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# EXPLORATION, IDENTIFICATION AND DIVERSITY ANALYSIS OF ALGAL SPECIES AVAILABLE IN KOHAT DIVISION

MUHAMMAD ASJAD KHAN[1], REHAN NAEEM[1], MUHAMMAD MOHSIN JAVED[2], MATIULLAH KHAN[2] AND MUHAMMAD JAMIL[1*]

[1]*Department of Biotechnology and Genetic Engineering, Kohat University of Science and Technology, (KUST) Kohat, Pakistan*
[2]*Department of Biological Sciences, Virtual University of Pakistan, Lahore, Pakistan*
[*]*Corresponding author's dr.jamil@kust.edu.pk*

**Abstract**

The study presents a systematic survey encompassing the large collection of algal species across diverse region of Kohat Division, with meticulous attention to varying temperature and pH conditions. Microscopy was employed for precise species identification from the collected samples. The report identifies twenty-five algal species from 4 kingdoms and 7 classes, representing 15 genera from the freshwater ecosystems of dams in Kohat, Karak, and Hangu. The ecological richness is substantiated by a calculated 0.82 Simpson's diversity index. Within the identified classes, chlorophyceae comprises of 5 species, Cynophyceae is represented by 1 species, Zygnematophyceae encompasses 3 species, Charophyceae includes 1 species, Xanthophyceae features 1 species, Trebouxiophycea entails 1 species, Ulvophyceae encompasses 8 species. The finding underscores the prolific algal abundance in Kohat Division's freshwater ecosystem. Taxonomic diversity extends across 4 kingdoms, specifically Monera, Plantae, Viridiplantae and Chromista. The detailed microscopic analysis and taxonomic categorization condition conducted in this study contribute valuable insight into the flourishing diversity of algae within the freshwater ecosystem of Kohat Division. These findings accentuate the ecological signification of algal communities and their intricate role within the broader ecological framework of aquatic environments. The comprehensive exploration of these diverse algal assemblages offers a nuanced understanding of ecological dynamics and underscores the need for ongoing research to enhance our comprehension of these vital components of freshwater ecosystem.

**Key words:** Algal species, Kohat Division, Ecological, Freshwater, Light microscope, Taxonomically, Morphologically, Simpson diversity index.

## Introduction

Algae are known as a significant group of the aquatic ecosystem that contain nucleus but lack of leaves, stems, and unique reproductive structure and roots (Mendes *et al.*, 2022). The seasonal and biodiversity variations of freshwater algal species were observed. There are several chemical and physical factors that affect the growth and structure of algae such as temperature, pH, carbonates, calcium, chloride, light, organic nutrients, seasonality, bicarbonates and magnesium. All these factors are responsible for the morphological change in algae. Some species are able to survive against environmental stress while some cannot survive (Dustov & Tashpulatov, 2023).

Each algal species requires specific temperature and pH for its growth. The temperature of 74 degrees centigrade is required for the growth of thermal blue green algae (Agha *et al.*, 2020). The temperature below 47°C is required for the growth of green algae. The temperature of 60°C is required for the growth of Diatoms (Siegel *et al.*, 2020). If nutrients are present in the culture, then algae can grow for many months without the presence of light. The pH is also responsible for the change in algal growth (Gao, 2021). The pH above 5 and below 8 is suitable for green algae. The pH above 8 is required for the growth of blue green algae. The pH below 4 is dangerous for the growth of the blue green algae (Corredor *et al.*, 2021).

The present study was conducted to explore the diversity of different algal species present in freshwater of Kohat Division. This exploration considers the importance of algae for its various ecological as well as nutritional importance. This study will not only provide basic information about the diverse species of algae but also opens the new horizons for researchers to explore the importance and effectiveness of these species in different fields of biomedical sciences and industrial sectors.

## Material and Method

**Study and sampling sites:** Algal species and water samples were collected from the selected dams of Kohat, Karak and Hangu district which comprised Kandar Dam, Darmalak Dam, Gandiali Dam, Tanda Dam, Zebi Dam, Mardankhel Dam, Ghol Dam, Sharqi Dam and Naryab Dam (Table 1). The mentioned freshwater reservoirs have been selected for the selection, identification and exploration of algal species because these water reservoirs have selected alkaline nature and many of the freshwater algae grow well in alkaline water. So, that is the basic reason behind selection criteria set for above-mentioned freshwater reservoirs for this research (Fig. 1).

## Results

**Observation of selected areas:** Sample collection has been done from specific selected locations after verifying the pH and temperature of water and air of sampling spot. The longitude and latitude have measured by the GPS (Global Positioning System) and pH of water has measured by using pH meter and temperature by thermometer.

**Species preservation:** Samples were preserved in plastic bottles with 3% solution of formalin.

**Table 1. Physiochemical parameters of selected locations in Kohat Division.**

| S No. | Sampling sites | Dams | Months | Temp (C$^0$) | pH | Latitude (N) | Longitude (E) |
|---|---|---|---|---|---|---|---|
| 1. | Kohat | Kander Dam | October | ± 33 | ± 8.65 | **33°33'08.7"N** | **71°49'16.2"E** |
| | | | November | ± 27 | ± 8.78 | | |
| | | | December | ± 25 | ± 8.89 | | |
| | | | January | ± 23 | ± 8.91 | | |
| | | | February | ± 21 | ± 8.95 | | |
| | | | March | ± 24 | ± 8.98 | | |
| | | Darmalak Dam | October | ± 35 | ± 8.63 | **33°24'13.9"N** | **71°16'58.3"E** |
| | | | November | ± 28 | ± 8.71 | | |
| | | | December | ± 25 | ± 8.83 | | |
| | | | January | ± 23 | ± 8.92 | | |
| | | | February | ± 20 | ± 8.97 | | |
| | | | March | ± 25 | ± 8.99 | | |
| | | Gandiali Bala | October | ± 38 | ± 8.64 | **33°35'20.5"N** | **71°26'38.1"E** |
| | | | November | ± 29 | ± 8.73 | | |
| | | | December | ± 26 | ± 8.84 | | |
| | | | January | ± 22 | ± 8.90 | | |
| | | | February | ± 20 | ± 8.92 | | |
| | | | March | ± 24 | ± 8.97 | | |
| | | Tanda Dam | October | ± 32 | ± 8.66 | **33°34'13.5"N** | **71°23'56.1"E** |
| | | | November | ± 27 | ± 8.77 | | |
| | | | December | ± 24 | ± 8.86 | | |
| | | | January | ± 22 | ± 8.93 | | |
| | | | February | ± 20 | ± 8.96 | | |
| | | | March | ± 25 | ± 8.98 | | |
| 2. | Karak | Zebi Dam | October | ± 17 | ± 7.81 | **33°10'33.9"N** | **71°16'45.5"E** |
| | | | November | ± 15 | ± 8.50 | | |
| | | | December | ± 21 | ± 7.35 | | |
| | | | January | ± 18 | ± 8.22 | | |
| | | | February | ± 14 | ± 8.38 | | |
| | | | March | ± 22 | ± 7.40 | | |
| | | Mardan Khel Dam | October | ± 17 | ± 7.83 | **33°20'51.8"N** | **70°59'20.5"E** |
| | | | November | ± 14 | ± 8.56 | | |
| | | | December | ± 23 | ± 7.31 | | |
| | | | January | ± 18 | ± 8.24 | | |
| | | | February | ± 15 | ± 8.32 | | |
| | | | March | ± 20 | ± 7.41 | | |
| | | Ghol Dam | October | ± 16 | ± 7.88 | **33°10'43.1"N** | **70°58'34.8"E** |
| | | | November | ± 14 | ± 8.57 | | |
| | | | December | ± 22 | ± 7.38 | | |
| | | | January | ± 17 | ± 8.32 | | |
| | | | February | ± 15 | ± 8.40 | | |
| | | | March | ± 23 | ± 7.49 | | |
| | | Sharqi Dam | October | ± 18 | ± 8.01 | **33°17'46.3"N** | **70°57'55.6"E** |
| | | | November | ± 15 | ± 8.88 | | |
| | | | December | ± 26 | ± 7.85 | | |
| | | | January | ± 19 | ± 8.55 | | |
| | | | February | ± 17 | ± 8.79 | | |
| | | | March | ± 24 | ± 7.81 | | |
| 3. | Hango | Naryab Dam | October | ± 32 | ± 8.65 | **33°29'31.5"N** | **70°48'09.9"E** |
| | | | November | ± 29 | ± 8.80 | | |
| | | | December | ± 25 | ± 8.93 | | |
| | | | January | ± 20 | ± 8.94 | | |
| | | | February | ± 21 | ± 8.96 | | |
| | | | March | ± 26 | ± 8.98 | | |

Fig. 1. Sample collecting sites where growth of algal flora is proliferating.

Species sampling is done through hand picking, squeezing and scarping. Then samples have saved in plastic bottles of 1liter. Identification was done onsite with the help of compound microscope based on morphological characteristics.

**Study of species in laboratory:** Specimens from collected samples have been picked up by using needles and forceps, then placed and spread on clean glass slide having a drop of sample's algae water then covered with cover slip and gently pressed. Removed water droplets around the sample and slide were observed under the light microscope. The morphology of samples was observed under 4x, 10x, 40x and 100x.

**Identification of species:** Identification of algal species was done under light microscope by making fresh slides. Samples were stored in the Botany Department of Kohat University of Science and Technology (KUST) (Sharma *et al*., 2018). Table 2 presents an overview of number of genera and species, whereas Fig. 2 demonstrates the percentage participation of species.

**Table 2. Name, number and percentage of classes, genera and species.**

| S No. | Class | No. of genera | No. of species | Percentage of species (%) |
|---|---|---|---|---|
| 1. | Chlorophyceae | 2 | 6 | 24 |
| 2. | Cyanophyceae | 2 | 3 | 12 |
| 3. | Zygnematophyceae | 4 | 5 | 20 |
| 4. | Xanthophyceae | 1 | 1 | 4 |
| 5. | Trebouxiophyceae | 1 | 1 | 4 |
| 6. | Ulvophyceae | 4 | 8 | 32 |
| 7. | Charophyceae | 1 | 1 | 4 |
| **Total** | 7 | 15 | 25 | 100 |

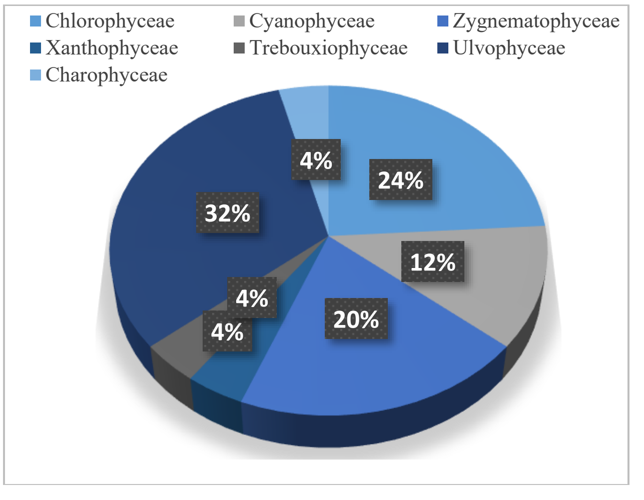


Fig. 2. Pie Chart showing the percentage distribution of Algal species.

**Taxonomical description**
**Kingdom Viridiplantae**
**Class Chlorophyceae**

**Genus 1: Hydrodictyon:** It is composed of a net of water and composed of large colonies. These colonies have cells which are elongated and attach in Net like reticulate manner. The colonies have width of 4 to 6 centimeters and length of 1 meter (Chou *et al*., 2006).

**Species: *Hydrodictyon reticulatum*:** The cells are mostly present in cylindrical and reticulate on surface of immobile water in ponds and pools. Cells have hexagonal shape having a complex network (Fig. 3(a)). Cells are 200µm in width (Jaffer *et al*., 2021).

**Genus 2: *Chlamydomonas*:** Chlamydonomas is a genus having green algae. It consists of flagellates which are unicellular. It is mostly found in the damp soil of fresh water, sea water, snow and stagnant water (Salomé & Merchant, 2019).

**Species: *Chlamydomonas globosa*:** The cells are desolated with two apical flagella which are equal in size. It is spherical in shape (Fig. 3(b)). The papilla is not present and the chloroplast is cup shaped having small basal pyrenoid (Menon Karthika & Harilal, 2020). The cells are 5 to 9µm in diameter.

**Species: *Chlamydomonas elegans*:** This specie belongs to the freshwater green algae (Fig. 3(b)). The papilla is not present and the chloroplast is cup shaped having small basal pyrenoid (Salomé & Merchant, 2019).

**Species: *Chlamydomonas nivalis*:** *Chlamydomonas nivalis* is red colored, unicellular and the photosynthetic green algae (Fig. 3(b)). It spends most of its life in the stage of cyst encompassed by snow in the depth of 0 to 20 cm (Zheng *et al*., 2020).

**Species: *Chlamydomonas reinhardtii*:** *Chlamydomonas reinhardtii* is a unicellular green algae which has a diameter of 10µm. It has two flagella for swimming (Fig. 3(b)). Cell wall is made up of hydroxyproline-rich glycoproteins. It has a big chloroplast of cup shaped and big pyrenoid. There is also a eyespot which is used to sense the light (Pröschold *et al*., 2005).

**Kingdom Monera**
**Class Cyanophyceae**

**Genus 1: Oscillatoria:** Oscillatoria is basically a genus that belongs to filamentous class Cyanophyceae. It is blue green in color and mostly found in freshwater. Its reproduction takes place by fragmentation which is referred as hormogonia. Oscillatoria reproduce and survive by photosynthesis (Marrez *et al*., 2022).

**Specie: *Oscillatoria sancta*:** The color of thallus is almost dark blue-green (Fig. 3(c)). The mucilaginous sheath is present in thallus and trichome is straight (Nagarkar, 2002). Mostly it has constricted cross walls up to 6µm in length and 12 µm in width. The end of cell is attenuated and hemispherical which is little capitated with the thick membrane (Halder, 2017).

**Genus 2: *Spirulina Turpin*:** The filaments are un-branched and cells are not enclosed in the sheath. It's rarely taken place in the form of solitary (Wan *et al*., 2021). The free-floating filaments are found in clusters. The filaments are mostly pink in color. Most filaments are uniseriate. Cells are isodiametric, non-granulose having special pores in side walls and the akinetes and heterocyst are absent. Cell division takes place by the transverse division. Reproduction takes place through fragmentation, the Trichomes break into thick wall and these is non-motile hormogonia (Chopra & Bishnoi, 2007).

**Species: *Spirulina major Kützing*:** This specie was present with Oscillatoria in many samples (Fig. 3(d)). It consists of broadly arranged spirals. Each spiral is 3-4µm in width. There is distance of 3-5µm among each spiral. Every Trichome is 1-2µm in diameter (Skácelová & Zapomělová, 2010).

**Species: *Spirulina subsala* (Oersted) ex Gomont:** This species is mostly irregular coiled and spiral, rarely coiled or little coiled. It forms a thallus of yellowish-green and bright blue-green color (Raghuraman *et al*., 2022) (Fig. 3(d)). The spirals are close and 3 to 5µm in width. Trichome is 2µm in width and blue-green or radish-violet in color. It is found in the stagnant water and on the dead leaves (Kuroiwa *et al*., 2014).

**Kingdom Plantae**
**Class Zygnematophyceae**

**Genus spirogyra:** It is a charophyte green alga which is filamentous. Chloroplast is arranged as spiral or helical. Mostly found in freshwater and has over 400 species of the *Spirogyra* all over the world. The width of *Spirogyra* is 10-100 micro-meters and length maybe of several centimeters. Mostly appear as green patches near water bodies and ponds (Sherwood *et al*., 2018).

**Species: *Spirogyra link*:** This species is cylindrical and filamentous. It is uniseriate and cells have 10-200µm of diameter (Fig. 3(e)). Cells are double length as compared to width. Chloroplast has a tape-like sheath. There are 1-15 chloroplasts in every cell having disc-shape pyrenoids (Chen *et al*., 2012).

**Kingdom Plantae**
**Class Zygnematophyceae**
**Genus: Closterium**

Closterium has the shape of crescent and elongated desmids. Few species are needle like and few are straight but mostly are curved and broader (Keshri, 2024). Desmid is composed of two hemi-cells which are mirror images of each other with single nucleus in the center. Semi-cells have two or one axial and chloroplasts which are ridged along one pyrenoid (Harsh & Shekhawat, 2020).

**Species: *Closterium moniliferum*:** It is normally curved, lunette, tumid sometimes concave or straight. Two chloroplasts are divided by the nucleus having longitudinal ridges of 3 to 6 and axial pyrenoids of 2-10. The walls are colorless and striated delicately (Fig. 3(f)). The cell ends have spherical terminal vacuoles and cells are 35-55µm in width and 210 to 350µm in length (Ohtaka & Sekimoto, 2023).

**Species: *Closterium acerosum*:** *Closterium acerosum* is a species of the plants that belongs to family of Closteriaceae (Fig. 3(f)). They have a link with the freshwater reservoir (Шахматов, 2023).

**Genus: Mougotia**

**Species:** ***Mougeotia*****:** This species is filamentous and un-branched green algae. It has parallel side and straight cell wall (Przystaoe & Adamkowska, 2020). The chloroplast is single having the shape of ribbon or axial plate and fills almost whole cell (Fig. 3(g)). The chloroplast is horizontal when observed under the microscope, sometime twisted, sometime narrow strip in the middle of cell (Zabłocka-Godlewska *et al*., 2020).

**Genus: Zygnema**

**Species:** ***Zygnema atrocoeruleum*****:** This is freshwater filamentous genus of the thalloid algal composed of almost 100 species. *Zygnema* build up as the free-floating filaments, but young plants are anchored. Filaments build a yellow-green to the bright-green color mat which is tangled (Fig. 3(h)). It is composed of the barrel shaped cells (DEVI & PANIKKAR, 1995).

**Kingdom Chromista**
**Class Xanthophyceae**

**Genus: Vaucheria:** Vaucheria is a yellow-green alga. It is the only genius in the family of Vaucheriaceae. Vaucheria shows the apical growth on the filaments tip by the formation of mats in fresh or terrestrial environments (Vishnyakov, 2021).

**Species:** ***Vaucheria litorea*****:** This is a species of Xanthophyceae (yellow-green algae) (Fig. 3(i)). Their growth occurs like filaments (large tubular cells) (Pierce *et al*., 2009).

**Kingdom Viridiplantae**
**Class Trebouxiophyceae**

***Zoochlorella*** is *nomen rejiciendum* for the green algal genus which is assigned to the *Chlorella* (Fig.3 (j)). This name refers to the symbiotic green algae living in the marine invertebrate, protozoan and freshwater body (Ritchie *et al*., 2024).

**Kingdom Monera**
**Class Ulvophyceae**
**Genus 1: Ulothrix**

**Species:** ***Pithophora sp. Kamigor****:* It is basically green algae and has coarse like filaments which is referred to as the "horse hair" (Rinku *et al*., 2012) (Fig. 3(l)).

**Species:** ***Ulothrix aequalis Kützing*****:** It has cylindrical cells, long and short filaments having 16-20 µm of diameter (Fig. 3(m)). It has thin walls, several pyrenoids, un-constricted end walls and broad chloroplast of almost 2 over 3 of cell (Norian *et al*., 2022).

**Species:** ***Ulothrix tenuissima Kützing*****:** It has cylindrical cells, long filaments, chloroplast is parietal and cells have 18-30µm of diameter (Mukhtar *et al*., 2021).

**Genus 2: Pithophora:** It is a genus of green algae belongs to the family *Pithophoraceae*. This filamentous alga has a coarse like texture which is denoted as "horse hair" (Chatterjee *et al*., 2023).

**Genus 3: Rhizoclonium**
**Species:** ***Rhizoclonium*****:** It is a green algae genus belongs to the family Cladophoraceae. This family has genus *Chaetomorpha* having fever members (Zhao *et al*., 2018).

**Species:** ***Rhizoclonium grande*****:** This specie belongs to the family Cladophoraceae. It is composed of un-branched and uniseriate filaments. It is short and unicellular (Fig. 3(n)). The rhizoidal branches held at the right angle to the axis (Kahindo *et al*., 2017).

**Specie:** ***Rhizoclonium riparium*****:** This specie belongs to chlorophytes from the family of *Cladophoraceae*. It is short and unicellular (Aroca *et al*., 2020) (Fig. 3(n)).

**Genus: Cladophora**

**Species:** ***Cladophora vagabunda, Cladophora sericea, Cladophora socialis:*** They belong to filamentous class Ulvophyceae and consist of great variations in their appearances. They consist of cladophora balls which are 2.5cm (Prazukin *et al*., 2020).

**Class Charophyceae**
**Genus: Chara**

**Chara** is a genus of charophyte green-algae and belong to Characeae family. They are superficial and multi-cellular, land plants having leaf-like and stem-like structures (Umen & Herron, 2021).

**Specie:** ***Chara vulgaris*****:** It is a stonewort and green-algae in *Chara* genus (Romanov *et al*., 2022) (Fig. 3(o)).

**Simpson's diversity index:** Simpson index was used to find out the diversity present in the observed species (Nunes *et al*., 2010) (Table 3). The following formula was used to calculate the diversity as:

$$D = 1- \frac{\sum n\,(n-1)}{N(N-1)}$$

D= Simpson's Diversity index
n= Total number of specific specie
N= Total number of all species

**Table 3. Calculations for Simpson's Diversity Index.**

| S No. | Class | No. of species (n) | n(n-1) |
|---|---|---|---|
| 1. | Chlorophyceae | 6 | 30 |
| 2. | Cyanophyceae | 3 | 6 |
| 3. | Zygnematophyceae | 5 | 20 |
| 4. | Xanthophyceae | 1 | 0 |
| 5. | Trebouxiophyceae | 1 | 0 |
| 6. | Ulvophyceae | 8 | 56 |
| 7. | Charophyceae | 1 | 0 |
| | **Total** | **25** | **112** |
| | | N= 25 | $\sum n\,(n-1) = 112$ |

**Algal Species Images:**

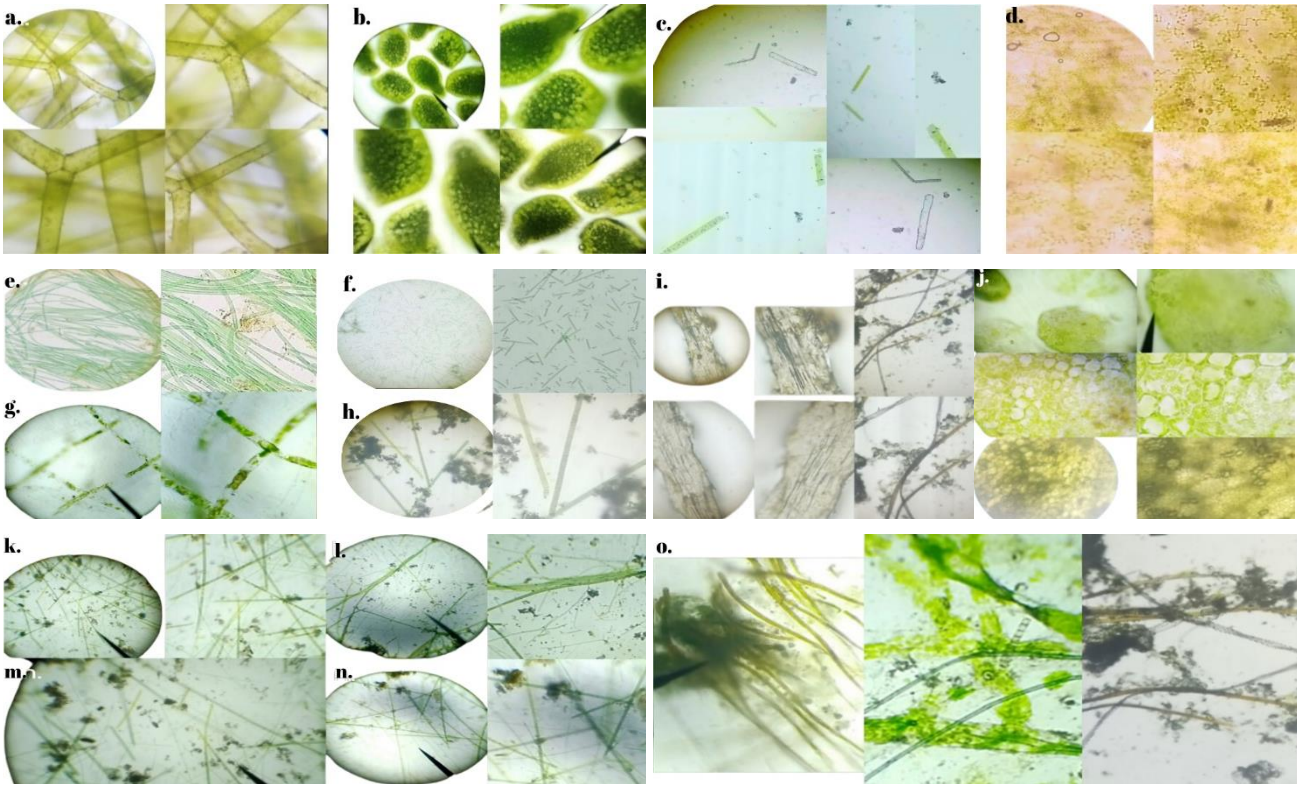


Fig. 3. Microscopic analysis and identification of different algal species collected from freshwater reservoirs of Kohat Division.
**(a)** *Hydrodictyon reticulum, Hydrodictyon plateforme* **(b)** *Chlamydomonas globose, Chlamydomonas elegens, Chlamydomonas nivalis, Chlamydomonas reinhardtii.* **(c)** *Oscillatoria sancta* **(d)** *Spirulina. Major Kützing, Spirulina subsala (Oersted) ex Gomont* **(e)** *Spirogyra* link (f) *Closterium acerosum, Closterium moniliferum* **(g)** Mougeotia **(h)** *Zygnema atrocoeruleum*. **(i)** (Xanthophyceae) *Vaucheria litore* **(j)** (Trebouxiophyceae) *Zoochlorella* **(k)** *Cladophora vagabunda, Cladophora sericea, Cladophora socialis* ***(l)*** *Pithophora sp. Kamigor* **(m)** *Ulothrix aequalis Kützing, Ulothrix tenuissima Kützing* **(n)** *Rhizoclonium riparium Rhizoclonium grande.* **(o)** (Charophyceae) *Chara vulgaris*.

**Table 4. Algal species occurrence in the selected areas of Kohat Division.**

| S # | Species name | Kohat | Karak | Hangu |
|---|---|---|---|---|
| 1. | *Hydrodictyon reticulum* | + | - | + |
| 2. | *Hydrodictyon plateforme* | + | - | - |
| 3. | *Chlamydomonas globose* | + | - | - |
| 4. | *Chlamydomonas elegens* | + | - | + |
| 5. | *Chlamydomonas nivalis* | + | - | - |
| 6. | *Chlamydomonas reinhardtii* | + | - | - |
| 7. | *Spirulina. major Kützing* | + | - | - |
| 8. | *Spirulina subsala (Oersted) ex Gomont* | + | - | - |
| 9. | *Oscillatoria sancta* | + | - | + |
| 10. | *Closterium acerosum* | + | - | - |
| 11. | *Closterium moniliferum* | + | + | + |
| 12. | *Mougeotia* | + | + | - |
| 13. | *Zygnema atrocoeruleum* | + | + | + |
| 14. | *Spirogyra link* | + | - | - |
| 15. | *Vaucheria litore* | + | + | + |
| 16. | *Zoochlorella* | + | + | + |
| 17. | *Pithophora sp. Kamigor* | + | + | + |
| 18. | *Cladophora vagabunda* | + | + | + |
| 19. | *Cladophora sericea* | + | - | - |
| 20. | *Cladophora socialis* | + | - | - |
| 21. | *Ulothrix aequalis Kützing* | - | + | - |
| 22. | *Ulothrix tenuissima Kützing.* | + | + | - |
| 23. | *Rhizoclonium riparium* | + | + | + |
| 24. | *Rhizoclonium grande* | + | - | - |
| 25. | *Chara vulgaris* | + | - | - |

+ = Present; - = Absent

$$D = 1- \frac{\sum n\,(n-1)}{N(N-1)}$$

$$D = 1- \frac{112}{25(24)}$$

Simpson's Index of Diversity = 0.82

**Distribution of Algal species in Kohat division:** The distribution of algal species in the Kohat Division varies significantly across different areas. Notably, species like *Closterium moniliferum, Zygnema atrocoeruleum*, and *Rhizoclonium riparium* are found in all three areas, while others like *Hydrodictyon reticulum* and *Oscillatoria sancta* are absent in Karak. Table 4 provides a comprehensive overview of the occurrence of various algal species in Kohat, Karak, and Hangu.

## Discussion

The present study undertook a comprehensive investigation into the microscopic identification of ecologically distributed algal species in the Kohat Division. Through taxonomical and morphological examinations, alongside the application of the Simpson Diversity Index (Zhou *et al*., 2020), the study aimed to elucidate the taxonomic composition, morphological characteristics, and species diversity of algal communities within the region's freshwater ecosystems. Microscopic examination served as the cornerstone of this study, allowing for the meticulous identification and characterization of algal species across diverse ecological niches within the Kohat Division. Taxonomical assessments facilitated the classification of these species into various genera and classes, unveiling a rich tapestry of algal diversity within the region. Morphological examinations provided invaluable insights into the structural features, reproductive strategies, and ecological adaptations of the identified taxa. By elucidating the morphological characteristics of algal species, we gained a deeper understanding of their ecological roles and interactions within freshwater ecosystems. The findings of this study hold significant implications for ecological conservation efforts in the Kohat Division. Algae play pivotal roles in aquatic ecosystems, contributing to nutrient cycling, primary productivity, and habitat formation (Chew *et al*., 2021). The identification of ecologically distributed algal species provides critical baseline data for assessing ecosystem health and formulating targeted conservation strategies. By understanding the taxonomic composition and distribution patterns of algal communities, conservation practitioners can prioritize areas for protection, restoration, and management. Furthermore, this study underscores the importance of preserving freshwater habitats to safeguard the biodiversity and ecological functionality of algal communities in the region.

The application of the Simpson Diversity Index enabled us to quantitatively assess species diversity within the studied area. This index incorporates both species richness and evenness, providing a robust measure of community diversity. The high diversity index values obtained in the study reflect the rich biodiversity harbored within the Kohat Division's freshwater ecosystems. Such high levels of species diversity are indicative of ecologically healthy and resilient ecosystems. Quantifying species diversity provides valuable insights into the ecological complexity and stability of algal communities, informing conservation priorities and management decisions. The study provides valuable insights into the taxonomic composition and diversity of algal communities in the Kohat Division, several avenues for future research warrant consideration. Long-term monitoring programs are essential for tracking temporal variations in algal communities, assessing the impacts of environmental change, and evaluating the effectiveness of conservation interventions. Additionally, molecular techniques such as DNA bar-coding could complement microscopic examinations, providing enhanced resolution in species identification. Furthermore, studies elucidating the ecological roles and ecosystem services provided by different algal taxa would contribute to our understanding of freshwater ecosystem functioning and resilience. In conclusion, this study represents a significant contribution to our understanding of algal biodiversity and ecology in the Kohat Division's freshwater ecosystems. Through taxonomical and morphological examinations, alongside the application of the Simpson Diversity Index, valuable insights into the taxonomic composition, morphological characteristics, and species diversity of algal communities within the region have been elucidated. These findings underscore the ecological importance of algae and highlight the need for proactive conservation and management efforts to preserve the biodiversity and ecological integrity of freshwater ecosystems. Moving forward continued research and monitoring are essential for ensuring the long-term sustainability of algal communities and freshwater habitats in the Kohat Division.

## Conclusion

The above given analytical research has been conducted to evaluate the diverse distribution of algal species in the freshwater reservoirs of the Kohat Division. This study has provided basic information about the taxonomical identification and growth of different species of algae in the mentioned areas with their diversity and adaptations. On the basis of this research, researchers can take steps forward to enhance the research in exploring the growth levels, medical effectiveness, industrial and economical importance and ecological efficacy of different algal species in the selected area. This research has not only unveiled the wide variety of algal species growth in the Kohat division but also provided new gateways for future researches to explore their industrial, economical and biomedical based benefits. Moreover, this study demands for the conservation maintenance of ecological integrity and surveillance of these algal diverse species in freshwater reservoirs of Kohat Division.

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