

Irradiation of Mushrooms – An Overview

Kalyani. B¹, Manjula. K²

¹ Research Scholar, Department of Home Science, S. V. University, Tirupati, Andhra Pradesh, India-517502

² Assistant Professor, Department of Home Science, S.V.University, Tirupati, Andhra Pradesh, India-517502

Abstract: Radiation is not a modern man-made creation and it is a direct, simple, and efficient one-time process. Food irradiation may be considered as a second big break through after pasteurization. Irradiation should be our next step in food safety and should play an integral part in our continued demand for food safety. Irradiation is the process of exposing food to ionizing radiation in order to destroy microorganisms or insects that could be present in the food and some time to improve the functional properties of food. Foods that contain physiologically active compounds that provides health benefits beyond basic nutrition. A functional food is similar in appearance to conventional food, is consumed as part of a usual diet, and helps to reduce the risk of chronic disease beyond basic nutritional functions. Mushrooms have attracted the attention of man from very ancient times, and the use of mushrooms as food is as old as human civilizations. Mushrooms are fleshy fungi, being used as food and medicine. Mushrooms have medicinal value in inhibiting tumor growth and enhancing immune system. Indian medicinal mushrooms are potential sources of antioxidant and anticancer compounds. The present review is related to studies on mushroom irradiation and their functional properties.

Keywords: Mushroom, Irradiation, Functional Food.

1. Introduction

1.1. Radiation technology

Radiation processing technology has been developed through worldwide R&D efforts of more than four decades. India is one of the few countries in the world having the necessary expertise and know-how for deployment of this technology. Irradiation processing of food involves the controlled application of energy from ionizing radiations such as gamma rays, electrons, and X-rays for food preservation. Gamma rays are emitted by radioisotopes such as Cobalt-60 and Caesium-137 while electrons and X-rays are generated by gaseous discharge using electricity. Gamma rays are a part of the electromagnetic spectrum. They can penetrate deep into food materials and bring about desired effects [3].

Food irradiation may be defined as the intentional exposure of food to ionizing radiation (such as gamma and electron beam) in order to enhance its shelf life as well as the safety of food. The softening and browning process associated with the ripening of certain fruits and vegetables, such as in mushrooms, can be delayed by utilizing irradiation. Therefore, to reserve nutrition as well as to enhance shelf life of mushrooms in conjunction with advanced food processing methods, irradiation can serve the purpose [1].

After decades of research, development, public debate and consumer acceptance trials in many countries, irradiation has emerged as a safe and viable technology for ensuring the safety and quality of food and for combating food-borne diseases. Indeed it is currently the best available technology suitable for treating raw and partially raw food products and those countries which adopt it will benefit greatly in both domestic and international markets [4]. The general ways in which irradiation can be useful in treating foods may be listed as follows [2]:

- Control of spoilage microorganisms
- Complete sterilization for unlimited product life

- Reduction of numbers to delay microbial spoilage
- Control of food-borne pathogenic microorganisms
- Control of helminthes and other food-borne parasites
- Control of insects
- Delay of senescence
- Product improvement

1.2. Importance of Mushrooms

Mushrooms, belong to the fungi kingdom, are being used for food and medicinal purposes by humans since time immemorial. Some species of mushroom are very poisonous. Over time mankind learnt to differentiate between edible and poisonous mushrooms and now mushrooms with nutraceutical properties are part of the daily food in many countries. In regards to the Romans, mushrooms were considered as “Food for Gods”. The number of recognized mushroom species has been reported to be 14,000, which is about 10% of the total estimated mushroom species on the earth. They are known as filamentous fungi and must obtain their nutrients from waste products or living things, as all fungi lack the chlorophyll required for obtaining energy directly from the sun. With the increase in the demand and consumption of mushrooms, the production and supply chain for mushrooms also require the use of highly developed technology. These days a large volume of mushrooms are being produced by means of cultivation with advanced agricultural practices [5].

2. Mushrooms as Functional foods:

Mushroom is defined as “a macro fungus with a distinctive fruiting body which can be hypogeous or epigeous, large enough to be seen with the naked eye and to be picked by hand. The first growing mushrooms have received worldwide popularity in recent decades with realization to the fact that they are good source of delicious food with high nutritional values. Besides nutritional value mushroom acts as antioxidant. Oxygen is converted to Reactive Oxygen Species (ROS) such as Superoxide radical, hydroxyl radical and hydrogen peroxide by univalent

reduction of oxygen. These free radicals are independent chemicals with one or more unpaired electrons and are responsible for biological injury. Antioxidants are molecules that can neutralize these radicals by accepting or donating an electron to eliminate the unpaired condition and protecting the damages caused by these radicals [9].

The antioxidants present in mushrooms are of great interest as possible protective agents to help the human body to reduce oxidative damage without any interference. Now they are recognized as functional foods and as a source of physiologically beneficial components. Mushrooms are reported to boost heart health; lower the risk of cancer; promote immune function; ward off viruses, bacteria, and fungi; reduce inflammation; combat allergies; and help to balance blood sugar levels and support the body's detoxification mechanism. Mushrooms have shown the ability to accumulate a variety of secondary metabolites including phenolic compounds, polypeptides, terpenes, steroids, etc. Mushroom phenolics have been found to be an excellent antioxidant and synergist. Furthermore, several companies are developing capsules from combinations of mushrooms, and these capsules, although expensive, are health beneficial, including fighting against cancer [7].

Mushroom is available abundantly in nature and seems to possess the ability to fulfill the highly increased demands on healthy food. Interestingly, mushroom is acknowledged as the only vegan source of vitamin D due to its high content of ergosterol which will be converted to vitamin D₂ (ergocalciferol) when exposed to UV light. *Cordyceps militaris* contain beneficial biological activities, for instance: sperm production enhancer, longevity promoter, hypoglycemic, anti-tumor, anti-metastatic, hypolipidemic, and antioxidant agent. Besides, *C. militaris*, likely the other species of mushroom, contains high amount of ergosterol, the precursor of vitamin D₂. Since its scarcity in nature, cultivation of *C. militaris* mycelia in submerged culture is currently a significant issue because it yields a great quantity of bioactive compounds in a compact space and shorter time with less chance of contamination in comparison with fruiting bodies cultivation. Pulsed UV (PUV) light enhances vitamin D₂ content of mushroom with intense pulses in short time of irradiation. Thus, physical appearance of mushroom is not affected by discoloration. The study on *C. militaris* mycelia exposed to PUV light is firstly presented in this paper. This research is mainly aimed to investigate the optimum dose of PUV light irradiation on cultured mycelia of *C. militaris* for the production of vitamin D₂, adenosine & cordycepin, polysaccharides and antioxidant activity [1].

Mushrooms are one of the few food sources where the precursor to vitamin D occurs naturally. Ergosterol, found in mushrooms (21-107 mg/100 g) is converted to ergocalciferol or vitamin D₂ by exposure to UV light. Small amount of vitamin D₂ are synthesized in the mushrooms by exposure to naturally occurring UV light during growing or processing. This conversion can be accelerated by exposing the mushrooms to UV light for 15-20 seconds during processing. The dose and length of treatment can affect the amount of D₂ synthesized during exposure [6].

White button mushrooms (*Agaricus bisporus*) are a potential breast cancer chemo preventive agent, as they suppress aromatase activity and estrogen biosynthesis. Therefore, we evaluated the activity of mushroom extracts in the estrogen receptor-positive/aromatase-positive MCF-7aro cell line in vitro and in vivo. Mushroom extract decreased testosterone-induced cell proliferation in MCF-7aro cells but had no effect on MCF-10A, a nontumorigenic cell line. The studies showed that mushroom extract decreased both tumor cell proliferation and tumor weight with no effect on rate of apoptosis. Therefore, our studies illustrate the anticancer activity in vitro and in vivo of mushroom extract and its major fatty acid constituents [8].

The pharmaceutical agents have a therapeutic role in cancer; dietary constituents should be explored for their preventive potential. Therefore, our laboratory initiated a research project to investigate anti-aromatase photochemical in common vegetables that may lead to the suppression of breast cancer cell proliferation. Our experiments revealed that of the seven vegetable extracts tested, the extract of white button mushroom was the most effective in inhibiting the activity of human placental aromatase. Of the other extracts evaluated, celery had a modest inhibitory effect. Extracts prepared from green onion, carrot, bell pepper, broccoli, and spinach did not exhibit significant aromatase inhibition under these experimental conditions. To determine whether aromatase inhibition was unique to the white button mushroom, 10 additional varieties of mushrooms were evaluated. The results identified the stuffing mushroom as the most potent inhibitor of aromatase activity; however, the shiitake, white button mushroom, portobello, crimini, and baby button mushrooms also showed significant inhibitory effects. These findings suggest that a number of varieties of mushroom possess inhibitory effects on aromatase activity. Because it is the most common type of mushroom consumed by the general population, we studied the anticancer potential of heat-stable extracts from white button mushroom. Our results led us to hypothesize that the white button mushroom contains potential chemo preventive agents active against hormone-dependent breast cancer [8].

3. Conclusion

The radiation technology is beneficial and should play an integral part in our continued demand for food safety. The present trend gives more propriety to functional foods. Mushroom is one of the natural functional foods having many health benefits. By the application of radiation technology to mushrooms it may be very beneficial. Food irradiation is one of the best and safest food preservation techniques designed to ensure the provision of better quality mushrooms with an extended shelf life. It can also contribute significantly to community health, as the risk of food borne diseases can be minimized with the proper use of this advanced technology.

References

- [1] Agnes Purwidyantri¹, Arif Rahmandita, Shu-Yao Tsai, "Optimization of Pulsed UV Light Irradiation for the Production of Vitamin D₂, Bioactive Metabolites and Antioxidant Activity of *Cordyceps militaris* Mycelia,"

2012 International Conference on Nutrition and Food Sciences, IPCBEE vol. 39 (2012) IACSIT Press, Singapore.

- [2] Chichester CO (1978) In Advances in Food Research Academic Press, New York, NY, U.S.A.
- [3] Hemant Lagvankar," Food Irradiation Technology in India," Material published by the Scientific information Resource Division, BARC, Mumbai.
- [4] <http://www-tc.iaea.org>
- [5] Kashif Akram and Joong-Ho Kwon," Food Irradiation for Mushrooms: A Review," J. Korean Soc. Appl. Biol. Chem. 53(3), pp.257-265, 2010.
- [6] Roberts, J.S., Teichert, A., and McHugh, T.H."Vitamin D2 formation from postharvest UV-B treatment of mushrooms (*Agaricus bisporus*) and retention during storage," J. Agric. Food Chem. 56, pp.:4541-4544, 2008.
- [7] S.K. Das, M. Masuda, A. Sakurai and M. Sakakibara. Medicinal uses of the mushroom *Cordyceps militaris*: current state and prospects. *Fitoterapia*. 2010, 81 (8): 961-968.
- [8] Shiuan Chen, Sei-Ryang Oh, Sheryl Phung, et al." Anti-Aromatase Activity of Phytochemicals in White Button Mushrooms (*Agaricus bisporus*), *Cancer Res*:66, pp.12026-12034,2006.
- [9] Tamal Mondal, Rupa Some and Sikha Dutta," Studies on antioxidant and antimicrobial properties of some common mushrooms," *Journal of Today's Biological Sciences: Research & Review*, Vol. 2(1), pp. 60-67, June 30, 2013.

Author Profile



Bandi Kalyani received the MS degree in Food technology from Sri Venkateswara University, Tirupathi. She is now doing Ph.D. in Sri Venkateswara University, Tirupathi.



Dr. K. Manjula Working as Assistant Professor in the Department of Home Science, Sri venkateswara University, Tirupathi, having 10 years of Teaching experience in the specializations food Science and Food technology and guided several PG and Ph.D Projects. The area of interest is food processing and Preservation and Food product development.