STUDY ON EFFECT OF LIGHT RARE EARTH - ISOLEUCINE CHELATE ON *HERICIUM ERINACEUM* GROWTH

LE MINH TUAN, NGUYEN THI CHINH, NGUYEN TRONG UYEN, NGUYEN DINH BANG

ABSTRACT

Today, the use of rare earth elements (REE) as trace nutrients in agriculture including plants and animals is widely practiced in some countries. In general, it is known that many organic compounds of REE are capable of influencing many physicochemical and biological processes taking place in the root-soil interface, such as uptake of nutrients by plants as well as microbe interactions.

This paper dealt with the effect of light rare earth elements (REE) isoleucine chelates on the growth of *Hericium erinaceum* mushroom at the different total rare earth concentrations. In our experiments, mixed light REE isoleucine chelates were applied in order to evaluate its potential. The obtained results showed that light REE isoleucine chelates have significant good effect on mycelia growth of this mushroom. The growth of *Hericium erinaceum* mushroom was stimulated when total rare earth element contents reached 100 ppm - 200 ppm. When REE contents were higher than 300 ppm, the growth of mushroom was inhibited.

Key words. Hericium erinaceum, rare earth elements, chelate, L-isoleucine.

1. INTRODUCTION

Rare earth elements (REE) and their compounds are widely applied in agronomic and medical fields for many years. The bioinorganic chemical research of REE during the past years indicates that REE play important roles in the promotion of photosynthetic rate as well as root absorption, regulation of hormone and nitrogen metabolism, and suppression of microbes, etc [1 - 3]. The metallic or non-metallic targets of key biomolecule in various physiological processes can be chosen by REE for the chelation or replacement, which enables REE to regulate the biological functions or behaviors of those biomolecule and consequently leads to significant embodiment of biological function of REE in plants and microbes [1, 4 - 8].

In China, extensive research started in 1972, involving both pot trials and field demonstrations, and since then a great variety of plant species has been tested. Different methods of rare earth applications and various concentrations, mostly low ones, have thereby been investigated. To date, yield increases for 50 plant species of trees and pasture grasses have been reported [1, 3].

Hericium erinaceum, commonly called"yamabushitake or lion's mane" is notable for its use in treatment of diverse diseases such as gastritis, gastric ulcer, and tumors [11]. This mushroom has also been known to contain diverse pharmaceutically important compounds such as novel phenols and fatty acids that have possible chemotherapeutic effect on calcer and ameliorative effect in Alzheimer's dementia cases [12, 13].

Recently, no any relevant research on application of rare earth chelates in the mushroom cultivation technology is found [1]. Therefore, to improve productivity and product quality of

mushrooms, especially the special mushroom used for medicinal purposes, we have studied the influence of rare earth isoleucine chelates on the growth of *H. erinaceum* - a type of good mushroom: food and medicine for testing their bio-activities.

2. MATERIALS AND METHODS

Total light rare earth elements isoleucine chelates $REE(Hile)_3(NO_3)_3$ are tested in our experiments compared to blank samples.

Microorganism used in this study was *H. erinaceus (Bull: Fr.) pers*. The experiments were carried out on agar & liquid medium (M) and also on solid substrates. The composition of M medium was as follows: potato extract 1 liter, 10 g glucose, 40 g dextrin, 4 g yeast extract, 2 g soytone peptone, 2 g KH_2PO_4, 0,6 g $MgSO_4.7H_2O$ and 0,2 g $FeCl_3.6H_2O$. The composition of substrate (% w/w) was as follow: sawdust 80%, boiled paddy 20%, KH_2PO_4 0,05%, $MgSO_4.7H_2O$ 0,05%, $CaCO_3$ 0,05%.

Hericium erinaceum mushroom was cultivated following procedure [9, 10]. The experiments were conducted at the same time and conditions to collect the exact results and the contents of total rare earth elements are in the range of 100 to 800 ppm on agar and liquid medium, 100 ppm - 1200 ppm on solid substrates. Measuring speed of growth of mushroom mycelial system, weighing fermented biomass, fresh fruitbody and dried fruitbody of *Hericium erinaceum* mushroom. All experiments were repeated at least triple.

3. RESULTS AND DISCUSSIONS

Colonie diameter of mycelial system and weights of femented biomass after 3, 5, 7, 10, 12 days are shown in Table 1 and figure 1.

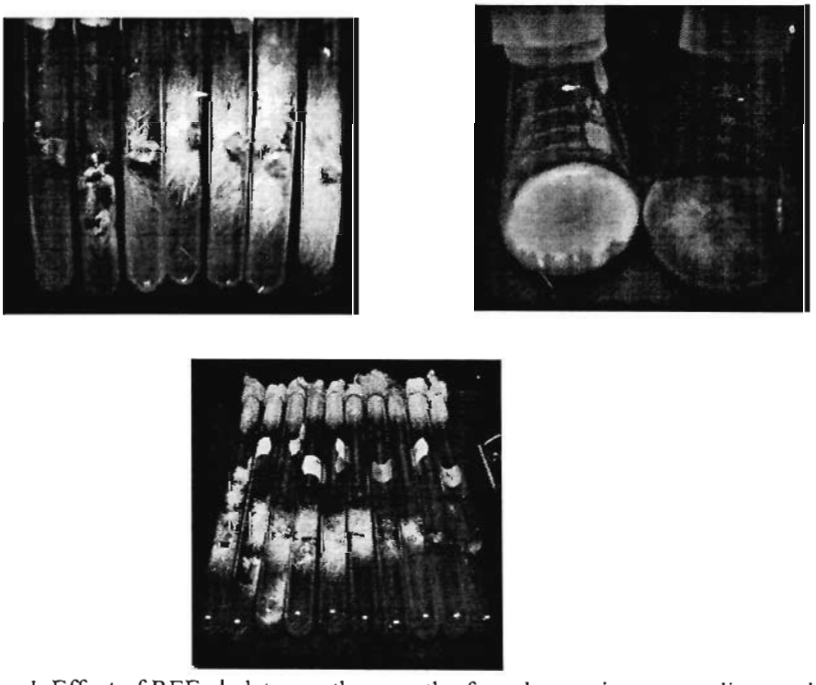

Figure 1. Effect of REE chelates on the growth of mushroom in agar medium at different REE concentrations

Table 1. Influence of rare earth isoleucine chelates on the growth of mycelial

Experiments	REE concentration *(ppm)*	Mycelia Growth *(μm/h)*	Biomass volume *(g/l)*
Blank sample	0	171	10.78
1	100	198	13.06
2	200	207	13.27
3	300	163	10.08
4	400	120	6.54
5	500	62	1.39
6	600	31	0.62
7	800	Dead mycelia	-

Thus, the rare earth chelates have significant effect on *Hericium erinaceum* mushroom growth. The results show that with the addition of 100 ppm - 200 ppm REE, REE isoleucine chelates have stimulating effects on the growth rate of mushroom mycelial. Especially at content of 200 ppm, maximum growth rate have reached (21% increase) and the biomass yield increases 23.1% compared with that of blank sample. When the contents of REE increase further more, they act as inhibitors and cause the decrease of growth rate of mushroom (over 300 ppm) or wither mycelial systems (800 ppm and over).

In solid substrates, The impacts of addition of rare earth chelate on the growth of mushroom are shown in table 2 and figure 2.

Table 2. Influence of rare earth isoleucine chelates on the growth of mycelial and cultivation yield

Experiments	REE concentration *(ppm)*	Mycelia Growth *(mm/day)*	Weight of fresh fruitbody *(g)*	Weight of dried fruitbody *(g)*
Blank sample	0	4.2	119	11.4
1	100	4.9	131	12.6
2	200	5.2	143	13.8
3	300	3.7	102	10.2
4	400	3.4	93	8.8
5	600	1.9	67	6.4
6	800	1.3	36	3.4
7	1000	0.9	23	2.2
8	1200	Dead mycelia	-	-

The same results and observation are obtained compared to the effect of RE chelates in agar and solution media. With the addition of 100 ppm - 200 ppm REE, light rare earth elements isoleucine chelates have stimulating effects on the growth rate of mushroom mycelial and cultivation yield. Especially at REE content of 200 ppm, the cultivation yield increases 21% compared with that of blank sample. When the contents of REE increase further more, they act as inhibitors and cause the decrease of growth rate of mushroom (over 300 ppm) or wither mycelial (1200 ppm and over).

a)

b)

c)

Figure 2. Effect of REE chelates on fruitbody of mushroom

a. Blank sample (left) and sample with 200 ppm REE supplementation (right)

b. Samples with 600 ppm REE (left) & 200 ppm REE (right) supplementation

c. Samples with 200 ppm REE (left) & 100 ppm REE (Right) supplementation

Thus, the light rare earth elements have obvious impact on the growth of *Hericium erinaceum* mushroom. With suitable doses of REE isoleucine chelate addition (in the range of 100-200 ppm REE) will have effect of stimulating the growth, accelerating growth rate of mycelials, increasing biomass volume, weight of fruitbody.

4. CONCLUSION

Demonstrate the good performance of Rare earth isoleucine chelates on growth of *Hericium erinaceum* mushroom. These chelates stimulate the growth of mycelial, biomass volume and weights of fruitbody like this improve mushroom farming efficiency.

Determine the optimal concentration of rare earth isoleucine chelates in different media for *Hericium erinaceum* mushroom cultivation. With the addition of 200 ppm REE, the maximum effect of chelates has reached. The increase of mycelial growth, biomass volume and cultivation yield are respectively 21%, 23.1% and 21%.

REFERENCES

1. Kerstin Redling - Rare Earth Elements in Agriculture, Doctoral Thesis, University of Munich, Munich, 2006.
2. Gou Bosheng et al - Rare Earth Elements in Agriculture, China Agri. Sci –Tech. Press, Beijing, 1988.
3. Yu Zongsen, Chen Minbo - Rare Earth Elements and Applications, Metallurgical Industry Press, Beijing, 1995.
4. Chen Xing-bit - Application of Rare-Earth Compound Fertilizer in Some Crops in Central Yunnan, Journal of Rare Earths (3) (2000).
5. Xing Zheng, Shixing, Xiaogen - New Type of Application Effect of Organic Compound Fertilizer on Sweet Maize, Anhui Agricultural Sciences (4) (2002).
6. Nguyen Trong Uyen - Investigation of antibiotic and anti-cancer activity of some lanthanide complex with L Aspartate, Inorganic Chemistry (33) (2004) 24-25.
7. Qiu Guanming, Li Wei, Li Xikun, Zhou We - Biological Function of REE in Plants & Microbes, Journal of Rare Earths (2005).
8. Cui Yingguo, Peng Jianzhang, Wang Jiachen, Fan Tianwen, Abudukahar - Study on Alfalfa Yield Improved by New Rare Earth Materials for Agriculture, Journal of Rare Earths (2004).
9. Nguyễn Thị Chính - Phát triển công nghệ sản xuất nấm dược liệu phục vụ tăng cường sức khoẻ, Báo cáo tổng kết đề tài hợp tác Việt nam – Hàn Quốc theo Nghị đinh thư chính phủ, 2005.
10. Kim H., Jeong G., Yong K. - Optimization of Submerged Culture Conditions for Mycelial Growth and Exopolysaccharides Production, J. Microbiol. Biotech. **14** (5) (2004) 944-951.
11. Liu M., H. Cheng, and H. Sun - Survey in medicinal value of Hericium erinaceum, Edible Fungi of China **18** (1999) 24-25.
12. Mizuno D. - Bioactive substances in Hericium erinaceous (Bull.; fr.) Per., and its medicinal utilization, Int. J. Med. Mush. **1** (1999) 105-119.
13. Mizuno T., T. Wasa, H. Ito, C. Suzuki, and N. Ukai - Antitumor-active polysaccharides isolated from the fruiting body of Hericium erinaceum, and edible and medicinal mushroom called or houtou. Biosci, Biotech. Biochem. **56** (1992) 347-348.

TÓM TẮT

NGHIÊN CỨU TÁC ĐỘNG CỦA CÁC PHỨC VÒNG CÀNG GIỮA CÁC NGUYÊN TỐ ĐẤT HIẾM NHẸ VÀ ISOLOXIN TỚI SỰ TĂNG TRƯỞNG CỦA NẤM *HERICIUM ERINACEUM*

Ngày nay, việc sử dụng các nguyên tố đất hiếm với vai trò như các chất vi dinh dưỡng trong nông nghiệp bao gồm cả cây trồng và vật nuôi được thực hiện rộng rãi ở một số quốc gia. Nói chung, nhiều hợp chất hữu cơ của các nguyên tố đất hiếm có khả năng tác động tới nhiều quá trình hoá lí và sinh học diễn ra tại bề mặt tiếp xúc giữa rễ và đất trong việc hấp thu các dưỡng chất cũng như các tương tác của các vi khuẩn.

Báo cáo này đề cập tới tác động của các phức vòng càng giữa iso-loxin và các nguyên tố đất hiếm nhẹ tới sự tăng trưởng của nấm *Hericium erinaceum* ở các nồng độ tổng đất hiếm khác nhau. Trong các thí nghiệm, hỗn hợp các phức vòng càng của iso-loxin và các nguyên tố đất hiếm nhẹ đã được sử dụng để đánh giá tiềm năng ứng dụng chúng. Các kết quả thu được cho thấy, các phức vòng càng này có tác động tích cực tới sự phát triển hệ sợi của nấm. Sự kích thích tăng trưởng của nấm *Hericium erinaceum* đạt được khi nồng độ tổng các nguyên tố đất hiếm được sử dụng ở mức 100 ppm - 200 ppm. Khi nồng độ các các nguyên tố đất hiếm được sử dụng ở mức cao hơn 300 ppm, sự tăng trưởng của nấm sẽ bị ức chế.

Từ khoá: Nguyên tố đất hiếm, isoloxin, phức vòng càng, Hericium erinaceum.

Nhận bài ngày 22 tháng 3 năm 2009

Địa chỉ:

Le Minh Tuan,

Institute for Technology of Radioactive and Rare Elements, VAEC.

Nguyen Thi Chinh,

Biology Faculty, Hanoi University of Science, HNU.

Nguyen Trong Uyen, Nguyen Dinh Bang,

Chemistry Faculty, Hanoi University of Science, HNU.