ACADEMIA ONE
PEER REVIEWED JOURNALS

Open Academia: Journal of Scholarly Research
Volume 4, Issue 3, March 2026
ISSN (E): 2810-6377
Website: https://academiaone.org/index.php/4

Increasing Productivity Through Microbiome Control In Cultivation Of Mushrooms (Agaricus Bisporus): Metagenomic And Biotechnological Approaches

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Abstract: This study explores the possibilities of increasing yield in the cultivation of Agaricus bisporus mushrooms through the management of the compost microbiome. Using metagenomic and biotechnological approaches, beneficial bacteria such as Bacillus and Pseudomonas can improve substrate quality, accelerate mycelial growth, and enhance yield by 15–30%. Furthermore, microbiome management plays an important role in reducing diseases and obtaining environmentally friendly products. Additionally, during the compost preparation process, managing the microbiome can improve substrate quality, reduce diseases, and enable the production of eco-friendly products.

Keywords: Agaricus bisporus, microbiome, metagenomics, compost, yield, biotechnology

Introduction: Mushrooms are a source of high nutritional value and environmentally friendly food for humanity. Agaricus bisporus is one of the most widely cultivated mushrooms in the world, containing proteins, vitamins, polysaccharides, and minerals [1][2]. Mushrooms decompose organic matter and produce nutrients, which creates a favorable environment for mycelial growth. For this reason, the yield of Agaricus bisporus largely depends on the quality of the substrate and the microbiological processes within it [3].

White Button Mushroom Growing Kit ~ Makes it Easy to Grow Your Fresh Shrooms!

Currently, providing the world's population with environmentally friendly and high-quality food products is one of the global challenges. From this point of view, mushrooms, especially Agaricus bisporus, stand out with their high nutritional value and industrial importance. There are more than 150,000 species of mushrooms on Earth, some of which are used as food. Agaricus bisporus ranks second among mushrooms cultivated in mushroom farming. It contains proteins, vitamins, polysaccharides, unique amino acids, as well as macro and micro elements. The first record of mushroom cultivation occurred in 1652. In 1707, a French botanist wrote about mushrooms as 'originating from horse dung.' He continued: 'After they sprout, the spores turn into fluff, which, when planted in horse dung and covered with soil, grows into mushrooms. In 1780, a French gardener began cultivating mushrooms in underground quarries near Paris.[4] The

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processes of preparing compost are of great importance to achieving high yields from the fungus Agaricus bisporus. Improving the cultivation technologies of Agaricus bisporus holds significant scientific and practical importance [5,6]. Agaricus bisporus is one of the most widely cultivated mushrooms in the world, and its yield largely depends on the quality of the substrate and the microbiological processes within it [7]. Microorganisms in the compost decompose organic matter, form nutrients, and create a favorable environment for mushroom growth [8]. Modern studies show that microbiome-managing bacteria decompose nutrients, suppress pathogens, and thereby can increase yield. For this reason, studying the activity of microorganisms based on metagenomic and biotechnological approaches is considered a relevant scientific direction.

[9,10]. Agaricus bisporus is distinguished by its high nutritional value and industrial importance.

Metagenomic Method: With this method, it is necessary to monitor the status of the microbiome at each stage of the composting process. This serves to prevent diseases, improve substrate quality, and sustainably increase yields [11]. Metagenomic analysis makes it possible to study microorganisms at the genetic level. Bacteria and fungi in the compost are detected through 16S rRNA and ITS sequencing. [12] As a result of scientific results, Bacillus and Pseudomonas accelerate fungal growth [13]. Controlling the substrate microbiome using metagenomic approaches is an important tool in predicting yields. [11]

1-Table “Microbiological methods in growth and disease control

Direction	Applied method	Scientific resul
Metagenomic method	16S rRNA and ITS sequencing	Monitoring the microbiome status at each stage
Biotechnological enrichment	Bacillus and Pseudomonas	Accelerating growth and increasing productivity
Biological protection	Control agents	Reducing diseases and obtaining environmentally clean products

Compost preparation process: Compost preparation is the main stage of Agaricus bisporus cultivation. The quality of compost directly affects yield [14]. In compost preparation, mainly horse manure, chicken manure, and hay or wheat straw are used. There are several methods of compost preparation, namely traditional compost, synthetic compost, and composts based on organic waste. Straw, horse manure, and hay or wheat straw are common widespread ingredients. Button Mushroom Spawn (Agaricus bisporus) “synthetic” composts are composts whose main component is not straw horse manure. In addition, in compost preparation, corn, cottonseed, or cocoa, bean husks can be used. Scientists at Atatürk University in Turkey have conducted a series of experiments to improve compost technology to increase the yield of Agaricus bisporus mushrooms [4]. Scientific studies conducted in Turkey have found that mushroom yield can be increased by optimizing compost technology [15].

Table 2. Compost strategies and yield

Compost type	Microorganisms Yield increase (%)	Pathogen reduction (%)	Notes / Description

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Traditional compost(control)	0-5%	0%	No additional microorganisms added Bacillus
Bacillus spp. added	15-20%	25-30%	Bacillus bacteria accelerate enzymatic processes
Pseudomonas spp. added	10-15%	20-25%	Pseudomonas suppresses pathogens
Bacillus + Pseudomonas	25-30%	40-45%	The most optimal combination, high yield
Biological control agents added	5-10%	30-35%	Disease reduction, environmentally friendly product

Biotechnological methods: Beneficial microorganisms can be added to the substrate through biotechnological methods: This reduces pathogens, accelerates growth, and increases yield. Biological control agents are considered an effective means against fungal diseases [13]. Producing environmentally friendly products and reducing pesticides is a global issue today. Managing the microbiome through mushroom cultivation can be a solution to these problems [16].

Results: Studies have shown that there is a statistically significant correlation between the composition of the compost microbiome and yield [11]. For example, metagenomic sequence analyses identified changes in the bacterial community during compost stages, and these changes affected yield indicators [12]. In biotechnological approaches, the addition of Bacillus and Pseudomonas increased yield by 20–40% and reduces pathogenic microorganisms [13].

Discussion: The composition of microorganisms directly affects yield [11,12,13]. Biotechnological strategies accelerate fermentation and reduce pathogens [15,16].

Results are consistent with global studies [6, 12, 14]

Conclusion: Metagenomic and biotechnological approaches allow for sustainable yield increases.

Addition of Bacillus and Pseudomonas provides optimal results.

Microbiome management is an effective strategy for environmentally friendly production [11,12,13,15]

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