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Selective cytotoxic action of Scots pine (*Pinus sylvestris* L.) needles extract in human cancer cell lines

Interest in medicinal plant constituents with potential anticancer effects has continuously grown, traditional or new natural products with high anticancer activity but low cytotoxicity in normal cells are receiving considerable attention. There are no reports available about the potential anticancer action of extracts from Scots pine (*Pinus sylvestris* L.) being a very common coniferous tree in Estonia and used in local ethnomedicine against cancer (Sak et al., 2014).

The aim of our international study was to examine the potential cytotoxicity of Scots pine needles extract on various human cancer cell lines. The pine needles were dried and extracted with methanol, the crude extracts were dissolved in dimethyl sulfoxide solutions that were later mixed with cell culture medium to achieve the desired concentrations. The final test concentrations were 0.8, 4, 20, and 100 $\mu\text{g/ml}$. The effects of pine needle extracts on viability of malignant cells were determined by sulforhodamine B cytotoxic assay (Monks et al., 1991). Human cancer cell lines including ER-positive breast cancer MCF-7, ER-negative breast cancer MDA-MB-231, prostate cancer LNCaP, gastric carcinoma MKN7, colon adenocarcinoma SW480, oral epidermoid carcinoma KB, lung adenocarcinoma LU-1, liver hepatocellular carcinoma HepG2, and promyelocytic leukemia HL-60 cells were used.

The pine needles extract was found to suppress the viability of several human cancer cell lines showing some selectivity to estrogen receptor negative breast cancer cells, the effect on ER-negative MDA-MB-231 cells was almost three fold stronger (IC₅₀ 35.56 $\mu\text{g/ml}$) than for ER-positive MCF-7 cells (IC₅₀ 86.37 $\mu\text{g/ml}$). It is the strongest cytotoxic effect at all measured thus far for the needles and leaves extracts obtained from various pine species (*Pinus* spp.) and is also the first study comparing the anticancer effects of pine tree extracts on molecularly different human breast cancer cells. The half-maximal cytotoxic effects of methanol extract prepared from Scots pine needles on other malignant cell lines studied in this work remained in the concentration range of 50 $\mu\text{g/ml}$ to 80 $\mu\text{g/ml}$. Scots pine needles extract exhibits some potential as chemopreventive or chemotherapeutic agent for mammary tumors unresponsive to endocrine treatment.