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# Medicinal Mushrooms as a Protective Strategy Against Doxorubicin-Induced Cardiotoxicity

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## ABSTRACT

Cardiotoxicity is an undesirable side-effect of chemotherapy that limits the effectiveness of cancer treatment. Almost all cardiotoxic drugs can cause a variety of heart conditions (heart failure, arrhythmias, myocardial infarction, etc.) by stimulation of oxidative stress and other pathological conditions. The search for bioactive compounds against chemotherapy-induced cardiotoxicity is a priority area of cardio-oncology. Doxorubicin (DOX) is one of the most effective and widely-used anthracycline derivative anticancer drug. Administration of DOX is restricted due to the risk of developing congestive heart failure promoting myocardial apoptosis and oxidative stress, decreasing the activities of antioxidant enzymes and increasing the production of pro-inflammatory cytokines. A combination of DOX and cardioprotective natural agents, including fungi and plants, is an effective therapeutic strategy to improve the outcome of cancer therapy. Medicinal mushrooms are producers of different bioactive compounds with various therapeutic effects, including antioxidant properties. They possess cardioprotective activity by reducing risk factors to develop cardiovascular diseases. *Agaricus bisporus, Fomes fomentarius, Ganoderma lucidum, Grifola frondosa, Morchella esculenta* and *Trametes versicolor,* as well as *Cordyceps*, *Inonotus*, *Phellinus* and *Pleurotus* species have been reported to prevent DOX-induced cardiotoxicity, including oxidative stress and adverse biochemical alterations in cardiac tissue. The administration of extracts from basidiomes and mycelia showed significant cardioprotective effect against DOX-induced cardiotoxicity, restored cellular viability and reduced the oxidative stress via mitochondria-dependent apoptotic pathways. Triterpenes isolated from *G. lucidum* prevented DOX-induced oxidative stress and ameliorated myocardial cardiomyopathy in rats. Thus, mushroom-derived pharmaceuticals and nutraceuticals can be used as a potential food supplement for reducing the DOX-induced cardiotoxicity during anticancer chemotherapy. Further clinical studies in integrative oncology are warranted to investigate the effect of mushrooms as a protective strategy against chemotherapy-induced cardiotoxicity in cancer patients.

**Keywords:** mushrooms, chemotherapy, cardiotoxicity, doxorubicin, integrative oncology

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