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Research Paper

Measurement of chlorophyll-A concentrations in the sea waters at selected sites along the western coast of Libya

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Abstract
The aim of this study was to measure the concentrations of chlorophyll-a and phaeophytene-a in the waters of four locations along the Libyan coast: the first location was Misrata Beach (Yader); the second was Tajoura Beach (Marine Research Centre); the third was Dhat al-Imad Beach; and the fourth was Mei'itiqa Beach
The highest concentrations of chlorophyll-a were recorded at the second site (Tajoura, Marine Research Centre) during January, at a concentration of 5.073 micrograms/m³, followed by a concentration of 3.0705 micrograms/m³ at the same site in November, followed by the third site (Dhat al-Imad) in January at 1.602 micrograms/m³, whilst the lowest concentrations were recorded at the fourth site (Mi'itiqa) in January at 0.534 micrograms/ m³, similar to the first site (Misrata Yader). No results were recorded in November at the first, third and fourth sites.
The highest concentrations of phaeophytene-a were recorded at the third site (Dhat Al-Imad) in November, at 69.6736 micrograms/ m³, followed by the second site (Marine Research Centre) in January with a concentration of 43.24 micrograms/m³, and at the fourth site (Mi'itiqa) in November, 41.558 micrograms/ m³, whilst the lowest concentrations were recorded at the first site (Misrata Yadr) in November at 4.8861 micrograms/m³, followed by the fourth site in January at a concentration of 5.8206 micrograms/m³, with no results recorded in January at the first and third sites.

Keywords: *Chlorophyll, Phaeophytene, Libyan coast, Phytoplankton*

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I. Introduction

Among the most significant biological factors having a major impact on aquatic environments are algae, as they constitute a fundamental component of any body of water, being one of the most important organisms contributing to primary productivity and forming the base of the food chain in aquatic ecosystems. Their primary productivity can be measured by determining the concentration of dissolved oxygen, which is the result of photosynthesis that relies entirely on chlorophyll-a (Al-Saadi, 1993). Some characteristics of seawater are constant and are not affected by the primary productivity of the ecosystem, such as salinity and pH, whilst others are variable, such as temperature, dissolved oxygen, nutrients and chlorophyll-a concentration (Al-Saadi, 1993; Al-Miyah *et al.,* 1991). The importance of nutrients in seawater stems from the importance of microorganisms, the most important of which are algae, on which they feed; they represent the first link in the marine food chain and in turn become food for zooplankton and other animals, where nutrients play a fundamental role in regulating and controlling the density and biomass of phytoplankton. (Al-Jatlawi *et al.,* 2015) (Lee, 2008)

In most marine environments, nitrogen acts as the limiting factor for phytoplankton, whilst in most freshwater ponds the situation changes and phosphorus becomes the limiting factor for the biomass of phytoplankton.

The amount of chlorophyll-a in the aquatic environment indicates the density of phytoplankton, which is considered a primary food source for zooplankton. (Al-Shahin, 2016)

Chlorophyll-a is the most abundant pigment found in all types of algae; it is therefore used to estimate the biomass of floating and benthic algae, as well as an indicator of water quality (Wilson, 1989).

Phytoplankton play a vital and fundamental role in aquatic environments, as they constitute the primary producer and the cornerstone of the aquatic food chain, owing to their ability to synthesize organic matter (which serves as food for zooplankton and other marine organisms) through photosynthesis. (Badran, 2001)

Phytoplankton belong to the Thallophyta and occur as single cells, in chains or colonies; they may form loosely connected chains, and in blue-green algae, they take the form of tightly packed cells surrounded by a gelatinous sheath (Susanne *et al*., 2005).

They are characterized by being microscopic and are transported through the water column by water currents; when the necessary conditions are met, they grow rapidly and their growth flourishes at certain times, causing algal blooms. (Al-Shahin, 2016) (Al-Shaaban, 1996).

Certain physico-chemical factors, such as temperature, light penetration into the water and nutrients, play an important role in the distribution of phytoplankton; these factors interact with one another to determine water quality (Badran, 2001).

The aim of this research is to conduct a practical study to measure the concentration of chlorophyll-a at four sites along the Libyan coast.

Materials and methods

Study sites:

Site 1: Misrata Beach (Yader)

Site 2: Tajoura Beach (Marine Research Centre)

Site 3: Dhat Al-Imad Beach

Site 4: Mei'itiqa Beach

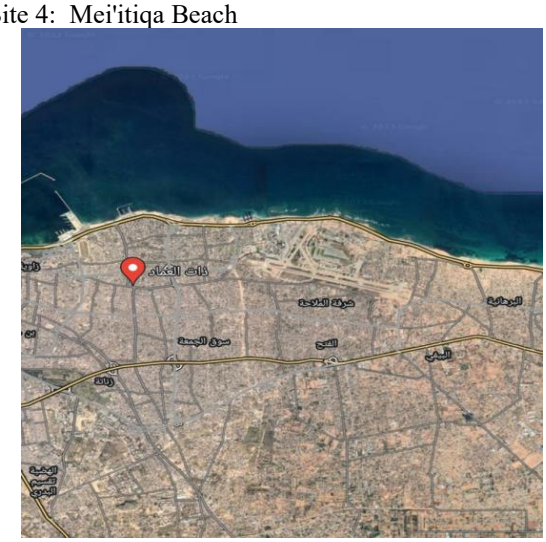

Figure 1:Dhat Al-Imad Beach

Figure 2: Mei'itiqa Beach

Figure 3: Tajoura Beach (Marine Research Centre)

Figure 4: Misrata Beach (Yader)

II. Methodology

Samples were collected by taking a 2-litre volume from the beach surface at each site using a medium-sized wide-mouthed container during November and January (2022–2023). The samples were transported to the Phytoplankton Laboratory (Marine Biology Research Centre).

Each sample was filtered individually using a filtration apparatus with filter paper and drops of magnesium carbonate solution. The filter papers for each site were placed in their own test tubes, to which 2 ml of concentrated acetone and 8 ml of 90% acetone were added to each tube. The samples were crushed using a glass rod until the filter paper dissolved, and the same process was repeated in each tube. The tubes were covered with aluminium foil and placed in the refrigerator for 24 hours. The samples were placed in a centrifuge to allow the sediment to settle to the bottom and to facilitate sample collection from the surface of the tube. The sample was taken with a pipette and placed in a cell of the spectrophotometer to measure the wavelengths; the instrument was switched on and adjusted to a wavelength of 665 nanometres for each sample; readings were taken to calculate the wavelength for each sample by taking (three absorption replicates), once before adding hydrochloric acid and once after adding the acid (1–2 drops).

The concentrations of chlorophyll-a and phaeophytene-a (degraded pigments) (Parsons *et al.,* 1984) were calculated using the following two equations:

$$\text{1- Chlorophyll-a} \quad (\text{mg} / \text{m}^3) = \frac{26.7\,(665_0 - 665_a) \times v}{V \times L}$$

(Sample volume 2 L.) =V

(Acetone volume 10 ml) = v

(Sample mean before adding HCL) = 665_0

(Sample mean after adding HCL) = 665_a

(1 L)= L

$$\text{2- Phaeo} - \text{pigments} \ (\text{mg}/\text{m}^3) = \frac{26.7\,[1.7\,(665_a) - 665_0] \times v}{V \times L}$$

III. Results

The concentration values of chlorophyll-a and phaeophytene-a which were calculated in the above equations were shown in the following (Table 1).

Fragmented pig conc (mg/m³)	Chlorophyll A(mg/m³)	Sites
4.8861	0	Misrata, November
0	0.267	Misrata, January
0.57405	3.0705	Tajoura, November
43.24	5.073	Tajoura, January
69.6736	0	Dhat al-EImad, November
0	1.602	Dhat al-Imad, January
41.558	0	Mi'itiqa, November
5.8206	0.534	Mi'itiqa, January

Table 1: Concentrations of chlorophyll-a and broken-down pigments

Chlorophyll-a concentration results

The highest chlorophyll-a concentrations were recorded at the second site (Tajoura Marine Research Centre) during January, at a concentration of 5.073 micrograms/ m³, followed by a concentration of 3.0705 micrograms/m³ at the same site in November, and then the third site (Dhat Al-Imad) in January 1.602 micrograms/ m³, whilst the lowest concentrations were recorded at the fourth site (Mi'itiqa) during January at a concentration of 0.534 micrograms/m³, similar to the first site (Misrata Yadr). No results were recorded during November at the first, third and fourth sites.

Phaeophytene-a concentration results

These broken-down pigments result from the breakdown of chlorophyll-a. The highest concentrations of phaeophytene-a were recorded at the third site (Dhat Al-Imad) during November at a concentration of 69.6736 micrograms/ m³, followed by the second site (Marine Research Centre) in January with a concentration of 43.24 micrograms/m³, and the fourth site (Mi'itiqa) in November with 41.558 micrograms/ m³, whilst the lowest concentrations were recorded at the first site (Misrata-Yadr) in November at 4.8861 micrograms/m³, followed by the fourth site in January at a concentration of 5.8206 micrograms/m³, with no results recorded in January at the first and third sites (Fig 5 & 6).

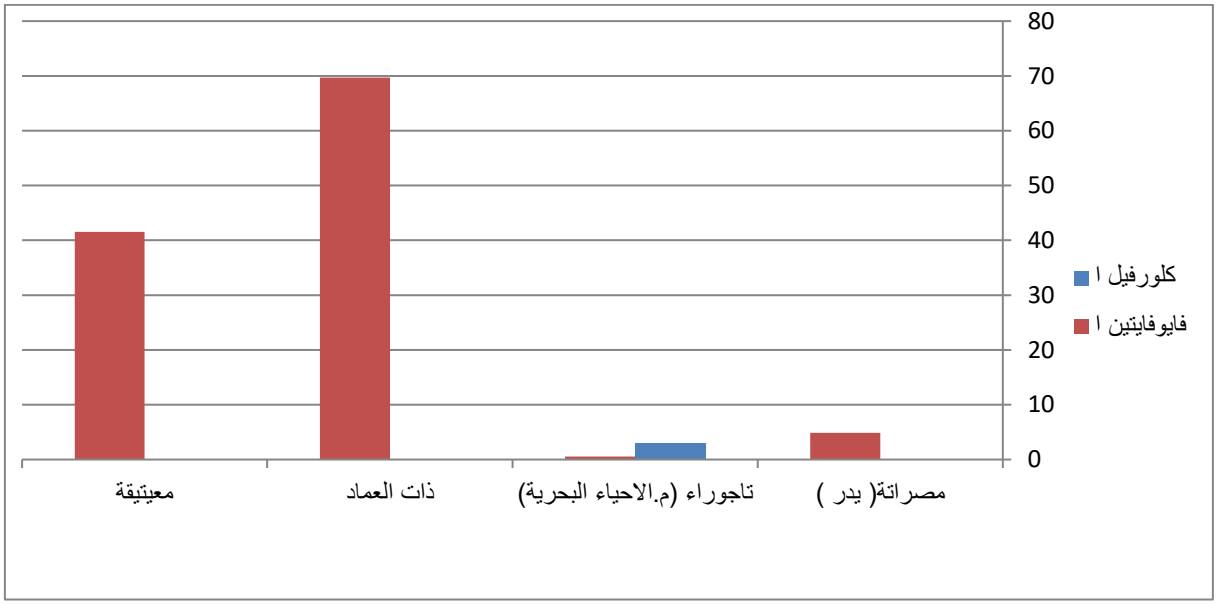

Figure 5: Concentrations of chlorophyll-a and phaeophytene- a (mg/m³) at the study sites for the month of November

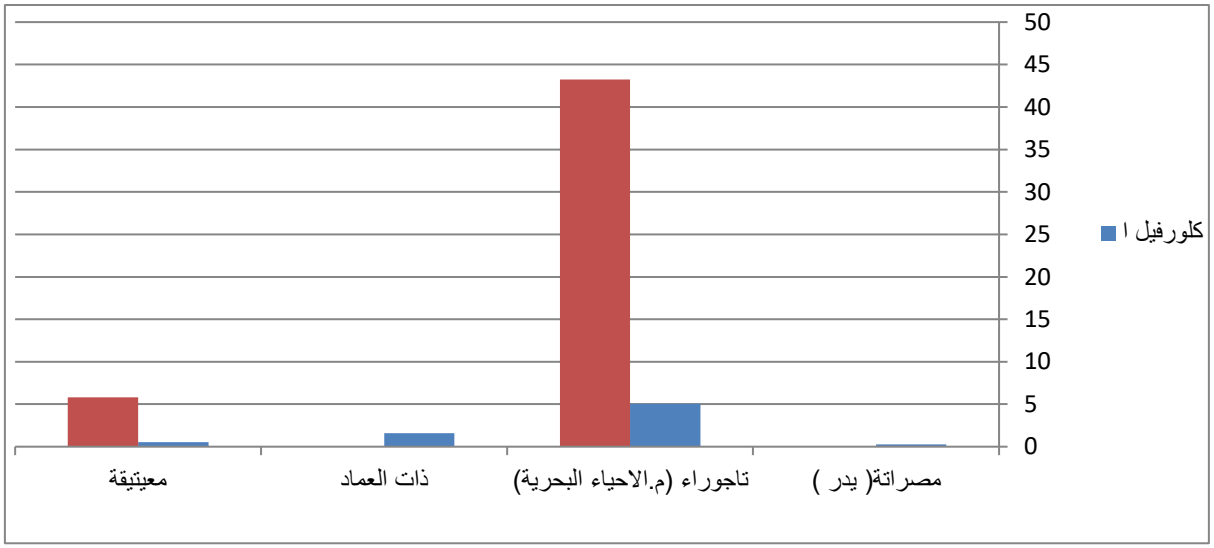

Figure 6: Concentrations of chlorophyll-a and phaeophytene-a (mg/m³) at the study sites for January

IV. Discussion

Chlorophyll-a serves as an indicator of the biomass of phytoplankton and benthic algae, which are the primary producers in estuarine environments; furthermore, chlorophyll-a is a robust and valuable indicator of nutrient enrichment in the environment. In this study, the concentrations of chlorophyll-a and phaeophytene-a, and their surface distribution, were measured along certain stretches of the Libyan coastline at four sites (Misrata Yadr, Tajoura Marine Research Centre, Dhat Al-Imad, and Mi'itiqa) during the months of January and November (2022–2023).

The coastal surface was characterized by the presence of the highest concentrations of chlorophyll-a at most study sites; specifically, the highest concentration of chlorophyll-a was recorded at the Tajoura site, where it reached 5.073 micrograms/ m³ in November, whilst no readings were recorded at the Dhat Al-Imad site during November. The highest concentrations of phycoflavonoids were 69.6736 micrograms/m³ at the Dhat Al-Imad site in November, whilst no readings were recorded at Dhat Al-Imad during January.

Overall, Tajoura Beach was characterized by the highest concentrations of chlorophyll-a throughout the study period, whilst the lowest concentrations were recorded at the That Al-Imad site. This significant variation in chlorophyll-a values among the four sites under study may be attributed to the influence of water quality characteristics at those sites. The sites with the lowest concentrations were the first, third and fourth sites, which may be due to the apparent water pollution at the third site resulting from the discharge of sewage.

The high concentrations of phaeophytene- A may be attributed to grazing and high temperatures in the study area; grazing by algae-feeding organisms leads to the breakdown of chlorophyll a, resulting in elevated levels of phaeophytene-a in the water. The observation that phaeophytene-a concentrations exceed those of chlorophyll is consistent with a previous study (Al-Handal and Hashim, 1990) (Al-Shaban, 1996), and the fact that this study records high concentrations of phaeophytene- may be attributed to grazing (Buffan-Dubau *et al*., 1996) (Bianchi *et al*., 1988). A study by Sun *et al*. (1993a) confirmed that most chlorophyll breaks down into colourless compounds under aerobic conditions, with a small portion converting to phaeophytene.

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