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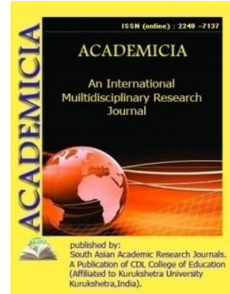

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AN OVERVIEW ON THE CULTIVATION AND BREEDING OF MUSHROOM

Dr. Sandeep Kumar*; Dr. Subrata Das; Dr. Amit Kumar*****

*School of Biotechnology and Bioinformatics,
Faculty of Engineering and Technology,
Shobhit Institute of Engineering and Technology,
(Deemed to be University), Meerut, INDIA
Email id: dr.sandeepkumar@shobhituniversity.ac.in

**School of Biomedical Engineering,
Faculty of Engineering and Technology,
Shobhit Institute of Engineering and Technology,
(Deemed to be University), Meerut, INDIA
Email id: subrata.das@shobhituniversity.ac.in

***School of Agriculture Technology and Agriinformatics,
Faculty of Engineering and Technology,
Shobhit Institute of Engineering and Technology,
(Deemed to be University), Meerut, INDIA
Email id: amit.agri@shobhituniversity.ac.in

ABSTRACT

Mushrooms are a nutrient-dense, environmentally friendly crop with many therapeutic properties. Edible mushroom production is very important in today's world, given the globe's rapidly growing population and severe environmental pressures. However, when compared to other crops, progress in mushroom breeding and production is relatively restricted. This may be owing to a lack of prior understanding of the crop's genetics and breeding system. Due to this fungus's mainly secondarily homothallic life cycle, traditional mushroom breeding has proven challenging. As a result, the genetic diversity of the grown strains is restricted. In addition, establishing an effective genetic transformation method and disease resistance in mushrooms is a difficult job. Knowledge about the gene organization and functions will be accessible when the mushroom genome is sequenced, which will aid in the development of better marker aided *selection breeding systems. This will result in better strains, which, along with improved growing methods, will lead to increased production and quality.*

KEYWORDS: *Breeding System, Cultivation, Disease Resistance, Mushrooms, Transgenic Breeding.*

1. INTRODUCTION

Mushrooms have been grown for their nutritional benefits and flavor in far eastern nations since ancient times[1]. Mushrooms have less protein than mammals, but considerably more than other plants. They are low in fat, rich in fiber, and contain all necessary amino acids, as well as all critical minerals (except iron). Mushrooms generate significant quantities of vitamin D when exposed to UV radiation, which is difficult to get from a typical diet. Given the rising rates of cancer in today's society, it's past time for people to become aware of the health benefits of mushrooms and to take advantage of their cancer-fighting properties[2].

This low-cost vegetable is not only high in nutrients like vitamin D, but it also possesses anti-cancer, anti-HIV-1, and anti-AIDS characteristics. It is a low-cost, low-resource, low-area crop that can be produced anywhere over the globe and at any time of year using low-cost starting ingredients. Growing a highly nutritious meal with great flavor from readily available and inexpensive substrates has enormous promise and appeal. It is also extremely environmentally beneficial, since it can transform lignocellulosic waste into food, feed, and fertilizers. Mushroom consumption and output, on the other hand, are low in contrast to other crops, and the mushroom sector receives little investment. The mushrooms have the highest gross value of all protected crops produced in the globe in terms of area grown, but the overall gross value of all protected crops is just a third of the value of the wheat crop. Mushroom research is a relatively young field of study, and the mushroom business is still tiny in comparison to other crops, thus funding is restricted[3], [4].

1.1 Common Cultivated Mushrooms:

Only a few species of mushrooms and similar fleshy basidiomycetes are economically grown, despite the fact that there are over 300 genera of these fungi. This may be because many of them are mycorhizal, meaning they won't sporulate without the host. Many saprophytic plants, on the other hand, have shown to be cultivable. The button mushroom, Agaricusbisporus, was widely cultivated in Europe before being exported to North America by the settlers; the Shiitake mushroom (Lentinusedodes), which has been grown in China and other oriental countries for centuries; and the oyster mushroom (Pleurotusostreatus), which was collected as wild specimens from forests in Flanders. The oriental Enoke or velvet stem mushroom (Flammulinavelutipes), which is mostly cultivated in Japan, as well as the paddy straw mushroom (Volvariellavolvacaea) and the ear fungus (Auriculariaauricula), are also farmed[5]. Other cultivated mushrooms include the Reishi mushroom (Ganodermalucidum), which is used as an alternative medicine and a flavoring agent in Japan; the Nameko (Pholiotanameko), which is grown in the Orient; and Tremeliafuciformis, or white jelly fungi, which is grown in Taiwan for use as food supplements. Commercially produced A.bisporus varieties include the crimini and portabello. Truffles (Tuber species) are mycorhizal plants that dwell in close proximity to the roots of certain trees. They are considered a delicacy and are among the world's most costly natural foods. Figure 1 illustrates the different types of mushrooms[6].

Figure 1: The above Diagram shows different types of mushroom[7]

1.2 Medicinal Uses of Mushrooms:

Mushrooms include a number of chemical substances that are said to have therapeutic properties. Anti-tumor or immuno-stimulating polysaccarides have been found in 651 mushroom species spanning 185 taxa, inhibiting tumorigenesis. There is evidence that the -D-glycans cause a physiologic response in immune effector cells by attaching to the membrane complement receptor. The anti-tumour effect of a chemical discovered in the lipid component of Agaricus was subsequently identified as ergosterol. Similarly, Grifola's lipid fraction has antioxidant properties and inhibits enzymes that cause a variety of chronic illnesses, including cancer. The mushroom components not only slow disease development by causing direct cytotoxicity in tumor cells, but they also upregulate non-immune suppressive mechanisms. These compounds contain cytostatic chemicals that cause apoptosis in leukamia cells, and isolates from mushroom cells have cytostatic compounds that induce apoptosis in leukamia cells. The compounds generated by Ganoderma species have antibacterial effects and have been proven to stop germs like Staphylococcus from growing. They produce steroid hormones that are active against a wide range of gram negative and gram positive bacteria[8]. Lentinula mycelial extracts have antiprotozoal properties against Paramecium. Mushrooms also have antiviral capabilities, and many substances identified from Ganoderma are potent against H1V-1, as well as influenza virus type 1. Only a few accounts have been included here among the many therapeutic applications of mushrooms.

1.3 Mushroom Breeding Strategies:

Mushrooms have a reputation for being tough to deal with, and it is generally recognized that the Agaricusbisporus mushroom, in particular, is difficult to control via breeding. The natural breeding system was not well understood during early efforts at genetic improvement in the farmed fungus A. bisporus. The mushroom is currently classified as a "secondarily homothallic" species with just one multiallelic mating type component. This knowledge may be used to assess past breeding techniques and propose alternatives. Strain selection based on single spores, multispores, or tissue culture may provide short-term benefits, but it is not as successful as techniques involving controlled crossover. Hybrids may be created by crossing viable strains, although they can be difficult to see. Because only hybrids bear fruit, it is preferable to utilize nonfertile isolates. Markers that can only be produced in hybrid cultures may be used to identify hybrids early, and the inclusion of a genetic resistance characteristic is particularly helpful for this[9].

1.4 Mushroom Breeding Goals:

The main objectives of mushroom breeders and mushroom research are to increase crop production and quality, as well as disease resistance. Other objectives include lowering manufacturing costs and maximizing the usage of compost for plant development. Some of the techniques used for this aim include mass selection based on natural chance mutation and planned mutation using ionizing radiations such as -rays, X-rays, and chemicals, as well as cross breeding and transgenic breeding. Cross and transgenic breeding, on the other hand, are more effective and have showed more promise and development in recent decades. Problems related with cultivation, distribution, and storage, as well as senescence-induced browning and disease resistance, are all areas of study for mushroom breeding. Another goal of mushroom breeding is to integrate different enhanced crop-growing characteristics, such as shorter growth cycle and spore avoidance. Traditionally, mushrooms release billions of spores into the air, causing health issues including lung allergies and fever episodes. Spores can cause climatic installations to be blocked, resulting in increased energy bills.

1.5 Breeding for Disease Resistance:

The output and productivity of commercial mushroom cultivation may be severely harmed by disease outbreaks. Benzimidazole fungicides are resistant to many mushroom diseases, although prochloraz tolerance is common. Over the years, new diseases including Trichoderma aggressivum, Cladobotryiummycophilum, and the mushroom virus X have appeared at regular intervals. Pesticides that have been approved have been drastically decreased in Europe owing to consumer and environmental concerns. Furthermore, since the mushroom is a fungus, many fungal infections are difficult to manage. Controlling disease outbreaks in mushrooms is more difficult due to this confluence of factors.Effective hygiene and sanitation are crucial for disease prevention. Growers may get insight into how diseases are transmitted and disseminated by understanding their disease cycle and epidemiology. Controlling the growing environment by controlling temperature and relative humidity has allowed certain airborne fungal infections to be contained without the use of genetic resistance or fungicides. However, the emergence of fungicide-resistant strains as well as pesticide-use restrictions has boosted the need for resistant cultivars.

1.6 Hybrid Breeding:

The hybrid mushroom strains developed in the 1980s were highly accepted and popular, but they restricted the range of production characteristics and environmental and cultural stress tolerance.

Since 1983, hybrids of the Lentinula, Pleurotus, and Agaricus mushrooms have been created via cross breeding. Hybrid strains have not only provided mushrooms with disease and pest resistance, but they have also decreased the reliance on and hazards associated with environmental and cultural stressors. Hybrids created by crossing monosporic cultures are grown and RAPD and RFLP analyses are performed to assess production characteristics. Mushroom breeding requires a significant financial commitment as well as patience on the part of both the breeder and the grower[10]. For the last 30 years, a variety of specialized industry standards have been established to cultivate strains accessible to the general population. For a new strain to succeed, certain changes in growing conditions are necessary for optimum development. To maximize strain performance, farmers have traditionally had to alter growing systems to suit cultural requirements, such as changing flushing regimes, watering schedules, and harvesting methods. For future strain growth to be effective, cultural practices like as watering frequency and timing must be changed.

1.7 Transgenic Breeding:

There are currently no commercially marketed transgenic mushroom strains, although many research groups are making excellent progress in this area. The use of recombinant DNA technology to produce transgenic mushrooms has opened up a world of possibilities. Importing genes from unrelated sources is now feasible, and the hunt for favorable genes is no longer limited to inside the species.Other filamentous fungus transformation methods are being developed for the mushroom. DNA has been incorporated into protoplasts, mycelium, and basidiospores using a variety of methods including polyethylene glycol, electroporation, and particle bombardment.

1.8 Marker Assisted Selection Breeding (MAS) in Mushrooms:

Breeders now utilize DNA molecular markers to find better characteristics by identifying and selecting particular genes. PCR-based approaches and RAPD methods both utilize repetitive DNA sequences to produce markers. To create genetic maps from experimental data, computer software is employed. For monogenic characteristics that segregate into discrete phenotypes in mushrooms, using genetic markers is simpler. Previously, white and off-white mushroom strains dominated the market, each with its own set of favorable and unfavorable characteristics. The off white strains were superior for mechanical harvesting but discolored when sliced and canned, while the white strains were less prolific but did not discolor when sliced and canned.

1.9 Agrobacterium-Based Transformation:

While many other transformation methods are unreliable and unstable, using the soil bacteria Agrobacterium tumefasciens for transformation is said to produce stable transformants. Both homokaryons and heterokaryons can be transformed using the Agrobacterium system, and both karyotypes of a heteroharyon may be transmitted at the same time. In Agaricusbisporus, the utilization of A.tumefasciens for effective transformation and activation of its virulence gene using the plant hormone acetosyringone was first attempted. However, this technique had drawbacks in that it was not repeatable, produced false positives, had a poor degree of integration, and required DNA modification after integration. It's also crucial to include redundant DNA in the transformation vector, which serves no use in Agaricus but is required for gene transfer alone. Infecting the fruiting gill tissue with Agrobacterium strains containing the gene construct of interest and using a vector with homologous promoter resulted in a successful Agrobacterium-mediated transformation. In most instances, the multinuclear structure of mushroom mycelia has limited genetic breeding's ability to produce significantly enhanced characteristics. Many transgenic mushroom modifications will need the transfer of the gene to both parental lines, with the progeny bearing double copies of the gene to imitate the normal inheritance process. In certain cases, a single copy of the gene is enough, although the resultant transgenic line may need to be further screened before being released as commercial strains. Importing cry genes from Bacillus thuringiensis for insect resistance and synthetase resistance from Agrobacterium for glyphosphate herbicide resistance are two examples of transgenic breeding potential.

2. DISCUSSION

Mushrooms have been eaten since the dawn of time. The term "mushroom" comes from the French words "fungus" and "mould." Mushrooms are a popular nutritious meal nowadays since they are low in calories, carbohydrate, fat, salt, and cholesterol. Mushroom also contains essential nutrients such as salenium, potassium, riboflavin, niacin, Vitamin D, proteins, and fiber. All of this comes with a lengthy history of use as a food source. Mushrooms are valued in traditional medicine for their therapeutic abilities and qualities. It has been shown to have positive benefits on health and the treatment of certain diseases. Mushroom has a variety of nutraceutical benefits, including cancer and anticancer capabilities. Mushrooms have antimicrobial, immune-boosting, and cholesterol-lowering properties. They are also a significant source of bioactive chemicals.

3. CONCLUSION

Mushrooms are a nutrient-dense, environmentally friendly crop with many therapeutic properties. Edible mushroom production is very important in today's world, given the globe's rapidly growing population and severe environmental pressures. However, when compared to other crops, progress in mushroom breeding and production is relatively restricted. Economic considerations linked to need and resources will influence the application of genetic engineering in the mushroom business. Mushrooms are lagging behind other crops in terms of molecular biotechnology development due to financial limitations. Acceptance of genetically engineered foods and increased mushroom consumption may boost research efforts. Single-gene traits like virus and insect resistance, as well as resistance to fungal and bacterial diseases and herbicides, may be targeted initially since they are easier to combat.Complex characteristics like as yield, size, color, shelf-life, and physical stress that are regulated by many genes may be studied in the future thanks to the mapping of the mushroom genome and knowledge of functional genomics in mushrooms. Mushrooms may also be used as bioreactors in the pharmaceutical and biotech industries to synthesize proteins and other chemicals. In a safe confinement facility with the possibility of automation and mechanical harvesting, a greater biomass of mushrooms may be grown on low-cost waste materials. In humans, the proteins generated by mushrooms will have greater specific biological activity than those produced by plants.

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