Biochemical variation in *Cystoseira*Sp.in eastern Libyan coast

*Hdoud A. M. Taher

ABSTRACT: Samples of eight species of brown algae *Cystoseira*Sp. were collected from a few locations ineasterncoasts of Libya between fall 2017 and spring 2018, to study the biochemical composition of dry samples and their percentage estimates. The soluble sugars were between (40.5–58.6%), proteins (12.5–18.5%), lipids (1.9 – 5.0 %), meanwhile percentages of ash were between 22.1 and 41.7% and Iodine (0.48 - 0.83%). These results show the economic importance of these algae, while providing nutrients for the herbivores in their environmental niche and community composition.

1. INTRODUCTION

Oceans and seas of the world are scattered with about 8,000 species of algae, in depths up to 270 meters (Luning, 1990). TheMediterranean sea, especially the Libyan coast, is very rich by economically and ecologically important macro-marine algae (Critchley et al., 1998).

Ecologically, *Cystoseira* genera is good example for bio-indicators according to Pergent-Martini et al., (2005) and Godeh et al., (2011), its predominance could indicate positively for rocky, unpolluted and well-illuminated areas of Mediterranean sea, according to Giaccone, (1973); , Godeh et al, (1992); Thibaut, et al., (2005); Sales and Ballesteros, (2007), Ballesteros, (2007) and Arévalo, et al., (2007), for their high sensitivity to the environmental changes and human impacts (Short and Wylline-Echeverria, 1996). Orfandis et al. (2001) indicated that their presence is indicative of the environmental state and the nutrients (nitrate, nitrite, ammonia and phosphate) level, and then, the quality of water.*Cystoseira* Sp., were not recorded in the Libyan coast before Nizamuddin et al., (1979) and Godeh et al., (1992), these brown algae are good shelters for many coastal fish species, compared to the other environments (Turk et al. 2007; Godeh, 2009 and Yilmaz-Kozetal, 2009).

Economically, Robledo&Pelegrin (1997) pointed that *Cystoseira* Sp. arecounted of edible brown algae species, used as direct and indirect man food, containing many proteins, B vitamins, lipids, sugars and minerals including iodine(Chapman and Chapman, 1980; Dawes, 1998and Rupe'rez and Saura-Calxto, 2001).

*Department of Zoology, Faculty of Sciences and Arts, Omar Almukhtar University, Al-Qubbah, Libya - Email:hudoud.ali.ali@gmail.com

Biochemically,Parthiban et al. (2013) have pointedaround (11.0%) of sugars in *Cystoseira* Sp. going to a quarter approximately (Chakraborty&Santra, (2008); Chakraborty& Bhattacharya, (2012) and Kim, (2012) (26.6%). Meanwhile Rameshkumar et al. (2012) recorded Sugars (38.3%) in the same genera, and Marinho-Soruano et al., (2006) reported sugars from 68 %, reaching the zenith of nineties (90.50 – 93.34%) according to El-Shafay, (2014).

Protein was observed in dry marine algae ranges till 30% by Kim (2012), it important content in the cell wall of algae (Lewis et al., 2011). It was continued in brown algae of *Cystoseira* Sp. from less than 10 % (Mageswaran&Sivasubramantam, 1984; Robledo&Freile-Pelegrin, 2006; Renaud &Luong-Van, 2006; Chakraborty& Bhattacharya, 2012; Parthibanet al. 2013 and El-Shafay, 2014), to a range of twenties per cent (Ruperez&Saura-Caloxto, 2001 and Kim, 2012) Kim, (2012) recorded lipids in brown algae till 1.2%, going to less than 6.0 % (Chakraborty&Santra, 2008; Manivannan et al. 2009;Chakraborty& Bhattacharya, 2012 and Parthiban et al. (2013), maximized to around 8.0% (Renaud &Luong-Van, 2006), and 12.0 % approximately (Rameshkumar et al. 2012).

Polat&Ozogul, (2008) stated that variation of minerals accumulation in ash remains to genetic and the environmental reasons, between 0.19% (El-Shafay, 2014), 0.26 – 1.03 % (Manve et al. 2013), Mageswaran&Sivasubramantam (1984) observed less than 15.0%, 22.5% (Kim, 2012), reaching 40% according to Renaud &Luong-Van, (2006).

Iodine;as major element for thyroid gland, physiologically (Van Nettenetal2000), was found in brown algae of *Cystoseira* Sp. between 0.03 % by Ganesan&SubbaRao, (1999) and Morrisey et al., (2001), till 0.43 % according to Van Netten et al., (2000) in various species of the same genus.

Medically, as well, El-Baghdady (2000);Tüney et al., (2006); El-Fatmy, (2008); El-Fatimy et al., (2009) reported some antimicrobial, antibacterial and antifungal effects of some crude extracts of some dictyotalesin Benghazi coasts. Although the healthybenefits of these seaweeds, our local culture still refusing and avoiding fact that algae are useful as food and drugs (Godeh et al. 1992).

In this work, biochemical structure will be studied in three species of *Cystoseira* Sp. in locations of the eastern Libyan coast, to estimate the nutritional value of these species of protein, lipids, sugars and minerals, and their potential use as food and medicine,to evaluate some of their economic importance and chemical composition in farther investigations.

2. MATERIALS AND METHODS

1.2. Locations (Fig. 1):

1.1.2. Susah (21^0 58 '34' 'E 31^0 53' 32 '' N): A rocky cliff that with semi-isolated ponds, where water is replenished depending on the state of the sea.

2.1.2. Al-Hamamah(37 '21^{0}' E '32^0 15 '' N): A shallow sand-line with up to one meter depth, a low-lying coastline, and filled with some rock masses.

3.1.2. Al-Haniah(21^0 31 '15' 'E 32^0 50 '44' 'N): A rocky bed with isolated rock pools that renew their water, according to state of sea and height of waves.

2.2. Sampling and samples preparation: From study sites, between fall 2017 and spring 2018, the samples of *Cystoseira* species were collected, washed and then transferred to the laboratory Department of Marine Sciences Faculty of Sciences in University of Omar Al-Mukhatr, Albayda - Libya, where they were identified taxonomically, using Italian list from Ardissone, (1893), Pampanini (1931), Nizamuddin et al. (1979), Burrows, (1991) Godeh et al. (1992),Godeh et al. (2009)Godeh et al. (2011) and Aleem (1993). In laboratory Epiphytes, impurities and salts removed carefully, then dried at room temperature, then grinded and kept away from light until the analysis, according to Turna et al. (2002) and Mayhoob et al. (2015).

2.3. Biochemical analysis: The following analysis were performed in the chemical laboratory of the Faculty of Science at the University of Omar Al-Mukhtar - Al-Bayda, the Food Control Laboratory - Al-Bayda, and the Environmental Lab at the Judicial Experience Center - Al-Bayda, as follows:

2.3.1. Soluble sugars: They were detected using (phenol phenethyline + concentrated sulfuric acid), which added to dry algae powder, where sugars dissolve into pentoses to combine with phenol and give a brownish brown complex (Dubois et al., 1956). Absorption was estimated at wavelength 490 nm, using a spectrophotometer, sugars were estimated as a percentage of dry weight, using standard solution of D. Glucose.

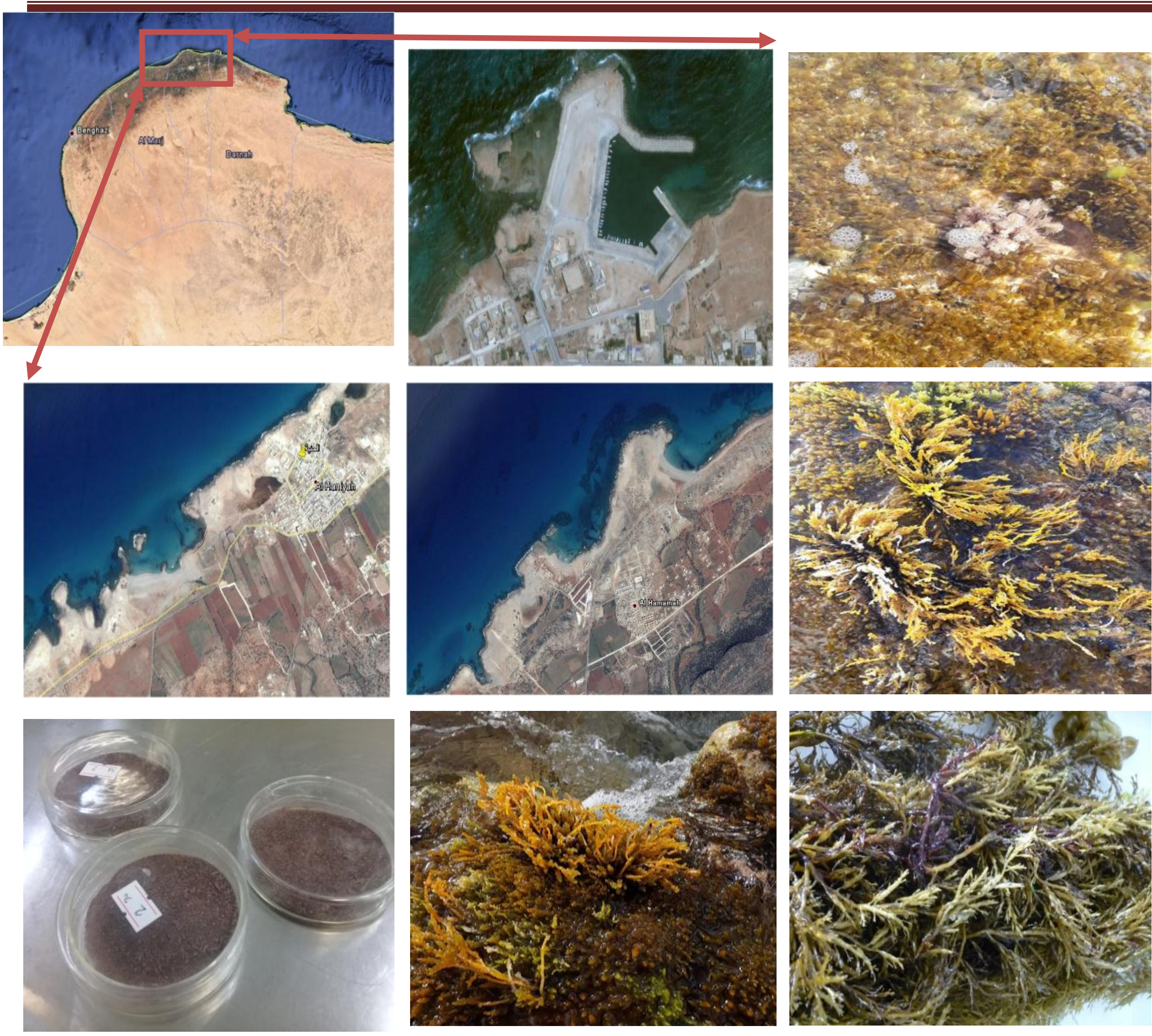

Figure 1: Google Images 2018 for coasts of Susah, Al-Hamamah and Al-Haniah - Al-Gabal Al-Akhdar, Libya, with some samples of brown algae specimens in the field trip and dried and powdered algae samples.

2.3.2. Protein: according to Raymontet al., (1964), proteins were determined by bioretic reagent (copper sulphate + sodium and potassium tartrates + sodium hydroxide and potassium iodide). When this reagent was added, peptides interacted with copper sulphate to form violet colour, absorbance was read at 540 nm wavelength on spectrophotometer. The amount of proteins was calculated as a percentage of the standard solution of Bovine serum albumin (BSA).

2.3.3. Lipids: were determined by adding chloroform-methanol (1: 2) to algae powder (Folch et al., 1956).

2.3.4. Ash: Organic matter was burned at 500 ° C to retain ash, which is the sulphates and oxides of minerals, ash was calculated as a percentage of dry weight (Larsen, 1978).

2.3.5. Iodine: Determined according to Saenkoet al., (1978), by converting iodine compounds to a partial form, allowing interaction with bromine probes to form L_2Br^- bright green complex, and using spectrophotometer to read absorption at wavelength 680 nm. Iodine was calculated in percentage of dry weight, using Standard solution of potassium iodide KI.

3. RESULTS AND DISCUSSION:

In general, some marine algae species contain significant proportions of proteins, lipids, sugars and minerals, and these ratios vary by species, seasons, geographical distribution and environment (Ito & Tsuchiya, 1977; Dhargalkaretal 1980 and Herbetreau et al., 1997). The most important results in this work (Table 1 and Figure 2).

Table (1): Biochemical content of three species of Brown algae *Cystoseira* Sp. In three coastal sites, Al-Gabal Al-Akhdar, Libya 2018.

Species	Soluble Sugars	Proteins	Lipids	Ash	Iodine
***C. abies-marina* –Susah**	**54.1**	**18.5**	**1.9**	**24.9**	**0.59**
C .amentacea–Alhannia	39.8	13.1	7.6	39	0.55
C. amentacea–Alhamama	41.1	11.9	2.2	44.4	0.41
***C. amentacea*–AVERAGE**	**40.5**	**12.5**	**4.9**	**41.7**	**0.48**
C. compressa–Susah	47.1	*17.3*	4.81	30	0.79
C. compressa–Alhamama	51.1	19.6	5.13	23.3	0.87
***C. compressa*–AVERAGE**	**49.1**	**18.45**	**5.00**	**26.65**	**0.83**
***C. discors*–Susah**	**42.1**	***20.1***	**3.6**	**33.5**	**0.71**
C. elegans–Susah	52.1	15.3	3.3	28.7	0.60
C. elegans–Alhamama	48.1	16.8	3.1	31.5	0.50
***C. elegans*–AVERAGE**	**50.1**	**16.05**	**3.2**	**30.1**	**0.55**
***C. gerloffi*–Susah**	**58.1**	**16.1**	**3.00**	**22.1**	**0.70**
***C. mediterranea var. valiante*–Susah**	**58.6**	**14.6**	**4.21**	**22.0**	**0.69**
C. susanensis–Alhamama	45.9	17.3	4	32.1	0.70
C. susanensis–Susah	44.1	11.8	4.3	39.1	0.83
***C. susanensis*–AVERAGE**	**45.0**	**14.55**	**4.15**	**35.6**	**0.77**

3.1. Soluble sugars: About 40.5 % in *C. amentacea*werethe nader of polysaccharides in the studies species, meanwhile it peaked to 58.6% dry weight in *C. mediterranea var. valiante*in Susahshores.This range of sugars is more significant than Renaud &Luong-Van, (2006), Rameshkumar et al. (2012) and Parthiban et al. (2013), although Marinho-Soruano et al., (2006), and El-Shafay, (2014) notified higher records than recent study. The difference between the studied species and this corresponds to Pádua et al. (2004). These values have been mainly similar to studies on brown seaweed in most other regions. Ruperez&Saura-Caliaxo (2001) reported that low-calorie brown algae due to low fats and high proteins and sugars ratios. Brown algae have high sugars suitable to produce ethanol (John &Anisha, 2011).

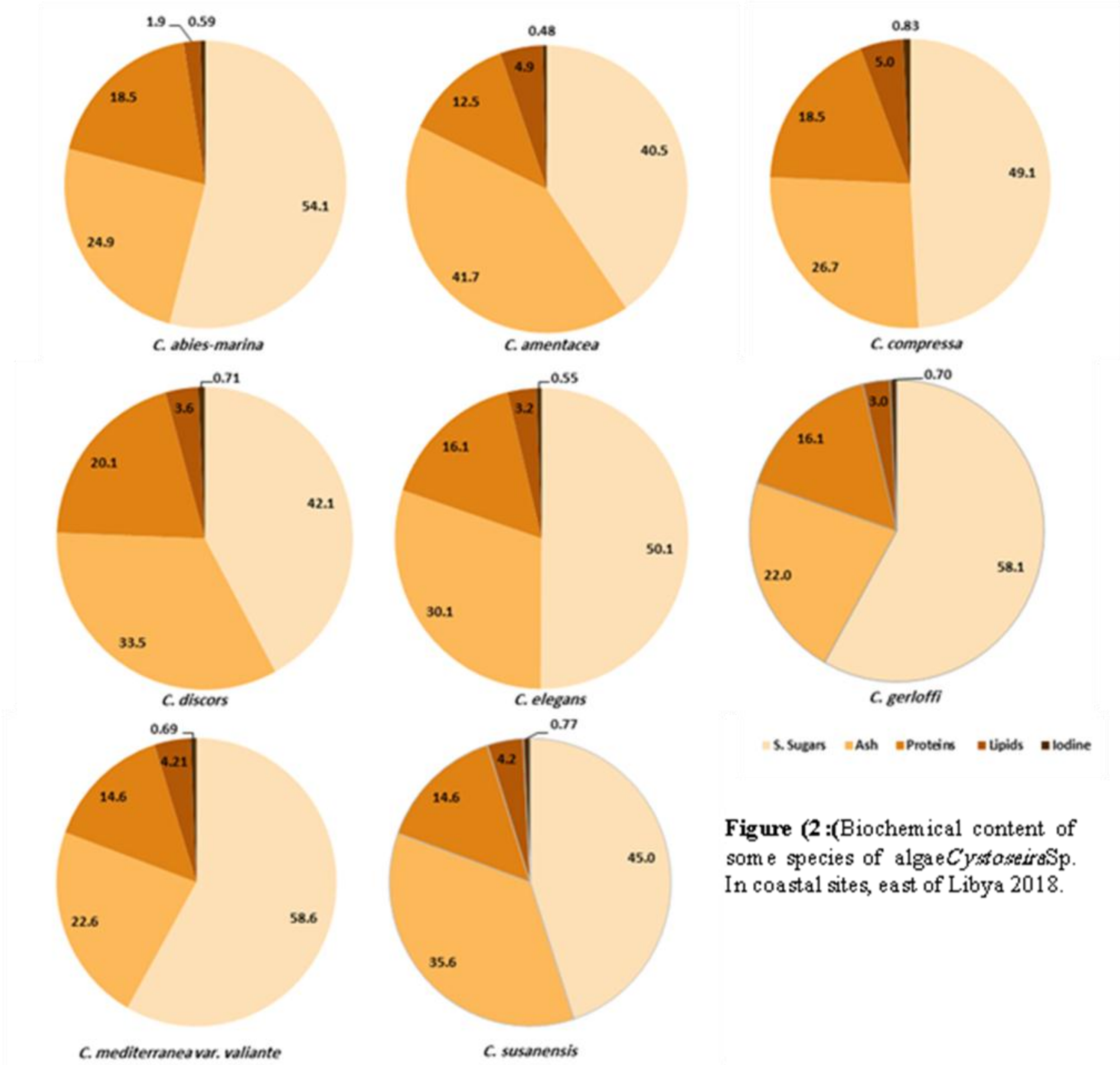

Figure (2 :(Biochemical content of some species of algae*Cystoseira*Sp. In coastal sites, east of Libya 2018.

<u>3.2. Proteins</u>: In Alhannia and Alhamama shores, *C. amentacea* had 12.5 % of protein in dry weight, whereas *C. abies-marina* in Susah peaked 18.5 %. Recent work has been recoded higher than Mageswaran&Sivasubramantam (1984), Robledo&Freile-Pelegrin, (2006), Kim, (2012) and Parthiban et al. (2013). Meanwhile Fleurence (1999) and Ruperez&Saura-Caloxto, (2001) recorded higher ratios. Differences were observed between studied species consistent with Kim (2012), who concluded that the overall protein content in dry marine algae ranges from 10-30%, and 5-15% in the cell wall (Lewis et al., 2011).

<u>3.3. Lipids</u>: *C. compressa* in Alhamama and Susah coasts had a significant level of lipids (5.0 %), meanwhile *C. abies-marina*in Susah shores has been recorded insignificantly (1.9% dry weight). These values were higher than Marinho-Soruano et al., (2006), Manivannan et al. (2009),Kim, (2012), El-Shafay, (2014) and Mayhoob, (2015), and lower than Renaud &Luong-Van, (2006), Rameshkumar et al. (2012) for the same genera. Altough lipids in most marine algae do not reach 4.5% (Murata &Nakazoe, 2001).The spatial and environmental differences have a role as well (Ito & Tsuchiya, 1977; Herbetreau et al., 1997), these compounds are used to feed fish larvae (Estovez et al., 1999), and as a source of omega-3 (Nordoy, 1989).

3.4. Ash: In Alhamama and Alhannia rocky shores, *C. amentacea* seaweeds have a large portion of mineral ashes up to 41.0 % approximately, whereas there was 22.1 into parts of *C. gerloffi* from Susah beach. These values are more significant than Mageswaran&Sivasubramantam (1984), Marinho-Soruano et al., (2006), Kim, (2012) and El-Shafay, (2014), and considerable than Robledo&Freile-Pelegrin, (2006) Renaud &Luong-Van, (2006). This ratios variationremains to the minerals accumulation degree within each species, and the environmental consideration as well (Polat&Ozogul, 2008).

3.5. Iodine: It plays a role to control the thyroid gland diseases (Van Nettenetal2000). It varies according to species, going from 0.48 *C. amentacea* in Alhannia and Alhamama locations, up to 0.83 % dry weight in *C. compressa*. Almost this variation level was higher than records of Ganesan&SubbaRao, (1999), Van Netten et al., (2000) and Morrisey et al., (2001) as well. Meaning that they are significant source of iodine.

4. CONCLUSION AND RECOMMENDATIONS

Brown algae – including *Cystosira* Sp. genera - are rich in proteins and soluble sugars, which cause slowing digestion, thus depleting nutrient uptake and then decreasing blood sugar and cholesterol, so they are considered suitable to human nutrition , to obesity and thyroid diseases control as well. Therefore: **(1)** Marine algae of such species should be taken into consideration in marine aquaculture projects, as an important food and therapeutic source, with intensification of studies on other families and species. **(2)** Libya coastline containsimportant resources, including algae, should be used sustainably.

5. REFFERENCES:

1. **Aleem, A. A. 1993.**The marine algae of the Alexandria, Egypt.

2. **Ardissone F. 1893.** Note allaPhycologia Mediterranean. Rend. Inst. lomborado Sci. Lett., Ser. 2, 26: 674-690.

3. **Arévalo, R.; Pinedo, O. and Ballesteros,E. 2007.** Changes in the composition and structure of Mediterranean

4. **Burrows, E. M. 1991.** Seaweeds of the British Isles. Volume 2. Chlorophyta. London: British Museum (Natural History).

5. **Chakraborty,S. andBhattacharya,T. 2012**.NutrientcompositionofmarinebenthicalgaefoundintheGulfofKutchcoastline,Gujarat,India.J.AlgalBiomassUtln.Vol.3: 32– 38.

6. **Chakraborty,S. andSantra,S.C. 2008.**Biochemicalcompositionofeightbenthicalgaecollectedfrom Sunderban.IndianJournalof MarineSciences. Vol.37:329-332.

7. **Critchley, A. T.; Gillespie, R. D. andRotman, K. W. G. 1998.** Seaweed resources of South Africa. Pp. 413- 425. In: "Seaweed resources of the world. (Critchley AT, Ohno M. eds)". Japan International Cooperation Agency, Japan.

8. **Dawes, C. J., 1998.** Marine Botany. John Wiley and Sons, New York. Geneid, Y, and Mourad, F. (2007): Levels of trace-metals in the seagrasses.

9. **El-Shafay,S.M. 2014.**BiochemicalCompositionofSomeSeaweedFromHurghadaCoastalAlongRedSeaCoastal, Egypt.InternationalJournalofBasic&Applied SciencesIJBAS-IJENS. Vol. 14: 29-35.

10. **Chapman, V. J. and Chapman, D. J. 1980.** Seaweeds and Their Uses. Chapman and Hall, London, 148pp.

11. **Dubois, M; Giles, K.A; Hamilton, K.S; Rebers, P. A and Smith, F. 1956.** Colorimetric method for the determination of sugar and related substances. Anal. Chem. Vol. 18: 350–356.

12. **Dhargalkar, V.K; Jagtap, T. G and Untawale, A. G.1980.** Biochemical constituents of seaweeds along the Maharastra coast. Indian J. Mar. Sci. 9: 297- 299.

13. **El-Baghdady H. 2000.** Study of the effective of some brown algal species extractions (order: Dictyotales) against bacteria. M. Sc. Thesis, Botany Department, Faculty of Science, Garyounis University, Libya. (in Arabic).

14. **El-Fatimy, E. S. 2008.** Study of the effective of some brown algal species rocky-shore commuities following a gradient of nutrient enrichment: descriptive study and test of proposed methods to assess water quality regardingmacroalgae. Marine Pollution Bulletin, 55: 104-113.

15. **El-Fatimy E. S.; Said, A. A.andGodeh M. M. 2009.** Seasonal Variation and Antifungal Activities of Methanolic Algal Extracts of some Dictyotaceae of Benghazi Coasts, Libya. Egypt. J. Phycol., 10: 49-57.

16. **Fleurence,J. 1999.**Seaweedproteins:biochemicalnutritionalaspectsandpotential uses.FoodScience&Technology. Vol.10: 25-28.

17. **Folch, J; Lees, M; and Solane Stanley, G. H. A. 1956**. Simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem. 226: 497- 509.

18. **Ganesan,M. andSubbaRao,P. V.1999.** Cultureofmarinebrownalga*Padinaboergesenii*(Dictyotales,Phaeophyta)atMandapamcoast,southeastcoastofIndia.Indian Journal of Marine Sciences 28,1999, 461-463.

19. **Giaccone G. 1973.**Ecologie et chrologie des *Cystoseira* de Méditerranée: Rapp. Com. Int. MerMédit., 22: 46-50.

20. **Godeh,M.; Nizamuddin, M. and El-Menifi F. 1992.** Marine algae from eastern coast of Libya (Cyrenaica). Pak. J. Bot., 24(1): 11-21.

21. **Godeh,M.; El-Menifi F. and Said, A. 2009.** Marine algae of Tobruk and AinGhazala coasts, Libya. Garyounis University Press. Journal of Science and Its Applications. Vol. 3 (1): 42-55.

22. **Godeh, M. M. ; Said, A.; Meftah, A.; Zarmouh, M. and El-Menifi, F. O. 2011.** Marine phaeophyceae of Benghazi coasts, Libya, Journal of Sebha University, Pure and Applied Sciences, Vol.10 (1): 32 - 39

23. **Ito, K. and Tsuchiya, Y. 1977.** Differential fatty acid composition of some marine algae associated with their habitat depths. Tohoku Journal of Agricultural Research 28: 145-150.

24. **John, R. P. and Anisha, G. S. 2011.**Macroalgae and their potential for biofuel, Environ. Impact 6: 1–15.

25. **Kim, K. T. 2012.** Seasonal variation of seaweed components and novel biological function of fucoidan extracted from brown algae in quebec. Thèse, Univ. Laval, France, 142pp

26. **Larsen, B. 1978.** Brown seaweeds: Analysis of ash, fibre, iodine and mannitol. In: (J. A. Hellebust and 1. S. Craigie, eds.) Handbook of Phycological Methods: Physiological and Biochemical Methods. Cambridge University Press, Cambridge, 181 – 188.

27. **Lewis, J. Salam, F; Slack, N; Winton, M; Hobson, L. 2011.** Product Options for the Processing of Marine Macro Algae. Faisal Salam, Neville Slack, Mike Winton, Lois Hobson. The Crown Estate, 44pp.

28. **Kumar,C.S;Ganesan,P.;Suresh,P.V;Bhaskar,N.2008.**Seaweedsasasourceofnutritionallybeneficialcompounds—areview.JFoodSciTechnol. Vol.45:1–13.

29. Mageswaran,R;Sivasubramantam,S.*MineralandProteinContentsofsomeMarineAlgaefromtheCoastalAreasofNorthernSriLanka*.J.Nam.Sci.Coun. SriLanka. Vol. 12:179-189.

30. **Manivannan,K.;Thirumaran,G.;KarthikaiD.G.Anantharaman,P;Balasubramanian,T. 2009.**Proximate Composition

ofDifferentGroupofSeaweedsfromVedalaiCoastalWaters(GulfofMannar):SoutheastCoast of India.Middle-East Journal of Scientific Research. Vol. 4: 72-77.

31. **Marinho-Soriano,E;Fonseca,P.C;Carneiro,M.A.A;Moreira,W.S.C. 2006.**Seasonalvariationinthechemicalcompositionoftwotropicalseaweeds.BioresourceTechnology. Vol.97: 2402–2406.

32. **Mayhoob, H. ; Abbass, A. and Arraj, H. 2015.**Study of biochemical composition of some algal species of *Cystoseira* (Phaeophyceae) at Ibn Hani coast – latakia, Tishreen University Journal for Research and Scientific Studies - Biological Sciences Series Vol. 37: 155-172.

33. **Murata, M; Nakazoe, J. 2001.** Production and use of marine algae in Japan. JpnAgr Res Q 35: 281–290.

34. **Nordoy, A. 1989.** Fish oils in clinical medicine. J. Int. Med., 225-3: 147- 145

35. **Nizamuddin, M.; West J. A. andMenez E. G. 1979.** A list of marine algae from Libya. Bot. Mar., 22: 465- 476.

36. **Orfanidis, S; Panayotidis, P. and Stamatis, N. 2001.** Ecological evaluation of transitional and coastal waters: A marine benthic macrophytes-based model. J. Ecological indicators, 3: 27–33.

37. **Pampanini, R. 1931.**ProdromodellaCirenaica. Algae. pp. 1-40.

38. P**ergent-Martini C, Leoni V, Pasqualini V, Ardizzone GD, Balestri E, Bedini R, Belluscio A, Belsher T, Borg J, Boudouresque CF, Boumaza S, Bouqouegneau JM, Buia MC, Calvo S, Cebrian J, Charbonnel E, Cinelli F, Cossu A, Di Madida G, Dural B, Francour P, Gobert S, Lepoint G, Meinesz A, Molenaar H, Mansour HM, Panayotids P, Peirano A, Pergent G, Piazzi L, Pirrotta M, Relini G, Romero J, Sanchez-lizaso JL, Semroud R, Shembri P, Shili A, Tomasello A, Velimirov, B. 2005**. Descriptors of P. oceanica meadows: Use and Application. Ecol. Indicators, 5(3): 213-230.

39. **Pádua, M. D; Fontoura, P. S.G and Mathias, A, B. 2004.** Chemical Composition of *Ulvariaoxysperma* (Kützing) Bliding, *Ulvalactuca* (Linnaeus) and Ulvafascita (Delile). Barazilian Archives of Biology and Technology, Vol. 47: 49–55.

40. **Parthiban, C; Saranya, C; Girija, K; Hemalatha, A; Suresh, M; Anantharaman, P. 2013.** Biochemical composition of some selected seaweeds from Tuticorin coast. Adv. Appl. Sci. Res. 4(3): 362-366.

41. Polat, S. and Ozogul, Y. 2008. Biochemical composition of some red and brown macroalgae from the northeastern Mediterranean Sea. Int. J. Food Sci. Nutr. Vol. 59: 566–572

42. **Rupe'rez P, Saura-Calxto F. 2001.** Dietary fibre and physicochemical properties of edible Spanish seaweeds. Eur. J. Food Res. Technol., 212(3): 349-354.

43. **Raymont, J. E. G; Austin, J. and Lineford, E. 1964.** Biochemical studies on zooplankton.The Biochemical composition of Neomycis integer. J. Cans. Perm. Emplor. Mer. Vol. 28: 354-363.

44. **Renaud,M.S andLuong-Van,J. T. 2006.***SeasonalvariationinthechemicalcompositionoftropicalAustralianmarinemacroalgae*.JournalofAppliedPhycology. Vol.18: 381–387.

45. **Robledo, D. and Pelegrin, Y. F. 1997.** Chemical and mineral composition of six potentially edible seaweed species of Yucatan. Botanica Marina, Vol. 40: 301-306.

46. **Ruperez, P. and Saura-Calixto, F. 2001.** Dietary fiber and physicochemical properties of edible Spanish seaweeds. European Food Research and Technology, Vol. 212: 349–354 .

47. **Saenko, G. N; Kravtsova, Y. Y; Ivanenko, V. V. and Sheludko, S. I. 1978.** Concentration of iodine and bromine by plants in the Seas of Japan and Okhotsk. Mar. Bioi. Vol. 47: 243 – 250.

48. **Sales M, Ballesteros E. 2007.** Shallow, sheltered water populations of *Cystoseira* sp. In Menorca (Balearic Islands). Proceeding of the 3rd Mediterranean symposium on marine vegetation. 27-29 March 2007 - Marseilles.164-171.

49. **Short, F. T. and Wylline-Echeverria, S. 1996**. Natural and human- induced disturbances of seagrasses. Environ. Conserv., 23 (1): 17-27.

50. **Thibaut T, Pinedo S, Torras X, Ballesteros E. 2005.** Long-term decline of the populations of Fucales (Cystoseira sp. and Sargassum sp.) in the Alberes coast (France, north-weastern Mediterranean). Mar. Pollut. Bull., 50(12): 1472-1489.

51. **Tüney, I.; Çadircl., B. H.;Ünal, D. and Sukatar, A. 2006.** Antimicrobial Activity of the Extracts of Marine Algae from Coast of Urla (Izmir, Turkey). Turk. J. Biol. 30: 171-175.

52. **Turk, R; Orlando-Bonaca, M; Dobrajc, Z. and Lipej, L. 2007.** *Cystoseira* communities in the Slovenian coast and their importance for fish fauna. Proceeding of the 3rd Mediterranean symposium on marine vegetation, Marseilles: 203- 208.

53. **Turna,Ü.Ü;Ertan,MerO;Cormaci,M;Furnari,G. 2002.***SeasonalVariationsintheBiomassofMacro-AlgalCommunitiesfromtheGulfofAntalya(north-easternMediterranean).*TurkJBot. Vol. 26:19-29.

54. **Van Netten, C; Cann, S.A.H; Morley, D.R and Van Netten, J.P. 2000.** Elemental and radioactive analysis of commercially available seaweed. Science of the Total Environment, Vol. 255: 169–175.

55. **Yilmaz-Koz, F. F, Karabay-Yavasoglu, N. U, Demirel Z, Sukatar A and Ozdemir, G. 2009.** Antioxidant and antimicrobial activities of Codium fragile (Suringar) hariot (Chlorophyta) essential oil and extracts. Asian J. Chem. Vol. 21: 1197- 1209.