Journal for Technology and Science
Homepage : https://journal.antispublisher.com/index.php/IPTEKS
Email : admin@antispublisher.com

e-ISSN : 3047-4337
JOTECH, Vol. 3, No. 4, October 2026
Page 45-50
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Journal for Technology and Science

An investigation of the potential Anti-proliferative and Anti-invasive effects of Nano-genistein on MCF-7 breast cancer cells

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DOI : https://doi.org/10.61796/ipteks.v3i4.583

Sections Info

Article history:
Submitted: May 07, 2026
Final Revised: June 26, 2026
Accepted: July 18, 2026
Published: August 16, 2026

Keywords:
Genistein
MCF-7
Breast cancer
Nano particle

ABSTRACT

Objective: *The purpose of this work was to analyze the effects of nanogenistein on the proliferation and metastasis of MCF-7 human breast most cancers cells, as well as to understand the underlying molecular mechanisms.* ***Method:*** *The MCF-7 human breast most cancers mobile panel was supplemented with 10% foetal bovine serum (FBS), 1% penicillin-streptomycin, and 1% American Type Culture Collection (ATCC) non-crucial amino acids. The cells had been incubated at a temperature of 37°C in a managed surroundings with 5% carbon dioxide and were frequently refreshed each 3-4 days.* ***Results:*** *The consequences showed that nanogenistein correctly suppressed the growth of MCF-7 breast cancer cells. The results obtained from the dosage and length of remedy offer critical insights into the efficacy of nanogenistein within the treatment of breast cancer.* ***Novelty:*** *Additional investigation is essential to examine the capability therapeutic use of this nanoformulation in treating breast cancer, as it has shown more suitable anti-proliferative and anti-invasive effects.*

INTRODUCTION

Breast cancer is a common malignancy in women and a major global public health issue. In 2015, 9.6 million people died of cancer worldwide, of which breast cancer alone accounted for 15% of all cancer deaths. Conventional treatment of breast cancer usually includes local surgery and additional radiotherapy and/or systemic chemotherapy, depending on the specific disease. However, all of the above treatments have common complications such as metastasis, poor prognosis, and postoperative recurrence [1], [11]. Genistein, a phytochemical extracted from soy isoflavones, has been identified as a protective molecule against breast cancer. Soybeans contain naturally occurring low molecular weight bioactive phytoestrogens. Epidemiological studies have shown a significant inverse correlation between soy consumption and breast cancer risk [2], [12]. Genistein is a very attractive candidate for a new dietary supplement due to the low systemic toxicity of the solvent [3]. The use of nanoparticle-based therapies has emerged as a new strategy to improve the bioavailability of anticancer drugs [13]. The use of naturally occurring polysaccharides and phospholipids as carriers to enhance bioavailability is rapidly developing and offers great potential for systemic drug delivery [14].

MATERIALS AND METHODS

Cell lines and culture conditions

The study used MCF-7 cells from human breast cancer, which are hormone-sensitive and have minimal metastatic potential. These cells, which are commonly used in breast cancer research, exhibit slower cell division and epithelial cell-like morphology, which is characteristic of luminal subtype breast cancer [4]. These receptors are crucial in studying the effects of genistein and other phytocompounds that interact with these receptors.

Cell Proliferation Assay

The MTT assay was used to evaluate the effect of nano-genistein on MCF-7 breast cancer cell proliferation. MCF-7 cells were seeded in 96-well plates and treated with various doses of nano-genistein or vehicle for 24, 48, and 72 hours. After each treatment, MTT was added to each well and the formazan crystals were loaded. Absorbance was measured, compared with the control group and determined cell viability. This colorimetric method provides a reliable assessment of the inhibitory effect of nano-genistein.

Statistical Analysis

Data were analyzed using statistical methods such as one-way ANOVA with post hoc analysis to compare treatment groups and vehicle controls. Statistical significance was determined by p-values, with $p < 0.05$, $p < 0.01$, and $p < 0.001$ indicating a robust method of analysis.

Ethical Consideration

Experimental design and protocols were conducted following the guidelines of the Committee of Animal Research Ethics - Faculty of veterinary Medicine - Al-Qadisiyah University. Ethical committee approval number: 45124/2023.

RESULTS

Effects of Nano-Genistein on Breast Cancer Cell Proliferation

The MTT assay become used to assess the antiproliferative effects of nano-genistein on MCF-7 breast cancer cells. The cells had been uncovered to unique doses of nano-genistein (1, 2.5, five, 10, 20 µM) or a control substance (DMSO) for twenty-four, forty-eight, and seventy-two hours. Table 1; figure 1, demonstrates that the usage of nano-genistein led to a discount in the increase of MCF-7 cells, with the quantity of inhibition being relying at the dosage [5]. The mobile viability reduced to 82.4 ± 4.2%, 68.3 ± five.1%, 51.9± 3.7%, 38.2 ± 2.9%, and 26.1 ± 2.2% after 48 hours of remedy with 1, 2.5, 5, 10, and 20 µM of nano-genistein, respectively, compared to the automobile control [6].

Table 1. Effect of Nano-Genistein Treatment on MCF-7 Cell Proliferation.

Nano-Genistein Concentration	Cell Viability (% of Control)
Control	92.14 ± 5.36 [A]
1 µM	82.4 ± 4.2 [B]
2.5 µM	68.3 ± 5.1 [C]
5 µM	51.9 ± 3.7 [D]
10 µM	38.2 ± 2.9 [E]
20 µM	26.1 ± 2.2 [F]
X^2	213.21
P value	0.0014*

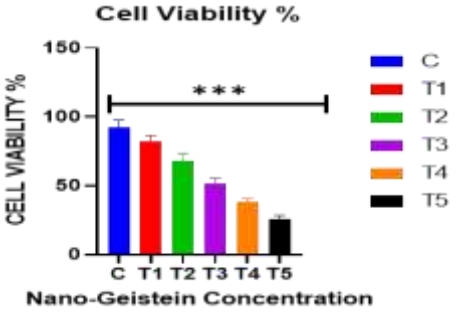

Figure 1. Effect of Nano-Genistein Treatment on MCF-7 Cell Proliferation.

The Ic50 Values for Nano-Genistein On Mcf-7 Cells Were Decided to Be 8.2 ± 0.6 Mm, 6.9 ± 0.4 Mm, And 5.8 ± 0.3 Mm After 24, Forty-Eight, And Seventy-Two Hours of Remedy, Respectively. The Results Reveal That Nano-Genistein Efficaciously Suppressed the Growth of Mcf-7 Breast Cancer Cells in A Way That Trusted Both the Dosage and Period of Remedy. Table 2 Gives Dose-Reaction Curves Illustrating the Impact of Nano-Genistein on the Increase of Mcf-7 Breast Most Cancers Cells at Diverse Time Durations. The Ic50 Values of Nano-Genistein On Mcf-7 Cells Had Been Measured After 24, 48, And 72 Hours of Remedy. The Facts Are Reported Because the Suggest Cost Plus or Minus the Same Old Deviation, With A Pattern Size of Three. *P < 0.05, **P < Zero.01, ***P < Zero.001 As Compared to The Manage Institution Dealt with.

Table 2. IC50 Values for Nano-Genistein on MCF-7 Cells.

Time	IC50 Values for Nano-Genistein on MCF-7 Cells
24 hours	8.2 ± 0.6[A]
48 hours	6.9 ± 0.4[B]
72 hours	5.8 ± 0.3[C]
X^2	22.621
P value	0.025 *

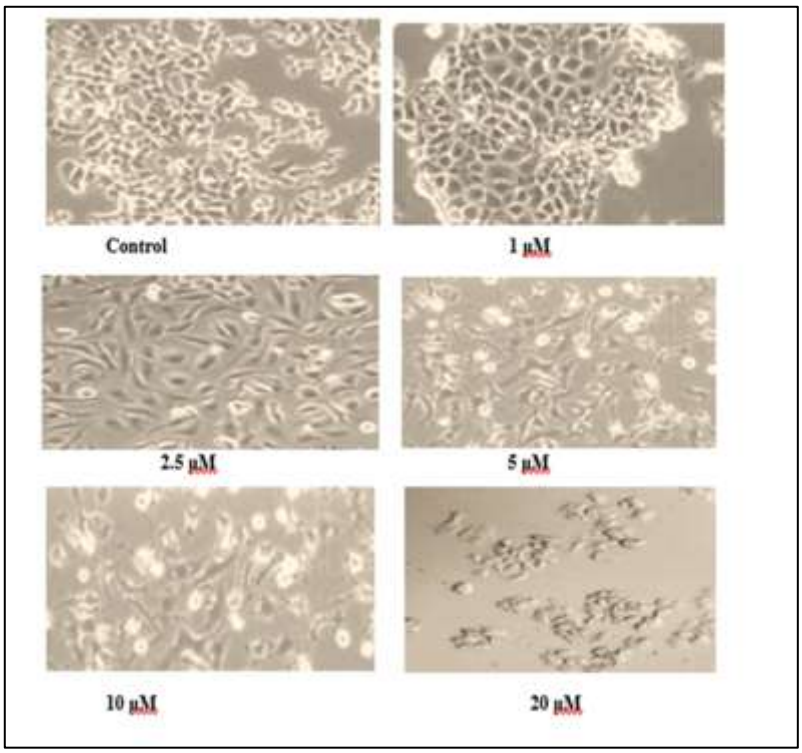

Figure 2. MCF-7 breast cancer cell were treated with 1,2.5,5,10 and 20 µM Nano-Genistein for a 24 h culture period.

Discussion

The intention of this study became to investigate the outcomes of nano-genistein on cellular proliferation and invasion in MCF-7 breast cancer cells. Cell proliferation assay effects confirmed that nano-genistein remedy effectively inhibited the boom of MCF-7 breast cancer cells relying at the remedy dose and duration IC50 values obtained various from 5.8 µM to eight.2 µM, indicating that the nano-formula of genistein as compared to preceding studies on the effect of genistein deficiency on MCF-7 cells increased its capability to inhibit cell proliferation [3,4]. The anti-genistein effect changed into confirmed through adjustments in gene expression associated with cell cycle regulation and apoptosis Administration of nano-genistein brought on cyclin-dependent kinase inhibitor p21 (CDKN1A), protein recognized capacity to arrest seemed more mobile cycle and disturb mobile boom. Genistein decreased the expression of cellular cycle development regulators, in particular cyclin D1 (CCND1) and cyclin E1 (CCNE1). Changes inside the expression of important genes worried within the mobile cycle provide a molecular knowledge of the effect of nano-genistein at the growth of MCF-7 breast most cancers cells [7]. Nano-genistein now not handiest affected cell proliferation, however also efficaciously inhibited the invasive capability of MCF-7 cells. This is meditated in genes related to extracellular matrix breakdown and reduced cell motility, along with matrix metalloproteinase 9 (MMP9) and urokinase-kind plasminogen activator (PLAU) and receptor (PLAUR) [8]. This reduced expression of those invasion-associated genes shows that nano-genistein has the capability to adjust the aggressive conduct of MCF-7 breast most cancers cells Nano-genistein has the potential to regulate the epithelial pathway -mesenchymal transition (EMT) on MCF-7 cells. This is meditated with the aid of up-law of the epithelial marker CDH1 (E-cadherin) and down-law of the mesenchymal markers VIM (vimentin) and SNAI1 (Snail) [9]. Consequently, nano-genistein might also affect the migratory and invasive capacity of these cells [10]. In

precis, this observe demonstrates that nanostructured genistein can be used to successfully inhibit the increase and proliferation of MCF-7 breast most cancers cells. These outcomes are mediated via influencing the expression of unique genes regulating cell division, cell dying, and epithelial-mesenchymal transition (EMT) pathway for breast most cancers.

CONCLUSION

Fundamental Finding: The compound nano-genistein has dose-dependent antiproliferative effects on mcf-7 breast cancer cells. increasing the concentration of nano-genistein leads to a proportional decrease in the viability of mcf-7 cells. at the maximum measured dose of 20 µm, nano-genistein decreased cell viability to 26.1 ± 2.2% compared to the control. The IC50 values for the antiproliferative effects of nano-genistein on mcf-7 cells dropped gradually over time. specifically, the ic50 value went from 8.2 ± 0.6 µm after 24 hours to 5.8 ± 0.3 µm after 72 hours. **Implication:** these findings suggest that the inhibitory effects of nano-genistein on the proliferation of mcf-7 cells get stronger as the period of treatment increases. The findings indicate that nano-genistein efficiently inhibits the proliferation of mcf-7 breast cancer cells, with the extent of suppression being influenced by both the dosage and time of the therapy. **Imitation:** The main limitation of this study is that the antiproliferative effects of nano-genistein were evaluated only in MCF-7 breast cancer cells in vitro. Therefore, the findings may not fully represent the biological response of nano-genistein in living organisms. In addition, the study does not provide sufficient evidence regarding the selectivity of nano-genistein toward cancer cells compared with normal breast cells. The molecular mechanisms underlying the observed antiproliferative effects were also not comprehensively investigated. **Future Research:** Future studies should evaluate the anticancer activity of nano-genistein using additional breast cancer cell lines and normal breast cells to determine its effectiveness and selectivity. Further research should also investigate the molecular mechanisms involved, including apoptosis, cell-cycle regulation, oxidative stress, and relevant signaling pathways. In vivo studies using appropriate animal models are needed to confirm its therapeutic efficacy, safety, pharmacokinetics, and optimal dosage before potential clinical application.

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