Cytotoxicity Potential of *Nelsonia canescens* (Lam.) Spreng Extracts against Cervical Cancer Cell Lines

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**Abstract**

*Nelsonia canescens* is a small perennial herb widely used in Burkina Faso traditional medicine for the treatment of any diseases. In the present study, the purpose was to investigate the potential cytotoxicity and selectivity of different extracts from *N. canescens* on human cervical cancer HeLa and SiHa cell lines. MTT assay revealed higher cytotoxic activity of methanol extract in a dose-dependent manner against both HeLa and SiHa cells with respective IC50 values of 21.72 ± 0.08 μg/mL and 25.30 ± 0.44 μg/mL. Methanol extract (ME) showed the best selectivity index value of 7.93 ± 0.03 with HeLa cell line and Ethyl acetate extract (EAE) showed the best selectivity index value of 7.48 ± 0.05 with SiHa. The potential cytotoxicity and selectivity of *N. canescens* extracts against HeLa and SiHa cells line suggest that this species could be exploited further as a potential lead in cervical cancer treatment.

**Key words:** Cervical cancer, HeLa, SiHa, Nelsonia canescens extracts.

**INTRODUCTION**

Cancer is considered as the second killer of human death in the world [1]. According to the World Health Organization (WHO), the number of people suffering from cancer in the world will continue to grow steadily, and it is estimated that the number of newly-increased cancer patients will reach 19 million or even more by 2025. Especially, cervical cancer is an important public health problem for adult women [2], where 80% of cases occur in the developing world [3]. It is the fourth most common cancer among women globally, with 570,000 new cases and 311,000 deaths (7.5% of all female cancer deaths) in 2018 [4]. The major risk factors associated with cervical cancer development include high-risk human papilloma virus (hrHPV) infection, age, smoking, childbirth, use of oral contraception, and diet [5]. For treatment of various cancers, as the use of concurrent platinum-based chemoradiation often leads to severe toxicity, complementary and alternative medicine is recently becoming popular [6]. In recent years, new drugs have been discovered from natural plant products and it has been proved to have the potential to cure cancer. Invent of natural anticancer drugs paved a way for cancer treatment with no or less side effects. The use of natural extracts that we use in day to day life is an excellent alternative for chemical drugs used in cancer treatment [7].

*Nelsonia canescens*, a small perennial herb with soft decumbent villous branches [8] is traditionally used for malaria, cancer, gout, cardiovascular and inflammatory diseases treatments[9-12].

Previous studies of *Nelsonia canescens* methanol extract showed a good anti-tumor activity on breast-cancer cell line U373 with a IC50 of 27.04 ± 1.55 μg/mL [13] and Phytochemical investigations by HPLC-MS revealed the presence of five phenol acids (p-coumaric acid, caffeic acid, chlorogenic acid, ferulic acid and gentisic acid) and three flavonoids (apigenin,
luteolin, Quercetol)] [14]. However, this plant species is widely used traditionally in the treatment of cervical cancer, but little scientific evidence supports its use. In the present study, we investigated the anticancer activities of *Nelsonia canescens* on human cervical cancer HeLa and SiHa cell lines.

**MATERIALS AND METHODS**

**Cell Cultures.**

In this research, two human cervical cancer cell lines HeLa (ATCC® CCL-2®) and SiHa (ATCC® HTB-35®) and one normal fibroblast (L.929) cell line are used. These cell lines were cultured in Dulbecco’s modified Eagle’s medium (DMEM) supplemented with 10% fetal bovine serum (FBS), L-glutamine, streptomycin (100 µg/mL), and penicillin (100 U/mL). All cells were incubated in humidified air with 5% CO₂ incubator at 37°C.

**Preparation of Nelsonia canescens Extracts.**

The plant material is constituted of the whole plant of *Nelsonia canescens*. This plant was selected based on the ethnomedicinal investigation of the professor Nacoulma [15]. The plant was identified and authenticated by professor Millogo, botanist at the Ouagadougou University. Whole plants of *N. canescens* collected in August 2017 in Loumbila, 15 km north of Ouagadougou, capital of Burkina Faso, were dried at ambient temperature. The extracts obtained were weighed and packed in waterproof plastic flasks and stored at 4°C until use.

Then, extracts were dissolved with dimethyl sulfoxide (DMSO) with a final concentration of DMSO in extracts less than 0.5% for preparation of various concentrations for cytotoxicity and other assays.

**Cytotoxicity and Selectivity Assay**

The cell viability was evaluated by the MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) dye reduction assay (Sigma, USA). This colorimetric assay utilizes the enzymatic activity of mitochondrial succinate dehydrogenase enzyme found in living cells. The enzyme reduces the yellow water-soluble MTT to formazan insoluble purple colored crystals that are measured using a spectrophotometer [16] and adapted by Kamini et al. 2015 [17]. Then, the activity of the enzymes to produce formazan is inversely proportional to the level of cell inhibition and directly proportional to the level of cell viability [18].

Briefly, Cells were maintained as a monolayer culture in their culture media supplemented with 10% fetal bovine serum and incubated at 37°C in a humidified incubator at 5% CO₂. The cells were seeded in 96-well plates to a final volume 100 µl media containing 2.4x10^4 cells per well, enumerated using the trypan blue dye exclusion method. The plates were incubated for 24 hours, then the extracts were added in row H and serially diluted up to ow B in their respective wells at concentrations of 500 µg/ml, 250 µg/ml, 125 µg/ml, 62.5 µg/ml, 31.25 µg/ml, 15.625 µg/ml and 7.813 µg/ml. Rows A, of the 96 well plates were left untreated to serve as a negative cell control. After 48 hours of incubation, the culture medium in the plates was discarded, followed by washing step using phosphate buffered saline (PBS). A volume of 10 µl of PBS solution containing 5 mg/ml MTT dye (5 mg of MTT, dissolved in 1 ml serum-free PBS) was added to all the wells and incubated for another 4 hours after which 100 µl of 100% DMSO was added. The plates were read using a scanning multiwell spectrophotometer (Multiskan Ex lab systems) at 562 nm and 690 nm as reference. The proliferation rate of the cells was calculated using the following formula [19, 20].

\[
\text{Proliferation rate} = \frac{At-Ab}{Ac-Ab}
\]

\[
\text{Percentage of viability} = \frac{At-Ab}{Ac-Ab} \times 100
\]

\[
\text{Percentage of inhibition} = 100 - \frac{At-Ab}{Ac-Ab} \times 100
\]

\(At\) = Absorbance value of test extract

\(Ab\) = Absorbance value of blank

\(Ac\) = Absorbance value of negative control (cells plus media)

The selectivity index (SI) was determined by the ratio of the EC₅₀ value of the extracts on normal cells (L.929) to the IC₅₀ value of the extracts on cancer cells (HeLa or SiHa). Samples with an SI greater than 3 were considered to have a high selectivity towards cancer cells [21].
STATISTICAL ANALYSIS

The experiments were repeated in three times and data were expressed as means ± standard deviation (SD). One-way ANOVA was used to compare means. A p value < 0.05 was considered to indicate a statistically significant difference.

RESULTS AND DISCUSSION

Using the MTT assay, we evaluated the antiproliferative activity of *Nelsonia canescens* extracts against human cervical cancer cells (HeLa and SiHa) and normal fibroblast cells (L929). These cancer and normal cells were tested using five different extracts such as Hexane, Dichloromethane, Ethyl Acetate, Methanol and Acidified water extracts at various concentrations (7,816-500 µg/mL). In this study, the finding is that all the extracts presented an inhibition, but the best inhibitions were obtained with polar extracts (Table 1). Then, it’s obtained that both HeLa and SiHa cancer cells line showed remarkable dose-dependent susceptibility with the different concentrations of extracts (Figure 1). When the concentration of the extract increase, the number of viable cancer cells decrease. Interestingly, the IC_{50} value obtained are respectively 21.72 ± 0.08 µg/ml and 25.30 ± 0.44 µg/ml with methanol extracts (ME), 54.95 ± 1.13 µg/ml and 43.87 ± 0.81 µg/ml with acidified water extracts (AWE) and 421.83 ± 3.40 µg/ml and 64.93 ± 0.85 µg/ml with ethyl acetate extracts (EAE).

The selectivity index (SI) is a value who indicates the safety of an extract used for anticancer therapy. It was calculated based on the ratio of the EC_{50} value of different extracts on normal L929 cells to the IC_{50} value of the same extracts on human cervical cancer cells (HeLa and SiHa). So, a SI value greater than 3 was regarded as highly selective [21]. Considering hour extracts, Methanol extract (ME) displayed high selectivity with a SI value of 7.93 ± 0.03 following by Acidified Water Extract (AWE) with 7.48 ± 0.05 for HeLa cells. It’s showed in this study that SiHa cells were more selected with Ethyl acetate extract (EAE), Methanol extract (ME) and Acidified Water Extract (AWE) with the respective values of 7.48 ± 0.05, 6.81 ± 0.05 and 3.81 ± 0.05 (Table 2).

| TABLE 1: Inhibition concentration 50% (IC_{50}) of extracts of *Nelsonia canescens* inoculated in HeLa and SiHa cell lines. All the results presented as Inhibition concentration at 50% mean ± SD (n=3) |
|---|---|---|
| Extract | HeLa | SiHa |
| HE | >500 | >500 |
| DCME | >500 | >500 |
| EAE | 421.83 ± 3.40 | 64.93 ± 0.85 |
| ME | 21.72 ± 0.08 | 25.30 ± 0.44 |
| AWE | 54.95 ± 1.13 | 43.87 ± 0.81 |

Key: HE= Hexane Extract; DCME = Dichloromethane Extract; EAE = Ethyl Acetate Extract; ME = Methanol Extract and AWE = Acidified Water Extract

| TABLE 2: Anti-proliferative activity and selectivity index (SI) of Nelsonia canescens extracts against HeLa, SiHa and L929 cell line. The results are presented as anti-proliferative activity at 50% mean ± SD (n=3) |
|---|---|---|---|---|---|
| Extracts | L929 | HeLa | SiHa |
| | EC_{50} | IC_{50} | SI | IC_{50} | SI |
| HE | >500 | >500 | nd | >500 | nd |
| DCME | >500 | >500 | nd | >500 | nd |
| EAE | 485.80 ± 3.29 | 421.83 ± 3.40 | 1.15 ± 00 | 64.93 ± 0.85 | 7.48 ± 0.05 |
| ME | 172.23 ± 1.43 | 21.72 ± 0.08 | 7.93 ± 0.03 | 25.30 ± 0.44 | 6.81 ± 0.05 |
| AWE | 167.12 ± 0.35 | 54.95 ± 1.13 | 3.04 ± 0.05 | 43.87 ± 0.81 | 3.81 ± 0.05 |

Key: HE= Hexane Extract; DCME = Dichloromethane Extract; EAE = Ethyl Acetate Extract; ME = Methanol Extract and AWE = Acidified Water Extract; nd = not determined

Figure 1: Dose-dependent Cell survival curves on HeLa, SiHa and L929 cell lines determined by MTT assay for 72h of treatment with Ethyl acetate extract (A), Methanol extract (B) and Acidified water extract (C) at concentrations of 500 µg/ml, 250 µg/ml, 125 µg/ml, 62.5 µg/ml, 31.25 µg/ml, 15.625 µg/ml and 7.813 µg/ml. Data are shown as mean ± SD of three independent experiments (p<0.05; one-way ANOVA).
In the present study, previous studies of *Nelsonia canescens* methanol extract showed a good anti-tumor activity on breast-cancer cell line U373 with a IC₅₀ of 27.04 ± 1.55 µg/mL [13]. However, according to the American National Cancer Institute (NCI), a plant extract with an IC₅₀ less than 30 µg/mL was interesting for research of antitumor compounds [22]. These two different studies using methanol extracts show that the most anticancer compounds in this medicinal plant were extractible with polar solvent including methanol. Interesting, in previous phytochemical investigations by HPLC-MS using methanol extract of this plant, we revealed the presence of five phenol acids (p-coumaric acid, caffeic acid, chlorogenic acid, ferulic acid and gentisic acid) and three flavonoids (apigenin, luteolin, Quercetol) [14]. Numerous researches noted the anticancer potential of these various molecules from herbal. So, it is demonstrated by any studies the potential anticancer activities Apigenin against cervical cancer [23, 24], in addition, this compound associated with interferon gamma (IFNγ) is a good combination therapy against cervical cancer cell line HeLa and SiHa [25]. According to numerous studies, Luteolin is known for it potent prevention and inhibition against cervical cancer [26]. Quercetin decreased cervical cancer cell proliferation and induced cell death [27]. It is showed that caffeic acid isolated from several kinds of vegetables and herbs had anti-proliferative effects on cervical cancer cell lines, this compound can significantly reduce the proliferation of HeLa cells in a time-dependent manner [28]. In another study, it was demonstrated that Ferulic acid significantly inhibit cell proliferation and invasion in Hela and Caski cells [29]. All these researches about compounds presented in *N. canescens* supported the potential cervical anticancer of this plant extracts. Regarding the selectivity index (SI) in this study, the high selectivity in cytotoxic response between cancer and normal cell lines could be due to unique or combine effect of compounds in *N. canescens* which could serve as a novel anticancer drug.

**CONCLUSION**

Serial dilution of different extracts from *Nelsonia canescens* showed in a dose-dependent manner high cytotoxicity on HeLa and SiHa cervical cancer cells and less cytotoxicity with the normal fibroblast cells L929. But, particularly, methanol extract exhibited a remarkable higher cytotoxic activity by MTT assay. The selectivity index obtained showed that the species contain active compounds with anticancer potential. Further molecular investigations are necessary in order to isolate the main active compound for any biological tests.

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**REFERENCES**

1. Anderson, B. O., & Flanigan, J. (2015). Novel methods for measuring global cancer burden: implications for global cancer control. *JAMA oncology, 1*(4), 425-427.

2. Sankaranarayanan, R., Budukh, A. M., & Rajkumar, R. (2001). Effective screening programmes for cervical cancer in low-and middle-income developing countries. *Bulletin of the World Health Organization, 79*, 954-962.

3. Olubodun, T., Odukoya, O. O., & Balogun, M. R. (2019). Knowledge, attitude and practice of cervical cancer prevention, among women residing in an urban slum in Lagos, South West, Nigeria. *The Pan African medical journal, 32*.

4. Organization, W. H. (2019). Screening and treatment of pre-cancerous lesions for secondary prevention of cervical cancer. uniltad.

5. Schiffman, M., & Solomon, D. (2013). Cervical-cancer screening with human papillomavirus and cytologic cotesting. *New England Journal of Medicine, 369*(24), 2324-2331.

6. Yan, L., Liu, X., Yin, A., Wei, Y., Yang, Q., & Kong, B. (2015). Huaiier aqueous extract inhibits cervical cancer cell proliferation via JNK/p38 pathway. *International journal of oncolgy, 47*(3), 1054-1060.

7. Jeya Shree, T., Gowri Sree, V., Priyanka, A., & Sundararajan, R. (2018). Antioxidant and anticancer activity of pulsed electric field treated grape extract. *J Nanomedine Biotherapeutic Discov, 8*(159), 2.
8. Owoyele, V. B., Oloriegbe, Y. Y., Balogun, E. A., & Soladoye, A. O. (2005). Analgesic and anti-inflammatory properties of Nelsonia canescens leaf extract. *Journal of ethnopharmacology*, 99(1), 153-156.

9. Hussain, M. S., Fareed, S., & Ali, M. (2010). Hygrophila auriculata (K. Schum) Heine: Ethnobotany, phytochemistry and pharmacology. *Asian J. Tradit. Med.*, 4, 122-131.

10. Rout, S. D., Panda, T., & Mishra, N. (2009). Ethno-medicinal plants used to cure different diseases by tribes of Mayurbhanj district of North Orissa. *Studies on Ethn-Medicine*, 3(1), 27-32.

11. Ali, S. S., Kasoju, N., Luthra, A., Singh, A., Sharanabasava, H., Sahu, A., & Bora, U. (2008). Indian medicinal herbs as sources of antioxidants. *Food research international*, 41(1), 1-15.

12. Bah, S., Diallo, D., Dembélé, S., & Paulsen, B. S. (2006). Ethnopharmacological survey of plants used for the treatment of schistosomiasis in Niono District, Mali. *Journal of Ethnopharmacology*, 105(3), 387-399.

13. Nabere, O., Samson, G., Adama, H., Moussa, C., Eric, S. P., Aminata, N. P., ... & Germaine, N. O. (2012). Antioxidant and anticancer activities of polyphenolic compounds from three Acanthaceae medicinal species from Burkina Faso. *International Journal of Phytomedicine*, 4(4), 552.

14. Ouattara, N., Meda, R. N. T., Hilou, A., Guenné, S., Konaté, K., Coulibaly, A. Y., ... & Nacoulma, O. G. (2013). Anti-acetylcholinesterase and antioxidant activities and HPLC-MS analysis of polyphenol from extracts of Nelsonia canescens (Lam.) Spreng. *Asian Pacific Journal of Tropical Disease*, 3(5), 382-388.

15. Nacoulma, O. G. (1996). Plantes médicinales et pratiques médicales traditionnelles au Burkina Faso: cas du plateau central. *Faculté des Sciences et Techniques, Université de Ouagadougou*, 320.

16. Mosmann, T. (1983). Rapid colorimetric assay for cellular growth and survival: application to proliferation and cytotoxicity assays. *Journal of immunological methods*, 65(1-2), 55-63.

17. Citalingam, K., Abas, F., Lajis, N., Othman, I., & Naidu, R. (2015). Anti-proliferative effect and induction of apoptosis in androgen-independent human prostate cancer cells by 1, 5-bis (2-hydroxyphenyl)-1, 4-pentadiene-3-one. *Molecules*, 20(2), 3406-3430.

18. Berridge, M. V., Herst, P. M., & Tan, A. S. (2005). Tetrazolium dyes as tools in cellular biology: new insights into their cellular reduction. *Biotechnology annual review*, 11, 127-152.

19. Patel, S., Gheeewala, N., Suthar, A., & Shah, A. (2009). In-vitro cytotoxicity activity of Solanum nigrum extract against Hela cell line and Vero cell line. *International journal of pharmacy and pharmaceutical sciences*, 1(1), 38-46.

20. Kimani, P. M., Mwitari, P. G., Mwenda Njagi, S., Gakio Kirira, P., & Kiboi, D. M. (2018). In vitro anti-proliferative activity of selected plant extracts against cervical and prostate cancer cell lines. *Journal of Cancer Science & Therapy*, 10(9).

21. Mahavorasirikul, W., Vijayanant, V., Chaijaroenkul, W., Itharat, A., & Na-Bangchang, K. (2010). Cytotoxic activity of Thai medicinal plants against human cholangiocarcinoma, laryngeal and hepatocarcinoma cells in vitro. *BMC complementary and alternative medicine*, 10(1), 55.

22. Jokhadze, M., Eristavi, L., Kutchukhidze, J., Chariot, A., Angenot, L., Tits, M., ... & Frédéric, M. (2007). In vitro cytotoxicity of some medicinal plants from Georgian Amaryllidaceae. *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives*, 21(7), 622-624.

23. Liu, J., Cao, X. C., Xiao, Q., & Quan, M. F. (2015). Apigenin inhibits HeLa sphere-forming cells through inactivation of casokinase 2α. *Molecular medicine reports*, 11(1), 665-669.

24. Tang, A. Q., Cao, X. C., Tian, L., He, L., & Liu, F. (2015). Apigenin inhibits the self-renewal capacity of ovarian cancer SKOV3-derived sphere-forming cells. *Molecular medicine reports*, 11(3), 2221-2226.

25. Yang, P. M., Chou, C. J., Tseng, S. H., & Hung, C. F. (2017). Bioinformatics and in vitro experimental analyses identify the selective therapeutic potential of interferon gamma and apigenin against cervical squamous cell carcinoma and adenocarcinoma. *Oncotarget*, 8(28), 46145.

26. Imran, M., Rauf, A., Abu-Isneid, T., Nadeem, M., Shariati, M. A., Khan, I. A., ... & Gondal, T. A. (2019). Luteolin, a flavonoid, as an anticancer agent: A review. *Biomedicine & Pharmacotherapy*, 112, 108612.

27. Ali, A., Kim, M. J., Kim, M. Y., Lee, H. J., Roh, G. S., Kim, H. J., ... & Choi, W. S. (2018). Quercetin induces cell death in cervical cancer by reducing O-GlcNAcylation of adenosine monophosphate-activated protein kinase. *Anatomy & cell biology*, 51(4), 274-283.

28. Ye, J. C., Hsiao, M. W., Hsieh, C. H., Wu, W. C., Hung, Y. C., & Chang, W. C. (2010). Analysis of caffeic acid extraction from Ocimum gratissimum Linn. by high performance liquid chromatography and its effects on a cervical cancer cell line. *Taiwanese Journal of Obstetrics and Gynecology*, 49(3), 266-271.

29. Gao, J., Yu, H., Guo, W., Kong, Y., Li, Q., Yang, S., ... & Wang, Y. (2018). The anticancer effects of ferulic acid is associated with induction of cell cycle arrest and autophagy in cervical cancer cells. *Cancer cell international*, 18(1), 102.