Antioxidant, photoprotective, cytotoxic, and antimicrobial activities of *Albuca amoena* Batt.

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**Implication for health policy/practice/research/medical education:**
Our findings reveal that *Albuca amoena* extracts have a remarkable cytotoxic activity and a beneficial effect on the skin. By carrying out other phytochemical tests, this plant might be used as a source of molecules for drug development.


**Introduction**

Medicinal plants contain an immense reservoir of active principles that are responsible of pharmacological activities, which provide unlimited possibilities for the discovery of new drugs from nature. Human was and remains linked to their use to treat and relieve various health problems (1,2). Based on the World Health Organization (WHO) calculations, 80% of world population utilizes plants as remedies for curing several diseases (3).

Because of its geographical position, Morocco is
characterized by an important medicinal flora that represents a very attractive track for the valorization of the therapeutic activities of these plants (4). Many species have been used by Moroccan people, mostly in rural regions, for centuries in folk medicine for medicinal purposes using traditional practices for preparations; most of them have been registered in the Moroccan pharmacopoeia (5). *Albuca amoena* Batt., called Ouliad in Morocco, is a fast-growing herbaceous annual plant from the Asparagaceae family. This medicinal plant is found on sandy and stony desert pastures of northwestern Sahara in Algeria and the adjacent regions of Morocco. Traditionally, *A. amoena* is known among the native population by its use at the dermal level for the treatment of melanoma or leishmaniasis, and at the sedative level against pain or excitement (6–9). There is no report in the literature about the biological activity of this species. However, various species of the genus *Albuca* have been found to have antioxidant, anti-diabetic, antibacterial, cytotoxicity, and anti-inflammatory activities (10–13).

Oxidative stress exerts a significant influence on the initiation and progression of numerous disorders, for example, cancer, diabetes, aging, autoimmune disorders, and even cardiovascular and neurodegenerative diseases (14). Plant-derived antioxidant compounds are considered effective in suppressing or inhibiting cellular damage caused by free radicals (15). Polyphenols are the major secondary metabolites of plants that have an aromatic ring with at least one hydroxyl group. They function as agents for reducing, scavenging of singlet and triplet oxygens, and providers of hydrogen (16).

Nowadays, the development of antibiotic resistance is due to the excessive use of antimicrobial agents in clinical practices, where bacteria develop this strategy to promote resistance to antimicrobial agents (17). Several studies have been conducted on natural antimicrobials of plant origin with the aim of discovering new and natural bioactive compounds with antimicrobial characteristics for drug development (18).

Ultraviolet (UV) radiation, particularly UVA and UVB rays, reach the earth and can penetrate the skin, resulting in various unhealthy effects (19). The primary impact of these radiations is the generation of reactive oxygen species (20). Skin protection against these external aggressions remain a priority, and only chemical protection, meaning the use of sunscreens, remains effective, because their chemical composition is based on the use of compounds capable of absorbing radiation (21).

Tyrosinase is an enzyme that plays an essential role in melanogenesis (22). It is involved in a speed-limiting step in melanin production, catalyzing the oxidation of L-tyrosine and L-DOPA (L-3,4-dihydroxyphenylalanine) to dopaquinone in melanocyte melanosomes (23). Melanin is responsible for pigmentation of the eyes, skin, and hair, and plays an important role in protecting the skin from UV damage (24). However, it has been asserted that hyperpigmentation anomalies are implicated in melasma and melanoma, and are also responsible for significant and adverse medical incidents, particularly in the elderly (25).

In the context of the valorization of an endemic plant, this work proposed the testing of various biological properties (antioxidant, photoprotective, cytotoxic, and antimicrobial) of the hydroalcoholic extracts obtained from the aerial and bulbous parts of *A. amoena*.

**Materials and Methods**

Plant materials and extraction process

The hydroalcoholic extracts from aerial part (AP) and bulbous part (BP) of *A. amoena* used in this study were the same as those prepared in our previous work (26). The specimen of the plant was gathered in March 2019 from Boudnib, Morocco. A vouchers specimen was placed in the herbarium unit of the Scientific Institute of Rabat, Morocco, under the reference code RAB108289. The extracts were prepared using cold maceration (during 24 h) in a mixture solution of ethanol and distilled water (1V: 1V).

**Phytochemical tests**

*Determination of total polyphenols content*

The content of total polyphenols was conducted by the Folin-Ciocalteu method (27). The results were presented using a standard curve based on gallic acid. Then, the total polyphenol content was expressed as milligram of gallic acid per gram of extract (mg GAE/g extract).

*Determination of total flavonoids content*

To determine the flavonoids present in the hydroalcoholic extracts of *A. amoena*, the aluminum chloride colorimetric method was used (28). A quercetin calibration curve was used to present the results in milligram equivalent of quercetin per gram of the extract (mg EQ/g extract).

*Determination of total flavonols content*

The detection of flavonol content in the extracts was determined according to the method described by Yermakov et al (29). The expression of the flavonol content was in milligram equivalent of quercetin per gram of any extract (mg EQ/g extract) from the calibration curve of quercetin, established under the same operating conditions.

*Determination of total condensed tannins content*

To detect the condensed tannin content, the method described by Karray-Bouraoui et al. (30) was used. A catechin standard was also prepared under the same conditions to present the results in equivalent milligrams of catechin per milligram of the extract (mg EC/mg extract).
Antioxidant activity

**DPPH free radical scavenging assay**

According to Sahin et al method (31), *A. amoena* extracts were tested for their antiradical activity. The results were expressed as an inhibition concentration of 50% of DPPH (IC₅₀). Indeed, quercetin was used as a positive control for comparison. The calculation of percentage of inhibition was determined using the following formula:

\[
\text{Percentage of inhibition (\%)} = \left( \frac{\text{absorbance of sample} - \text{absorbance of control}}{\text{absorbance of control}} \right) \times 100
\]

**ABTS radical scavenging assay**

The effects of the extracts on stabilizing 2,2’-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) as a source of free radicals were evaluated according to the method described by Tuberoso et al (32). The ascorbic acid was used as positive control and the percentage of inhibition was calculated in the same way as for DPPH.

**Ferric reducing antioxidant power assay**

The ability of the extracts to reduce ferric iron (Fe³⁺) to ferrous iron (Fe²⁺) was determined according to the method described by El Jemli et al (33). The standard employed in this assay was catechin.

**Total antioxidant capacity assay**

The total antioxidant capacity (TAC) of *A. amoena* extracts was determined according to the method adjusted from Ohikhena et al (34). The TAC was expressed in equivalent milligrams of acid ascorbic per milligram of the extract (mg EAA/mg extract).

**Photoprotection activity**

**UV absorption assay**

For this test, the absorbance of *A. amoena* extracts at a concentration of 5 mg/mL was read at two wavelengths, which exhibited UVA (365 nm) and UVB (300 nm). Methyl salicylate (100 µg/mL) and zinc oxide (5%) were used as positive controls (35).

**Tyrosinase activity assay**

The determination of the anti-tyrosinase activity of *A. amoena* extracts was carried out according to a previous work (36). Kojic acid served as a positive control, and the calculation of percentage of inhibition was carried out in following manner:

\[
\text{Percentage of inhibition (\%)} = \left( \frac{\text{Control} - \text{Blanc} - (\text{Sample} - \text{Blanc sample})}{\text{Control} - \text{Blanc}} \right) \times 100
\]

**Cytotoxic activity**

**Cell culture**

In order to appreciate the cytotoxic effects of the extracts, three cancerous cell lines were employed in this study. Two breast cancer cell lines (MCF-7 and MDA-MB-231) and a colon cancer cell line (HT-29) were kindly obtained by Prof. Hamid Morjani from UFR of pharmacy, Reims, France. The culture of the cell lines was made in DMEM media with 10% Gibco BRL fetal serum, 1% penicillin-streptomycin, and 1% L-glutamine at 37 °C in an atmosphere of 5% CO₂ and 95% air.

**Cell viability: MTT assay**

The evaluation of cancer cell growth inhibition was carried out based on the MTT colorimetric assay (37). The cell cultures were distributed in 96-well microplates at a density of 8000 cells per well. After 24 hours, different concentrations of the extracts, ranging from 3125 to 100 µg/mL, were added to the cells and the whole was re-incubated for 72 hours at 37 °C. In the end, 10 µL of MTT (5 mg/mL) was added and the plates were incubated for 4 h. In these experiments, the negative control consisted of a medium without the extract, while Mitomycin C served as the positive controls. Afterwards, the optical density of each well was read using Wallac Victor X3 multiplate reader, at a wavelength of 570 nm. All *in vitro* experiments were performed in triplicates for each tested substance as well as the control. The cytotoxic effect or the percentage of cell lysis was measured in relation to the viability of untreated cells, according to the following formula:

\[
\text{Cytotoxicity (\%)} = \left( \frac{\text{OD Control} - \text{OD Essai}}{\text{OD Control}} \right) \times 100
\]

Where OD is optical density.

**Antimicrobial activity**

The antimicrobial activities of the hydroalcoholic extracts of AP and BP were evaluated against six pathogens, including Gram-negative bacteria (*Pseudomonas aeruginosa* ATCC 3354, *Escherichia coli* ATCC 25922, *Klebsiella pneumoniae* ATCC 13883, and *Proteus mirabilis* ATCC 21100), Gram-positive bacteria (*Staphylococcus aureus* ATCC 29213), and one yeast (*Candida albicans* ATCC 90028) available in the Research Laboratory of the Ibn Sina Hospital in Rabat, Morocco.

**Preparation of the inoculum**

Each species was inoculated beforehand on nutrient agar to obtain a 24 h culture. Then, 4 to 5 well-isolated bacterial colonies were suspended in 0.9% NaCl physiological water. Finally, this suspension was adjusted to the McFarland 0.25 standard using a turbidimeter.

**Diffusion method in agar medium: Sensitivity test**

The well technique consisted of distributing Muller-Hinton medium for bacteria and Sabouraud simple medium for yeast in Petri dishes. After solidification, the plates were flooded with the pathogenic strain. Identical
volume wells of 5 mm in diameter were made using a sterile Pasteur pipette. Each well received 100 µL of the extract (50, 100, or 200 mg/mL). After 30 minutes of diffusion at laboratory temperature, the dishes were incubated for 24 hours at 37 °C. Tetracycline and Ceftazidime served as positive controls, while distilled water was employed as a negative control. The presence or absence of an inhibition zone was observed (38).

Statistical analysis
We employed the “GraphPad Prism 8” software for conducting statistical analysis. The outcomes were reported as the mean value along with the standard deviation (SD), based on three replicates. The data underwent scrutiny through one-way analysis of variance (ANOVA), followed by a post hoc assessment, with statistical significance set at a P value < 0.05."

Results
Phytochemical test
The total polyphenols and total condensed tannins contents were determined using the calibration curves of gallic acid and catechin, respectively. While, total flavonoids and total flavonols were determined using the calibration curve of quercetin. The results of total polyphenols, flavonoids, flavonols, and condensed tannins contents of A. amoena extracts were summarized in Table 1. Generally, it can be noted that the two hydroalcoholic extracts of AP and BP contained a source of phenolic compounds. Indeed, the total phenolic contents in AP and BP were found to be 6.40 ± 0.06 and 1.34 ± 0.07 mg EAG/g extract, respectively. In addition, the concentration of flavonoids of A. amoena extracts ranged between 8.21 ± 0.03 and 2.80 ± 0.16 mg EQ/g extract. However, the flavonols contents were absent in both extracts. The AP and BP hydroalcoholic extracts also contained condensed tannins with 5.80 ± 0.10 and 2.83 ± 0.11 mg EC/g extract, respectively.

Antioxidant activity
The antioxidant activity of the two extracts of A. amoena was assisted in vitro using four complementary tests: DPPH, ABTS, FRAP, and TAC assays. As summarized in Table 2, the hydroalcoholic extract from the aerial part of A. amoena showed the highest antioxidant capacity compared to the hydroalcoholic extract from the bulbous part in the four tests. The AP extract presented free radical neutralization capacities, with IC₅₀ of 0.250 ± 0.009 and 0.380 ± 0.008 mg/mL for DPPH and ABTS, respectively. However, the BP extract was inactive against DPPH and ABTS. The results of reducing power and the TAC were 0.270 ± 0.030 mg/mL and 0.094 ± 0.003 mg AAE/g extract for AP extract and 1.520 ± 0.010 mg/mL and 0.010 ± 0.001 mg AAE/g extract for BP extract.

Photoprotection activity
UV absorption assay
The absorbance values of UVA and UVB of AP and BP extracts are reported in Table 3. Zinc oxide (5%) was considered as a positive control for UVA absorption and Methyl salicylate (100 µg/mL) for UVB absorption. At a concentration of 5 mg/mL, the absorbance of UVB by AP extract was comparable to Methyl salicylate (100 µg/mL), which absorbed 2.19 ± 0.01 and 2.23 ± 0.02, respectively. In addition, there was a slight difference between the

Table 1. Total polyphenols, flavonoids, flavonols, and condensed tannins contents in hydroalcoholic extracts of Albuca amoena

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Aerial part</th>
<th>Bulbous part</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total polyphenols content (mg EAG/g extract)</td>
<td>6.40 ± 0.06a</td>
<td>1.34 ± 0.07a</td>
</tr>
<tr>
<td>Total flavonoids content (mg EQ/g extract)</td>
<td>8.21 ± 0.03a</td>
<td>2.80 ± 0.16a</td>
</tr>
<tr>
<td>Total flavonols content (mg EQ/g extract)</td>
<td>Nd</td>
<td>Nd</td>
</tr>
<tr>
<td>Total condensed tannins content (mg CE/g extract)</td>
<td>5.80 ± 0.10a</td>
<td>2.83 ± 0.11a</td>
</tr>
</tbody>
</table>

Values are means ± standard deviation of three replicates. Values on the same line with different superscript letters indicate significant differences (P value < 0.05).

Nd: not detected; GAE: gallic acid equivalent; QE: quercetin equivalent; CE: catechin equivalent.

Table 2. The antioxidant activity of hydroalcoholic extracts of Albuca amoena

<table>
<thead>
<tr>
<th>Tests</th>
<th>Aerial part (mg/mL)</th>
<th>Bulbous part (mg/mL)</th>
<th>Quercetin</th>
<th>Catechin</th>
<th>Ascorbic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPPH IC₅₀</td>
<td>0.250 ± 0.009b</td>
<td>Inactive</td>
<td>0.005 ± 0.001b</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ABTS IC₅₀</td>
<td>0.380 ± 0.008b</td>
<td>Inactive</td>
<td>-</td>
<td>-</td>
<td>0.002 ± 0.001b</td>
</tr>
<tr>
<td>FRAP IC₅₀</td>
<td>0.270 ± 0.030b</td>
<td>1.520 ± 0.010b</td>
<td>-</td>
<td>0.013 ± 0.001b</td>
<td>-</td>
</tr>
<tr>
<td>TAC</td>
<td>0.094 ± 0.003b</td>
<td>0.010 ± 0.001b</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Values are means ± standard deviation of three replicates. Values on the same line with different superscript letters indicate significant differences (P value < 0.05).

AAE: Acid ascorbic equivalent; ABTS: 2,2’-Azinobis-(3-ethylbenzothiazoline-6-sulfonic acid); DPPH: 2,2-Diphenyl-1-picrylhydrazil; FRAP: Ferric reducing antioxidant power assay; IC₅₀: The concentration to exert 50% of the maximal inhibition; TAC: Total antioxidant capacity.
Tyrosinase activity assay
As summarized in Table 4, the results of this test showed that to inhibit 50% of the tyrosinase effect, concentrations of 1.69 ± 0.05 mg/mL and 1.67 ± 0.04 mg/mL of AP and BP extracts, respectively, were required. The extracts showed poor results when compared with the kojic acid result (positive control).

Cytotoxicity activity
In order to evaluate the cytotoxic potential of A. amoena, we confronted our extracts to three tumor cell lines, two breast cancer cell lines (MCF-7 and MDA-MB-231) and one colorectal cancer cell line (HT-29).

First, the observation of the morphology of cells optical microscope allowed us to notice the effect of the extracts. Indeed, the treated cells lost their anchoring properties and detached by adopting a round morphology, compared to the untreated cells, which retained their anchoring properties and remained attached to each other.

Treatment of MCF-7 and MDA-MB-231 human breast cancer cell lines, and HT-29 human colon cancer cells for 72 hours with increasing concentrations of the extracts ranging from 100 to 3.125 µg/mL caused remarkable morphological changes (Figure 1). For HT-29 cells, considerable morphological changes were observed at all concentrations tested, even at low concentrations (3.125 µg/mL) (Figure 1C and D). The cytotoxic effects of AP and BP extracts on the proliferation of the MCF-7, MDA-MB-231, and HT-29 cell lines were evaluated by MTT assay. The calculation of the IC$_{50}$ values was performed using a dose-response curve and the values are presented in Table 5.

Using cell viability indices, the MTT test revealed that both extracts reduced cell viability in all cancerous cells tested in a dose-dependent manner after 72 hours of treatment (studied range 3.125 to 100 µg/mL) with a pronounced effect of extracts on HT-29 cells after 72 post incubation. The responses of MCF-7, MDA-MB-231, and HT-29 cancer cells to increasing concentrations of both extracts are shown in Figures 2 and 3.

Results showed that the MCF-7 cells were more sensitive to BP and AP extracts recording IC$_{50}$ of 4.012 ± 0.12 and 12.92 ± 2.30 µg/mL, respectively; the IC$_{50}$ corresponding to BP and AP extracts on MDA-MB-231 cells were 7.94 ± 1.86 and 75.69 ± 9.40 µg/mL, respectively.

The viability of colorectal tumor cells (HT-29) was found to be very low after 48 and 72 hours of incubation; however, IC$_{50}$ was determined after only 24 hours of incubation (Figure 1C and D), which indicated that the extracts had a strong cytotoxic effect on the HT-29 cell line.

Antimicrobial activity
The results tabulated in Table 6 show that the hydroalcoholic extracts of A. amoena were not as active as positive controls (tetracycline and ceftazidime); they did not inhibit bacterial growth, therefore they did not form an inhibitory zone.

Discussion
In this study, the antioxidant activities of A. amoena extracts were assessed using four tests frequently used for the valorization of plant extracts namely DPPH, ABTS, FRAP, and TAC. The first two methods (DPPH and ABTS) rely on the ability of the product to inhibit free radicals by giving up protons, while the two others (FRAP and TAC) require electrons (39,40). The AP extract was active in all four methods, while the BP extract was inactive in DPPH.

### Table 3. The absorbance values of UVA and UVB of hydroalcoholic extracts of Albuca amoena

<table>
<thead>
<tr>
<th>Product</th>
<th>UVA</th>
<th>UVB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerial part (5 mg/mL)</td>
<td>1.97 ± 0.01c</td>
<td>2.19 ± 0.01c</td>
</tr>
<tr>
<td>Bulbous part (5 mg/mL)</td>
<td>0.52 ± 0.03b</td>
<td>1.59 ± 0.03b</td>
</tr>
<tr>
<td>Methyl salicylate (100 µg/mL)</td>
<td>0.03 ± 0.01c</td>
<td>2.23 ± 0.02b</td>
</tr>
<tr>
<td>Zinc oxide (5%)</td>
<td>2.33 ± 0.04c</td>
<td>3.25 ± 0.02c</td>
</tr>
</tbody>
</table>

Values are means ± standard deviation of three replicates. Values on the same column with different superscript letters indicate significant differences ($P$ value < 0.05).

### Table 4. The anti-tyrosinase activities of hydroalcoholic extracts of Albuca amoena

<table>
<thead>
<tr>
<th>Product</th>
<th>IC$_{50}$ (mg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerial part</td>
<td>1.69 ± 0.0500b</td>
</tr>
<tr>
<td>Bulbous part</td>
<td>1.67 ± 0.0400b</td>
</tr>
<tr>
<td>Kojic acid</td>
<td>0.01 ± 0.0007b</td>
</tr>
</tbody>
</table>

Values are means ± standard deviation of three replicates. Values on the same column with different superscript letters indicate significant differences ($P$ value < 0.05). IC$_{50}$: The concentration to exert 50% of the maximal inhibition.

### Table 5. The cytotoxic effects of hydroalcoholic extracts of Albuca amoena on various cell lines

<table>
<thead>
<tr>
<th>Product</th>
<th>IC$_{50}$ (µg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HT-29</td>
</tr>
<tr>
<td>Aerial part</td>
<td>18.55 ± 2.15c</td>
</tr>
<tr>
<td>Bulbous part</td>
<td>12.39 ± 2.37a</td>
</tr>
<tr>
<td>Mitomycin</td>
<td>-</td>
</tr>
</tbody>
</table>

Values are means ± standard deviation of three replicates. Values on the same column with different superscript letters indicate significant differences ($P$ value < 0.05). IC$_{50}$: The concentration to exert 50% of the maximal inhibition.

http://www.herbmedpharmacol.com
and ABTS. According to the results, we can deduce that both extracts have antioxidant activities with a different order of action: AP tends to scavenge free radicals by giving up electrons or protons, while BP only gives up electrons. One of the chemical groups present in plants is the polyphenols, which have a great biological activities, especially antioxidant activity (41,42). As show in our results, AP extract is more centered of polyphenols and has more antioxidant activity than BP extract.

Exposure to sunlight causes an oxidative stress and a stimulation of tyrosinase for L-Dopa to oxidize and turn into melanin. However, a high exposure to sunlight induces a deregulation of melanogenesis and causes pigmenitary anomalies and even cancers. To prevent this

Figure 1. Microscopic observation of the cytotoxic effect of bulbous part extract on MCF-7 cell line (A), MDA-MB-231 cell line (B), HT-29 cell line 24 h post incubation (C), and HT-29 cell line 72 h post incubation (D). Red arrows: Cancer cell detached as well as the loss of anchor properties. Yellow arrows: Cancer cells attached to neighbors with preservation of anchor properties.

Figure 2. The dose-response curves for cell viability assay following the treatment with aerial part extract.

Figure 3. The dose-response curve for cell viability assay following the treatment with bulbous part extract.
A. amoena, a species of the same genus as A. officinalis, has proven to be effective against several tumor cell lines, including human esophageal carcinoma (Eca-109), human gastric carcinoma (MGC-803), human lung adenocarcinoma (LTEP-a-2), nasopharyngeal (KB), and lymphocytic leukemia (L1210) (62). Some studies have proven the antiproliferative ability of D. maritime, given its chemical composition rich in cardiotonic heteroside, especially bufadienolide, against human lymphoma (U-937GTB) (63), hepatocellular cancer (HepG-2), colon cancer (HCT-116), cervical cancer (HeLa), and breast cancer (MCF-7) (64).

Some spices of Albuca genus like Albuca bracteata, and Albuca setosa, are known for their antioxidant and antibacterial activities (12,13). According to our results, the extracts of A. amoena did not have the same antibacterial activity. Therefore, this plant is not promising in terms of antimicrobial activity, at least for the six isolates tested in our experimental conditions.

**Conclusion**

In conclusion, the extracts of A. amoena, particularly AP extracts, revealed their richness in phenolic compounds. Our findings brought novel insights to the existing

Table 6. Antimicrobial susceptibility of hydroalcoholic extracts of Albuca amoena at different concentrations

<table>
<thead>
<tr>
<th>Microorganisms</th>
<th>Aerial part (mg/mL)</th>
<th>Bulbous part (mg/mL)</th>
<th>Distilled water</th>
<th>Tetracycline</th>
<th>Ceftazidime</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>20.66 ± 0.57</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Nt</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>24 ± 0.10</td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>21 ± 0.87</td>
</tr>
<tr>
<td>Proteus mirabilis</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Nt</td>
</tr>
<tr>
<td>Candida albicans</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Nt</td>
</tr>
</tbody>
</table>

Values are means ± standard deviation of three replicates.
Nt: not tested.

disequilibrium, the photoprotectors intervene, which are either in the form of physical or chemical barriers (43). Our work indicate that AP and BP absorb the UVA and UVB radiations like a sunscreen. However, the extracts have a low antityrosinase activity compared with Kojic acid. In the other hand, A. amoena extracts have tendency to protect the skin against sunlight by a physical and not chemical barrier. Some natural compounds are as active as sunscreen agents, such as some flavonoids (44), terpenoids (45), amino acids (46), lipids (47), glycosides (48), and polyphenols (49). Other works show that A. amoena is composed of those phytochemical compounds (26,50), and in this work the polyphenols have been detected and dosed explaining the photoprotective activity of AP and BP extracts.

Our experimental study demonstrated that A. amoena extracts could destroy colorectal tumor cells strongly, like a polysaccharide. The polysaccharides are a part of the chemical composition of plants; they are excellent antioxidant and anti-inflammatory compounds. Further, they provide colon-protective effects that are summarized in the maintenance of homeostasis as well as the alteration of colon cancer cells. The polysaccharides have an effect on colon cancer cells via different signaling pathways (PI3K/AKT signaling, NF-xB signaling and MAPK signaling), via mitochondrial apoptotic pathway, TP53 apoptotic pathway, gut microflora and the disruption of cell cycle (57). Some polysaccharides extracted from Albuca bracteata, a species of the same genus as A. amoena, have been reported to have a synergistic effect with 5-fluorouracil against colorectal cancer (58,59).

Traditional Moroccan medicine offers a diversity of medicinal plants for antitumor use; two plants of the Asparagaceae family are used in this sense Asparagus officinalis L. and Drimia maritima (L.) Stearn in the form of a decoction or an infusion, orally (60,61). The steroidal saponin (25S)-5β-spirostan-3β-ol-3-O-β-Dglucopyranosyl-(1→2)-β-Dglucopyranoside isolated from A. officinalis has proven to be effective against several tumor cell lines, including human esophageal carcinoma (Eca-109), human gastric carcinoma (MGC-803), human lung adenocarcinoma (LTP-e-2), nasopharyngeal (KB), and lymphocytic leukemia (L1210) (62). Some studies have proven the antiproliferative ability of D. maritime, given its chemical composition rich in cardiotonic heteroside, especially bufadienolide, against human lymphoma (U-937GTB) (63), hepatocellular cancer (HepG-2), colon cancer (HCT-116), cervical cancer (HeLa), and breast cancer (MCF-7) (64). Some species of Albuca genus like Albuca bracteata, and Albuca setosa, are known for their antioxidant and antibacterial activities (12,13). According to our results, the extracts of A. amoena did not have the same antibacterial activity. Therefore, this plant is not promising in terms of antimicrobial activity, at least for the six isolates tested in our experimental conditions.
literature regarding the cytotoxicity activity of this plant. Moreover, the extracts displayed high photoprotective activity. However, the antioxidant and antityrosinase properties of the extracts studied were found to be of low activity. The extracts also did not show any antibacterial activity. Hence, additional research is needed to delve into the primary compounds found in *A. amoena* and elucidate their mechanisms of actions.

**Authors' contributions**

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**References**


Some pharmacological activities of A. amoena


