Review Article

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Mushroom production, research and marketing options in Pakistan

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ABSTRACT

Mushroom is extensively produced for human consumption in many nations, including Pakistan due to their high protein and vitamin contents. Pakistan boasts a high diversity of mushroom because of its harsh geographical conditions and seasonal variations. Due to the plentiful supply of agro-wastes that make mushroom production possible, mushroom manufacturing is one of Pakistan's most potential cottage industries. The most popular commercially produced mushroom species are Oyster, Paddy Straw, and Button mushrooms; however, the most common and best-selling variety is the white button mushroom (*Agaricus bisporus*). This review article's objective is to gather information regarding Pakistan's mushroom production. Despite an increase in mushroom production, there are some issues that mushroom producers face during production and marketing that need to be resolved for further development of this sector. In light of the nation's land scarcity and high unemployment rate, boosting mushroom production may be a viable strategy for boosting the rural economy. The growth of this industry would also enhance the variety of company projects and job prospects in semi-urban and rural regions.

Keywords: Mushroom production, challenges, research status, market value, Pakistan.

INTRODUCTION

Mushrooms are delicate structures that can be seen growing in humid, shaded areas on organic materials and agricultural waste, acting as scavengers or decomposers. Some mushrooms are edible and inedible (Kulshreshtha et al., 2014).

Edible mushrooms have significant therapeutic value and are used to treat a variety of diseases, including cancer (Borchers et al., 2008). Mushrooms are utilized as healthy food due to their great nutritional value (Shah, 2004) and rich in protein, essential amino acids, minerals, vitamins B-complex, and other biochemical substances (Beluhan and Ranogajec, 2011; Tahir and Hassan, 2013; Kulshreshtha et al., 2014).

It has been noted that individuals are choosing and switching to a natural diet over processed foods (Ogazi, 2010; Ihediohanma et al., 2014). In Pakistan, many people now consume mushrooms, which were once considered a highly expensive delicacy and were in high demand for over 2,000 years. The common mushrooms species reported from different provinces of Pakistan are mentioned in Table 1. Nevertheless, not much is known about Pakistan's mushroom market, challenges, and production status.

Thus, the purpose of this study is to provide an overview of the various facets of mushroom production and commercialization in Pakistan by reviewing the information that is currently accessible.

Article History

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Different mushroom species are reported from different provinces of Pakistan (Sajjad, 2011).

Province	Mushroom species
Azad Kashmir/ NWFP	*Agaricus bisporus, A. sylvaticus, Armillaria melae, Cantherallus citsarius, Coprinus comatus, Boletus edulis, Bovista nigrescens, Morchella conica, M. crassipes, M. delicosus, M. semilibra, M. smithiana, M. vulgaris, M. elata, M. esculenta, M. miyabeabus, Langermannia gigantean, Lycopredon echinatus, Pleurotus ostreatus, Termitomyces macrocarpus, T. microcarpus, T. mammyformis, Truffles, Volvariella volvacea, Volvariella speciosa*
Punjab	*Agaricus bisporus, A. sylvaticus, Pleurotus cornucopiae, P. dryinus, P. ostreatus, Coprinus comatus, C. atromentarius, Lycoperdon, Podaxis pistillaris, Volvariella volvacea, V. bombycine, V. speciosa*
Sindh	*Langemannia gigantean, Podaxix pistillaris, Lycoperdon, Phellorina inquinans,*
Balochistan	*Podaxix pistillaris, Phellorina inquinan, Agaricus rodmani,Lycoperdon* sp.

Production of mushrooms in Pakistan

In the agriculture industry, producing mushrooms is a useful technique for bio-conservation. Agricultural waste material is utilized as a substrate to produce high-quality mushrooms, once the mushrooms are harvested, this substrate may be used as a great soil reclaimer (Alice and Michael, 2004; Sher et al., 2011; Aslam et al., 2021). Among all the crops grown in developed nations, mushrooms have emerged as one of the most significant. Globally, there is a tremendous increase in the production of mushrooms, which are year-round and utilized in a wide variety of cuisines. Approximately 10000-14000 different kinds of edible and beneficial mushrooms have been found worldwide, only 20-60 of these species are commercially produced for human consumption (Khan et al., 2021). Mushrooms are cheap, readily available, and consumed worldwide, with an average yearly production of approximately 12 million tons, to meet nutritional and therapeutic needs. Pakistan offers four distinct seasons and the optimal climate for both naturally occurring and artificially produced mushrooms for commercial purposes (Jahangir et al., 2018). Pakistan's mushroom production could be the answer to the country's inedible organic waste disposal issue and have a major impact on food production. Organic wastes that break down into simple compounds and minerals include cellulose, hemicelluloses, and lignin. Additionally, this will aid in increasing soil fertility. The remnants can subsequently be utilized as fertilizer for different crops and as animal feed (Sajjad, 2011). Mushrooms can be produced in growth chambers, greenhouses, caves, ditches, huts, cottages, hovels, bee hive-shaped huts, garages, sheds or shelters, thatched or meted roofs, dense tree groves, and gardens, kitchens, bathrooms or other spare rooms of a house or any other empty building (Jiskani, 2006). Pakistan is blessed by nature with a range of environmental conditions that are ideal for mushroom production, ranging from high mountains to sea level, where various species can be produced year-round with ease (Pakpost, 2005). Naturally, mushrooms thrive in Pakistan's temperate forests which include Gilgit Baltistan, Quetta, Zayarat and Zhob (Baluchistan), Bagh and Chakoti (Azad Jamu & Kashmir), Dir, Chitral, Kohistan, Tirah, Mingora and Kalam (Swat), Mansehra, Kurram Agency, Murree, and Margalla Hills (Rehman et al., 2000). KPK produces almost 70% of Pakistan's mushrooms. In the regions of Punjab (Fiasalabad), KPK, and Azad Jammu & Kashmir, some people are going to produce mushrooms (Sultana et al., 2007). The National Logistic Cell (NLC) in Islamabad, Pakistan, began commercial mushroom production for the first time, with an average yearly output of roughly 48 tons, 80% of the production was sold to the United States and Europe to create foreign reserve (Sher et al., 2010; Jamil et al., 2019). The white button mushroom (*Agaricus bisporus*), known locally as Khumbhi, is one of the commercially valuable species. It is mostly found in the regions of Sindh, the Thar Desert and mountains, and Kohistan. The NWFP, Gilgit Baltistan, Kashmir, and Punjab are all home to Black

morels (*Morchella elata*). Meanwhile, Balochistan residents are accustomed to consuming large quantities of white umbrella-shaped mushrooms. In Pakistan, a variety of mushroom strains are always accessible, particularly during the monsoon season. These include the Oyster mushrooms (*Pleurotus spp*.), white button mushrooms, the Phoenix Oyster mushroom (*Pleurotus pulmonarius*), the Golden Oyster mushroom (*Pleurotus citrinopileatus*), and the Pink Oyster mushroom (*Pleurotus djamor*) (Dawn, 2013). Since most of these are available in various parts of Pakistan and have commercial value, sourcing spawn would be possible and not provide difficulty over time (Tariq et al., 2020).

Basic requirements for mushroom production

i. Temperature: The temperature can be controlled by the cooling and heating system following needs.

ii. Humidity: The 80-95% humidity that is ideal for mushroom growth can be achieved by using a desert room chiller or by sprinkling water close to the mushroom beds.

iii. Light: Most mushrooms grow well in typical natural light while oyster mushroom requires consistent light, which can be provided by tube lamps.

iv. Others: Benches, floors, ceilings, and Walls: for optimal results, Concrete flooring with adequate drainage should be used, if not, materials that are resistant to high humidity and can be cleaned should be used.

v. Mushroom spawn and culture: Though sorghum grain makes the greatest spawn, all industrial and agricultural wastes as well as other cereal grains can be utilized.

vi. Growing medium / Substrate: Mushrooms can be produced using a variety of agricultural and industrial straw wastes. The majority of materials that can be utilized as a substrate (medium) for mushroom production include sawdust, logs, straw papers, manure, wheat, barley, paddy, oat, and gram straw, sugarcane and maize leaves, cotton waste, thin sticks, and boll locules, empty millet heads and corn cobs, banana pseudo stems, sugarcane baggage, etc. Being an agricultural nation, Pakistan has an abundance of inexpensive, readily available crop wastes that might be used singly or in combination to create edible mushrooms (Jiskani, 1999; Jiskani, 2001).

Challenges for Mushroom Production in Pakistan

In Pakistan, mushrooms are a relatively new crop and the majority of the producers are having a lot of difficulties. Pest insects destroy the spawn of mushrooms. The main cause is that the growth of mushrooms requires a gloomy space and as most insect pests prefer that kind of habitat, they consume the mushroom spawn. In addition to posing a threat from viruses, fungi, and bacteria, high temperatures also hinder the production of mushrooms. It is challenging to keep indoor temperatures at the levels required to produce a productive crop during times of extreme heat and humidity. Overly cold temperatures may pose a greater risk to smaller producers lacking access to modern facilities. Composted material may not cure correctly if there is excessive rain throughout the process cause problems. Growing mushrooms on logs, windstorms, and heavy snowfall can damage the mushroom house and result in yield losses (Abbas, 2016). The main insect pests of mushrooms include phorid flies, Cockroaches, springtails, and sciarid flies. Although the phorid flies do not directly feed on or harm crops, it does carry the verticillium virus which can reduce crop productivity (Babar et al., 2012; Babar et al., 2014). Two common bacterial diseases that affect mushrooms are mummy disease (Pseudomonas var.), which causes mushrooms to dry up and mummify (Abbas, 2016), and bacterial blotch (Pseudomonas tolaasii), which causes brown or golden-brown blotches or lesions on the mushrooms (Kumar et al., 2020). Viruses that primarily harm mushrooms are those that cause LaFrance disease, which has been less common in recent years. Numerous fungi that impact the production of mushrooms are spread through soil. They are dispersed by pickers' clothing, machinery, dust, and insects (Abbas, 2016). The brown patches on mushrooms caused by Verticillium fungicola lower the value and quality of the mushrooms (Nasir et al., 2023). Green mold (Trichoderma harzianum) is a recent issue facing the mushroom industry (Kumar et al., 2020). When the outside weather is humid and the temperatures are mild, Dactylium mildew develops in mushroom homes. When diseases spread throughout their farm, producers frequently feel themselves powerless to control them. Along with these, the producers had to deal with issues with good mother spawn, inadequate storage facilities, high raw material costs, a challenging loan application process, and a shortage of land for mushroom production (Abbas, 2016).

Research and development status of mushrooms in Pakistan

Researchers were prompted to develop techniques for artificial and semi-production of highly valuable mushrooms due to the declining production of these extremely nutritious and therapeutic mushrooms (Chang, 1999). Technology has advanced, and with it, the mushroom industry’s ability to produce more, develop innovative production techniques, design innovative products and packaging, capitalize on ongoing research into the nutritional and medicinal qualities of mushrooms, and use mushrooms to create a balanced environment. The production of mushrooms has a tremendous possibility to become a

cottage industry in Pakistan's rural areas since it may generate income on a small scale and thousands of women and youth would profit from this initiative (Tariq et al., 2020).

Market of mushroom in Pakistan

According to a press release, the market for mushrooms is expected to be worth USD 16.7 billion in 2020 and is expected to increase at a compound annual growth rate (CAGR) of 4.0% starting in 2020 and reaching USD 20.4 billion by 2025 (OpenPR, 2020). Currently, China is among the top three countries in the world for both mushroom production and consumption. Two other nations that led the world in mushroom exports were the Netherlands and the United States (FAO, 2018). Hano (2015) states that mushroom production is currently spread over a hundred countries worldwide including Pakistan, and it is still growing with an estimated total production of more than 12 million tons. White button mushrooms (Agaricus bisporus), commonly known as Portobello mushrooms are the most produced and highly desirable mushrooms (Delcaire, 1978; Jiskani, 2001). To start the business and earn foreign exchange, Pakistani mushroom producers will also push the government to help them out by giving them the seeds and the training they need. This is especially important as mushrooms now fetch between $18- 20 per case (Dawn, 2013). Approximately, 90 tons of mushrooms are exported from Pakistan to Europe annually, out of the world's total production of 1.5 million tons. In 1998-99, Pakistan exported approximately 79 tonnes of mushrooms worth $ 4.49 million. In 2013, the mushroom productivity and gross return were estimated to be 155.6 kg ha and Rs.77,800 ha, respectively, generating $ 6.90 million in foreign exchange earnings (Tahir and Hussan, 2013). Pakistan's mushroom market is expanding quickly due to its unique flavor, aroma, and nutritional value. Mushrooms are used in many unusual cuisine preparations such as soups, pickles, and vegetables (Sajjad, 2011; Tahir and Hussan, 2013). Supermarket and Kohsar market are the two largest supplier markets in Pakistan (Ejaz et al., 2015).

Problems confronted during marketing

•Inability to access a market where the product could be sold.

•Producers were unable to sell their products to retailers directly.

•The primary causes are a lack of knowledge about mushrooms and a communication gap.

•There are issues with advertising and a lack of knowledge regarding the production of mushrooms.

•Transport related issues (Abbas, 2016).

Conclusion and future remarks

In Pakistan, mushrooms have been utilized as healthy food due to their great nutritional value. The nation produces a variety of mushroom species, white button mushrooms are one that are produced widely. The mushroom production requires a sophisticated infrastructure, it has not received the same level of support from the public or private sectors as other mushroom industries, and its growth has been slower in Pakistan than that of other mushroom industries. Pakistan is blessed with a variety of climate zones, therefore practically any kind of mushroom may be produced here without creating market competition for the producers. Although the production of mushrooms has increased, the producers still face several challenges during the production and marketing stages, such as a lack of quality spawn, a lack of funding, a lack of local market and promotion opportunities, a lack of storage facilities, etc., these issues must be resolved for the industry to continue developing. Further study could lead to the production of numerous high-value mushrooms, which would benefit the local people economically. In addition to production, mushroom marketing needs to be promoted. To increase demand for mushrooms, consumers should be informed about the various varieties of mushrooms as well as their therapeutic and nutritional benefits.

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