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Increased anticancer effects of organically-cultivated kale (*Brassica oleracea* Acephala group) in AGS human adenocarcinoma cells

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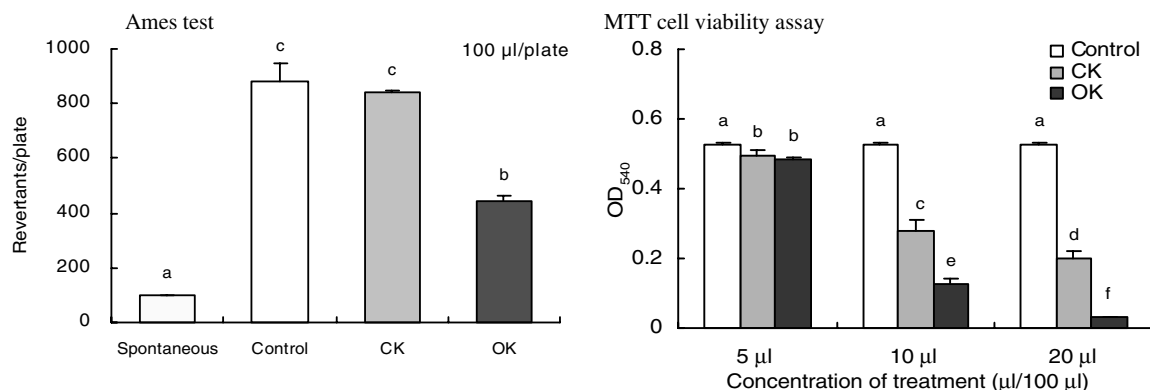
Increased antimutagenic and anticancer effects of organically-cultivated kale (OK) were investigated. In contrast to conventionally-cultivated kale (CK), OK was cultivated without pesticides and synthetic fertilizer.

The antimutagenic and anticancer effects of juice from OK and CK were investigated using *Sal. typhimurium* TA100 and AGS human gastric adenocarcinoma cells respectively. Proximate compositions, vitamins, chlorophylls and carotenoids in kale juices were evaluated. Antimutagenicity was measured by Ames test using N-methyl-N'-nitro-N-nitrosoguanidine (MNNG) in *Sal. typhimurium* TA100. The viability and growth of AGS cells were evaluated by the 3-(4,5)-dimethyl-thiazol-2,5-diphenyltetrazolium bromide (MTT) assay and growth inhibition test respectively. Gene expression of apoptosis-related mRNA such as Bax, Bcl-2, p53 and p21 was investigated by RT-PCR.

The general composition, antimutagenicity and *in vitro* anticancer effects of juice from OK were evaluated and compared with those of juice from CK. The contents of crude protein, crude fibre and chlorophylls in OK were significantly higher than those in CK. The contents of total carotenoids, lutein and β-carotene in OK were also higher than those in CK. The antimutagenicity against MNNG was considerably increased in OK compared with CK. The kale juices inhibited the survival or growth of AGS human gastric adenocarcinoma cells in the MTT cell viability assay and the growth inhibition test. The juice from OK exhibited a higher inhibitory effect (76%) on the growth of AGS human adenocarcinoma cells than juice from CK (47%). The juice from OK significantly decreased the growth of AGS cells compared with that of CK. OK juice induced apoptosis by the 4',6-diamidino-2-phenylindole staining assay; the ratio of apoptotic bodies increased in a dose-dependent manner, which indicates that OK has a greater chemopreventive effect. The OK-induced apoptosis was associated with the decreased expression of the anti-apoptotic Bcl-2 mRNA and increased expression of p53, p21 and Bax.

		CK		OK	
		Mean	SE	Mean	SE
Vitamins	Vitamin C (mg/100 g)	98.0	0.3	112.6*	2.2
	Vitamin E (mg/100 g)	1.2	0.1	3.0*	0.1
Chlorophylls	Total chlorophylls (mg/100 g)	6.2	0.2	9.9*	0.4
	Chlorophyll a (mg/100 g)	4.4	0.1	6.9*	0.2
	Chlorophyll b (mg/100 g)	1.9	0.1	3.0*	0.3
Carotenoids	Total carotenoids (mg/100 g)	1759	12.3	2250*	20.0
	β-Carotene (mg/kg)	7.4		8.2	
	Lutein (mg/kg)	4.5		9.6	

Mean values were significantly different from those for CK (Students *t* test): **P*<0.05.



Mean values with their standard errors represented by vertical bars. ^{a-f}Means with the different superscript letters were significantly different (Duncan's multiple range test; *P*<0.05).

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