第 17 卷 第 2 期　　环　境　科　学　　Vol. 17, No. 2
1996 年 4 月　　ENVIRONMENTAL SCIENCE　　Apr., 1996

应用水螅细胞重聚体对 2 种食品添加剂安全性评价的探讨*

陈钦耀　穆守玉　陈　兵　季冬阳　吴晓东

（安徽大学生物系，合肥　230039）

摘要　应用水螅细胞重聚体对苯甲酸钠、亚硝酸钠 2 种食品添加剂的安全性进行了研究。结果表明，苯甲酸钠、亚硝酸钠对水螅重聚体的生长发育均产生抑制作用，抑制的起始浓度分别为：34.7×10^{-4} mol/L、2.9×10^{-3} mol/L。并且细胞重聚体的解离时间与受试物浓度呈负相关趋势。因此，水螅细胞重聚体技术可以作为预测食品添加剂潜在毒性的快速筛选的一种方法。

关键词　水螅细胞重聚体，食品添加剂安全性评价，快速筛选。

随着食品工业和化学工业的发展，食品添加剂等各种化学物质的使用日益广泛。1984 年 Arthur J. Kudla 等报道了应用水螅细胞重聚体技术预测化学药物和食品添加剂的致畸研究[1]。在国内，应用水螅细胞重聚体评价食品添加剂安全性的研究鲜见有报道。为此，本试验参照 Kudla 等的试验方法，应用苯甲酸钠、亚硝酸钠对水螅细胞重聚体进行了毒性试验。

1　实验

1.1　材料与方法

（1）材料　本试验选用的为拟寡水螅（*H. pseudoligactis*）是本系采集经多年培养形成的无性繁殖系，在水螅培养液中以卤虫饲养。

（2）培养液配制　水螅培养液：在 1000 ml 蒸馏水中加入 $CaCl_2$ 0.147 g，TES（N-三（羟甲基）甲基-2-氨基乙磺酸）0.115 g，EDTA 0.004 g，硫酸丁胺卡那霉素 0.150 g（pH6.9）；重聚体培养液：在 1000 ml 蒸馏水中加入柠檬酸钠 1.764 g，葡萄糖 1.080 g，KCl 0.269 g，$CaCl_2$ 0.667 g，$MgSO_4\cdot7H_2O$ 1.765 g，丙酮酸钠 0.662 g，TES 2.865 g，硫酸丁胺卡那霉素 0.150 g（pH6.9）。

1.2　实验方法

实验前，将成体水螅禁食 1 d，再用蒸馏水冲洗，以保持体内外完全清洁。挑选状态良好的水螅个体每 1 组 3 条，放入 3 ml 70 m Osm（毫渗量）的重聚体培养液中，约 30 min 后用吸管反复吸移，使之个体分离成游离状态的单个细胞或小细胞团。离心去除上清液，将细胞悬浮液注入内径为 0.8 mm 聚乙烯管中，蜡封后再离心，使水螅细胞聚成棒状的细胞团。再将细胞团移入盛有 9 ml 70 m Osm 重聚体培养液的无菌培养皿中，培养至 4 h 和 8h，分别将培养液浓度降至 35 m Osm 和 17.5 m Osm。24 h 以后将已经初步分化、大小形状基本一致的重聚体分置于含有不同浓度受试物的水螅培养液中。每组 3 条，设 2 个平行 1 个对照。每种受试物的毒性试验重复 3 次，取其平均效应值。每隔 4 h 用体视显微镜观察 1 次，记录其变化。以重聚体的细胞分离脱落，至完全解体作为个体死亡标志。在整个实验过程中，各种培养液的 pH 值以及硫酸丁胺卡那霉素的浓度保持恒定。温度在 20±2℃。

2　结果与分析

2.1　苯甲酸钠（C_6H_5COONa）浓度的影响

* 安徽省自然科学基金资助项目
收稿日期：1995-08-02

首先进行预备实验确定受试物的浓度范围。本实验是将苯甲酸钠浓度检测范围设定为20.82×10^{-4} mol/L－69.4×10^{-4} mol/L。结果见表1。

当苯甲酸钠浓度在20.82×10^{-4} mol/L－27.76×10^{-4} mol/L时，水螅细胞重聚体形态大小与对照无显著性变化，并能在其两端长出触手和基盘。其形态与正常水螅完全相似，也具有扑食行为。当浓度为34.7×10^{-4} mol/L时，重聚体发育停滞，双胚层结构不能进一步分化，生长受到明显抑制。当浓度为41.64×10^{-4} mol/L－69.4×10^{-4} mol/L时，重聚体细胞逐渐分离、脱落，最终完全解体。

表1 不同浓度苯甲酸钠(mol/L)对水螅细胞重聚体解离时间(h)

苯甲酸钠(×10^{-4})	20.82	27.76	34.7	41.64	48.58	55.52	62.46	69.4
解离时间			Δ	50	42	38	34	30

Δ 表示水螅细胞重聚体生长发育停滞，细胞团不解离

2.2 亚硝酸钠($NaNO_2$)浓度的影响

设定亚硝酸钠浓度检测范围为1.45×10^{-3} mol/L－11.6×10^{-3} mol/L。结果见表2。当浓度在1.45×10^{-3} mol/L时，能正常发育成水螅个体；当浓度为2.9×10^{-3} mol/L时，重聚体生长发育停滞；在4.35×10^{-3} mol/L－11.6×10^{-3} mol/L时，重聚体解离。

以表中的数据运用直线回归与相关系数分析法对不同浓度受试物(Y)及水螅细胞重聚体解离时间(X)进行统计分析，可得出线形回归方程：

C_6H_5COONa $\hat{Y}=1586.48-20.27X$ $r=-0.986$

$NaNO_2$ $\hat{Y}=1060.73-9.95X$ $r=-0.983$

经相关系数检验，在$P<0.005$时，水螅重聚体解离时间与这2种食品添加剂浓度的线性关系具有极显著意义。

表2 不同浓度亚硝酸钠(mol/L)对水螅细胞重聚体解离时间(h)

亚硝酸钠(×10^{-3})	1.45	2.9	4.35	5.8	7.25	8.7	10.15	11.6
解离时间		Δ	72	68	60	48	32	28

Δ 含义同表1

3 讨论

试验结果表明，苯甲酸钠和亚硝酸钠对水螅细胞重聚体均产生毒害作用。其毒性强度亚硝酸钠大于苯甲酸钠。毒性的主要表现是破坏细胞膜和细胞间质的结构，干扰了细胞正常的生理功能。

水螅细胞重聚体形成和生长发育过程，是类似于其它动物胚胎生长发育过程。呈现出动物胚胎发育过程中的一些现象[2,3]。采用水螅细胞重聚体作为检测食品添加剂安全性试验，可根据重聚体生长、分化受到抑制，最终致使细胞分离，解体的规律来判断受试物的毒性强度。

迄今，国内外所进行的食品添加剂的毒性试验，大多是用大白鼠、小白鼠等哺乳动物进行的。其费用高、耗时长。与日益众多的食品添加剂广泛使用所必需进行的毒性试验难以适应。笔者认为应用水螅细胞重聚体的实验过程，反映出受试物毒性对动物胚胎致突变的一些现象。具有快速敏感，预测价值高，实验方法也简便易行。这项技术作为快速筛选具有潜在毒性的化学物质的一种方法，有必要进一步加以探讨。

参 考 文 献

1 Arthur J. Kudla., Hydra Reaggregation: A Rapid Assay to Predict Teratogenic Hazards Induced by Environmental Toxicity. Journal of the Washington Academy of Sciences, 1984, **74**(4): 102—107

2 Gierer A, Berking S et al.. Regeneration of Hydra from Reaggregated Cell. Nature New Biology, 1972, **239**: 98—101

3 陈钦耀等. 水螅细胞分离和重聚. 安徽大学学报(自然科学版), 1991, **15**(3): 79—82

4 郡司笃孝. 食品添加剂手册. 日本国力出版社. 1984: 51

5 陈钦耀等. 汞、镉对水螅重聚体的毒性及其分析. 环境科学与技术, 1992, **3**: 1—4

tration increased; and the toxicity (EC_{50}, 96 h.) of rare-earth elements on *Chlorella pyrenoides* was insequence as: Nd > Ce > Pr > La > mixture of them, but little difference.

Key words: rare-earth element, *Chlorella pyrenoides*, effect on growth and reproduction.

Study on in-Bed Desulfurization within Fluidized Bed Coal Gasifier. Bu Xuepeng et al. (Beijing Research Institute of Coal Chemistry, Central Coal Mining Research Institute, Beijing 100013): *Chin. J. Environ. Sci.*, **17** (2), 1996, pp. 39—41

The data obtained from the tests indicated that both limestone and dolomite can be used effectively for capturing sulfur during the gasification of high sulfur coals. Desulfurization efficiencies can be improved with increasing the Ca/S molar ratio, the efficiencies were maximum when the ratio was 3, or by increasing total sulfur in raw coals. The effect of operating pressure on desulfurization efficiency is determined by temperature and partial pressure of carbon dioxide. The desulfurization rate was range of 50% —85% under different conditions.

Key words: fluidized bed gasification, in-bed desulfurization, desulfurizaiton sorbent.

Mass Transfer-Reaction Process Mechanism of Wet Flue Gas Desulfurization with Lime. Wu Zhongbiao and Tan Tian'en (Dept. of Chem. Eng., Zhejiang University, Hangzhou 310027): *Chin. J. Environ. Sci.*, **17** (2), 1996, pp. 42—44

By studying experimentally wet flue gas desulfurization with lime as absorbent and rotating-stream-tray scrubber as absorber, the mass transfer and reaction process on $Ca(OH)_2$ slurry absorbing SO_2 is analyzed. Furthermore, the process mechanism is proposed. According to the mechanism, the total reaction rate is controlled by SO_2 diffusion in gas phase and $Ca(OH)_2$ dissolution and diffusion in liquid phase. The reaction process can be divided into three stages, the stage controlled by gas phase resistance, by gas phase and liquid phase resistance, and by liquid phase resistance. The process mechanism has been verified by the experiment. These results will help to optimize the design and operation of the industrial installation of wet flue gas desulfurization with lime.

Key words: flue gas desulfurization, mechanism, mass transfer-reaction process, lime, wet.

Effects of Three Sorts of Anaerobic Promoter on Anaerobic Digestion of the Waste Liquor from Ammonium Sulfite Pulping of Straws. Zhang Renquan (Dept. of Resource and Environ. Sci., Hefei Univ. of Technol., Hefei 230009): *Chin. J. Environ. Sci.*, **17**(2), 1996, pp. 45—46

The effects of activated carbon, ferrous sulphate and bentonite on anaerobic digestion of the waste liquor from ammonium sulfite pulping of straws have been analysed on the basis of the experimental results of anaerobic batch assays with the waste liquor. The results indicate that, with a dose of 2.5 g/L, each sort of the anaerobic promoter can substantially promote anaerobic digestion of the waste liquor, which can increase 30 day total gas production of the anaerobic system by 16.1%, 13.9% and 26.1% respectively compared with the control. The action mechanisms of the three sorts of anaerobic promoter have been discussed preliminarily.

Key words: anaerobic promoter, waste liquor from ammonium sulfite pulping of straws, anaerobic digestion, action mechanisms.

Using *Hydra* Reaggregations Evaluating the Safety of Two Kinds of Food Additives. Cheng Qinyao et al. (Dept. of Biology, Anhui University, Hefei 230039): *Chin. J. Environ. Sci.*, **17**(2), 1996, pp. 47—48

This paper studied the safety of two kinds of food additives using *Hydra* reaggregations. The results showed that both sodium benzoate and sodium nitrite inhibited the growth of reaggregations. The minimum effective concentrations were 34.7×10^{-4} mol/L and 2.9×10^{-3} mol/L respectively. In addition, the negative correlation existed between the depolymerization time of the reaggregations and the concentration of food additives. Therefore, *Hydra* reaggregations technique will be a rapid screening method for predicting the potential toxicity of food additives.

Key words: *Hydra* reaggregation, food additive, evaluation safety, rapid screening.

A Study on Long-wave Pulsed Electromagnetic Fields Around A Long Range Navigation Station. Yao Gengdong et al. (School of Public Health, Zhejiang Medical University, Hangzhou 310031): *Chin. J. Environ. Sci.*, **17**(2), 1996, pp. 49—50

A measurement and a theoretical calculation of long-wave pulsed electromagnetic fields (PEMF) around the antenna of the first long range navigation station in China were conducted. The results showed that the electric field intensities were 0.5—3.6 V/m (RMS) corresponding to peak values of 38.5—276.9 V/m in the PEMF generating room; in the residential area which is 850—1100 m away from the antenna, the electric fields were 0.7—3.9 V/m corresponding to peak values of 53.9—300.3 V/m; the PEMF decreased in environment with the distance away from the antenna and when the distance is over 1200 m from it, the fields tended towards minimum.

Key words: pulse, long-wave, environment, electric field intensity.

Determination of Hydraulic Load Cycle in Rapid Infiltration Treatment System of Waste Water. Wu Yongfeng et al. (Dept. of Environ. Sci., China University of Geosciences, Beijing, 100083): *Chin. J. Environ. Sci.*, **17**(2), 1996, pp. 51—53

Hydraulic load cycle is the most important operation parameter in rapid infiltration treatment system of waste water. The decrease curve and recovery curve of infiltration rate in flooding and drying periods are obtained from the in situ test with the area of 80 m^2 and flooded with brewery waste water. The curves can be expressed with exponential and logarithmic equations respectively. A quantitative method is proposed to determine the hydraulic load cycle with maximum hydraulic load. The calculated result is 1.78 days flooding and 2.77 days drying, very similar with the test results.

Key words: rapid infiltration, hydraulic load, hydraulic load cycle, infiltration rate.

A New Way to Accelerate the Start-up of UASB Reac-