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Mutation Research 626 (2007) 4–14
Genetic Toxicology and Environmental Mutagenesis
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Genotoxicity of five food preservatives tested on root tips of *Allium cepa* L.

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Received 5 April 2006; received in revised form 30 June 2006; accepted 28 July 2006
Available online 26 September 2006

Abstract

The effects of the food preservatives sodium benzoate (SB), boric acid (BA), citric acid (CA), potassium citrate (PC) and sodium citrate (SC) have been studied on root tips of *Allium cepa* L. Roots of *A. cepa* were treated with a series of concentrations, ranging from 20 to 100 ppm for 5, 10 and 20 h. The results indicate that these food preservatives reduced mitotic division in *A. cepa* compared with the respective control. Mitotic index values were generally decreased with increasing concentrations and longer treatment times. Additionally, variations in the percentage of mitotic stages were observed. The total percentage of aberrations generally increased with increasing concentrations of these chemicals and the longer period of treatment. Different abnormal mitotic figures were observed in all mitotic phases. Among these abnormalities were anaphase bridges, C-mitosis, micronuclei, lagging, stickiness, breaks and unequal distiribution.

Keywords: Genotoxicity; Food preservative; Mitotic index; Chromosomal abnormalities; *Allium cepa*

1. Introduction

Because food is so important for survival, food preservation is one of the oldest technologies used by man. Different ways and means have been found and improved for this purpose. Sugar and salt are often used as preservatives. Chemical preservatives are also being used and they seem to be the best and the most effective for a longer shelf-life and are generally foolproof for preservation purposes. It has been reported that certain food additives, especially antimicrobial agents are genotoxic in different test systems [1–5]. However, there are many food preservatives whose possible genotoxic effects are unknown.

Sodium benzoate (SB), boric acid (BA), citric acid (CA), potassium citrate (PC) and sodium citrate (SC) are used as additives in food products. SB is used in items such as jams, salad dressing, juices, pickles, and carbonated drinks in the food industry. Limited studies have been conducted with SB. Moustafa and Collins [6] and Boylan et al. [7] reported no significant influence on the growth of *Pseudomonas fragi* and *Staphylococcus aureus*, respectively. However, benzoate is toxic to mice, rats, cats, guinea pigs, rabbits and dogs [8]. Njagi and Gopalan [9] stated that sodium benzoate and sodium sulphite inhibit DNA synthesis, induce anaphase bridges, and cause premature chromosome condensation leading to pycnotic nuclei and chromatin erosion in interphase nuclei in roots of *Vicia faba*. Nair reported [10] that genotoxicity tests for benzyl alchol, benzoic acid and sodium benzoate were mostly negative, but some assays were positive. Carcinogenicity studies, however, were negative. The Ministry of Health of Turkey [11] has suggested that SB may be used in food at 500–1000 mg/kg. BA is used as food preservative in caviar. Additionally,

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doi:10.1016/j.mrgentox.2006.07.006

Table 1
Cytogenetic analysis of *A. cepa* root tips exposed to different concentrations of sodium benzoate for different periods

Time of treatment (h)	Concentrations (ppm)	Examined total cells	Total mitosis	% Prophase	% Metaphase	% Anaphase–telophase	Mitotic index (mean ± S.E.[a])	C-M.	S.	U. D.	(%) Total abnormalities[a]
5	Control	1008	250	34.00	18.00	48.00	24.80 ± 0.10 a	–	–	–	0.00 a
	20	1006	165	33.33	30.30	36.36	16.40 ± 0.29 b	6.06	–	1.21	7.27 bem
	40	1012	95	47.36	31.57	21.05	9.38 ± 0.16 ce	8.42	2.10	1.05	11.57 cgn
	60	1013	100	40.00	35.00	25.00	9.87 ± 0.08 c	5.00	3.00	3.00	11.00 bcn
	80	1018	95	36.84	47.36	15.78	9.33 ± 0.25 ce	13.68	1.05	4.21	18.94 d
	100	1011	180	33.33	41.66	25.00	17.80 ± 0.60 b	12.22	–	1.66	13.88 ch
10	Control	1019	305	41.51	32.07	26.42	29.93 ± 0.17 d	–	–	–	0.00 a
	20	1021	180	43.75	18.75	37.50	17.62 ± 0.88 b	7.22	0.55	–	7.77 bgm
	40	1010	60	44.44	38.88	16.66	5.94 ± 0.09 f	15.00	1.66	–	16.66 dh
	60	1007	60	60.00	20.00	20.00	5.95 ± 0.17 f	–	–	–	0.00 a
	80	1016	80	44.44	22.22	33.33	7.87 ± 0.09 eh	1.25	2.50	–	3.75 aem
	100	1012	100	70.00	20.00	10.00	9.88 ± 0.17 c	–	2.00	–	2.00 ak
20	Control	1013	265	68.85	16.39	14.75	26.06 ± 0.22 a	–	–	–	0.00 a
	20	1008	80	66.60	33.33	0.00	7.93 ± 0.08 eh	1.25	–	–	1.25 ak
	40	1012	90	41.66	50.00	8.33	8.89 ± 0.14 ch	2.22	1.11	–	3.33 ae
	60	1016	58	33.33	25.00	41.66	5.70 ± 0.11 f	3.44	1.72	–	5.16 ekm
	80	1014	45	50.00	16.66	33.33	4.43 ± 0.08 fg	4.44	2.22	2.22	8.88 mn
	100	1016	40	35.00	45.00	20.00	3.93 ± 0.03 g	47.50	2.50	–	50.00 f

C-M., C-Mitosis; S., stickiness; U. D., unequal distribution.
[a] Means with the same letters do not significantly differ at 0.05 level (DMR test).