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COMPARATIVE EVALUATION OF GARLIC EXTRACT AND CONVENTIONAL ANTICANCER DRUGS (CISPLATIN) ON THE VIABILITY AND PROLIFERATION OF HELA CERVICAL CANCER CELLS

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Abstract

Background: Cervical cancer is a major public health issue, and the pursuit of effective and well-tolerated treatment alternatives is a crucial research objective. Further research is needed to investigate the effects of garlic (Allium sativum) on cervical cancer cells, namely HeLa cells, due to its potential anticancer qualities.

Objective: The objective of this study was to assess the cytotoxic and antiproliferative effects of garlic extract on HeLa cervical cancer cells in a dose-dependent manner. Additionally, the study aimed to compare the anticancer properties of garlic extract with those of standard chemotherapeutic drugs.

Methods: HeLa cells were exposed to different doses of garlic extract (ranging from 1 to 20 mg/mL), and the impact on cell survival and proliferation was evaluated using colorimetric assays. The anticancer properties of garlic extract were also evaluated in comparison to cisplatin, doxorubicin, paclitaxel, and 5-fluorouracil.

Results: The data indicated that garlic extract displayed strong dose-dependent cytotoxic and antiproliferative effects on HeLa cells. At the maximum concentration tested (20 mg/mL), the garlic extract decreased the average cell viability to 42.6% ± 3.5% (standard error of the mean) and the average cell proliferation to 46.8% ± 3.2% (standard error of the mean). Significantly, the garlic extract had anticancer properties that were equivalent to or even surpassing those of traditional chemotherapeutic drugs.

Conclusion: The results indicate that garlic extract has a notable ability to combat cervical cancer cells (HeLa) by impeding their growth and reproduction. The findings endorse the additional investigation of garlic extract as a potentially effective natural substitute or supplement to traditional chemotherapeutic drugs in the treatment of cervical cancer.

Introduction

Cervical cancer is a major health issue worldwide, with human papillomavirus (HPV) being the leading cause. Conventional chemotherapy, such as the platinum-based drug cisplatin, is the mainstay of treatment. Nevertheless, the consequences and the emergence of drug resistance led to the search for alternative therapeutic strategies such as the use of natural products [1,2]. It is widely recognized as Garlic, with the scientific name Allium sativum, has

healing properties, especially its anti-cancer properties. Several studies have investigated the ability of garlic extract to inhibit the expansion and proliferation of various cancer cells such as cervical cancer cells [3,4]. Recent studies focus on the effects of garlic extracts and traditional anticancer agent's cisplatin has on the survival and growth of comparable cervical cancer cells In vitro to investigate the subject for example [5,6]. A study published in the Journal of Ethnopharmacology in 2022 showed that garlic extract had a marked cytotoxic effect on HeLa cells, comparable to or even superior to cisplatin [7]. A separate study published in the Journal of Pharmaceutical Sciences and Research in 2021 showed apoptosis) and arrests the cell cycle in HeLa cells, possibly affecting multiple signaling pathways These data suggest that garlic extract may be an effective new natural product or added to conventional drugs treat cervical cancer [8]. Further studies are also needed to investigate their use The aim of this study was to evaluate and compare the effects of garlic extracts and common anticancer agents on the survival and growth of Greek cells.

Materials and Methods

Cell Culture and Maintenance

Human cervical cancer cell line HeLa cells were obtained from the American Type Culture Collection (ATCC, Manassas, VA, USA). Cells were cultured in Dulbecco's modified Eagle's medium (DMEM, Gibco, Waltham, MA, USA) supplemented with 10% fetal bovine serum (FBS, Gibco) and 1% penicillin-streptomycin (Gibco) at 37°C at humid atmosphere with 5 in % CO2. Cells were subcultured with 0.25% trypsin-EDTA (Gibco) every 2–3 days when they reached 80–90% confluence.

Cell Passage and Seeding

HeLa cells were seeded at appropriate concentrations in culture dishes for experimental procedures. Briefly, adherent cells were detached with trypsin-EDTA, resuspended in complete growth medium, and counted with a hemocytometer. Cells were then seeded at desired concentrations on culture plates, vials, or dishes, and incubated with 5% CO2 at 37°C until the required confluence was reached.

Extraction of garlic compounds

Fresh garlic (Allium sativum) bulb was obtained from local market. Garlic cloves were peeled, minced, and solvent extracted. Briefly, 100 g of crushed garlic was mixed with 500 mL of absolute ethanol in a round bottom flask. The mixture was then incubated again at 78 °C for 2 h with constant stirring. After cooling, filter paper filtered the ethanolic extract, and the solvent was removed by rotary evaporator under reduced pressure at 40 °C. The resulting plain garlic extract was weighed and stored at -20°C for further analysis.

Treatments:

Garlic extract at different concentrations and Anticancer drugs (Cisplatin, Doxorubicin, Paclitaxel 5-Fluorouracil), Cell viability assay (MTT) from Elabsceiences, USA. Cell proliferation analysis (cell counting).

Statistical analysis

The data were expressed as mean + SEM from at least three independent experiments. The statistical analyses were carried out using SPSS,2010, and the student's t-test, one-way ANOVA, P values less than 0.05 are considered significant.

Results

Effects of garlic extract on HeLa cell viability

The data in this table show the dose-dependent effect on cytotoxic effect of garlic extract on HeLa cervical cancer cells. As the concentration of garlic extract increased, cell extracts decreased significantly, accompanied by an increase in standard error of the mean At the lowest concentrations tested, cells of the extract was 92.4% ± 2.1% (SEM), indicating that garlic extract had little effect on cell viability at this dose As the extract concentration increased, the average cell viability was gradually decreased, reaching 42.6% ± 3.5% (SEM) at the highest concentration tested These data indicate that the garlic extract has potent cytotoxic activity against HeLa cervical cancer cells, and the ability to the anti-cancer of applied is directly proportional to the amount of extract

Table 1. Effects of Garlic Extract on HeLa Cell Viability

Garlic Extract Concentration	Mean Cell Viability (%) ± (SEM)
Lowest Concentration Tested	92.4±2.1
Intermediate Concentration	67.5±3.0
Highest Concentration Tested	42.6±3.5

Dose-dependent cytotoxicity of garlic extract

The data in this table show the dose-dependent effect on cytotoxic effect of garlic extract on HeLa cervical cancer cells. As the concentration of garlic extract increased, cell extractability decreased significantly, accompanied by an increase in standard error of medium At the lowest concentration of 1 mg/mL, cell a extract concentration was 92.4% ± 2.1% (SEM), indicating that garlic extract was minimal effect on cell viability at this dose The extract concentration increased and therefore the interstitial cell density decreased gradually. At 2.5 mg/mL, cell viability was 81.2% ± 2.6% (SEM), whereas at 5 mg/mL it decreased to 67.5% ± 3.0% (SEM). Further increasing the concentration to 10 mg/mL and 20 mg/mL resulted in cell viability of 52.1% ± 3.3% (SEM) and 42.6% ± 3.5% (SEM), respectively These data show that garlic extract possesses dose-dependent cytotoxic activity against HeLa cervical cancer cells, while the extract exhibits strong anticancer activity at higher doses

Table 2. Dose-dependent Cytotoxicity of Garlic Extract on HeLa Cells

Garlic Extract Concentration	**Mean Cell Viability (%) ± (SEM)**
1 mg/mL	**92.4±2.1**
2.5 mg/mL	**81.2±2.6**
5 mg/mL	**67.5±3.0**
10 mg/mL	**52.1±3.3**
20 mg/mL	**42.6±3.5**

Comparison with anticancer drug (Cisplatin, Doxorubicin, Paclitaxel 5-Fluorouracil) treatments

The data in this table compare the cytotoxic effects of garlic extract and several commonly used anticancer drugs on HeLa cervical cancer cells at a concentration of 10 mg/mL, regular garlic extract viable cells consumed an average of 52.1% ± 3.3% (SEM). In comparison, conventional anticancer drugs showed the following.

Table 3. Dose-dependent Cytotoxicity of drugs on HeLa Cells

Drugs **Concentration**	**Mean Cell Viability (%) ± (SEM)**
Cisplatin (10 μM)	**55.4 ± 3.1**
Doxorubicin (1 μM)	**61.2 ± 2.8**
Paclitaxel (100 nM)	**58.9 ± 3.0**
5-Fluorouracil (100 μM)	**63.5 ± 2.7**

The results show that the cytotoxic effect of garlic extract on HeLa cells was comparable or even higher than the tested conventional anticancer drugs The average cell vigor was activation is lower for garlic extracts compared to drugs, suggesting that garlic extracts may have anticancer activity against HeLa cervical cancer cells exhibit changes, while Garlic a extracts exhibit slightly higher SEM values compared to some drugs, which may indicate broader effects These findings suggest that garlic extracts may be a promising new natural product or affect drug therapy of common use in cervical cancer management

Table 3. Comparison of Anticancer Effects of Garlic Extract and Conventional Drugs on HeLa Cells

Treatment	**Mean Cell Viability (%) ± (SEM)**
Garlic Extract (10 mg/mL)	**52.1±3.3**
Cisplatin (10 μM)	**55.4±3.1**
Doxorubicin (1 μM)	**61.2±2.8**
Paclitaxel (100 nM)	**58.9±3.0**
5-Fluorouracil (100 μM)	**63.5±2.7**

Effects of garlic extract on HeLa cell proliferation

The data in this table show the dose-dependent inhibitory effect of garlic extract on the proliferation of HeLa cervical cancer cells. As the concentration of garlic extract increased, the average cell number decreased significantly, accompanied by an increase in the standard error of the mean At the lowest concentration of 1 mg/mL of the extract, the average cell proliferation was 91.3% ± 2.4% (SEM), indicating that at this concentration of garlic extract There was little effect but as the extract concentration increased, cells proliferation gradually declined. Cell proliferation at 2.5 mg/mL was 82.4% ± 2.8% (SEM), whereas it decreased to 67.2% ± 3.1% (SEM) at 5 mg/mL. When the concentration was further increased to 10 mg/mL and 20 mg/mL, the average cell proliferation was 54.6% ± 3.4% (SEM) and 46.8% ± 3.2% (SEM), respectively These data this shows that the garlic extract has a potent dose-dependent effect against HeLa

cervical cancer cells, while higher concentrations of the extract exhibit a stronger cell proliferation inhibitory effect

Table 4. Effects of Garlic Extract on HeLa Cell Proliferation

Garlic Extract Concentration	Mean Cell Proliferation (%)±(SEM)
1 mg/mL	**91.3±2.4**
2.5 mg/mL	**82.4±2.8**
5 mg/mL	**67.2±3.1**
10 mg/mL	**54.6±3.4**
20 mg/mL	**46.8±3.2**

Inhibition of cell proliferation by garlic extract

The data in this table compare the effects of garlic extract and several commonly used anticancer drugs on the proliferation of HeLa cervical cancer cells At a concentration of 10 mg/mL, the garlic extract exhibited an average cell proliferation of 54.6% ± 3.4% (SEM). In comparison, conventional anticancer drugs showed the following.

Drugs Concentration	Mean Cell Proliferation (%)±(SEM)
Cisplatin (10 µM)	**61.2 ± 3.0**
Doxorubicin (1 µM)	**65.8 ± 2.9**
Paclitaxel (100 nM)	**59.4 ± 3.1**
5-Fluorouracil (100 µM)	**68.2 ± 2.8**

The results show that the antioxidant effect of garlic extract on HeLa cells was more potent or at least comparable to the tested conventional anticancer drugs want Cell proliferation is lower for garlic extracts compared to drugs, suggesting that garlic extracts may possess greater cancer proliferation inhibitory effect HeLa cervical cancer cells exhibit changes, While garlic extract exhibits a slightly higher SEM value compared to some compounds, which may indicate broader effects these findings suggest that garlic extract may be an effective inhibitor of HeLa cell proliferation during in comparison with the traditional anticancer agents evaluated in this study

Table 5. Comparative Analysis of the Antiproliferative Effects of Garlic Extract and Conventional Drugs on HeLa Cells

Treatment	Mean Cell Proliferation (%) ± (SEM)
Garlic Extract (10 mg/mL)	**54.6±3.4**
Cisplatin (10 µM)	**61.2±3.0**
Doxorubicin (1 µM)	**65.8±2.9**
Paclitaxel (100 nM)	**59.4±3.1**
5-Fluorouracil (100 µM)	**68.2±2.8**

Comparative analysis with anticancer drug effects

The results show that the anticancer effect of garlic extract, in terms of cytotoxicity and inhibition of cell proliferation, was more potent or at least comparable to that of conventional drugs cancer tested get it compare s may have superior anticancer activity Avg Standard error of (SEM) . values indicate variability in data, with garlic extracts exhibiting slightly higher

SEM values in some cases, indicating potentially widespread effects These findings suggest that garlic extracts may be a biological novelty promising or complementary to conventional chemotherapeutics in the management of cervical cancer

Table 6. Comparative Analysis of the Anticancer Effects of Garlic Extract and Conventional Drugs on HeLa Cells

Treatment	Mean Cell Viability (%) ± (SEM)	Mean Cell Proliferation (%) ± (SEM)
Garlic Extract (10 mg/mL)	52.1± 3.3	54.6±3.4
Cisplatin (10 µM)	55.4±3.1	61.2± 3.0
Doxorubicin (1 µM)	61.2±2.8	65.8±2.9
Paclitaxel (100 nM)	58.9±3.0	59.4±3.1
5-Fluorouracil (100 µM)	63.5±2.7	68.2±2.8

Discussion

The data presented in Table 2 show the dose-dependent effects on the cytotoxic effect of garlic extract on HeLa cervical cancer cells. As the concentration of the garlic extract increased, cell extractability decreased significantly, accompanied by an increase in the standard error of the mean At the lowest concentration tested (1 mg/mL); of cell extract concentration was 92.4% ± 2.1% (SEM), indicating that garlic extract had but minor effect on cell viability at this concentration. When the extract concentration went surface, the average cell viability gradually decreased, reaching 42.6% ± 3.5% (SEM) at the highest concentration tested (20 mg/mL) in different experiments with uterus cancer -Dose-dependent cytotoxic effects of garlic extract have been reported in various cancer cell lines. A study by [9] showed that garlic extract significantly decreased the viability of HeLa cells in a dose-dependent manner, and higher doses exhibit more potent cytotoxic effects [10]. The observed effect of garlic extract on HeLa cells can be attributed to various active compounds such as allicin, allene, and allyl propyl disulfide which have been shown to have potent anticancer activity [11;12]. These compounds can inhibit apoptosis , cell cycle arrest, and angiogenesis contribute to decrease cell viability [13;14] Increase in standard error of the mean (SEM) value with increasing amount of garlic extract suggests a potentially broad spectrum, which may be linked to the complexity of HeLa cell structure and variable response to the presence of various bioactive compounds. This observation calls for further studies to elucidate the underlying mechanisms and identify the specific metabolites responsible for the observed cytotoxic effects To summarize, the data presented in Table 2 illustrates the strong dose-dependent effect of garlic extract on HeLa cervical cancer cells in cervical cancer management Promising- Recent studies have supported the findings indicating the potential of this natural compound on as a drug or adjuvant, and further research is needed to better understand the mechanisms of action and optimize the use of garlic extracts in cancer therapy

Conclusion

This study showed that garlic extract possessed potent anticancer activity against HeLa cervical cancer cells. Cell viability and proliferation of HeLa cells significantly decreased with increasing extract concentration. Its anticancer activity was comparable or even superior to conventional chemotherapeutic agents such as cisplatin, doxorubicin, paclitaxel, and 5-fluorouracil. Further studies are needed to understand the specific mechanisms involved and to

identify key functional factors responsible for these effects.

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