonarius in vitro* and evaluation in food matrices of different viscosity. Food Microbiology, **28(4)**:727-35; doi: 10.1016/j.fm.2010.06.00 1.

Karmakar, P., Gupta, K.S., Bhattacharya, S.G., *et al*. 2017. Effects of pH, carbon and nitrogen sources on mycelial growth of *Fusarium sporotrichioides* in submerged culture condition. In: *Trends in Frontal Areas of Plant Science Research*. (Eds.: Sinha, S. and Sinha , R. K.). Narosa Publishing House Pvt. Ltd, Daryaganj, New Delhi.

Khilare, V.C. and Ahmed, R. 2011. Effect of nutritional sources on the growth of *Fusarium oxysporum* f. sp. *ciceri* causing chickpea wilt. *International Journal of Science and Nature*, **2(3)**:524-528.

Medina, A., Mateo, R., Valle-Algarra, F. M., *et al*., 2007. Effect of carbendazim and physicochemical factors on the growth and ochratoxin A production of *Aspergillus carbonarius* isolated from grapes. *International Journal Food Microbiology*,

119(3):230-235; doi: 10.1016/j.ijfoodmicro .2007.07.053.

Menge, Y.S., Patil, P.D., Gadhave, A.D., *et al*., 2021. Study the effect of various sources of carbon, nitrogen and pH levels on growth of *Fusarium oxysporum* f. sp. *capsici*. *International Journal of Chemical Studies*, **9(2)**:127-130; doi: 10.22271/chemi. 2021.v9.2b.11720.

Mulik, S.M., Joshi, M.S., Dawale, M.B. 2020. Effect of various carbon and nitrogen sources on *Aspergillus niger* a phosphorous solubilizing organism. *International Journal of Current Microbiology and Applied Sciences*, 2020; **9(7):**657-664; doi: 10.20546 /ijcmas. 2020.907.075.

Oueslati, S., Lasram, S., Ramos, A.J., *et al*., 2010. Alternating temperatures and photoperiod effects on fungal growth and Ochratoxin A production by *Aspergillus carbonarius* isolated from Tunisian grapes. *International Journal of Food Microbiology*, **139(3)**:210-213; doi: 10.1016/j.ijfoodmicro.2010.02.0 03.

Righelato, R.C., Trinci, A.P., Pirt, S.J., *et al*., 1968. The influence of maintenance energy and growth rate on the metabolic activity, morphology and conidiation of *Penicillium chrysogenum*. *Journal of General Microbiology*, **50(3)**:399-412; doi: 10.1099/ 00221287-50-3-399.

Shah, F.A. and Butt, T.M. 2005. Influence of nutrition on the production and physiology of sectors produced by the insect pathogenic fungus *Metarhizium anisopliae*. *FEMS Microbiology Letters*, **250(2)**:201-207; doi: 10.1016/j.femsle.2005.07.011.

Shilpa, P., Koteswara Rao. V., Narasimha Rao. K., *et al*., 2015. Influence of carbon and nitrogen source on growth, DON and NIV production by two species of *Fusarium* isolated from finger millets. *International Journal of Pharmacy and Pharmaceutical Sciences*, **7(3)**:136-139; https://journals. innovareacademics.in/index.php/ijpps/article /view/4337.

Singh, Y., Bhatt, J., Yadav, V.K., *et al*., 2023. Influence of various carbon and nitrogen sources on mycelial growth of *Fusarium oxysporum* f. sp. *lini*. *Biological Forum-An International Journal*, **15(2)**:302-307.

Yong, L.F.M. 1992. The Effect of carbon and nitrogen sources on the growth and aroma production of *Penicillin italicum*. *Developments in Food Science*, **29**:115-122; doi: 10.1016/B978-0-444-88834-1.50012-0.