

Biological Activities of Quinoa Seeds Extract and their Effects on Antioxidants of Cancer Cells and Ultrastructure of *Candida tropicalis*

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Over the current decade, drugs based on natural sources have attracted much consideration. Quinoa seeds extract (QSE) was analysed by gas chromatography-mass spectrometry which reflected the presence of 23 compounds. QSE exhibited anticancer effect against prostate (PC-3) and ovarian (SKOV3) cancer cell lines with IC_{50} 65.21 ± 0.24 $\mu\text{g/mL}$ and 81.45 ± 0.79 $\mu\text{g/mL}$, respectively. Apoptosis of cancer cells was confirmed by flow cytometric analysis. Oxidative markers including catalase, glutathione, and superoxide dismutase decreased in specimens treated by QSE, while malondialdehyde increased in treated cancer cells. Growth of different yeasts was inhibited by QSE with different inhibition zones of 12 ± 0.33 , 13 ± 1.5 , and 21 ± 0.5 mm. The minimum inhibitory concentration was 250, 125, and 31.2 $\mu\text{g/mL}$ using *Candida glabrata*, *C. albicans*, and *C. tropicalis*, respectively. Transmission electron microscopy reflected ultrastructure changes in treated *C. tropicalis* by QSE, including cell wall rupture, collapse of cytoplasm, and shrinking of cytoplasmic membrane. It was concluded that QSE could suppress the proliferation of SKOV3 cells *in vitro* and induce their apoptosis. Moreover, the inhibition of tested yeasts might be mediated by ultrastructural changes.

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INTRODUCTION

Quinoa (*Chenopodium quinoa*), a species from the Chenopodiaceae family, is recognized as a pseudo-cereal originating from South America and has lately been familiarized to Europe, Asia, North America, and Africa. It serves as a natural source of food for humans due to its high nutritional value (Hernandez-Ledesma 2019). The *Chenopodium* genus is globally distributed, encompassing over 200 species, with seed colors including white to grey, red, and black. Quinoa is particularly valued as a nutritious food source, especially in developing nations. The seeds are rich with minerals and vitamins, as well as various bioactive compounds, including phenolics, carotenoids, and

flavonoids, which exhibit several biological properties (Vega-Gálvez *et al.* 2010). These metabolites are associated with a range of biological utilizations, including antimicrobial, anti-inflammatory, antioxidant, and anti-carcinogenic influences (Rahimi and Bagheri 2020). Some constituents of quinoa include phytosterols, betalains, phytoecdysteroids, saponins, polysaccharides, and phenolic compounds according to the review paper by Agarwal *et al.* (2023) and have antimicrobial, anticancer, and antiacetylcholinesterase properties. Khan and Javaid (2020a) mentioned that in addition to the quinoa seeds, the whole plant contains a variety of bioactive compounds that play an important role in the regulation of diabetics, in the prevention of inflammation, cancer suppression, management of cardiovascular, and obesity, besides other health issues.

The antifungal properties of quinoa saponins have been noted for their capability to bind with membranes steroids, which disrupts the membrane's integrity. In a previous study, quinoa saponins such as hederagenin and oleanolic acid glycosides suppressed *Candida albicans* growth (Woldemichael and Wink 2001). According to Bhaduri (2016), the extract of quinoa seeds inhibited some bacteria, namely *Enterococcus faecalis*, *P. aeruginosa*, and *Staphylococcus epidermidis*. However Park *et al.* (2017) did not record antibacterial properties of quinoa seed extracts (QSE) against *Listeria monocytogenes*, *Escherichia coli*, *Listeria monocytogenes*, *Staphylococcus aureus*, *Campylobacter jejuni*, *Salmonella typhimurium*, and *Bacillus cereus*. A gas chromatography-mass spectrometric (GC-MS) investigation of quinoa stems exhibited the occurrence of some composites which reflected antifungal, antibacterial, and antioxidant functional (Khan and Javaid 2019). Also *via* GC-MS analysis, several compounds were detected in quinoa leaves which repressed the growth of *Macrophomina phaseolina* (Khan and Javaid 2020b).

One of the most fatal diseases with a high occurrence in recent decades is cancer, which is a term used to describe about 100 different forms of malignant tumors with varying pathological and etiological characteristics (Al-Rajhi *et al.* 2022; Alghonaim *et al.* 2023). The current study concentrated on two cancer types: ovarian and prostate cancer. Recent research indicates that ovarian cancer is the most lethal gynecologic cancer, with less than half of patients surviving for more than five years following diagnosis (Li *et al.* 2024). Ovarian cancer is most often detected after menopause; however it can affect women at any age (Baker 2024). Regarding the other kind of cancer, 15% of all malignancies in males are prostate cancers, making it the second most frequent kind of male cancer (Almeeri *et al.* 2024). James *et al.* (2024) reviewed several scientific papers and concluded that prostate cancer cases will reach to 2.9 million infections in 2040, while in 2020 the number of cases was 1.4 million. Quinoa leaves extract showed anticancer activity against prostate cancer cell proliferation (Gawlik-Dziki *et al.* 2013). Human breast cancer (MCF-7) was inhibited by quinoa seeds because of the presence of several phenolic acids in their extract (Liu *et al.* 2020). Allami *et al.* (2022) indicated that QSE possess anticancer potential against hepatocarcinoma cell line (HepG2). The anticancer properties of quinoa seeds were linked to the existence of polyphenolic compounds, betalain saponin, flavonoids, and carotenoids, as reported previously (Pellegrini *et al.* 2017). Also, Hu *et al.* (2017) found that polysaccharide, phytoecdysteroids, and bioactive peptides of quinoa served as anticancer agents. Numerous cervical carcinoma cell lines in human namely C4-I, HTB-34, and HTB-35, were suppressed by quinoa extract (Pasko *et al.* 2019). As mentioned in the present introduction, QSE has been shown to possess anticancer and antimicrobial activities. The novelty of the present investigation lies in its focus on the

mechanisms of anticancer and antiyeast activities. This study planned to estimate the bio-function of QSE against pathogenic yeasts and two kinds of cancer including prostate cells and ovarian cells with action mechanisms.

EXPERIMENTAL

Quinoa Seeds Extract Preparation and Its Characterization via GC-MS

The seeds of quinoa (*Chenopodium quinoa*) were sourced from the Agriculture Research Center, Jazan, Saudi Arabia. For the preparation of the QSE, 50 g of quinoa seeds (finely ground) were blended with 300 mL of methanol. The resulting mixtures were then allowed to sit in a shaking incubator for 45 min at 150 rpm and 25 °C (room temperature) prior to filtration. The clear extract was gathered and subsequently evaporated at 70 °C utilizing rotary evaporator to obtain 5 g dry weight extract. The GC-MS (Agilent 7890A, Agilent Technologies, Santa Clara, CA, USA) was utilized to characterize the obtained extract from quinoa seeds. The employed carrier gas was helium (flow proportion was 1 mL/min). The temperature of inlet, MSD ion source, filter mass, interface GC-MSD were 270, 170, 150, and 280 °C, respectively. The temperature of the column was programmed serially at 60 °C (held for 2 min), 240 °C/min, and 300 °C/min. Compound identification was conducted utilizing the NIST MS data library.

Antitumor Activity of QSE with Malondialdehyde and Antioxidants Detection

The anticancer potential of QSE was examined using the MTT test on human prostate (PC-3) and ovarian (SK-OV-3) cancer cells (American Type Culture Collection, Rockville, Maryland, United States). The cells were cultivated with the extract for 48 h at 37 °C with 5% CO₂ in a humidified incubator after being seeded at a density of 1×10^5 cells per well. About 10 µL of MTT reagent were applied to each well. Following a 4-h incubation period at 37 °C, the medium was extracted. Dimethyl sulfoxide (DMSO) was used to dissolve the formazan crystal. A microplate reader was employed to measure the absorbance at 570 nm. The inhibition of cells was recorded from the Eq. 1:

$$\text{Inhibition (\%)} = 1 - \frac{\text{Treated cells absorbance by the extract}}{\text{Untreated cells absorbance}} \times 100 \quad (1)$$

Glutathione malondialdehyde (MDA), Superoxide dismutase, and Catalase were determined according to Tsikas (2017), Zhao *et al.* (2019), and Kumar *et al.* (2012), respectively.

Cell Cycle and Apoptosis Analysis

For cell cycle analysis, the PC-3 and SK-OV-3 cells treated by 100 µg/mL of QSE for 48 h were harvested and then fixed through dipping in ice-cold 70% ethanol for 12 h at 4 °C. The pellets of cells were obtained *via* centrifugation (1000 rpm) and then resuspended in phosphate buffered saline (PBS), a commonly used buffer in cell biology that maintains a stable pH. Propidium iodide (PI) was used to staining the tested cells and analyzed using a flow cytometer (CytoFLEX, CA, USA). For analysis of cell apoptosis, apoptosis-mediated PC-3 and SK-OV-3 cells death was detected by FITC-labeled Annexin V/PI. The

resuspended PC-3 and SK-OV-3 cells in PBS were mixed with Annexin V and PI for 15 min in dark. The apoptosis of tested cells were assessed using the flow cytometer.

Yeast Inhibition Evaluation Using QSE

The well-plate agar diffusion method was used with slight modifications, to evaluate QSE anti-yeast efficacy against *Candida glabrata* (66032), *Candida albicans* (ATCC 10221), and *Candida tropicalis* (66029) in accordance with Almeyhayawi *et al.* (2024). The studied yeasts were placed in petri dishes after being standardized (according to the 0.5 McFarland scale) and sown in sterile Sabouraud dextrose agar (SDA) medium. Four wells (6 mm radius) were cut from the solidified SDA medium *via* sterile cork borer. The tested QSE (100 μ L of 100 μ g/mL) was injected into the wells using an automated microlitre pipette. Nystatin, an antifungal, served as a standard control, and DMSO was served as an un-effective control. The cultivated plates were then refrigerated at 4 °C for 1 h. After that, it was kept for 2 days at 35 °C in an incubator. The imaged clear zones were documented using a calibrated ruler (Al-Rajhi *et al.* 2023).

Detection of Minimum Inhibitory Concentration of QSE

The minimum inhibitory concentration (MIC) of QSE against the investigated yeasts were examined. A dilution equal to 0.5 McFarland was made for every type of yeast. The QSE was diluted to a dose of 1.0 mg/mL. RPMI 1640 broth (100 μ L) was poured in the well of 96-well microtiter plate, then 100 μ L of serial dilutions of QSE dose (3.9 to 500 μ g/mL) was mixed with RPMI 1640 broth. The wells were inoculated with 100 μ L (0.5 McFarland) of the studied yeast suspensions whereas wells devoid of yeast cell suspensions functioned as a negative control. After that, the plate was incubated at 30 °C for one day. MIC was the lowest extract concentration that resulted in a 50% drop in growth when compared to the controls. (Alsalamah *et al.* 2023).

Ultrastructure Investigation of *C. tropicalis* by Transmission Electron Microscopy (TEM)

C. tropicalis was the most sensitive to QSE compared to other tested yeasts. Therefore, it was selected for further study *via* TEM investigation. *Candida tropicalis* treated by a sub-dose of extract MIC (20 and 30 μ g/mL) was initially cultured for one day before being viewed under a microscope. The cultures were then ready for TEM examination. The treated *C. tropicalis* was centrifuged at each step of the procedure: the fixation and dehydration stages took 5 min at 1500 rpm, and the infiltration stage took 10 min at 3000 rpm. After being received, the pellets were fixed for 30 min at 25 °C, employing 2% glutaraldehyde that had been dissolved in 0.05 M sodium phosphate. Using 1% solution of OsO₄, *C. tropicalis* cells were post-fixed with for 2 h at 5 °C, next being washed with sodium phosphate. After that, sample of *C. tropicalis* was desiccated for 2 h in ethanol. After 3 h of infiltration into each of the resin/ethanol sequences (20/80, 40/60, 60/40, and 80/20), the samples were left in 100% Spurr resin for 12 h. After being “sandwiched” in 100% Spurr resin and sprayed with a Teflon-like substance, the pellets were finally placed into coverslips to go through a 24-h polymerization process at 60 °C. After cooling, the coverslips were taken off and examined under a stereomicroscope to scrape off any resin fragments that contained pellets. The samples of *C. tropicalis* cells were then dried in an ethyl alcohol sequences (15%, 30%, 50%, 75%, and 100%) for 2 h

each. Next came 3 h of infiltration into the resin/ethyl alcohol sequences 20/80, 40/60, 60/40, and 80/20. The samples of *C. albicans* were incubated for 12 h at 100% Spurr resin. The pellets were ultimately put into coverslips to undergo a 24-h polymerization process at 60 °C after being “sandwiched” in 100% Spurr resin and sprayed with a Teflon-like material. Coverslips were removed once cooled and inspected under a stereomicroscope to eliminate any pellet-containing resin pieces. The pellets were cut *via* a Leica Ultracut R ultramicrotome, then located in resin blocks and examined by TEM (Hitachi H7500, running at 100 keV) (Abd El-Ghany and Tayel 2009).

Statistical Analysis

The analyses were performed as mean $\pm$ standard deviation (SD) and were estimated employing Microsoft Excel 365 and SPSS v.25.

RESULTS and DISCUSSION

The GC-MS analysis of QSE revealed the presence of 23 compounds in different retention times, molecular weight, area%, and molecular formula (Table 1 and Fig. 1). Ethyl oleate, followed by ethyl-9,12-octadecadienoate, ethyl hexadecanoate, ethyl octadecanoate, and glyceryl monooleate, were detected with high area% as 24.3%, 13.4%, 7.33%, 7.19%, and 3.50%, respectively. Other compounds were detected at area % ranging from 0.25% to 2.47%. Leaves extract of quinoa was analysed *via* by GC-MS (Khan and Javaid 2022). Nine compounds were detected, from which 1,2-benzenedicarboxylic acid, diisooctyl ester, and stigmasterol exhibited fungicidal effects against *M. phaseolina*. Carranza-Concha *et al.* (2021) mentioned that the chemical constituents of QSE and their levels of biological activities can differ among varieties. Some of the identified in QSE such as n-hexadecanoic acid demonstrated effect on human colon cancer cells IC₅₀ quantity of 36.04 μ g/ml (Bharath *et al.* 2021). Also flavone 4'-OH,5-OH,7-Di-O-glucoside reflected antioxidant and anticancer properties (Khan *et al.* 2021). n-Hexadecanoic acid and ethyl oleate according to study by Saravanakumar *et al.* (2018) have been employed as antimicrobial and antioxidant agents.

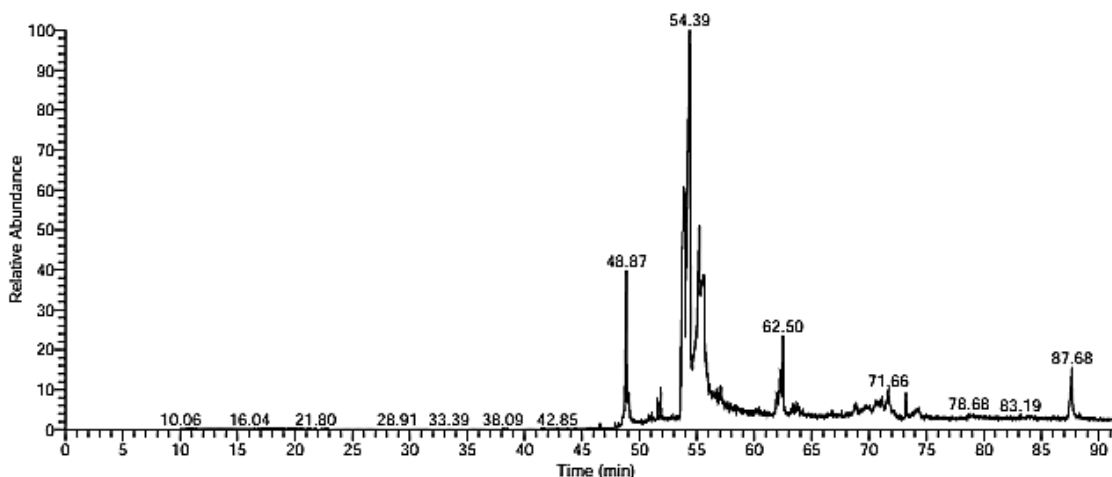


Fig. 1. GC-MS chromatograms of QSE

The cells of PC-3 and SK-OV-3 were affected by the QSE, but PC-3 was more affected than SK-OV-3 at all studied doses. For instance, up to a dose of 250 µg/mL QSE, the toxicity level reached to 96.3% for PC-3, while it was 21.4% for SK-OV-3 (Fig. 2). Moreover, the IC₅₀ quantities of QSE were 65.21 ± 0.24 and 81.45 ± 0.79 µg/mL for PC-3 and SK-OV-3, respectively. The QSE was tested on normal Vero cells (ATCC: CCL-81) but gave high IC₅₀ 213.52 ± 2.33 µg/mL (data not tabulated). The influence of QSE was noticed on the morphological profile of tested cancer cells, as illustrated in Fig. 3. The change that occurred in PC-3 cell shape was highly influenced by quinoa extract compared to their effect on SK-OV-3 cells, particularly at high doses of the extract.

Table 1. Detected Compounds in QSE via GC-MS Analysis

*RT (min)	Area (%)	Compound	Formula	**MW (g/mol)
46.56	0.25	Methyl hexadecanoate	C ₁₇ H ₃₄ O ₂	270
48.51	0.20	Octadec-9-enoic acid	C ₁₈ H ₃₄ O ₂	282
48.86	7.33	Ehtyl hexadecanoate	C ₁₈ H ₃₆ O ₂	284
49.12	1.32	n-Hexadecanoic acid	C ₁₆ H ₃₂ O ₂	256
50.81	0.29	(9E,12Z)-octadeca-9,12-dienoic acid	C ₁₈ H ₃₂ O ₂	280
51.58	1.20	9,12-Octadecadienoic acid, methyl ester, (E,E)	C ₁₉ H ₃₄ O ₂	294
51.86	1.51	Methyl octadec-9-enoate	C ₁₉ H ₃₆ O ₂	296
53.80	13.43	Ethyl-9,12-octadecadienoate	C ₂₀ H ₃₆ O ₂	308
54.39	24.29	Ethyl oleate	C ₂₀ H ₃₈ O ₂	310
54.59	1.63	9,12-Octadecadienoyl chloride, (Z,Z)	C ₁₈ H ₃₁ ClO	298
55.22	7.19	Ethyl octadecanoate	C ₂₀ H ₄₀ O ₂	312
62.26	2.25	Linoleoyl chloride	C ₁₈ H ₃₁ ClO	298
62.51	3.50	Glyceryl monooleate	C ₂₁ H ₄₀ O ₄	356
63.35	0.47	(Z,Z)-1,3-Dioctadecenoyl glycerol	C ₃₉ H ₇₂ O ₅	610
63.80	0.46	(9Z)-9-Hexadecenoic acid 2-oxiranylmethyl ester	C ₁₉ H ₃₄ O ₃	310
67.62	0.25	(Z,Z)-1,3-Dioctadecenoyl Glycerol	C ₃₉ H ₇₂ O ₅	620
68.68	0.33	Linolein, 2-mono	C ₂₁ H ₃₈ O ₄	354
70.52	0.27	Tricyclo[20.8.0.0(7,16)]triacontane, 1(22),7(16)-diepoxy	C ₃₀ H ₅₂ O ₂	444
73.21	1.21	Supraene	C ₃₀ H ₅₀	410
74.33	0.36	1,2,3-propanetriyl tris[(E)-9-octadecenoate	C ₅₇ H ₁₀₄ O ₆	884
78.68	0.25	Flavone 4'-OH,5-OH,7-Di-O-glucoside	C ₂₇ H ₃₀ O ₁₅	594
87.67	2.47	(9E)-9-Hexadecenyl (9E)-9-hexadecenoate	C ₃₂ H ₆₀ O ₂	476
88.31	0.31	2-[12-(oxiran-2-yl)dodecyl]oxirane	C ₁₆ H ₃₀ O ₂	254

*RT: Retention time, **MW: Molecular weight

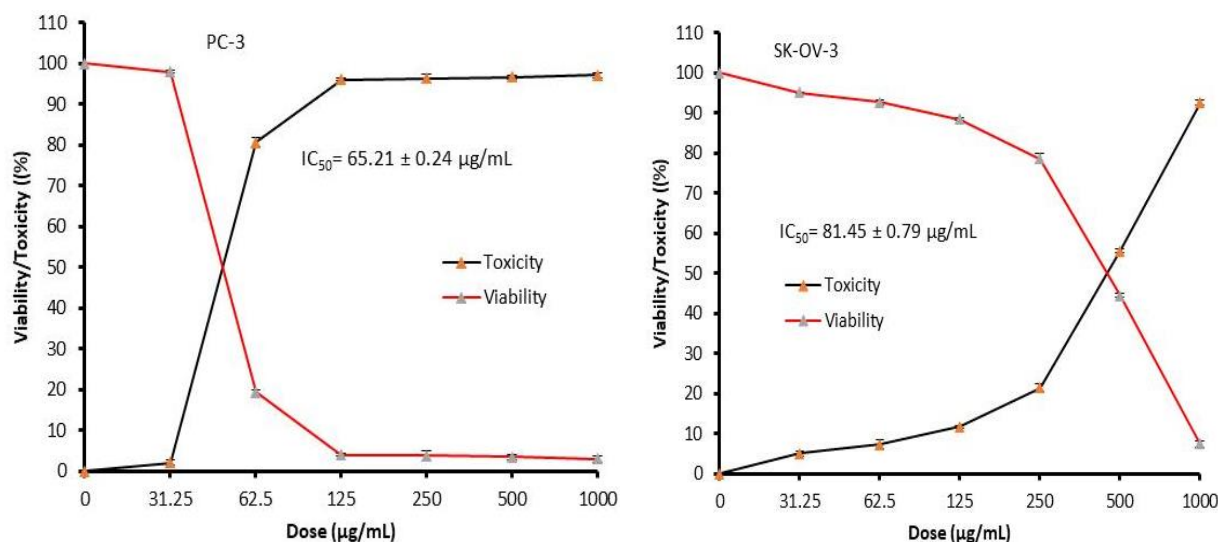


Fig. 2. Toxicity of quinoa seeds extract against PC-3 and SK-OV-3 cancer cell lines

The cells appeared to be circular, and led to shrinkage of cells, besides aggregation due to the effect of the QSE, particularly at high doses. These results indicated that QSE may perform a vital effect in the chemoprevention of tumor. According to Shen *et al.* (2022), in a dose-dependent manner, seed oil of black quinoa displayed anti-propagation influence on HCT 116 cells *via* the stimulation of apoptosis. In a previous study, polysaccharide composed of glucose and galacturonic acid separated from *C. quinoa* seeds exhibited multiple biological functions including immune-regulatory, antioxidant, and anticancer (human liver cancer and human breast cancer) effects *in vitro* (Hu *et al.* 2017). Mollaei *et al.* (2021) observed that lung cancer cells apoptosis was induced by exposure to QSE, and apoptosis was accompanied by increasing the *BAX/BCL2* ratio. The anticancer potential of quinoa seeds may be attributed to the presence of some constituents such as 1H-indole-3-carboxaldehyde and benzaldehyde, 4-hydroxy- as mentioned previously (Khan and Javaid 2020a). Excellent IC_{50} value ($14.6 \mu\text{g/mL}$) was recorded using QSE against HepG2 (Mohamed *et al.* 2019). The powder of quinoa seeds was attractive (IC_{50} was $14.6 \mu\text{g/mL}$) against hepatocarcinoma cell line of HepG2 (Allami *et al.* 2022). Additional, quantification of QSE-stimulated apoptosis of PC-3 and SK-OV-3 cells was conducted by flow cytometric assessment (Figs. 4 and 5). Cellular DNA content in cancer cells was analysed after staining by propidium iodide, the analysis showed four phases G0/G1/S/G2-M, which reflect that it probably can be used to determine cell cycle arrest, which is correlated to the quantity of DNA in all phases separately. The outcomes of cycle analysis explained that the PC-3 and SK-OV-3 cells presented an increase in proliferation of cells, but QSE treatment exhibited a decline in cell development, indicating a progress of apoptosis. The results of Mollaei *et al.* (2021) indicated that quinoa may possess fatal properties on the MCF-7 through apoptotic mechanism. A similar remark concerning cell cycle arrest at various stages was recognized by El Makawy *et al.* (2024); they showed that quinoa extract efficaciously arrested the cycle of cancer cells at the G0/G1. According to Shang *et al.* (2024), saponins of quinoa ($40 \mu\text{g/mL}$) decreased the HT-29 cells viability, where the cell cycle illustrated that the cell number proportion in the G0/G1 phase

multiplied by 23.0%, besides the apoptosis percentage being raised by 22.6%. As mentioned in Table 2, the oxidative markers were influenced in treated cells by quinoa extract. Catalase, glutathione, and superoxide dismutase (SOD) declined in treated cells, while MDA increased (16.9 ± 0.80 and 20.13 ± 1.05 $\mu\text{mol/mg}$ protein in PC-3 and SKOV-3, respectively) in treated cells. The present findings were similar with a recent investigation that used the cinnamon plant and other cancer cells (breast and human fetal lung fibroblast) (Selim *et al.* 2024).

Table 2. Malondialdehyde and Antioxidants in PC-3 and SK-OV-3 Cancer Cell Lines Treated by Quinoa Seeds Extract

Cell Type		MDA ($\mu\text{mol/mg}$ protein)	Catalase (U/mg protein)	Glutathione Reduced (mmole/mg protein)	SOD (U/mg protein)
PC-3	Control	7.23 ± 0.31	23.50 ± 0.87	28.43 ± 0.68	25.43 ± 0.61
	Treated	16.9 ± 0.80	13.97 ± 1.60	12.53 ± 1.27	11.83 ± 1.62
SKOV-3	Control	9.10 ± 0.46	30.67 ± 1.46	21.50 ± 0.82	17.30 ± 0.60
	Treated	20.13 ± 1.05	19.03 ± 2.02	15.77 ± 0.31	7.77 ± 0.25

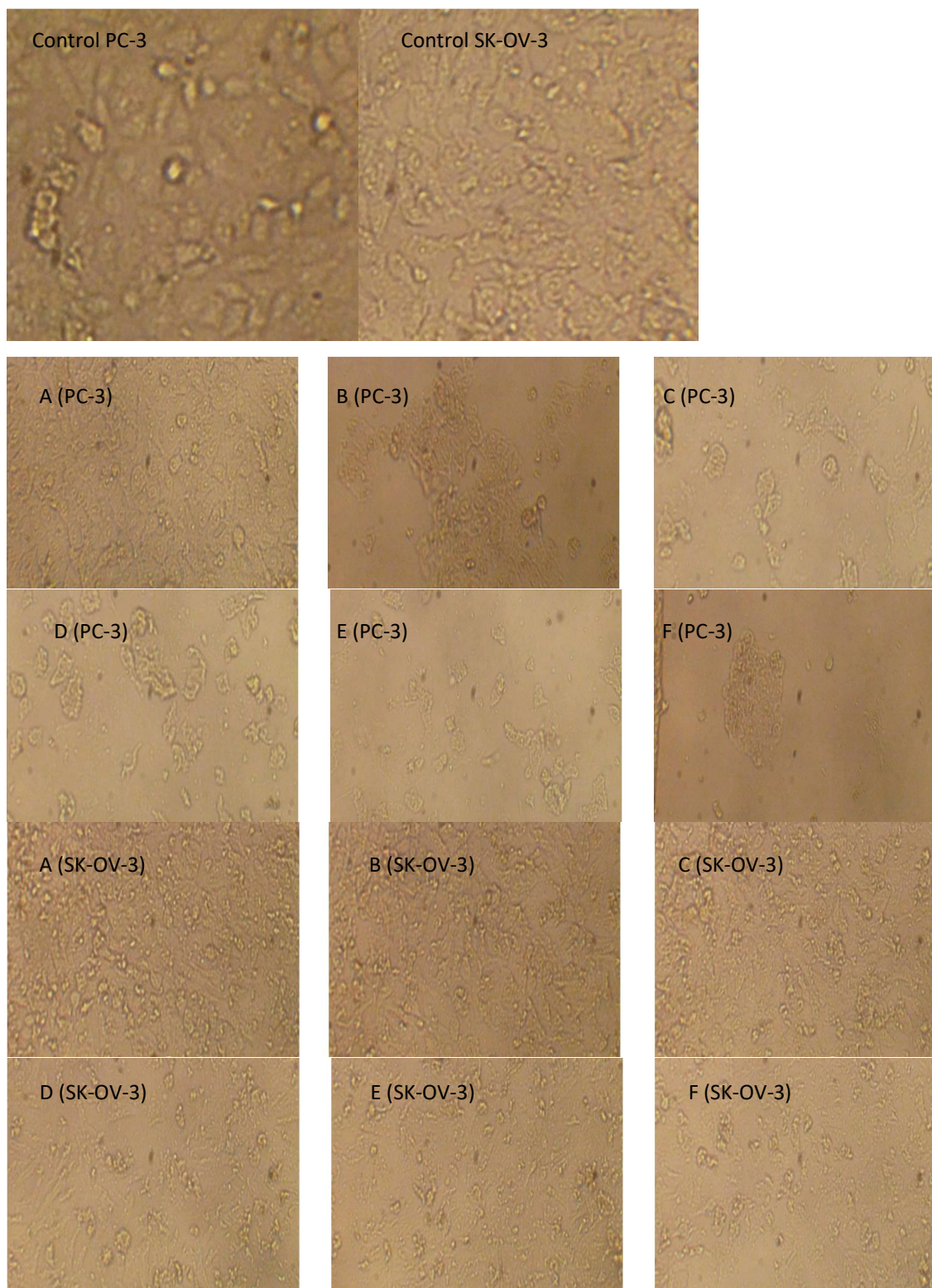


Fig. 3. Morphological changes in treated PC-3 and SK-OV-3 cancer cell lines treated by different doses of quinoa seeds extract. A, 31.25; B, 62.5; C, 125; D, 250; E, 500; and F, 1000 $\mu\text{g/mL}$

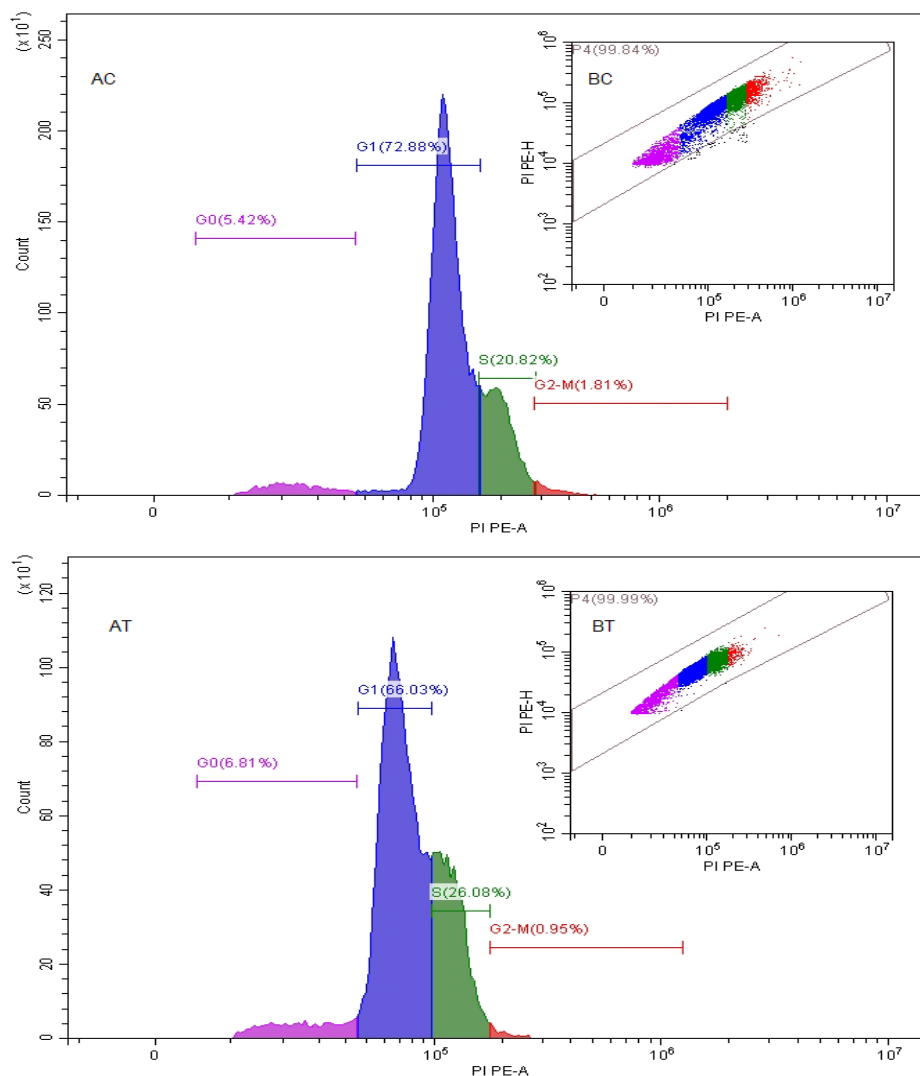


Fig. 4. Flow cytometric assess of PC-3 (AC) and apoptosis rate (BC) (control), Flow cytometric assess of PC-3 (AT) treated and apoptosis rate BT (treated)

The recorded results indicated that QSE inhibited the tested yeasts but less than the effect of the standard drug (Table 3 and Fig. 6). *Candida tropicalis* was the most susceptible (inhibition zone 21 ± 0.5 mm), followed by *C. albicans* (inhibition zone 13 ± 1.5 mm), and *C. glabrata* (inhibition zone 12 ± 0.33 mm) with MIC values of 31.25, 125, and 250 $\mu\text{g/mL}$, respectively. *Candida tropicalis* was examined via TEM to show the effect of quinoa extract on their ultrastructure; remarkable changes were watched in the treated cells including cell wall, collapse of cytoplasm, and shrinking of cytoplasmic membrane at 20 $\mu\text{g/mL}$ (Fig. 7). At 30 $\mu\text{g/mL}$, damage with rupture in cell wall was observed besides appearance of irregular cytoplasm. These changes were compared to the untreated cell (control), which was observed in identical form. Antimicrobial activities of crude polysaccharide extracts were tested against various bacteria and yeasts. The extracts inhibited bacteria but not inhibited *Cryptococcus neoformans* and *C. albicans* (Zhu *et al.* 2024). Sen *et al.* (2024) documented the antifungal and anticancer characteristics of quinoa-derived peptides and consequently suggested their possible use in drug industry.

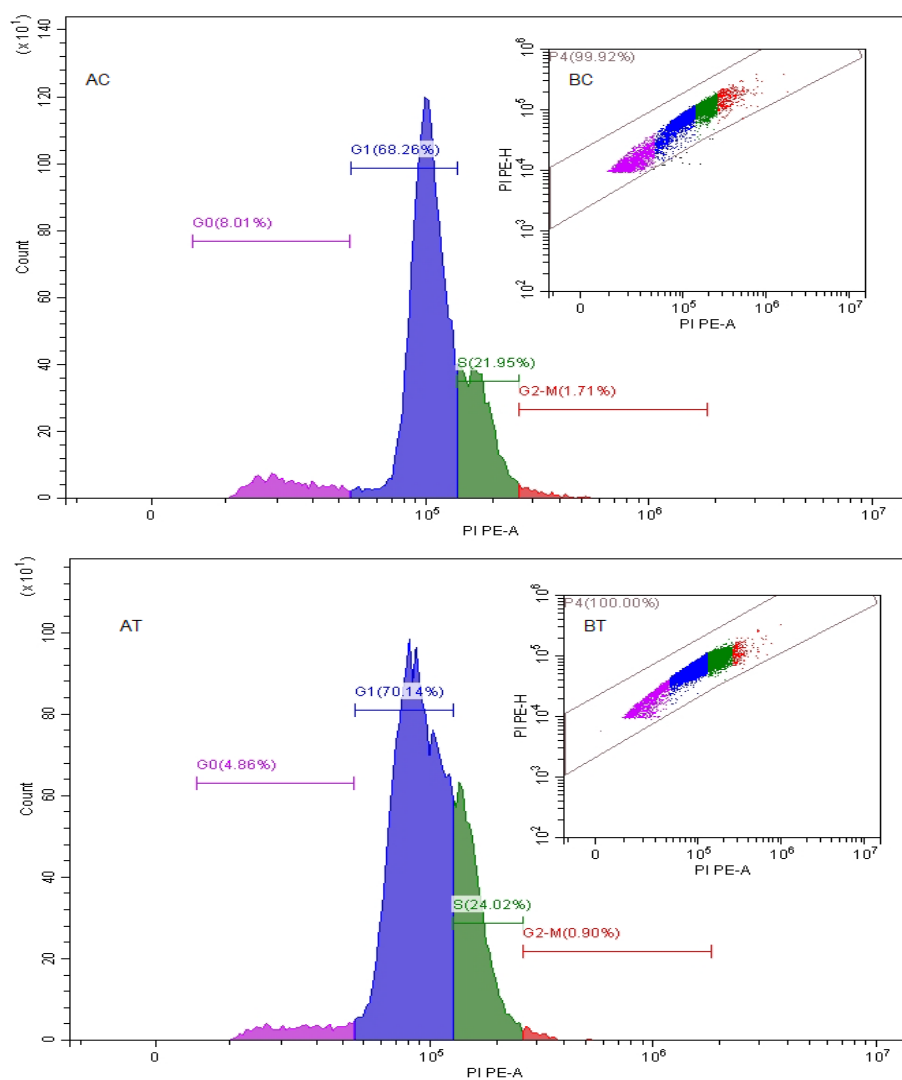


Fig. 5. Flow cytometric assess of SK-OV-3 (AC) and apoptosis rate (BC) (control), Flow cytometric assess of SK-OV-3 (AT) treated and apoptosis rate BT (treated)

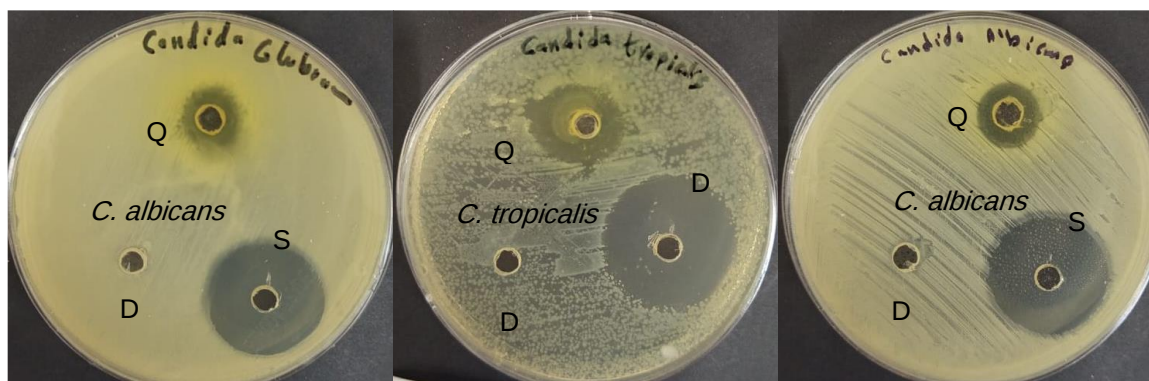


Fig. 6. Inhibition of different species of yeasts by quinoa extract (Q), fluconazole (S), and DMSO (D)

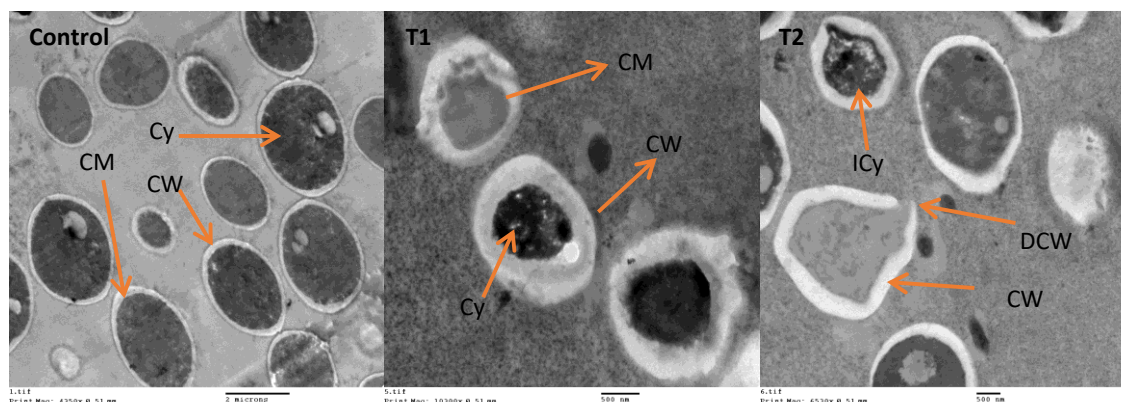


Fig. 7. Ultrastructure of *C. tropicalis* at two different doses of quinoa seeds extract 20 µg/mL (T1) and 30 µg/mL (T2). (CW, cell wall; CM, cell membrane; Cy, cytoplasm; ICy, irregular cytoplasm; DCY, damage cell wall)

Table 3. Inhibition of Different Yeasts of Quinoa Seeds Extract with MIC Values

Tested Yeast	Inhibition Zone (mm)			MIC (µg/mL)	
	Extract	Standard	DMSO	Extract	Standard
<i>C. albicans</i>	13±1.5	28±0.5	0.0	125	3.9
<i>C. tropicalis</i>	21±0.5	30±0.33	0.0	250	7.8
<i>C. glubruim</i>	12±0.33	27±0.66	0.0	31.25	15.62

CONCLUSIONS

1. By means of gas chromatography-mass spectrometry (GC-MS), numerous compounds were detected in quinoa seed extract (QSE); moreover, the ethyl oleate represented the main detected compound with the highest area %
2. The results showed that the PC-3 and SK-OV-3 cells were sensitive to quinoa seeds extract.
3. The pathogenic yeasts namely *Candida tropicalis*, *C. albicans*, and *C. glubruim* were inhibited by QSE with different levels of inhibitions.
4. Transmission electron microscopy (TEM) investigation showed changes in the ultrastructure of *C. tropicalis* that had been exposed to different doses of QSE.

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