Synthesis and Therapeutic Applications of Mesoporous Silica Nanoparticles

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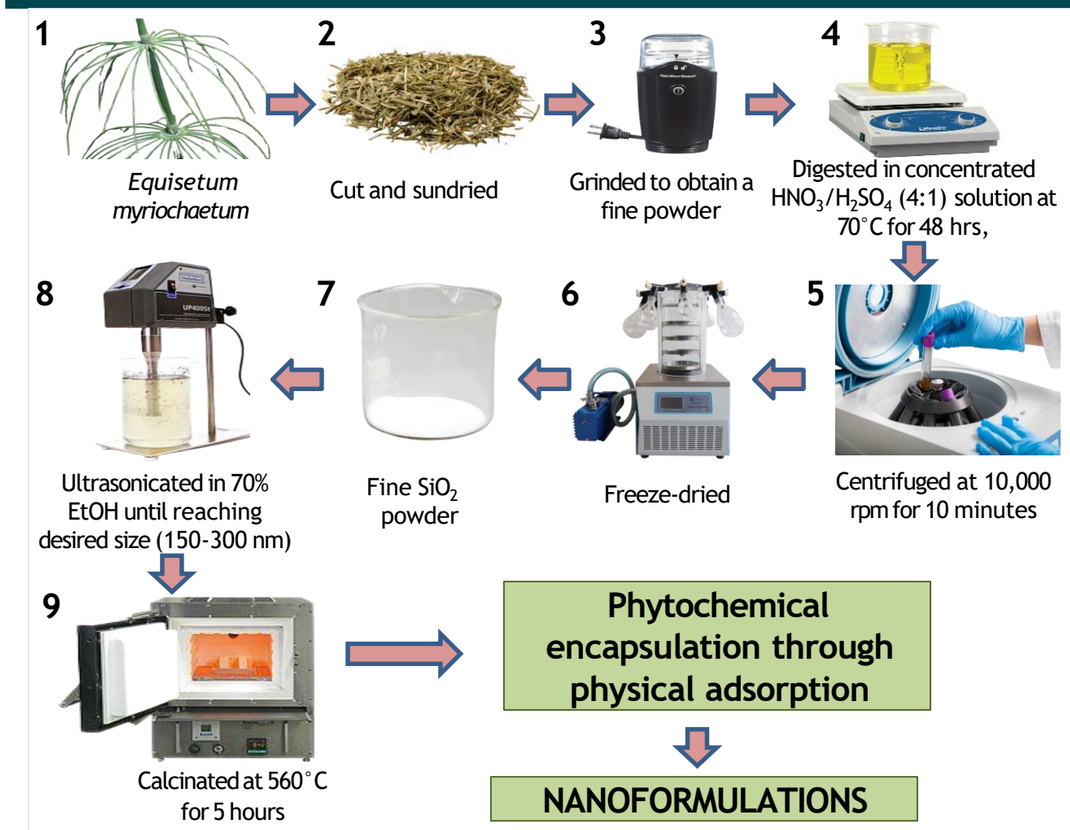
INTRODUCTION

- Mesoporous SiO_2 ($mSiO_2$) nanoparticles have been recognized as non-toxic and biocompatible nanocarriers thanks to their high loading capacity, extensive surface area, and large pore size [1].
- These nanoparticles can be extracted from *Equisetum myriochaetum* (Figure 1), which grants them biocompatibility and low toxicity properties, as well as proper environmental biodegradability [1].
- Some of the most popular cargos that these nanoparticles can deliver are phytochemicals such as Curcumin (Cur), Quercetin (Quer), Resveratrol (Res), or Thymoquinone (Tq), all of which have proven to have remarkable antimicrobial, anti-inflammatory, analgesic, antioxidant, antitumor, and anticancer properties [1, 2].
- Together, the $mSiO_2$ as vehicle and the therapeutic phytochemicals enhance the systematic drug concentration, cell uptake, solubility, and controlled release, constructing efficient therapeutic nanoformulations against various diseases that include cancer, neurodegenerative, and chronic disorders [1]. In this study, we evaluated the anticancer synergistic effect of phytochemicals loaded $mSiO_2$ on ovarian (Skov) and prostate ((PC3) cancer cells.

Figure 1. *Equisetum myriochaetum* (Canva photos, 2024).

MATERIALS AND METHODS



Characterization of the nanomaterial/ nanoformulation

- SEM/EDX analysis: To know the physical feature of the nanomaterial.
- N_2 Adsorption: To determine the specific surface área, pore size and pore volume.
- FTIR: For identifying the functional groups.
- DLS: For measuring the size and size distribution of the nanomaterial.
- XRD: For determining the crystalline/amorphous structures.

Cytotoxicity evaluation on Skov and PC3 cell lines

Skov and PC3 cells were incubated at 37°C and 5% CO_2 until 80% confluency was reached. Then, 10,000 cells/well were transferred into a 96-well plate and were incubated under the same conditions for 24 h. Quer-Res-$mSiO_2$ treatment was applied at concentrations from 200-1000 ug/ml while TQ-SiO_2 from 15-500 ug/mL. The cell viability was determined by MTT 24 hours after treatment.

ACKNOWLEDGEMENTS

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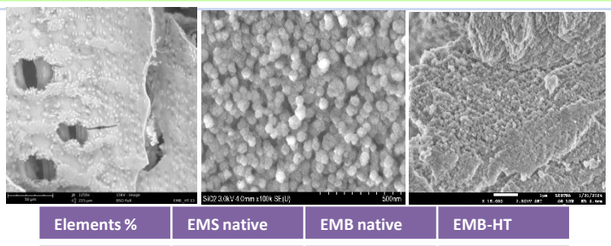
RESULTS AND DISCUSSION



Elements %	EMS native	EMB native	EMB-HT
K	5.5	2.5	0.4
O	68.1	55.1	62.8
C	8	3.1	3.5
Ca	2.1	0.4	0.5
S	1.9	0.3	-
Cl	1.4	1.2	-
Si	1.2	29.9	22.8
N	10.5	5.8	7.5
Mg	1.1	0.8	5.7
P	0.2	0.2	-

Figure 1. SEM images *of E.myrochaetum* and the extracted $mSiO_2$ [1]

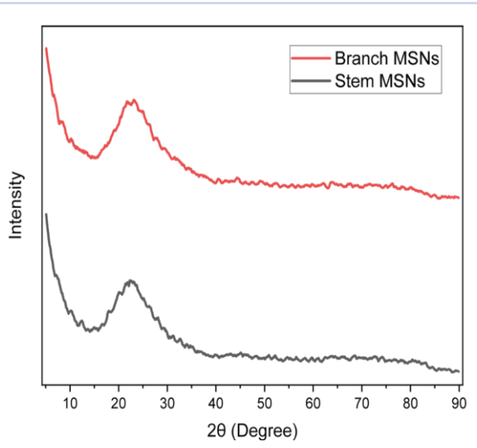


Figure 2. XRD diffractograms of extracted $mSiO_2$ from the stem and branch.

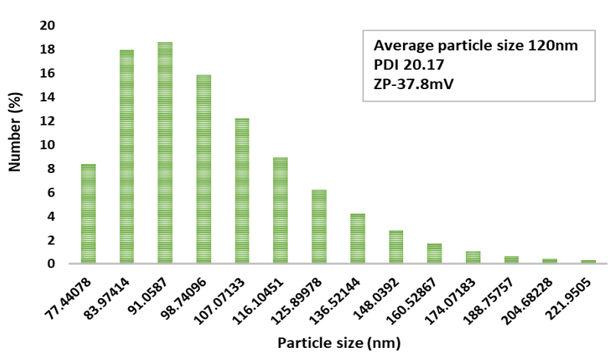


Figure 3. DLS graph of the particle size distribution of $mSiO_2$

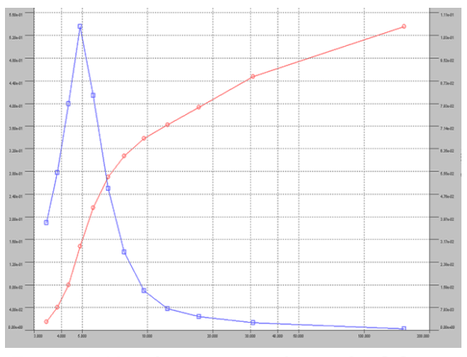


Figure 4. N_2 adsoprtion analysis of $mSiO_2$ showing the pore size distribution

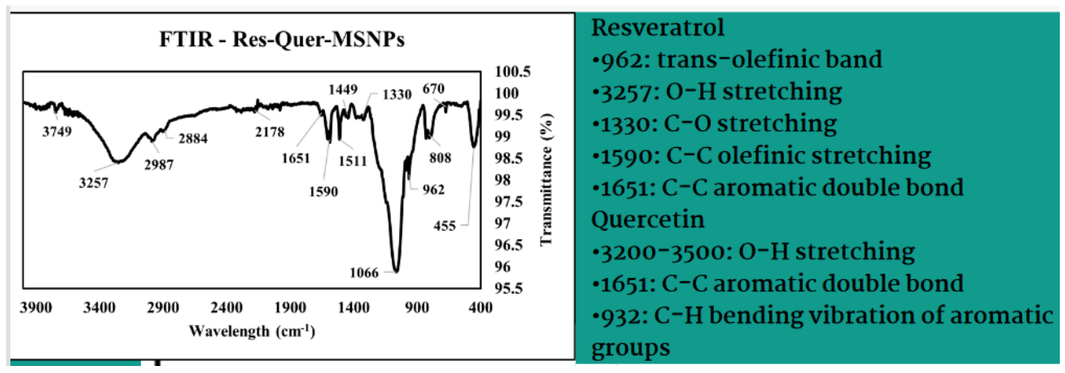
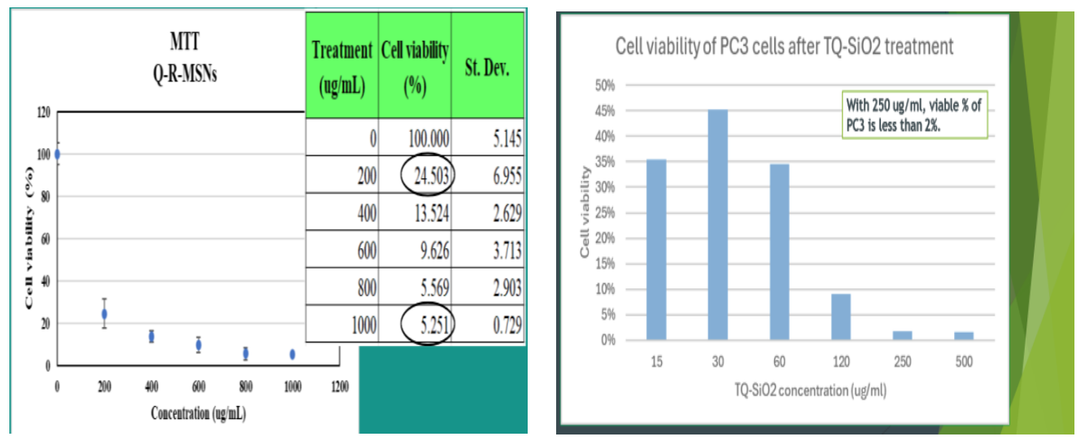


Figure 5. FTIR graph of Quercetin and Resveratrol loaded $mSiO_2$ with their corresponding peaks



Treatment (ug/mL)	Cell viability (%)	St. Dev.
0	100.000	5.145
200	24.503	6.955
400	13.524	2.629
600	9.626	3.713
800	5.569	2.903
1000	5.251	0.729

Figure 6. Percentage of viable Skov cells after Q-R-$mSiO_2$ and PC3 cells after TQ-$mSiO_2$ treatments.

CONCLUSIONS

Phytochemical-loaded amorphous $mSiO_2$ nanoparticles work in a synergistic manner to enhance drug availability and solubility to cancerous cells, evidencing its elevated therapeutic potential to revolutionize medicine administration with a more enclosed focus. Still, more specialized evaluations in *in vivo* models have to be done to broaden the knowledge of the systematic effects.

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