Antimicrobial, antioxidant and anticancer activities of *Laurencia catarinensis*, *Laurencia majuscula* and *Padina pavonica* extracts

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**A B S T R A C T**

The antimicrobial, antioxidant, and anticancer activities of ethanolic extract of *Laurencia catarinensis*, *L. majuscula* and *Padina pavonica* were determined. The highest antibacterial activity: 23.40 ± 0.58 mm (0.98 μg/ml) and 22.60 ± 2.10 mm (03.90 μg/ml) were obtained against *Klebsiella pneumonia* by *Laurencia catarinensis* and *Padina pavonica*, respectively. However, *Padina pavonica* showed excellent antibacterial activity against *Bacillus subtilis* (21.7 ± 1.5 mm; 1.95 μg/ml), *Staphylococcus aureus* (21.7 ± 0.58 mm; 1.95 μg/ml), *Streptococcus pyogenes* (20.7 ± 1.2 mm; 1.95 μg/ml) and *Acinetobacter baumannii* (20.1 ± 1.2 mm; 3.9 μg/ml). Moreover, the highest antifungal activity: 24.7 ± 2.0 mm (0.98 μg/ml), 23.7 ± 1.5 mm (0.98 μg/ml), 23.6 ± 1.5 mm (0.98 μg/ml) was obtained by *Padina pavonica* against *Candida tropicalis*, *C. albicans* and *Aspergillus fumigatus*, respectively. The algal extracts showed DPPH radical scavenging activity in a concentration–dependent manner with maximum scavenging activity (77.6%, IC50 = 5.59 μg/ml and 77.07%, IC50 = 14.3 μg/ml) was provided by *Padina pavonica* and *Laurencia majuscula*, respectively. The in vitro antitumor activity revealed that the IC50 values of *Padina pavonica* were 58.9, 115.0, 54.5, 59.0, 101.0, 101.0, and 97.6 μg/ml; *Laurencia catarinensis* were 55.2, 96.8, 104.0, 78.7, 117.0, 217.0, 169.0 μg/ml; and *Laurencia majuscula* were 115.0, 221.0, 225.0, 200.0, 338.0, 242.0, and 189.0 μg/ml; respectively against A-549 (Lung carcinoma), Caco-2 (Intestinal carcinoma), HCT-116 (Colon carcinoma), Hela (Cervical carcinoma), HEp-2 (Larynx carcinoma), HepG-2 (Hepatocellular carcinoma), and MCF-7 (Breast carcinoma) cell lines.

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0. Introduction

Marine algae have long been used as food and medicine in many Asian countries including Japan, China, Thailand and Korea. Natural products of marine algae are in great demand due to their prolific biological activities that might represent useful leads in the discovery of novel bioactive compounds and new pharmaceutical agents (Blunden, 2001; Iwamoto et al., 2001). Consumption of the marine algae is thought to ameliorate some inflammatory disorders, breast cancer and high cholesterol level (Fitchen and Helen, 2003). Numerous novel compounds have been isolated, during the last few decades, from marine organisms and many of these substances have been proved to possess remarkable biological activities (El Gamal, 2010; Proksch et al., 2002; Faulkner, 2002, 2001).

Different compounds isolated from marine algae have shown antimicrobial activities and are used in pharmaceutical industries (Rajasulochana et al., 2009; El-Fatemy, 2008; Venkateswarlu et al., 2007; Tüney et al., 2006; Ely et al., 2004; Lima-Filho et al., 2002). Antioxidant activity is important in various pharmacological activities such as anti-aging, anti-inflammatory, and anti-cancer activities (Lee et al., 2004; Middleton et al., 2000). Antioxidant activity is claimed to be present in most of the nutraceuticals and cosmeceuticals. However, numerous synthetic antioxidants are produced, but are quite unsafe and their toxicity is of concern (Madhavi et al., 1995). On the other hand, Natural products with antioxidant activity are used for human consumption because of their safety. Different compounds with cytotoxic, antiviral,
antihelmintic, antioxidant, antifungal and antibacterial activities have been detected in green, brown and red algae (Newman et al., 2003; Lindeque and Schweder, 2001).

One of the most life-threatening in developed and developing countries is cancer. Natural anticancer compounds are able to control the growth of cancer cells with no or minor side effects. Accordingly, identification of new effective cancer chemopreventive agents has become an important worldwide strategy in cancer prevention. Different compounds isolated from marine algae were found to have antiproliferative activity in cancer cell lines (Yang et al., 2008; Ye et al., 2008; Rocha de Souza et al., 2007; Kwon and Nam, 2006). The current study was carried out to determine the antimicrobial, antioxidant and anticancer activities of Laurencia catarinensis, L. majuscula and Padina pavonica.

1. Material and methods

1.1. Algal samples collection, extraction and screening

1.1.1. Algal species collections

The algal species used in this study; namely, Laurencia catarinensis, Laurencia majuscula and Padina pavonica were collected from Alharra, Umluj, Red Seashore, Kingdom of Saudi Arabia. Algal species were identified according to Aleem (1978, 1993), Bold and Wynne (1978) and Coppejans et al. (2009). Samples collected were air-dried in shade, reduced to fine powder, packed in tightly closed containers and stored for phytochemical and biological studies.

1.1.2. Algal extraction

Dry powder of each alga under investigation were separately (600 g) was extracted by percolation in 95% ethanol (Awawd et al., in press) at room temperature for two days. The ethanol extracts were separately filtered and the residues were re-percolated for five times for each alga. The total ethanol extracts were separately concentrated under reduced pressure at a temperature not exceeding 35 °C.

1.1.3. Phytochemical screening

Powdered samples from the of the investigated alga were subjected to phytochemical screening for their different constituents such as: carbohydrates and/or glycosides, flavonoids, tannins, sterols and/or triterpenes, proteins and/or amino acids, alkaloids and/or nitrogenous bases, saponins, anthraquinones, cardinolides and oxidase enzyme (Khan et al., 2011).

1.2. Antimicrobial activity

1.2.1. Test organisms

Different clinically isolated bacteria, Acinetobacter baumannii (RCMB 0100282-9), Escherichia coli (RCMB 010056), Klebsiella pneumonia (RCMB 0010093), Proteus mirabilis (RCMB 0100254-2) and Pseudomonas aeruginosa (RCMB 0100243-5), Gram-positive bacteria, Bacillus subtilis (RCMB 0100169-3), Staphylococcus aureus, Staphylococcus epidermidis (RCMB 010027), Streptococcus pyogenes (RCMB 0100174-2) and Streptococcus sanguinis (RCMB 0100171-3); and 10 fungal strains including Aspergillus fumigatus (RCMB 02568), Aspergillus niger (RCMB 02724), Candida albicans (RCMB 05036), C. tropicalis (RCMB 05239), Cryptococcus neoformans (RCMB 05642), Geotrichum candidum (RCMB 05097), Microsporum canis (RCMB 0834), Penicillium expansum (RCMB 01924), Syncephalothrix racemosum (RCMB 05922) and Trichophyton mentagrophytes (RCMB 0925) were identified by in the Microbiology Laboratory, Regional Center for Mycology and Biotechnology, Al-Azhar University, Cairo, Egypt and used as test organisms.

1.2.2. Antimicrobial assay

The antibacterial and antifungal activities of ethanolic extract of Laurencia catarinensis, L. majuscula and Padina pavonica were determined using the well diffusion method (Zain et al., 2012). Petri plates containing 20 ml of, nutrient (for bacteria) or malt extract (for fungi), agar medium were seeded with 1–3 day cultures of microbial inoculums. Wells (6 mm in diameter) were cut off from agar and 50 μl of algal extracts were tested in a concentration of 100 mg/ml and incubated at 37 °C for 24-48 h (bacterial strains) and for 3–5 days (fungal strains). The antibacterial and antifungal activities were determined by measurement of the diameter of the inhibition zone around the well.

1.2.3. Determination of minimum inhibitory concentration (MIC)

The minimum inhibitory concentration (MIC) was determined by micro-dilution method using serially diluted (2 folds) algal extracts (Zain et al., 2012). The MIC of Laurencia catarinensis, L. majuscula and Padina pavonica extracts were determined by dilution of concentrations from 0.0 to 100 mg/ml. Equal volume of each extract and nutrient broth were mixed in a test tube. Specifically 0.1 ml of standardized inoculum (1–2 × 10^7 cfu/ml) was added in each tube. The tubes were incubated at 37 °C for 24–48 h and/or 3–5 days. Two control tubes, containing the growth medium, saline and the inoculum were maintained for each test batch. The lowest concentration (highest dilution) of the algal extract that produced no visible microbial growth (no turbidity) when compared with the control tubes were regarded as MIC.

1.3. Antioxidant activity (DPPH (1-diphenyl-2-picrylhydrazyl) radical-scavenging assay)

The antioxidant activity of Laurencia catarinensis, L. majuscula and Padina pavonica extract was determined using the DPPH free radical scavenging assay according to the method described by Yen and Duh (1994). The assay was carried out in triplicate and the mean value was recorded.

Freshly prepared (0.004%w/v) methanol solution of 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical was prepared and stored at 10 °C in the dark. A methanol solution of the test compound was prepared. A 40 μL aliquot of the methanol solution was added to 3 ml of DPPH solution, under light protection. Absorbance measurements were recorded immediately with a UV–visible spectrophotometer (Milton Roy, Spectronic 1201). The decrease in absorbance at 515 nm was determined continuously, with data being recorded at 1 min intervals until the absorbance stabilized (16 min). The absorbance of the DPPH radical without antioxidant (control) and the reference compound ascorbic acid were also measured. The percentage inhibition (PI) (scavenging activity) of the DPPH radical was calculated according to the formula (Yen and Duh, 1994):

\[
\text{PI} = \frac{(AC - AT)}{AC} \times 100
\]

where AC = Absorbance of the control at t = 0 min and AT = absorbance of the sample + DPPH at t = 16 min.

1.4. Antitumor activity

The cell lines A-549 (Lung carcinoma), Caco-2 (Colorectal carcinoma), HCT-116 (Colon carcinoma), Hela (Cervical carcinoma), Hep-2 (Larynx carcinoma), HepG-2 (Hepatocellular carcinoma), and MCF-7 (Breast carcinoma) were used for determination of antitumor activity of Laurencia catarinensis, L. majuscula and Padina pavonica. The tumor cell lines were suspended in medium at
concentration $5 \times 10^4$ cell/well in Corning® 96-well tissue culture plates and then incubated for 24 hr. The tested algal extracts were then added into 96-well plates (six replicates) to achieve seven concentrations for each extract. Six vehicle controls with media or 0.5% DMSO were run for each 96 well plate as a control. After incubation for 24 h, the numbers of viable cells were determined by the MTT assay method.

Briefly, the media was removed from the 96 well plate and replaced with 100 μl of fresh culture RPMI 1640 medium without phenol red, then 10 μl of the 12 mM MTT (Sigma) stock solution (5 mg of MTT in 1 mL of PBS) was added to each well including the untreated controls. The 96 well plates were then incubated at 37 °C and 5% CO2 for 4 hours. An 85 μl aliquot of the media was removed from the wells, and 50 μl of DMSO was added to each well and mixed thoroughly with the pipette and incubated at 37 °C for 10 min. Then, the optical density was measured at 590 nm with the microplate reader (SunRise, TECAN, Inc, USA) to determine the number of viable cells.

The percentage of viability was calculated as:

$$1 - \frac{OD_t}{OD_c} \times 100\%$$

where ODt is the mean optical density of wells treated with the tested sample and ODc is the mean optical density of untreated cells.

The relation between surviving cells and extract concentration is plotted to get the survival curve of each tumor cell line after treatment with the specified extract. The 50% inhibitory concentration (IC50), the concentration required to cause toxic effects in 50% of intact cells, was estimated from graphic plots of the dose response curve for each concentration using Graphpad Prism software (San Diego, CA, USA) (Kameyama et al., 2005).

1.5. Statistical analysis

All values were expressed as mean ± S.D. Comparisons between means were carried out using a one-way ANOVA test followed by the Tukey HSD test using SPSS, version 14 (SPSS, Chicago, IL). Differences at p<0.05 were considered statistically significant.

### Table 1

Antibacterial activity of *L. catarinensis*, *L. majuscula* and *Padina pavonica* against clinically isolated bacteria.

| Bacteria                        | Sample | Inhibition zone (mm) | MIC (μg/ml) | Inhibition zone (mm) | MIC (μg/ml) | Inhibition zone (mm) | MIC (μg/ml) | Standard antibiotic | MIC (μg/ml) |
|--------------------------------|--------|----------------------|-------------|----------------------|-------------|----------------------|-------------|---------------------|-------------|
| **Gram negative**             |        |                      |             |                      |             |                      |             | Gentamicin           |             |
| Acinetobacter baumannii       | (RCMB 0100282-9) | 20.70 ± 1.50         | 03.90       | 18.30 ± 2.10         | 07.81       | 20.10 ± 1.20         | 03.90       |                     |             |
| Escherichia coli (RCMB 010056) | 21.20 ± 2.10        | 01.95     | 16.30 ± 2.10         | 31.25       | 18.20 ± 0.63         | 07.81       | 20.30 ± 0.85         | 03.90       |
| Klebsiella pneumonia (RCMB 0010093) | 23.40 ± 0.58        | 00.98     | 20.50 ± 1.20         | 01.95       | 22.60 ± 2.10         | 03.90       | 27.20 ± 2.10         | 00.49       |
| Proteus mirabilis (RCMB 010254-2) | 00.00        | ND         | 00.00             | ND         | 00.00             | ND         | 21.20 ± 1.20         | 01.95       |
| Pseudomonas aeruginosa (RCMB 010243-5) | 21.30 ± 0.63        | 01.95     | 17.20 ± 1.50         | 15.63       | 19.60 ± 0.63         | 03.90       | 20.60 ± 1.50         | 01.95       |
| **Gram positive**             |        |                      |             |                      |             |                      |             | Ampicillin           |             |
| Bacillus subtilis (RCMB 0100169-3) | 17.39 ± 2.10        | 15.57     | 14.70 ± 1.50         | 62.50       | 21.70 ± 1.50         | 01.95       | 22.30 ± 0.63         | 01.95       |
| Staphylococcus aureus (RCMB 0100027) | 20.49 ± 1.20        | 03.90     | 17.10 ± 1.00         | 15.63       | 21.70 ± 0.58         | 01.95       | 22.00 ± 1.00         | 01.95       |
| Staphylococcus epidermis (RCMB 010024) | 15.70 ± 0.58        | >10000    | 14.30 ± 1.50         | 62.50       | 18.30 ± 0.58         | 07.81       | 23.00 ± 1.20         | 00.98       |
| Streptococcus pyogenes (RCMB 0100174-2) | 16.20 ± 1.50        | 5000      | 17.70 ± 0.58         | 15.63       | 20.70 ± 1.20         | 01.95       | 22.70 ± 0.58         | 00.98       |
| Streptococcus sanguis (RCMB 0100171-3) | 00.00        | ND         | 00.00             | ND         | 00.00             | ND         | 21.70 ± 1.50         | 01.95       |

ND, not determined. These are the mean of three determinations.
obtained by *Padina pavonica* against *Candida tropicalis*, *C. albicans* and *Aspergillus fumigatus*, respectively (Table 2).

### 2.2.1. Antioxidant activity

The free radicals are involved in several diseases including cancer, AIDS and neurodegenerative diseases. The scavenging activity of antioxidants is very useful for the control of those diseases. The DPPH assay is most commonly used method for screening antioxidant activity and it is a sensitive method to determine the antioxidant activity of different plant, fungal, or algal extracts (Suresh et al., 2008; Koleva et al., 2002).

The ethanolic extract of *Laurencia catarinensis*, *L. majuscula* and *Padina pavonica* showed DPPH radical scavenging activity in a concentration–dependent manner (Table 3, Fig. 1). The maximum

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**Table 2**

Antifungal activity of *L. catarinensis*, *L. majuscula* and *Padina pavonica* against clinically isolated fungi.

| Sample                  | Fungi                          | L. catarinensis | L. majuscula | Padina pavonica |
|-------------------------|--------------------------------|----------------|--------------|-----------------|
|                         | Standard Antibiotic (Amphotericin B) | Inhibition zone (mm) | MIC (µg/ml) | Inhibition zone (mm) | MIC (µg/ml) | Inhibition zone (mm) | MIC (µg/ml) |
| Aspergillus fumigatus (RCMB 02568) | Aspergillus niger (RCMB 02724) | Candida albicans (RCMB 05036) | Candida tropicallis (RCMB 05239) | Cryptococcus neoformans (RCMB 05642) | Geotrichum candidum (RCMB 05097) | Microsporum canis (RCMB 0834) | Penicillium expansum (RCMB 01924) | Syncephalastrum racemosum (RCMB 05922) | Trichophyton mentagrophytes (RCMB 0925) |
| Aspergillus fumigatus (RCMB 02568) | 19.50 ± 1.20 03.90 | 22.40 ± 1.00 01.95 | 23.6 ± 1.50 00.98 | 25.70 ± 1.50 0.49 | 21.30 ± 1.50 0.98 | 23.70 ± 2.00 00.98 | 23.70 ± 2.00 00.98 | 24.0 ± 1.50 0.98 | 23.30 ± 1.50 00.98 |
| Aspergillus niger (RCMB 02724) | 16.30 ± 0.58 31.25 | 18.60 ± 1.50 03.90 | 20.3 ± 0.58 03.90 | 20.44 ± 0.36 03.90 | 21.30 ± 1.50 0.98 | 23.70 ± 2.00 00.98 | 23.70 ± 2.00 00.98 | 21.00 ± 1.44 01.95 | 20.31 ± 1.50 03.90 |
| Candida albicans (RCMB 05036) | 15.20 ± 0.51 62.50 | 21.30 ± 1.50 03.90 | 23.7 ± 1.50 00.98 | 21.30 ± 1.50 0.98 | 21.30 ± 1.50 0.98 | 23.70 ± 2.00 00.98 | 23.70 ± 2.00 00.98 | 21.00 ± 1.44 01.95 | 20.31 ± 1.50 03.90 |
| Candida tropicallis (RCMB 05239) | 19.10 ± 0.32 03.90 | 23.10 ± 1.30 00.98 | 24.2 ± 2.00 00.98 | 24.2 ± 2.00 00.98 | 24.2 ± 2.00 00.98 | 24.2 ± 2.00 00.98 | 24.2 ± 2.00 00.98 | 24.2 ± 2.00 00.98 | 24.2 ± 2.00 00.98 |
| Cryptococcus neoformans (RCMB 05642) | 0.00 0.00 | 0.00 0.00 | 0.00 0.00 | 0.00 0.00 | 0.00 0.00 | 0.00 0.00 | 0.00 0.00 | 0.00 0.00 | 0.00 0.00 |
| Geotrichum candidum (RCMB 05097) | 20.10 ± 0.58 03.90 | 20.30 ± 1.50 03.90 | 21.30 ± 1.50 01.95 | 21.30 ± 1.50 01.95 | 21.30 ± 1.50 01.95 | 21.30 ± 1.50 01.95 | 21.30 ± 1.50 01.95 | 21.30 ± 1.50 01.95 | 21.30 ± 1.50 01.95 |
| Microsporum canis (RCMB 0834) | 14.60 ± 1.50 >1000 | 16.10 ± 1.70 31.25 | 21.70 ± 2.00 01.95 | 21.70 ± 2.00 01.95 | 21.70 ± 2.00 01.95 | 21.70 ± 2.00 01.95 | 21.70 ± 2.00 01.95 | 21.70 ± 2.00 01.95 | 21.70 ± 2.00 01.95 |
| Penicillium expansum (RCMB 01924) | 0.00 0.00 | 0.00 0.00 | 0.00 0.00 | 0.00 0.00 | 0.00 0.00 | 0.00 0.00 | 0.00 0.00 | 0.00 0.00 | 0.00 0.00 |
| Syncephalastrum racemosum (RCMB 05922) | 11.80 ± 1.21 >1000 | 00.00 0.00 | 00.00 0.00 | 00.00 0.00 | 00.00 0.00 | 00.00 0.00 | 00.00 0.00 | 00.00 0.00 | 00.00 0.00 |
| Trichophyton mentagrophytes (RCMB 0925) | 00.00 ND | 00.00 ND | 00.00 ND | 00.00 ND | 00.00 ND | 00.00 ND | 00.00 ND | 00.00 ND | 00.00 ND |

ND, not determined. These are the mean of three determinations.

**Table 3**

The scavenging activity of DPPH radicals of *L. catarinensis*, *L. majuscula* and *Padina pavonica*.

| Concentration (µg/ml) | L. catarinensis | L. majuscula | Padina pavonica |
|-----------------------|----------------|--------------|----------------|
| 000                   | 00.00          | 00.00        | 00.00          |
| 001                   | 12.17 ± 1.50   | 06.67 ± 1.32 | 14.13 ± 1.41   |
| 002                   | 13.65 ± 1.11   | 09.20 ± 1.21 | 26.53 ± 1.44   |
| 004                   | 17.83 ± 1.71   | 18.93 ± 1.54 | 44.80 ± 1.62   |
| 008                   | 24.09 ± 1.32   | 30.93 ± 1.33 | 57.87 ± 1.57   |
| 016                   | 30.26 ± 1.91   | 55.07 ± 1.38 | 73.60 ± 1.75   |
| 032                   | 38.00 ± 1.22   | 70.00 ± 1.30 | 75.73 ± 1.51   |
| 064                   | 55.57 ± 1.58   | 74.80 ± 1.27 | 76.67 ± 1.14   |
| 128                   | 67.65 ± 1.30   | 77.07 ± 1.12 | 77.60 ± 1.09   |
| IC50                  | 53.80 ± 1.22   | 14.30 ± 1.35 | 05.59 ± 1.55   |

These are the mean of three determinations.

ND, not determined. These are the mean of three determinations.
scavenging activity (77.6%, IC$_{50}$ = 5.59 µg/ml and 77.07%, IC$_{50}$ = 14.3 µg/ml) was provided by Padina pavonica and Laurenica majuscula, respectively (Table 3). However, the scavenging activity of Laurencia catarinensis was 67.65% (IC$_{50}$ = 53.8 µg/ml).

2.2.2. Antitumor activity

Marine Algae when uttered strikes about its healing property (Dziwornu et al., 2017) due its unique bioactive compounds present in it. The compounds present in it paves way for the synthesis of new drug molecules in treating various diseases (Alves et al., 2016).

The in vitro antitumor activity of algal species like Laurencia catarinensis, L. majuscula and Padina pavonica extract was evaluated on A-549 (Lung carcinoma), CACO (Intestinal carcinoma), HCT-116 (Colon carcinoma), Hela (Cervical carcinoma), HEp-2 (Larynx carcinoma), HepG-2 (Hepatocellular carcinoma), and MCF-7 cell lines. The cytotoxic effect of L. catarinensis on A-549, CACO, HCT-116, Hela, HepG-2, and MCF-7 cell lines.
(Breast carcinoma) cell lines by using MTT assay method which is reliable to assess the in vitro cytotoxicity of the anticancer compounds (Allely et al., 1998). The obtained results exhibited direct cytotoxic effect of the investigated algal extracts on the cell lines in a concentration dependent manner (Figs. 2–4). The results indicated that the extract of Padina pavonica has the lowest percentage of viability and shows significant antitumor activity followed by Laurencia catarinensis and L. majuscula (Table 1).

The IC₅₀ values of Padina pavonica were 58.9, 115.0, 54.5, 59.0, 101.0, 101.0, and 97.6 µg/ml; Laurencia catarinensis were 55.2, 96.8, 104.0, 78.7, 117.0, 217.0, 169.0 µg/ml; and L. majuscula were 115.0, 221.0, 225.0, 200.0, 338.0, 242.0, and 189.0 µg/ml; respectively against A-549 (Lung carcinoma), CACO (Intestinal carcinoma), HCT-116 (Colon carcinoma), Hela (Cervical carcinoma), HEp-2 (Larynx carcinoma), HepG-2 (Hepatocellular carcinoma), and MCF-7 (Breast carcinoma) (Table 4). Standard reference Vin-

![Fig. 3. The cytotoxic effect of L. majuscula on A-549, CACO, HCT-116, Hela, HepG-2, and MCF-7 cell lines.](image-url)
Blastine Sulphate showed various effect on the same sell lines (Table 4 and Fig. 5).

L. catarinensis effect (55.2 ± 0.7 μg/ml) on A-549 (Lung carcinoma) showed activity the closest to Vinblastine Sulphate (24.6 ± 0.7 μg/ml) followed by Padina pavonica (58.9 ± 0.1 μg/ml), While Padina pavonica effect (59.0 ± 0.1 μg/ml) was equal to the standard (59.0 ± 0.7 μg/ml) when it tested on HCT-116 (Colon carcinoma).

In general Padina pavonica reported to have the best anticancer activities on the 7 tested cell lines followed by L. catarinensis and L. catarinensis respectively (Table 4 & Figs. 2–5).
Table 4
The IC₅₀ values of L. catarinensis, L. majuscula and Padina pavonica extracts on cell lines.

| Algal extract | Cell line | L. catarinensis | L. majuscula | Padina pavonica | Vinblastine Sulphate |
|---------------|-----------|----------------|--------------|----------------|---------------------|
|               | A-549 (Lung carcinoma) | 055.2 ± 0.7 | 115.0 ± 0.4 | 058.9 ± 0.1 | 24.6 ± 0.7 |
|               | CACO-2 (Colon carcinoma) | 096.8 ± 0.3 | 221.0 ± 0.6 | 115.0 ± 0.9 | 30.3 ± 1.4 |
|               | HCT-116 (Colon carcinoma) | 104.0 ± 0.4 | 225.0 ± 0.2 | 054.5 ± 0.3 | 3.5 ± 0.2 |
|               | Hela (Cervical carcinoma) | 078.7 ± 0.5 | 200.0 ± 0.3 | 059.0 ± 0.1 | 59.7 ± 2.1 |
|               | HEp-2 (Larynx carcinoma) | 117.0 ± 0.2 | 338.0 ± 0.5 | 101.0 ± 0.2 | 21.2 ± 0.9 |
|               | HepG-2 (Hepatocellular carcinoma) | 217.0 ± 0.3 | 242.0 ± 0.2 | 101.0 ± 0.4 | 2.93 ± 0.3 |
|               | MCF-7 (Breast carcinoma) | 169.0 ± 0.1 | 189.0 ± 0.1 | 097.6 ± 0.3 | 5.9 ± 0.4 |

These are the mean of three determinations.

Fig. 5. The cytotoxic effect of Vinblastine Sulfate as Reference Standard on A-549, CACO, HCT-116, Hela, HepG-2, and MCF-7 cell lines.
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