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Ionic composition in saline habitats on Kachchh (Gujarat) coast with reference to salt tolerant plants

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Abstract
Shorelines are the most rapidly changing places on earth. Kachchh is second largest district in India and has approximately 350 km long coastal belt. There are different types of habitats observed on Kachchh coast *viz.* sandy, muddy, marshy and rocky. In the saline habitat, the plant species which are able to tolerate or avoid salt can only survive. One of the group of plants able to mechanize themselves physiologically are the group of salt tolerant plants - 'Halophyte'. These plants have the ability to not only to tolerate excess salt along with normal growth in saline environmental conditions. The present investigation was carried out to know the halophytic plants status with respect to soil characteristics of the coastal habitats during the post-winter season. The level of salinity and mineral ion concentration was observed to variable with habitat as well as with intertidal area. The dominant families throughout different location of Kachchh coast were observed to be Poaceae. Study area represents mainly one invasive exotic species *Prosopis juliflora*.

Keywords: Kachchh coast, habitats, halophyte, mineral ions

Introduction
Halophytes, which are about 1% of the world's flora, are unique plants that can grow in saline habitat. In this saline environment plant mechanized to resist saline habitat, like salt-avoiding, salt salt-tolerant etc. Gujarat covers 1600 km long coastline, the mangrove flora of the Gujarat coast constitutes, Fifteen species, among them *Avicennia marina*, *Avicennia officinalis*, *Ceriops tagal* and *Rhizophora mucronata* in majority numbers. Drastic ecological conditions on the Gujarat coast seem to have resulted in 90 % stands of *Avicennia marina* in the study area (Pandey, C. N.). The intertidal areas of Kachchh around Kori creek, Mundra, Kandla and Satsaida Bet support dense patches of mangrove and another halophyte plant diversity. One of the surveys of some regions of the Jakhau, Koteshwar and Lakhpat is chiefly dominant with *Avicennia marina var. acutissima*, which forms almost a pure stand. In marshy borders of mangroves associated with *Salicornia brachiata*, *Suaeda fruticosa*, *Cressa cretica* and salt grass like, *Aelurops lagopoides*. Certain low salinity growing grass plant species such as *Dichanthium annulatum*, *Sehima nervosum*, *Cenchurus siliaris*, *C. setigerus* and *Panicum antidotale* find out along with *Acacia nilotica* and *Capparis decidua*. (Stanley, O. D.). Reflecting the hot, arid hinterland of Gujarat, ambient temperatures and salinities are high in this macro tidal estuary, decreasing somewhat during the monsoon. The littoral soil supporting the mangrove is abundant in loam, silty clay and silty clay loam. Selected sites of Kachchh coast viz., Jakhau, Mandvi, Bhadreshwar and Gandhidham locations having a marshy and sandy habitat, the region texture found Sand>Silt>Clay in all samples. Parameter of soil like pH 7.5, Sodium 190 mg/l, Calcium 0.23375 mg/l, Magnesium 0.40075 mg/l. Total Hardness 0.635mg/l, Chloride 3.552 mg/l, Potassium 106 mg/l. (Vyas, S. J., *et al*.). Mangrove sediments contain variation in percentages of sand, silt and clay. Further, the combinations of silt and clay form a muddy habitat that is rich in organic matter (Hossain et al.). Industries, salt pans and other developments along the Kachchh coast have directly affected the saline habitat and ionic compositions. In the present study edaphic conditions of coastal area along Kachchh district was observed.

Materials and Methods
Samples have been collected from two different intertidal zones of Kachchh and these zones were sub divided in a particular site. The sampling sites are shown as follows.
Zone 1: Bhachau to Gandhidham (20 Km intertidal zone)
Zone 2: Anjar to Mundra (5 Km intertidal zone)

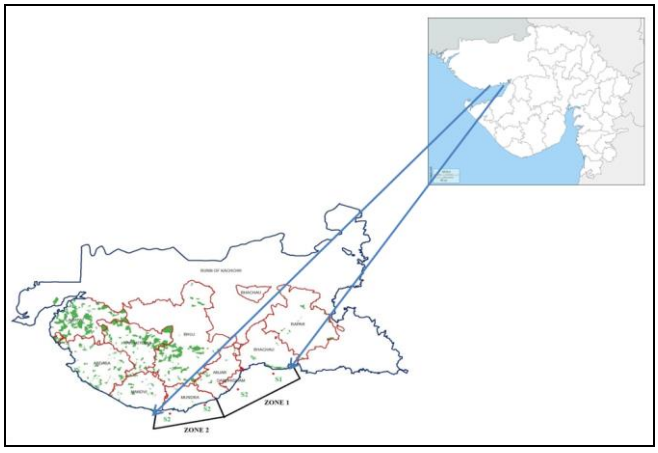

Fig 1: Map showing study area

Physico-chemical characterization of soil sample:\
Soil sample collected in triplicate numbers, around 1 kg and up to 15 cm deep. Before analysis, the air-dried soil samples were sieved using a 2.0 mm mesh sized sieve for analysis. For all the tests, the 100-gm soil sample was subjected in the 200 ml of distilled water and filtered. The filtrate was used for further analysis. pH and electrical conductivity

(EC) of the soil samples were measured by using a digital pH and conductivity meter. Calcium (Ca), Magnesium (Mg) by EDTA titration method (APHA), Sodium (Na), Potassium (K) by flame photometry and Chloride (Cl-) by Argenometric method (Nakanishi, M.), then required amount of soil sample was taken for total organic carbon analysis following Walkely and Black method (Walkley, A., *et al*.).

Fig 2: Sample collection from different locations of respective zones.

Result

Habitat and plant diversity

According to habitat the plant diversity changes, here major 2 types of habitat was surveyed and analyzed, it was reflected that plant grow in particular habitat and adept themselves.

Table 1: Zone wise habitat and plant diversity

Major plant species	Marshy habitat		Muddy habitat	
	Zone 1	Zone 2	Zone 1	Zone 2
Avicennia marina (Forsk.) Vierh.	-	√	√	√
Prosopis julifera (Sw.) DC.	√	√	√	√
Urochondra setulosa (Trin.) Hubb.	√	√	-	-
Sporobolus Spe.	√	√	-	-
Suaeda fruticosa (L.) Forsk.	√	√	√	√
Suaeda nudiflora (Willd.) Moq.	√	√	√	√
Aeluropus legopoides (L.) Trin. ex Thw.	√	√	-	-
Acasia nilotica (L.) Del. subsp. (Bth.) Brenan	√	√	-	-
Acasia Senegal (L.) Willd.	√	√	-	-
Capparis decidua (Forssk.) Edgew.	√	√	-	-
Sesuvium portulacastrum (L.) L.	√	√	√	√
Salicornia brachiate Roxb.	-	-	√	√

Table 2: Physico-chemical analysis of soil sample.

Parameters		pH	EC (mS/cm)	Ca^{2+} (meq. g^{-1})	Mg^{2+} (meq. g^{-1})	Na^{+} (meq. g^{-1})	K^{+} (meq. g^{-1})	Cl^{-} (meq. g^{-100})	TOC (Total organic carbon) %	TOM (Total organic matter) %
Zone 1	Location 1 Marshy	8.16	6.77	2.24	2.05	9.52	0.082	10.11	0.28	0.48
	Location 2 Muddy	8.36	5.65	0.61	1.25	9.49	0.24	8.75	0.14	0.25
Zone 2	Location 1 Marshy	8.89	4.43	0.41	1.29	8.65	0.23	9.50	0.16	0.28
	Location 2 Muddy	9.14	5.87	0.67	2.11	9.90	0.27	14.17	0.11	0.19

The results of soil sample for pH & EC at various locations of zone 1&2 was recoded to be having mean value of 8.64 and 5.58 mS/cm, respectively. Specifically, the pH in soil or zone 2 was recorded at the highest value of 9.02. The value of pH was found to be 8.26 in the soil sample of zone 1. Considering zone 1 the EC value was found to be highest (6.21 mS/cm) whereas lowest (5.15 mS/cm), from the soil samples.

Data of soil sample for calcium (Ca^{+2}) and magnesium (Mg^{+2}) at various location of zone 1&2 was noted to be having mean value of 0.98 and 1.67 meq. g^{-1}. The calcium in soil or zone 1 recorded at the highest value of 1.42 meq. g^{-1}, the value of calcium (Ca^{+2}) was recorded to be 0.54

meq. g^{-1} in the soil sample of zone 2. Considering zone 1 magnesium (Mg^{+2}) value was found to be highest (1.7 meq. g^{-1}) whereas lowest (1.65 meq. g^{-1}) in zone 2.

Finding of soil sample for sodium (Na^{+}) and potassium (K^{+}) at various location of zone 1&2 reflected to be having mean value of 9.39 meq.g^{-1} and 0.20 meq.g^{-1}, specifically the sodium in soil or zone 1 recorded at the highest value of 9.50 meq.g^{-1}, the value of sodium (Na^{+}) was noted to be 9.27 meq.g^{-1} in the soil sample of zone 2. Considering zone 2 potassium (K^{+}) value was found to be highest (0.25 meq. g^{-1}) whereas lowest (0.16 meq. g^{-1}) in zone 1.

Chloride (Cl^{-}) of the soil sample at various location of zone 1&2 was recorded to be having mean value 10.63 meq.g^{-100}, chloride (Cl^{-}) in soil at zone 2 was recorded at the highest value of 11.83 meq.g^{-100}, whereas, the lowest value of chloride (Cl^{-}) was found 9.43 meq.g^{-100} in soil sample of zone 1.

Value of total organic carbon and total organic matter at various locations of zone 1&2 was recorded to be having mean value of 0.17 and 0.30 %, whereas, total organic carbon in soil or zone 1 noted at the highest value 0.21 %, the value of total organic carbon was recorded to be 0.16 % in zone 2. At zone 1 total organic matter value was found to be highest (0.36 %), whereas lowest (0.23 %) in zone 2.

Conclusion

Coastal belt of Kachchh district was divided in two zones on the basis of intertidal area. As discussed earlier the zones distributed along the coastal belt of Kachchh district showed variations in the habitat of marshy and muddy areas. Bothe the zones included verity of plant diversity in various forms which include herbs (zone 1 herb) and shrubs (zone 1) in zone 1. Interestingly, zone two was also categorized having marshy and muddy habitats. The characteristic of habitats both the zones were having variations in many of the physic-chemical parameters for marshy and muddy areas. Furthermore, few species namely *Capparis decidua* (Forssk.) Edgew. and *Urochondra setulosa* (Trin.) Hubb., were recorded at marshy habitat of zone 1 and were not seen at muddy habitat. *Acasia nilotica* (L.) Del. subsp. (Bth.) Brenan, Acasia *Senegal* (L.) Willd. and a *Sporobolus spe*., Were observed at muddy habitat of zone 2 and were not found on 20 km of zone 1. On *prima-facie* it can be concluded that the habitat of zone 2 can be consider to be more alkaline compare to that of zone 1. The results of ionic compositions showed that zone 1&2 are saline may be due to higher concentration of sodium and chloride. The current study highlights the habitat characteristic and plant species distribution on gulf of Kachchh along the Kachchh coast.

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