The Antitumoral Activity of Zataria multiflora Methanolic Extract on Acute Promyelocytic Leukemia Cell Line; NB4

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ABSTRACT

Background & Objective: Zataria multiflora is a plant that belongs to Lamiaceae family. It is traditionally believed to have several therapeutic effects. Acute promyelocytic leukemia is a distinct subtype of acute myeloid leukemia with dominancy of promyelocytes in bone marrow and blood stream. The aim of this study is to investigate the antitumor effects of Z. multiflora on acute promyelocytic leukemia cell line.

Materials & Methods: Viability of NB4 cells was determined by trypane blue test after treatment with 20, 40 and 80 µg/mL of Z. multiflora extract for 24 hours. Then, the metabolic activity of cells was determined by MTT assay after 24 hours of treatment with 80 µg/mL Z. multiflora. Finally, Real-time PCR was employed to study the effect of Z. multiflora extract on the expression of hTERT gene.

Results: Z. multiflora extract decreased the viability of NB4 cells in a dose-dependent manner. Metabolic activity of NB4 cells significantly decreased following treatment with 80 µg/mL Z. multiflora. Gene expression analysis showed 59% ± 4% decrease in the expression of hTERT gene after treatment with 80 µg/mL of Z. multiflora.

Conclusion: Z. multiflora extract significantly decreased the viability and metabolic activity of NB4 cells. It also led to significant downregulation of hTERT gene compared to the control group. Therefore, Z. multiflora methanolic extract potentially has anticancer effect on acute promyelocytic leukemia cells through down regulation of hTERT gene. Further investigations are needed to explore other mechanisms of actions and the active ingredients.

Keywords: Zataria multiflora, Tumor Suppressor, Leukemia, Acute Promyelocytic Leukaemia, NB4, hTERT gene

Introduction

Global efforts have been made to reduce the incidence of cancers, but it has been the most important cause of death in the last 50 years. Since the incidence of cancers is increasing in developed and developing countries, immediate need to find a more effective remedy for them is vital (1). Herbal medicines refer to any product derived from plants that has therapeutic benefits. The use of herbal medicines in developing and industrialized countries is increasing. About 65-80% of the population around the globe take herbal medicines for primary health care (2).

Acute myeloid leukemias (AMLs) are malignant neoplasms that are responsible for a huge number of cancer-related deaths (3). A distinct subtype of AML is Acute promyelocytic leukemia (APL), morphologically known as M3 in French-American-British (FAB) classification. APL is recognized by the bilateral translocation between the chromosomes 15 and 17. This translocation leads to the fusion of promyelocytic leukemia (PML) and retinoic acid receptor α (RARα) genes (4).

The management and outcome of APL have been revolutionized since the introduction of all-transretinoic acid (ATRA) and arsenic trioxide. However, Cure of APL is dependent on peculiar aspects that are related to the management and supportive measures that are central to counteract life-threatening complications associated with the molecularly targeted treatment and disease biology (5).

Natural products with plant origin have been medicinally used for many years (6) and they play an undeniable role in the treatment of diseases (7) including cancer (6, 8). Zataria multiflora Boiss is a plant belonging to the Lamiaceae family and is well-known for various therapeutic effects (9, 10). The Persian name for this plant is Avishan Shirazi (11-13). It grows in Iran,
Afghanistan and Pakistan and has traditionally been used as antiseptic, anti-anesthetic, anticonvulsant and anti-seizure medication (14). Its benefit for employment in inflammatory and immunomodulatory diseases has been demonstrated (15). It also diminishes tumor growth by inhibiting angiogenesis and migration (16).

The aim of the current study is to investigate the effects of *Z. multiflora* methanolic extract on acute promyelocytic leukemia. The expression of hTERT gene was also investigated.

**Materials and Methods**

This study was approved by the ethical committee of Kerman University of Medical Sciences. The Ethic approval Cod is IR.KMU.REC.1395.875.

**Preparation of *Zataria Multiflora* Extract**

Fresh aerial segments of *Z. Multiflora* were prepared and desiccated at room temperature. Then, they were grinded by a hammer mill. A sequential extraction was performed using petroleum ether, chloroform, and methanol. Then, rotary evaporator was employed to evaporate the methanolic extract at 45°C. Finally, the desiccated extract was gathered and kept 4°C (11).

**Cell Culture**

Acute promyelocytic leukemic cell line, NB4 (Pasteur Institute, Iran), was cultured in RPMI 1640 (Gibco Laboratories, Grand Island, NY, USA) with 10% fetal bovine serum (Gibco Laboratories, Grand Island, NY, USA) and 1% penicillin-streptomycin (Gibco Laboratories, Grand Island, NY, USA) at 37°C and 5% CO2.

**Viability Assay**

NB4 cells were treated with different concentrations of *Z. multiflora* methanolic extract (20, 40, 80 µg/mL) for 24 hours. Cell viability was determined by trypan blue exclusion test (Sigma-Aldrich). For this end, cell suspension was mixed with trypan blue 0.04% in a 1:1 ratio and incubated for 2 minutes. Viability was calculated after counting the number of live and dead cells under light microscope using neubauer hemocytometer. The results were presented as percentage.

<table>
<thead>
<tr>
<th>Table 1. Sequences of primers</th>
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<tr>
<td><strong>Reverse</strong></td>
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<tr>
<td>5'-CCAACCGCGAGAAGATGA-3'</td>
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<tr>
<td>5'-CACTGTCTTGACAAATGTC-3'</td>
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**Statistical Analysis**

Statistical analysis was performed by SPSS 22 (SPSS Inc., Chicago, Ill. USA). One-way ANOVA and Tukey’s post hoc test was used to compare the results. P-value less than 0.05 was considered statistically meaningful.

**Metabolic Activity**

NB4 cells (10,000 cells/well) were treated with *Z. multiflora* methanolic extract (80 µg/mL) in a 96-well plate. Metabolic activity was determined using MTT assay. MTT dye 0.5 mg/mL was added to each well and incubated at 37°C with 5% CO₂ for 3-4 hours. Then, 100 µL dimethyl sulfoxide (DMSO) was added to each well and the plate was incubated at room temperature in darkness for 30 minutes. The Absorbance was measured at 570 nm by ELISA reader. Metabolic activity was calculated using OD treated group/OD control multiply by 100. Finally, the results were expressed as percentage.

**RNA Extraction and cDNA Synthesis**

RNA was extracted 24 h after treating NB4 cells with *Z. multiflora* by RNA extraction kit according to the manufacturer protocol (Yektaatibiz, Iran). Then cDNA was synthetized using cDNA Synthesis kit (TaKaRa, Japan). The reaction contained nuclease-free water (9-µl), Random Hexamer Primer (1 µl), 5× Reaction Buffer (4 µl), dNTP Mix 10 mM (2 µl), RiboLock RNase Inhibitor 20 U/µl (1 µl), and 1 µl RevertAid M-MuLV Reverse Transcriptase (200 U/µl), and 2 µl of total RNA (1 µg per reaction). The temperature profile for reverse transcription contained 5 min incubation at 25°C, followed by 60 min incubation at 42°C. The reaction was terminated upon heating at 70°C for 5 min.

**Quantitative Real-Time PCR**

Real-time PCR was performed using 5 µL of RealQ Plus 2X Master Mix Green (Ampliqon), 80 ng of the cDNA product, 5 pmol of each forward and reverse primers, and nuclease-free water in total volume of 10 µL. Temperature profile contained an initial activation step at 95°C for 15 min that was followed by 40 cycles. Each cycle included a denaturation step at 95°C for 30 s and a combined annealing/elongation step at 65°C for 60 s. The reactions were performed in Rotor Gene 6000 Real-time PCR System (QIAGEN). The specificity of the products was approved by analyzing melt curves. The expression of hTERT gene was compared with the control group by computing the fold changes using the 2^(-ΔΔCT) formula. β actin gene was used as the house-keeping gene for normalizing the results. The sequences of the specific primers are presented in Table1.

**Results**

**Investigation of Viability**

Viability of the NB4 cells was evaluated 24 hours following treatment with different concentrations of *Z. multiflora* methanolic extract. The viability was
decreased in a dose dependant pattern. The viability of NB4 cells was decreased to 81.99 and 79.32% after treatment with 20 and 40 µg/mL of Z. multiflora methanolic extract respectively. The decreases were not statistically significant (P>0.05). Therefore, low concentrations of Z. multiflora methanolic extract did not significantly affect the viability of NB4 cells. Cell viability demonstrated a significant decrease at the dose of 80 µg/mL (P<0.001).

Investigation of Metabolic Activity

Metabolic activity of NB4 cells was evaluated 24 hours after treatment with 80 µg/mL Z. multiflora methanolic extract. Metabolic activity was decreased to 73.66 %±5.78 after treatment in comparison with the control group. The reduction in metabolic activity was meaningful (P<0.01).

Investigation of Gene Expression

The expression of hTERT gene was evaluated 24 hours after treatment with Z. multiflora methanolic extract. As shown in Figure 3, the expression of hTERT gene in NB4 cells significantly decreased following treatment with 80 µg/mL Z. multiflora methanolic extract (P<0.01).

Figure 1. Viability of NB4 cells 24 hours following treatment with different concentrations of Z. multiflora methanolic extract

Discussion

Cancer is considered as the most prevalent disease and a human tragedy in the world. Therefore, identifying new strategies to treat such deadly diseases is essential. Of the cancers, APL is a distinct subtype of AML, (18) constituting 4.8%-34% of AML cases with a high prevalence in Iran (19). Standard cares for APL are ATRA, arsenic trioxide (ATO) and chemotherapy with the cure rate exceeding 80% (14, 15). ATRA accompanies some potentially severe complications including ATRA syndrome, thrombosis, pulmonary distress syndrome, and hepatotoxicity. ATO poses complications as well; the most prevalent complications are hepatotoxicity, gastrointestinal symptoms, and damage to nervous system (17). Recently, plant-derived medicines have gained popularity since they have fewer side effects and have natural origin (20). Moreover, studies have indicated that Chinese herbal medicines in combination with chemo- or radio-therapy enhance the efficacy of chemo- and radio-therapy and diminish the complications in cancer treatment (21). Throughout the study, the anti-cancer effects of Z. multiflora methanolic extract as a herbal medicine was investigated on acute promyelocytic leukemia cells NB4. It was shown that Z. multiflora methanolic extract had potent anticancer effects on NB4. It was shown that Z. multiflora methanolic extract significantly decreased the viability and metabolic activity of NB4 cells. Therefore, this study suggests that Z. multiflora methanolic extract has cytotoxic effects on NB4 cells.

The study conducted by Maryam Janitemi et al. in 2015 on breast cancer cells, showed that Z. multiflora extract had an inhibitory effect on cancer cells while not affecting normal fibroblast cells and it can be used as a potential drug for the treatment of cancer; however, further studies should be conducted to evaluate its effect on other cancer cells (22). In 2015, they also showed that Z. multiflora extract had potent inhibitory effect on gastric cancer and cervical cancer cells (23, 24). The maximum cytotoxicity of Z. multiflora extract was seen after 24 hours (23). In full accord with previous studies, this study showed that Z. multiflora extract had potent anticancer effects on acute promyelocytic leukemia cells.

One of the hallmarks of cancer is the activation of hTERT enzyme, which prevents shortening of the chromosomes end by adding repetitive sequences (20). Resultantly, the expression of hTERT was investigated throughout this study. It was demonstrated that Z. multiflora methanolic extract significantly diminished the expression of hTERT gene, compared with the control group. Thus, down-regulation of hTERT can be suggested as a possible anticancer mechanism for Z. multiflora extract. Baharara et al. in 2018 also reported p53 activation and resultantly apoptosis induction by Z. multiflora (25). More studies should be conducted to further approve the anticancer effects of Z. multiflora extract and unveil other anti-cancer mechanisms. Hosseinimehr et al. showed that Z. multiflora extract...
had chemoprotective effects on murine bone marrow cells (26). However, the effect of Z. multiflora extract on normal human hematopoietic cells should be studied in future investigations. Meanwhile, Methanolic extract of Z. multiflora was used throughout this study, which contains several therapeutic compounds. Further investigations are recommended to unveil the pure anticancer compounds and their effects on other cancer cell lines.

Conclusion

The results of current study demonstrated that Z. multiflora methanolic extract decreased the cell viability and metabolic activity of acute promyelocytic leukaemia cells in a dose dependant manner. It was also shown that the expression of hTERT was significantly downregulated. Therefore, Z. multiflora can potentially have anti-cancer effects on acute promyelocytic leukaemia cells. However further investigations are needed to approve the underlying mechanism and unveil the active ingredients.

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Conflict of Interest

Authors declare no conflict of interests.

References


