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## Anti-cancer effect of *Cordyceps militaris* in human colorectal carcinoma RKO cells via cell cycle arrest and mitochondrial apoptosis

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Affiliations

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### Abstract

**Background:** *Cordyceps militaris* has been used as a traditional medicine in Asian countries for a long time. Different types of *Cordyceps* extract were reported to have various pharmacological activities including an anti-cancer effect. We investigated the inhibitory effect of *Cordyceps militaris* ethanol extract on a human colorectal cancer-derived cell line, RKO.

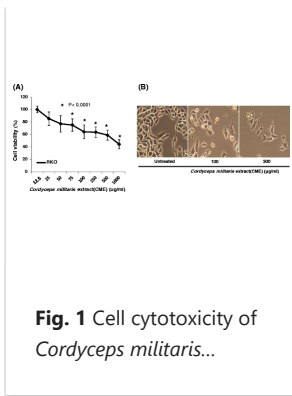
**Methods:** RKO cells were treated with various concentrations of nucleosides-enriched ethanol extract of *Cordyceps militaris* for 48 h and cytotoxicity was measured using a CCK-8 assay. Then, xenograft Balb/c nude mice were injected with RKO cells and subsequently orally administered with ethanol extract of *Cordyceps militaris* every day for 3 weeks to examine the inhibitory effect on tumor growth. Lastly, the effect of *Cordyceps militaris* on cell cycle as well as apoptosis was measured using flow cytometry. Also, the expression of p53, caspase 9, cleaved caspase-3, cleaved PARP, Bim, Bax, Bak, and Bad were detected using western blot assay.

**Results:** RKO cells were highly susceptible to the ethanol extract of *Cordyceps militaris* (CME) and the growth of RKO cells-derived tumor was significantly delayed by the treatment of *Cordyceps militaris*. *Cordyceps militaris* induced cell cycle arrest in G2/M phase (untreated; 20.5 %, CME 100 µg/ml; 61.67 %, CME 300 µg/ml; 66.33 %) and increased early apoptosis (untreated; 1.01 %, CME 100 µg/ml; 8.48 %, CME 300 µg/ml; 18.07 %). The expression of p53, cleaved caspase 9, cleaved caspase-3, cleaved PARP, Bim, Bak, and Bad were upregulated by the treatment of *Cordyceps militaris*.

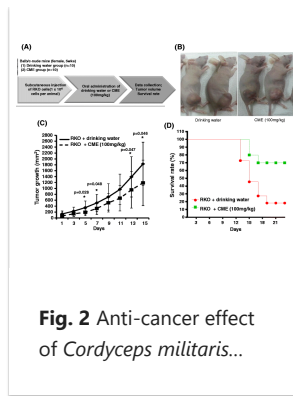
**Conclusion:** Ethanol extract of *Cordyceps militaris* was highly cytotoxic to human colorectal carcinoma RKO cells and inhibited the growth of tumor in xenograft model. The anti-tumor effect of *Cordyceps militaris* was associated with an induction of cell cycle arrest and mitochondrial-mediated apoptosis.

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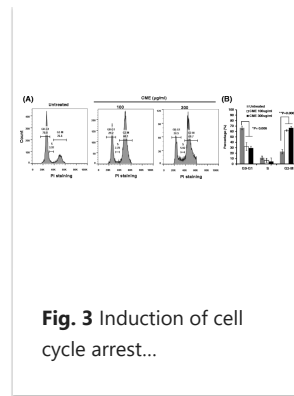
### Figures



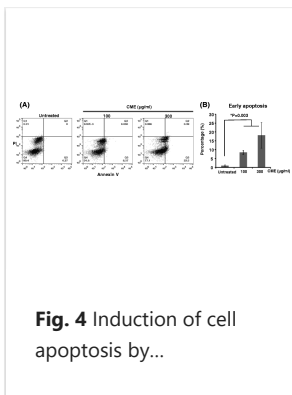
**Fig. 1** Cell cytotoxicity of *Cordyceps militaris*...



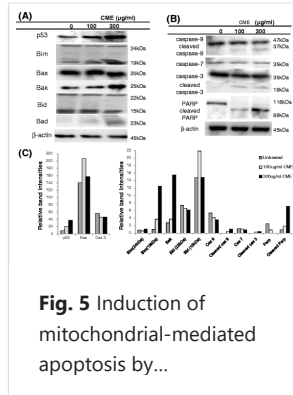
**Fig. 2** Anti-cancer effect of *Cordyceps militaris*...



**Fig. 3** Induction of cell cycle arrest...



**Fig. 4** Induction of cell apoptosis by...



**Fig. 5** Induction of mitochondrial-mediated apoptosis by...

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