1. Introduction

The interest in ancient herbal remedies has been significantly increased in the last few decades. In the worldwide, all the natural resources including medicinal plants, fungi and algae are screened for their biological activities (Awaad et al., 2013; Zain et al., 2012, Amornlerdpison et al., 2007). Accordingly, the therapeutic values and pharmaceutical usage of numerous herbal medicines have already been validated. The herbal medicines which obtained from natural sources are considered as safe for human beings. However, they would have some antagonistic effects due to presence of other active ingredients (Izzo and Ernst, 2009).

Algae are found everywhere: in the sea, rivers, lakes, soil, walls, and as symbiont in animal and plants. Algae include four main divisions; namely, Red algae (Rhodophyta), Brown Algae (Phycophyta), Green Algae (Chlorophyta) and Diatoms. Although, Seaweeds which are macroscopic, multicellular, and marine algae, are divided into three categories; red, green and brown organisms comprises about 30000 species. In most of Asian countries, seaweeds are traditionally traded as food items including sushi wrappings, seasonings, condiments, and vegetables (El Gamal, 2010; Mark et al., 2016).

Antioxidants have attracted the most interest among the many biologically-active compounds found in algae. Antioxidants are important compounds in the treatment and recovery from various diseases including cancer, chronic inflammation, atherosclerosis, cardiovascular disorders, and aging process (Kohen and Nyska, 2002). Although, the search for anticancer drugs has similar attention as marine compounds revealed promising results at different stages of cancer progress (Mayer and Gustafson, 2006). On the other hand, in developed and developing countries, the most people died following infectious bacterial and/or fungal diseases. The bacterial Gram-positive and Gram-negative organisms including...
different species of Bacillus, Proteus, Klebsiella, Staphylococcus, Salmonella and Pseudomonas are the main source of severe infections in animals including humans (Nathan, 2004).

Among seaweeds, numerous macroalgae have potent cytotoxic activities (Mayer and Gustafson, 2006; Smit, 2004) and algal consumption has been suggested as a chemo-preventive agent against several cancers (Yuan and Walsh, 2006). Recently, due to their exceptional richness in bioactive compounds (e.g., antimicrobial, anti-inflammatory, and antitumoral activities), the seaweeds has significantly expanded into the pharmaceutical and para-pharmaceutical industry (Kornprobst, 2005; Smit, 2004). The current study aimed to assess the biological activity including antioxidant, antimicrobial, and anticancer of different extracts of the red algae Galaxaura rugosa and Liagora hawaiiana.

2. Material and methods

2.1. Algal samples collection, extraction and screening

2.1.1. Algal species collections

The algal species used in this study; namely, Galaxaura rugose and Liagora hawaiiana Butters were collected from Alharra, Umluj, Red Seashore, Kingdom of Saudi Arabia. Algal species were identified according to Aleem (1993) 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.

2.1.2. Algal extraction

Dry powder (830 and 795 g) of Galaxaura rugose and Liagora hawaiiana; respectively, were extracted by percolation in 95% ethanol (Awaad et al., 2017a) at room temperature for two days. The total ethanolic extract was filtered and the residue was re-percolated by the same manor for five times. The ethanolic extract was then concentrated, under reduced pressure at low temperature, and a yield of 81 and 77 g was obtained from Galaxaura rugose and Liagora hawaiiana, respectively.

The obtained extracts of each algae was separately suspended in water (300 ml) and filtered over a piece of cotton. The lipoidal matter, collected on top of the cotton piece (25 and 28 g. for Galaxaura rugose and Liagora hawaiiana, respectively) were obtained. The aqueous layer, which filtered off, was successively fractionated according to Aleem (1993) 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.

2.1.3. Phytochemical screening

Powdered sample of each investigated alga (Galaxaura rugose and Liagora hawaiiana) was subjected to phytochemical screening as published by Khan et al. (2011) to investigate their phytochemical constituents.

2.2. Antimicrobial activity

2.2.1. Test organisms

Different clinically isolated bacterial and fungal strains; namely, Aspergillus fumigatus (RCMB 02568), Aspergillus niger (RCMB 02724), Bacillus subtilis (RCMB 010015), Candida albicans (RCMB 05003), Candida tropicalis (RCMB 05004), Cryptococcus neoformans (RCMB 05642), Escherichia coli (RCMB 010052), Geotrichum candidum (RCMB 05097), Klebsiella pneumonia (RCMB 0010093), Microsporum canis (RCMB 0834), Penicillium expansum (RCMB 01924), Pseudomonas aeruginosa (RCMB 0100243-5), Proteus vulgaris (RCMB 01004), Staphylococcus aureus (RCMB 010010), Staphylococcus epidermidis (RCMB 010009), Streptococcus bovallis (RCMB 100174-2), Streptococcus mutans (RCMB 0100017), Staphylococcus typhimurium (RCMB 14028), Syncephalastrum racemosum (RCMB 05922) and Trichophyton mentagrophytes (RCMB 0925) were obtained from the Microbiology Laboratory, Regional Center for Mycology and Biotechnology, Al-Azhar University, Cairo, Egypt and used as test organisms.

2.2.2. Antimicrobial assay

The antibacterial and antifungal activities of total ethanol, lipoidal matters, chloroform n-butanol, aqueous extracts and powder of Galaxaura rugosa and Liagora hawaiiana were determined using the well-diffusion method (Almalki, 2017). 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.

2.2.3. Determination of minimum inhibitory concentration (MIC)

The minimum inhibitory concentration (MIC) of algal extract was determined by micro-dilution method using serially diluted (2 folds) algal extracts (Zain et al., 2012). The MIC of total ethanol, lipoidal matter, chloroform, n-butanol, aqueous extracts and powder of Galaxaura rugosa and Liagora hawaiiana were determined by dilution of concentrations from 0.0 to 100 mg/ml. Equal volumes of each extract and nutrient broth were mixed in a test tube. Specifically 0.1 ml of standardized inoculum (1–2 × 10⁷ 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.

2.3. Antioxidant assay

The antioxidant activity of Galaxaura rugosa and Liagora hawaiiana different extracts were determined using DPPH free radical scavenging assay as describe by Aksoy et al. (2013) in triplicate and average values were considered. The tested extracts were also compared using the IC₅₀ value; i.e., the concentration leading to 50% inhibition which was estimated from graphical plots of DPPH Radical Scavenging% Vs concentrations.

2.4. Antitumor activity

The antitumor activity of total ethanol, lipoidal matters, chloroform, n-butanol, aqueous extracts and powder of Galaxaura rugosa and Liagora hawaiiana were determined using A-549 (Lung carcinoma), CACO (colorectal carcinoma), HCT-116 (Colon carcinoma), Hela (Cervical carcinoma), HepG-2 (Hepatocellular carcinoma), and MCF-7 (Breast carcinoma) cell lines as described by Kameyama et al. (2005).

2.5. 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.

3. Results and discussion

3.1. Preliminary phytochemical screening

The preliminary phytochemical analyses of Galaxaura rugosa and Liagora hawaiiana revealed the presence of different primary and secondary metabolites, they contains unsaturated sterols and/or triterpenoids, flavonoids, carbohydrates or glycosides, proteins and/or amino acids, tannins and coumarin, no saponins or alkaloids were detected. This variety of active metabolites give these algae high potentials to be used as source of medication specially the presence of flavonoids (Kosanic et al., 2015).

3.2. Antimicrobial activity

The antimicrobial activity of total ethanol, lipoidal matters, chloroform, n-butanol, aqueous extracts, and powder of Galaxaura rugosa and Liagora hawaiiana were determined against Gram-negative, Gram-positive bacteria and fungi (Tables 1 and 2). The results revealed that all the extracts of Galaxaura rugosa showed antibacterial and antifungal activities. On the other hand, only lipoidal matters, chloroform, n-butanol and aqueous extracts of Liagora hawaiiana showed antibacterial and antifungal activity, in addition to the powder which has only antifungal activity (Tables 1 and 2).

Among the extracts of Galaxaura rugosa, chloroform, n-butanol, and aqueous extracts inhibited the growth of nine, out of ten, bacterial test organism. While total ethanol extract and lipoidal matter showed antifungal activity against 8, out of ten, fungal test strains. Interestingly, the chloroform extract of Galaxaura rugosa exhibited antibacterial activity against Klebsiella pneumoniae (24 mm, 0.15 mg/ml) higher than the standard antibiotic Gentamycin (23 mm, 0.49 mg/ml). Moreover, the total ethanol, lipoidal matter and chloroform extracts showed antifungal activity (21, 22 and 25 mm, 1.25, 0.312 and 0.156 mg/ml) similar to the antibiotic Ketoconazole activity (23, 24 and 27 mm, 1.25, 0.312 and 0.156 mg/ml) against Aspergillus fumigatus, A. niger and Candida tropicalis, respectively (Tables 1 and 3). The chloroform extract of Liagora hawaiiana showed the best antibacterial and antifungal activities. With the exception of Microcanis canis and Trichophyton mentagrophytes, it inhibited the growth of all tested fungal strains in addition to all the bacterial strains. Furthermore, the potency of chloroform extract against Candida tropicalis (27 mm, 0.078 mg/ml) was similar to that of the standard antibiotic, Ketoconazole (27 mm, 0.98 mg/ml) (Tables 2 and 4).

From the previous studied it was concluded that researchers have isolated different compounds from algae including terpenoids, phlorotannins, polyphenols, phenolic acids, anthocyanins, hydroxyxinnamic acid derivatives, and flavonoids (Bhat and Madyastha, 2000, 2001; Benedetti, 2004). Nevertheless, the antibacterial, antifungal and antiviral activities of algal extracts are extensively published (El-Fatemy and Said, 2011; Manilal et al., 2009; Rajasulochana et al., 2009; Ely et al., 2004). Although, the obtained results of the current study revealed the antimicrobial activity of extracts of Galaxaura rugosa and Liagora hawaiiana using different solvents which indicates the multiplicity and diversity of the compounds present in algae.

3.3. Antioxidant activity

The antioxidant activity of Galaxaura rugosa, and Liagora hawaiiana were screened using DPPH assay. It is the most commonly used assay because it can run many samples in short time and detect the active components at low concentration (Piao et al., 2004). The current results exhibited that the total ethanol extract of Galaxaura rugosa, and Liagora hawaiiana have DPPH radical scavenging activity in a concentration–dependent manner (Table 5).

Table 1
Antimicrobial activity of different extracts of Galaxaura rugosa.

| Extract Test organism | Mean diameter of inhibition zone (mm) | Bacteria | Fungi |
|-----------------------|--------------------------------------|----------|-------|
|                       | Total (Ethanol) | Lipoidal matter | Chloroform | n-Butanol | Aqueous | Powder | Standard antibiotic |
| **Bacteria**          |             |                 |            |           |         |        |            |
| Gram-negative         |             |                 |            |           |         |        |            |
| Escherichia coli      | 15          | 18               | 22          | 16         | 22      | 15     | 36            |
| Klebsiella pneumoniae | 14          | 19               | 24          | 15         | 16      | 14     | 23            |
| Proteus vulgaris      | 18          | 22               | 20          | 19         | 15      | 16     | 31            |
| Pseudomonas aeruginosa| 00          | 00               | 15          | 00         | 00      | 00     | 25            |
| Salmonella typhimurium| 00          | 14               | 21          | 15         | 15      | 00     | 27            |
| **Gram-positive**     |             |                 |            |           |         |        |            |
| Bacillus subtilis     | 14          | 18               | 17          | 16         | 16      | 15     | 32            |
| Staphylococcus aureus | 19          | 14               | 22          | 21         | 18      | 20     | 30            |
| Staphylococcus epidermidis | 20 | 00               | 19          | 21         | 17      | 14     | 34            |
| Streptococcus mutans  | 00          | 00               | 14          | 15         | 20      | 00     | 26            |
| Streptococcus pyogenes| 00          | 00               | 14          | 14         | 18      | 00     | 28            |
| **Fungi**             |             |                 |            |           |         |        |            |
| Aspergillus fumigatus | 21          | 16               | 00          | 00         | 00      | 00     | 23            |
| Aspergillus niger     | 15          | 22               | 00          | 00         | 00      | 00     | 24            |
| Candida albicans      | 18          | 16               | 20          | 18         | 15      | 18     | 26            |
| Candida tropicalis    | 17          | 19               | 25          | 19         | 16      | 23     | 27            |
| Cryptococcus neoformans| 20          | 15               | 27          | 22         | 18      | 15     | 31            |
| Geotrichum candidum   | 15          | 17               | 22          | 20         | 15      | 22     | 30            |
| Penicillium expansum  | 14          | 23               | 00          | 00         | 00      | 00     | 28            |
| Syncophalastrum racemus | 14 | 14               | 00          | 00         | 00      | 00     | 24            |
| Dermatophytes         |             |                 |            |           |         |        |            |
| Amphotericin B        |             |                 |            |           |         |        |            |
| Microsporum canis     | 00          | 00               | 00          | 00         | 00      | 00     | 30            |
| Trichophyton mentagrophytes | 00 | 00               | 00          | 00         | 00      | 00     | 29            |

Values are expressed as mean ± SEM of 3 determinants.
The maximum scavenging activity (80.96%, IC₅₀ = 27.8 μg/ml) was provided by *Galaxaura rugosa*. However, the scavenging activity of *Liagora hawaiiana* was 66.87% (IC₅₀ = 57.2 μg/ml) (Table 5). 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 (Suresh et al., 2008; Koleva et al., 2002). Interestingly, the antioxidant activity of *Galaxaura rugosa* was very good (27.8 ± 1.22) and almost similar to the antioxidant activity of ascorbic acid (86.36%, IC₅₀ = 11.2 μg/ml) (Table 5), this can be due to the presence of flavonoids in both algae (Farasat et al., 2014; Yen & Duh, 1994).

### 3.4. Antitumor activity

The cancer, cells growing out of control, causes are diverse, complex and not fully understood. The cancer diseases are classified according to the type of cell that the tumor cells resemble and are presumed to be the origin of the tumor. Herbal medicines are used worldwide for cancer prevention and treatment. The

### Table 2

| Extract Test organism | Mean diameter of inhibition zone (mm) |
|-----------------------|--------------------------------------|
|                       | Total (Ethanol) | Lipoidal matter | Chloroform | n-Butanol | Aqueous | Powder | Standard Antibiotic |
| **Bacteria**          |              |                |            |           |         |        |                        |
| *Gentamycin*          |              |                |            |           |         |        |                        |
| Gram-negative         |              |                |            |           |         |        |                        |
| *Escherichia coli*    | 00            | 21             | 21         | 15        | 23      | 00     | 36                     |
| *Klebsiella pneumoniae* | 00           | 22             | 20         | 16        | 16      | 00     | 23                     |
| *Proteus vulgaris*    | 00            | 15             | 18         | 21        | 15      | 00     | 31                     |
| *Pseudomonas aeruginosa* | 00        | 14             | 15         | 00        | 00      | 00     | 25                     |
| *Salmonella typhimurium* | 00       | 19             | 16         | 14        | 00      | 00     | 27                     |
| Gram-positive         |              |                |            |           |         |        |                        |
| *Bacillus subtilis*   | 00            | 15             | 17         | 00        | 00      | 00     | 32                     |
| *Staphylococcus aureus* | 00         | 17             | 18         | 00        | 00      | 00     | 30                     |
| *Staphylococcus epidermidis* | 00   | 14             | 14         | 00        | 00      | 00     | 34                     |
| *Streptococcus mutans* | 00           | 20             | 24         | 00        | 00      | 00     | 26                     |
| *Streptococcus pyogenes* | 00         | 19             | 19         | 00        | 00      | 00     | 28                     |
| **Fungi**             |              |                |            |           |         |        |                        |
| *Ketocona-zole*       |              |                |            |           |         |        |                        |
| *Aspergillus fumigatus* | 00          | 00             | 16         | 00        | 00      | 00     | 23                     |
| *Aspergillus niger*   | 00            | 00             | 16         | 00        | 00      | 00     | 24                     |
| *Candida albicans*    | 00            | 21             | 22         | 14        | 16      | 16     | 26                     |
| *Candida tropicalis*  | 00            | 22             | 27         | 15        | 18      | 15     | 27                     |
| *Cryptococcus neoformans* | 00      | 24             | 25         | 19        | 21      | 17     | 31                     |
| *Geotrichum candidum* | 00            | 21             | 21         | 14        | 15      | 14     | 30                     |
| *Penicillium expansum* | 00          | 00             | 20         | 00        | 00      | 00     | 28                     |
| *Syncephalastrum racemosum* | 00     | 00             | 15         | 00        | 00      | 00     | 24                     |

**Table 3**

| Extract Test organism | Minimum Inhibitory Concentration (μg/ml) |
|-----------------------|------------------------------------------|
|                       | Total (Ethanol) | Lipoidal matter | Chloroform | n-Butanol | Aqueous | Powder | Standard Antibiotic |
| **Bacteria**          |              |                |            |           |         |        |                        |
| *Gentamycin*          |              |                |            |           |         |        |                        |
| Gram-negative         |              |                |            |           |         |        |                        |
| *Escherichia coli*    | 5.000         | 2.500           | 0.312      | 5.000     | 0.625   | 5.000  | 03.90                   |
| *Klebsiella pneumoniae* | 10.00       | 2.500           | 0.156      | 5.000     | 5.000   | 10.00  | 00.49                   |
| *Proteus vulgaris*    | 2.500         | 0.625           | 1.250      | 2.500     | 5.000   | 5.000  | 01.95                   |
| *Pseudomonas aeruginosa* | ND          | ND              | 5.000      | ND        | ND      | ND     | ND                     |
| *Salmonella typhimurium* | ND         | 10.00           | 0.625      | 5.000     | 5.000   | ND     | 01.95                   |
| Gram-positive         |              |                |            |           |         |        |                        |
| *Bacillus subtilis*   | 10.00         | 1.250           | 2.500      | 5.000     | 5.000   | 5.000  | 01.95                   |
| *Staphylococcus aureus* | ND          | 10.00           | 0.625      | 0.625     | 2.500   | 1.250  | 01.95                   |
| *Staphylococcus epidermidis* | ND      | ND              | 1.250      | 0.625     | 2.500   | 10.000 | 00.98                   |
| *Streptococcus mutans* | ND          | ND              | 10.00      | 5.000     | 1.250   | ND     | 01.95                   |
| *Streptococcus pyogenes* | ND          | ND              | ND         | 10.00     | 2.500   | ND     | 00.98                   |
| **Fungi**             |              |                |            |           |         |        |                        |
| *Ketocona-zole*       |              |                |            |           |         |        |                        |
| *Aspergillus fumigatus* | 1.250        | 5.000           | ND         | ND        | ND      | ND     | 00.49                   |
| *Aspergillus niger*   | 5.000         | 0.312           | ND         | ND        | ND      | ND     | 03.90                   |
| *Candida albicans*    | 2.500         | 5.000           | 1.250      | 1.250     | 5.000   | 1.250  | 01.95                   |
| *Candida tropicalis*  | 2.500         | 1.250           | 0.156      | 2.500     | 5.000   | 0.312  | 00.98                   |
| *Cryptococcus neoformans* | 1.250      | 5.000           | 0.078      | 0.625     | 2.500   | 5.000  | 01.95                   |
| *Geotrichum candidum* | 5.000         | 2.500           | 0.312      | 1.250     | 5.000   | 0.625  | 03.90                   |
| *Penicillium expansum* | 10.00        | 0.312           | ND         | ND        | ND      | ND     | 01.95                   |
| *Syncephalastrum racemosum* | 10.00  | 10.00           | ND         | ND        | ND      | ND     | 00.98                   |

ND, not determined. Values are expressed as mean ± SEM of 3 determinants.
The effect of natural products as anti-cancer was widely studied because their nature, low toxicity and side effects (Manglani et al., 2014, Mulla & Swamy, 2012, Jani & Jain, 2011).

In the present study, the in vitro antitumor activity of *Galaxaura rugosa* and *Liagora hawaiiana* extracts was determined against different cell lines including 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). Because it is reliable to assess the in vitro cytotoxicity of the anticancer compounds, MTT assay method (Allely et al., 1998) was used.

The obtained results revealed that the extracts of *Galaxaura rugosa* and *Liagora hawaiiana* have a remarkable antitumor activity against different types of tumor cells (Tables 6 and 7). Interestingly, the lipoidal matters of *Galaxaura rugosa* and *Liagora hawaiiana* possessed antitumor activity (IC50 = 15±1.7 and 21.2 ± 1.6, Table 4).

### Table 5

| Concentration (µg/ml) | DPPH scavenging (%) |
|-----------------------|----------------------|
|                       | *Galaxaura rugosa*    |
|                       | *Liagora hawaiiana*   |
|                       | Ascorbic acid         |
| 0.00                  | 0.00                  |
| 0.01                  | 10.87 ± 1.50          |
| 0.02                  | 12.35 ± 1.11          |
| 0.04                  | 21.39 ± 1.71          |
| 0.08                  | 28.09 ± 1.32          |
| 0.16                  | 34.35 ± 1.91          |
| 0.32                  | 55.48 ± 1.22          |
| 0.64                  | 66.00 ± 1.58          |
| 1.28                  | 80.96 ± 1.30          |

K50 = 27.8 ± 1.22, 97.2 ± 1.35, 11.2 ± 1.55

Values are expressed as mean ± SEM of 3 replicates.

### Table 6

| Cell line              | Concentration (µg/ml) | A-549                  | CACO-2                  |
|------------------------|-----------------------|------------------------|
|                        |                       | Lung carcinoma         | Intestinal carcinoma    |
|                        |                       | Total (Ethanol)        | Lipoidal matters        |
|                        |                       |                        | Chloroform              |
|                        |                       |                        | n-butanol               |
|                        |                       |                        | Aqueous                 |
|                        |                       |                        | Powder                  |
|                        |                       |                        | Vinblastine sulfate     |
| 0.000                  | 100                   | 100                    | 100                     |
| 0.01                   | 100                   | 100                    | 100                     |
| 0.02                   | 98.1                  | 100                    | 100                     |
| 0.03                   | 94.0                  | 100                    | 100                     |
| 0.07                   | 87.3                  | 100                    | 100                     |
| 0.15                   | 76.9                  | 100                    | 100                     |
| 0.31                   | 63.1                  | 100                    | 100                     |
| 0.62                   | 41.9                  | 100                    | 100                     |
| 1.25                   | 30.6                  | 100                    | 100                     |
| 2.50                   | 22.8                  | 100                    | 100                     |
| 5.00                   | 18.5                  | 100                    | 100                     |
| IC50 (µg/ml)           | 50.7 ± 3.5            | 15 ± 1.7               |

Values are expressed as mean ± SEM of 3 replicates.

The scavenging activity of DPPH radicals of *Galaxaura rugosa* and *Liagora hawaiiana*. Effect of natural products as anti-cancer was widely studied because their nature, low toxicity and side effects (Manglani et al., 2014, Mulla & Swamy, 2012, Jani & Jain, 2011).

In the present study, the *in vitro* antitumor activity of *Galaxaura rugosa* and *Liagora hawaiiana* extracts was determined against different cell lines including 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). Because it is reliable to assess the *in vitro* cytotoxicity of the anticancer compounds, MTT assay method (Allely et al., 1998) was used.

The obtained results revealed that the extracts of *Galaxaura rugosa* and *Liagora hawaiiana* have a remarkable antitumor activity against different types of tumor cells (Tables 6 and 7). Interestingly, the lipoidal matters of *Galaxaura rugosa* and *Liagora hawaiiana* possessed antitumor activity (IC50 = 15±1.7 and 21.2 ± 1.6, Table 4).
Table 6 (continued)

| Cell line | Concentration (µg/ml) | IC_{50} (µg/ml) |
|-----------|----------------------|----------------|
| HCT-116 Colon carcinoma | 000.00 | 100 |
|          | 001.00 | 100 |
|          | 002.00 | 100 |
|          | 003.90 | 98.7 |
|          | 007.80 | 93.2 |
|          | 015.60 | 86.9 |
|          | 031.25 | 69.1 |
|          | 062.50 | 43.5 |
|          | 125.00 | 30.7 |
|          | 250.00 | 18.6 |
|          | 500.00 | 06.4 |
|          | 100.00 | 0.00 |
|          | 250.00 | 0.00 |
|          | 500.00 | 0.00 |

| HeLa Cervical carcinoma | 000.00 | 100 |
|                        | 001.00 | 100 |
|                        | 002.00 | 99.5 |
|                        | 003.90 | 94.6 |
|                        | 007.80 | 89.7 |
|                        | 015.60 | 80.9 |
|                        | 031.25 | 65.2 |
|                        | 062.50 | 48.1 |
|                        | 125.00 | 31.4 |
|                        | 250.00 | 14.7 |
|                        | 500.00 | 08.9 |
|                        | 100.00 | 0.00 |
|                        | 250.00 | 0.00 |
|                        | 500.00 | 0.00 |

| HepG-2 Hepatocellular carcinoma | 000.00 | 100 |
|                                 | 001.00 | 100 |
|                                 | 002.00 | 98.2 |
|                                 | 003.90 | 91.7 |
|                                 | 007.80 | 80.1 |
|                                 | 015.60 | 69.4 |
|                                 | 031.25 | 48.1 |
|                                 | 062.50 | 34.5 |
|                                 | 125.00 | 23.7 |
|                                 | 250.00 | 11.9 |
|                                 | 500.00 | 05.6 |
|                                 | 100.00 | 0.00 |
|                                 | 250.00 | 0.00 |
|                                 | 500.00 | 0.00 |

| MCF-7 Breast carcinoma | IC_{50} (µg/ml) | 25.00 |
|                       | 000.00 | 100 |
|                       | 001.00 | 100 |
|                       | 002.00 | 100 |
|                       | 003.90 | 99.4 |
|                       | 007.80 | 96.2 |
|                       | 015.60 | 89.4 |
|                       | 031.25 | 71.4 |
|                       | 062.50 | 43.5 |
|                       | 125.00 | 29.4 |
|                       | 250.00 | 17.2 |
|                       | 500.00 | 08.2 |
|                       | 100.00 | 0.00 |
|                       | 250.00 | 0.00 |
|                       | 500.00 | 0.00 |

| PC-3 Prostate carcinoma | IC_{50} (µg/ml) | 25.00 |
|                         | 000.00 | 100 |
|                         | 001.00 | 100 |
|                         | 002.00 | 100 |
|                         | 003.90 | 98.0 |
|                         | 007.80 | 91.7 |
|                         | 015.60 | 86.9 |
|                         | 031.25 | 71.4 |
|                         | 062.50 | 43.5 |
|                         | 125.00 | 29.4 |
|                         | 250.00 | 17.2 |
|                         | 500.00 | 08.2 |

Values are expressed as mean ± SEM of 3 determinants.
Table 7
The antitumor activity of extracts of *Liagora hawaiiana* against different cell lines.

| Cell line     | Concentration (µg/ml) | Cell viability (%) | Cell viability (%) |
|---------------|-----------------------|--------------------|--------------------|
|               | Total (Ethanol) Lipoidal matters Chloro-form n-butanol Aqueous Powder Vinblastine sulfate |                   |                    |
| A-549         |                       |                    |                    |
| Lung carcinoma| 000.00                | 100 100 100 100 100 100 100 100 100 100 |                    |
|               | 001.00                | 100 99.6 98.7 100 100 100 100 100 98.2 |
|               | 002.00                | 99.8 94.8 95.2 100 100 100 100 94.7 |
|               | 003.90                | 96.7 89.5 86.7 100 100 100 100 81.4 |
|               | 007.80                | 90.3 70.4 79.5 100 100 100 98.1 100 73.8 |
|               | 015.60                | 80.6 56.2 63.8 98.0 91.4 98.7 62.5 |
|               | 031.25                | 68.5 38.7 40.8 86.9 79.5 94.3 40.7 |
|               | 062.50                | 53.2 28.1 31.9 72.1 63.8 87.1 32.9 |
|               | 125.00                | 34.9 22.4 23.5 50.6 45.9 69.2 25.2 |
|               | 250.00                | 21.8 14.0 14.8 39.8 37.6 51.8 15.3 |
|               | 500.00                | 079.9 06.1 06.9 26.5 24.9 32.7 06.8 |
| CACO-2        |                       |                    |                    |
| Intestinal carcinoma | 73.6 ± 5.8 | 21.2 ± 1.6 | 25 ± 3.1 | 132 ± 11.4 | 111 ± 8.9 | 274 ± 26.2 | 246 ± 0.7 |
|               | 000.00                | 100 100 100 100 100 100 100 100 100 |
|               | 001.00                | 100 93.7 98.1 100 100 100 100 93.8 |
| HCT-116       |                       |                    |                    |
| Colon carcinoma | 118 ± 10.5 | 122 ± 0.6 | 254 ± 1.2 | 529 ± 3.3 | 605 ± 4.7 | 206 ± 16.2 | 30.3 ± 1.4 |
|               | 000.00                | 100 100 100 100 100 100 100 100 100 |
|               | 001.00                | 100 96.7 91.4 100 100 100 100 100 66.4 |
| HeLa          |                       |                    |                    |
| Cervical carcinoma | 442 ± 0.9 | 195 ± 0.7 | 166 ± 0.8 | 114 ± 9.2 | 104 ± 8.7 | 216 ± 12.3 | 3.5 ± 0.2 |
|               | 000.00                | 100 100 100 100 100 100 100 100 100 |
|               | 001.00                | 100 99.7 98.6 100 100 100 100 100 98.1 |
| HepG-2        |                       |                    |                    |
| Hepatocellular carcinoma | 58.8 ± 1.4 | 70.2 ± 3.5 | 50.7 ± 2.9 | 340 ± 16.7 | 231 ± 20.1 > 500 59.7 ± 2.1 |
|               | 000.00                | 100 100 100 100 100 100 100 100 100 |
|               | 001.00                | 100 99.8 99.8 100 100 100 100 100 60.9 |
| MCF-7         |                       |                    |                    |
| Breast carcinoma | 50.8 ± 5.1 | 50.4 ± 4.3 | 144 ± 0.8 | 233 ± 19.6 | 101 ± 7.8 > 500 2.9 ± 0.3 |
|               | 000.00                | 100 100 100 100 100 100 100 100 100 |
|               | 001.00                | 100 100 100 100 100 100 100 100 67.1 |
|               | 002.00                | 100 97.2 97.2 100 100 100 100 52.9 |
|               | 003.90                | 100 97.0 97.0 100 100 100 100 47.2 |
|               | 015.60                | 91.4 89.5 60.8 100 95.1 100 40.5 |
|               | 031.25                | 79.8 71.3 39.6 99.4 89.5 100 31.9 |
|               | 062.50                | 45.1 49.8 28.1 96.5 76.8 98.2 23.8 |
|               | 125.00                | 32.7 36.2 19.4 81.4 47.2 94.5 15.1 |
|               | 250.00                | 19.4 21.4 08.7 63.1 35.9 83.1 07.8 |

(continued on next page)
respectively) against lung carcinoma (A-549) better than vinblastine sulfate (IC$_{50} =$ 24.6 ± 0.7). Although, the lipoidal matters (IC$_{50}$) against lung carcinoma (A-549) better than vinblastine sulfate (IC$_{50} =$ 59.7 ± 2.1 and 30.3 ± 1.4, respectively) (Tables 6 and 7). These results give new promising resource of anticancer drug discovery from marine this was clear from the variation of the anticancer effect of the algae extracts which due to their huge biodiversity and safety, as they have long been used in traditional Asian foods and folk medicine (Namvar et al., 2014).

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