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# Ganoderma lucidum spore oil induces apoptosis of breast cancer cells in vitro and in vivo by activating caspase-3 and caspase-9

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## Abstract

**Ethnopharmacological relevance:** The mushroom *Ganoderma lucidum* (*G. lucidum*) is a traditional Chinese medicine reported to have a variety of pharmacological properties, including anti-cancer activity. *G. lucidum* spore oil (GLSO) is a lipid substance extracted from sporoderm-broken spore of *G. lucidum*. However, the effect of GLSO on breast cancer and the underlying molecular mechanism remain unclear.

**Aim of the study:** The aim of this study was to identify the effects of GLSO on breast cancer cells in vitro and in vivo as well as to investigate the mechanistic basis for the anticancer effect of GLSO.

**Materials and methods:** First, in vitro MDA-MB-231 cells were treated with GLSO (0.2, 0.4, and 0.6  $\mu\text{L}/\text{mL}$ ). The protein levels of B-cell lymphoma-2 (Bcl-2), Bcl-2-associated X (Bax), X-linked inhibitor of apoptosis (XIAP), total poly (ADP-ribose) polymerase (PARP), caspase-3 and caspase-8 were examined using western blotting. The mRNA expression levels of Fas-associated protein with death domain (FADD), TNF receptor-associated factor 2 (TRAF2), caspases-3, -8, -9 and Bax were examined using qRT-PCR. Second, in vivo the anticancer properties of GLSO were assessed by H&E, TUNEL and immunohistochemistry in BALB/c mice injected with 4T1 cells. In addition, the levels of caspase-9/caspase-3 signaling pathway proteins in tumor tissue were evaluated by immunoblotting. Finally, MDA-MB-231 cells were treated with caspase inhibitors to measure cell viability, the protein levels were examined with western blotting.

**Results:** The results in vitro showed that GLSO up-regulated the expression of Bax and caspase-3 in MDA-MB-231 cells, but had no effect on the expression of caspase-8. Moreover, the growth of tumors in vivo was significantly suppressed in the GLSO-treated group. The results of Western blot were consistent with in vitro. In vitro, co-treatment of MDA-MB-231 cells with caspase inhibitors reduced the inhibitory effect of GLSO on cell growth.

**Conclusions:** GLSO inhibits the growth of MDA-MB-231 cells and tumors in vivo by inducing apoptosis, which may be achieved through the mitochondrial apoptotic pathway.

**Keywords:** Apoptosis; Breast cancer; Caspase-3; Caspase-9; *Ganoderma lucidum*; Sporoderm-broken spore oil.

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