SOD activity, Cytochrome P-450, Cytochrome P-450 reductase and secondary metabolites - Chemical and Biological Properties in Mushroom Nutrition

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Mushrooms have been known to possess medicinal properties for thousands of

years. Higher basidiomycete mushrooms have been used in clinical nutrition because they exhibit anti-tumour, immune modulating, cardiovascular and anti-microbial activities (1).

The benefits of mushroom nutrition on these clinical conditions has attracted great interest in the scientific community in the last decade in order to understand the molecular mechanism responsible for their action (2).

Mushroom biomass contains many complex substances of therapeutic interest such as protein-bound polysacharide complexes (i.e PSK, PSP and Lentinan), secondary metabolites (i.e terpenes, alkaloids and lactones) and enzymes (i.e laccase, superoxide dismutase, glucose oxidase and peroxidase) (3,4).

It has been known that enzyme therapy plays an important role in several clinical conditions such as in cancer treatment, malignant lymphoma and cardiovascular disorders (5,6).

A number of pathological damages such as carcinogenesis and cellular degeneration related to aging process are due to reactive oxygen species (ROS) produced by sunlight, ultraviolet radiation , chemical reactions and metabolic processes. These reactive oxygen species (i.e superoxide radicals) are toxic to living cells since they oxidize and degrade important biological macromolecules such as lipids and proteins.

Superoxide dismutase (SOD) catalyses the destruction of superoxide radicals and hence protects oxygen –metabolizing cells from the harmful effect of these free radicals. Several research workers have shown that SOD is involved in some diseases such as Parkinson´s disease, cancer and anemia. Several mushrooms have shown to contain substances which mimick SOD activity (7,8).

Another important enzyme system consist of cytochrome P-450 which is located in the endoplasmic reticulum and play an important role in metabolism and detoxification of endogenous substances (9). This enzyme system has been also found in some higher basidiomycete fungi.

Thrombin is an important protease of the coagulation system and therefore it is a suitable target for inhibition of blood coagulation. There are a number of secondary metabolites in mushrooms which play an important role as thrombin inhibitors (10).

In the present work, we investigated the levels of SOD, cytochrome P-450, cytochrome P-450 reductase (NADPH dependent) and secondary metabolites as thrombin inhibitors in MRL products (*Coriolus versicolor, Cordyceps sinensis, Ganoderma lucidium* (Reishi) and *Grifola frondosa* (Maitake*)* by simulating the intestinal tract of the human body. Therefore, we treated the MRL products with the following proteolytic enzymes:

1. Pepsin (500IU/g biomass) at pH2 for 30 min. at 37ºC in an incubator with orbital shaking
2. Trypsin (500IU/g biomass) at pH 7.6 for 30 min. at 37ºC in an incubator with orbital shaking.

The analysis of SOD, cytochrome P-450, cytochrome P-450 reductase (NADPH dependent) and secondary metabolites as thrombin inhibitors in *Coriolus versicolor, Cordyceps sinensis, Ganoderma lucidium* (Reishi) and *Grifola frondosa* (Maitake*)* produced the following results:

Table 1- In the absence of proteolytic enzymes

	Enzymes and secondary metabolites Analysis Per Tablet of MRL Product	Maitake MRL	Reishi MRL	Coriolus MRL	Cordyceps MRL
1	Superoxide dismutase (SOD) activity	70.2U	50.4U	77.1U	77.1U
2	Cytochrome P-450	0.60 nmoles	0.66 nmoles	0.51 nmoles	0.25 nmoles
3	Cytochrome P-450 reductase	7.14 mU	7.05 mU	11.9mU	4.14mU
4	Secondary metabolites (Thrombin inhibitors)	49%	4.4%	59%	56%

Table 2- In the presence of pepsin

	Enzymes and secondary metabolites Analysis Per Tablet of MRL Product	Maitake MRL	Reishi MRL	Coriolus MRL	Cordyceps MRL
1	Superoxide dismutase (SOD) activity	58.7U	41.3U	61.2U	49.5U
2	Cytochrome P-450	0.48 nmoles	0.53 nmoles	0.49 nmoles	0.24 nmoles
3	Cytochrome P-450 reductase	6.06mU	5.92mU	9.52mU	3.80mU
4	Secondary metabolites (Thrombin inhibitors)	46.5%	3.7%	54.2%	50.9%

Table 3- In the presence of trypsin

	Enzymes and secondary metabolites Analysis Per Tablet of MRL Product	Maitake MRL	Reishi MRL	Coriolus MRL	Cordyceps MRL
1	Superoxide dismutase (SOD) activity	69.5U	51.4U	68.5U	90.6U
2	Cytochrome P-450	0.58 nmoles	0.63 nmoles	0.52 nmoles	0.24 nmoles
3	Cytochrome P-450 reductase	7.03mU	6.98mU	11.1mU	4.02mU
4	Secondary metabolites (Thrombin inhibitors)	46%	3.7%	52%	57%

The data presented in these tables reveal that the simulation of intestinal tract (pepsin and trypsin) decreases the enzyme and secondary metabolites´s levels by a factor in the range of 15-20%.

Conclusions:

Mushrooms contain several important enzymes involved in detoxification process (i.e cytochrome P-450) and destruction of super-oxide free radicals (i.e SOD activity) as well as secondary metabolites which act as thrombin inhibitors.

Further research is required to study the effect of mushroom nutrition on the levels of some key proteins and enzymes *in vivo* which are involved in several clinical conditions such as cardiovascular, cancer, HIV and neurological disorders.

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