Concocting Nanostructured Plant Molecules for Inhibiting the Corrosion Activity in HYSD Bars

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1 Introduction

Many heavy metals are being slowly prohibited with the help of enormous by-laws due to their poisonous behaviour along with their disposal hurdles especially in the marine environment [1]. In order to replace inorganic compounds, nowadays extracts of plants are considered the vital source of naturally concocted one that involves simple low-cost extraction procedure [2–6]. These extracts have the tendency to replace synthetic organic and inorganic inhibitors with many successive literatures. Active ingredients present in the natural extract help in the treatment of many wastes and helped many researchers to formulate related theories [7–10].

Most of the industries such as cleaning industries, petrochemical related works, pickling processes and others, using corrosion inhibitors are the most critical thing in the current trends of research [12–14]. Inhibitors with oxygen, nitrogen and sulphur proved to be effective in the majority areas. Among various synthetic compounds showing good anticorrosive properties, they emerge as toxic to human beings and their surrounding environment. Characteristics such as natural, low cost, availability and renewable nature make the extracts of plants suitable in all scenarios. In this regard, one of the perennial trees like Musa paradisiaca (Banana) is used in many research-related activities [15]. Researches to find more compounds as corrosion inhibitors in various acidic and alkaline media are yet to be done. More works are

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done to find active plant compounds from various natural substances [11, 16]. Thus, in this work, the suitability of Musa extract under varying time and concentration to act as a green corrosion inhibitor over HYSD bar specimen is planned to be tested [17].

2 Experimental Work

2.1 Concoction of Leaves Powder

Musa were dried naturally and used to make the fine powder. Initially, leaves were collected from local farmers and washed thoroughly and soaked in deionized water for 5 h followed by air drying using natural sunlight. This extract of leaf powder was used as an inhibitor for HYSD bars [18].

2.2 Making of Trial Compound

Acidic compound of 0.25 molarity H_2SO_4 was prepared by the dilution of Analytical Grade 98% H_2SO_4 with deionized water to a volume of 100 ml in the existence or non-existence of various concentrations of leaves extract varying from 3 to 10 g/l.

2.3 Arrangement of Specimen

Initially, the HYSD specimen of 16 mm diameter was cleaned with various emery paper up to 300 grade and cut into 2.5 cm length and used for further process. Each specimen was thoroughly cleaned with deionized water then air dried with acetone and preserved in an air tight container.

2.4 Weight Loss Technique

Weight loss technique (WLT) is one of the common corrosive action observing methods. It includes exposure of specimen to a specific duration, then removed for measurement of the same. It is a basic measurement where the W_L happening over a particular period of exposure is given in terms of rate of corrosive action. In this work, HYSD bars in three trials were submerged in 100 ml of the trial compound of acidic nature (0.25 molarity H_2SO_4) in the existence or non-existence of the inhibitor at varying temperatures.

The metal samples were taken out from the trial compounds after 5 h at temperatures of 27 and 40 °C. After cleaning the specimen with Dimethyl ketone, the W_L was found as the difference in weight of the samples before and after immersion using analytical balance with an accuracy of ± 0.1 mg. For the authenticity of the outcome and to report the average value of the W_L, observations were performed triple time. Using this technique, the average rate of corrosive action was expressed in mg per sq cm per hr. Assuming, that uniform corrosion taking place over the sample, corrosiveness is calculated. Using the W_L measurements, the rate of corrosion will be found using the following Eq. 1:

$$\text{Rate of Corrosion (MMPY)} = (87.6 \times W_L)/(\text{d.a.t}) \quad (1)$$

where MMPY = Milli metre per year, W_L = Weight Loss (mg), d = Density (g per cubic metre), A = Area of sample (square cm), t = time (hours).

The Inhibition Efficiency (% I.E.) and Surface Coverage (θ_s) were found using the below Eqs. (2) and (3),

$$\text{Inhibition Efficiency (\%I.E.)} = [(Wt_1 - Wt_2)/(Wt_1)] \times 100 \quad (2)$$

$$\text{Surface Coverage } (\theta_s) = [(Wt_1 - Wt_2)/(Wt_1)] \quad (3)$$

where Wt_1 = Rate of Corrosion with the extract and Wt_2 = Rate of Corrosion without the extract.

3 Results and Discussion

As per Fig. 1, the SEM image of Banana leaf powder represents the formation of shielding coat around the HYSD bar. Because of 5 h contact period, for a sample length of 2.5 cm, most of the surface has been covered with the particles of Musa.

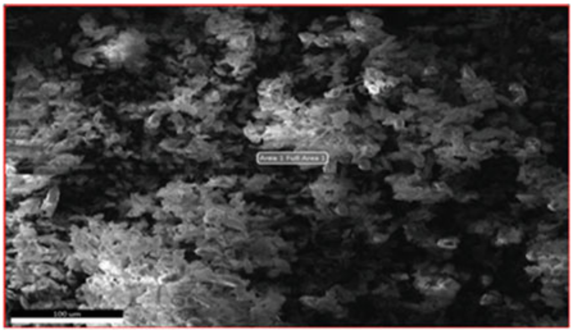


Fig. 1 Area 1 SEM result banana leaf powder

This shielding coat will play an important role in inhibiting the corrosion in HYSD bar specimen used in this work.

Figures 2 and 3 substantiate the effective role of Banana leaf powder as a protective sheath over the HYSD bar. Various elements present in the leaf powder help to analyze the inhibiting property of Musa extract.

Figure 4 shows the composition of various elements in the duplicate sample of Musa powder. Elements such as C, O are present in enormous amount, whereas minor elements such as Mg, Si, Mo, Cl are present in minimal amount. Carbon and Oxygen play an important role as protective cover for the high-yield strength deformed bars.

From Fig. 5, it is found that the percentage transmittance of the peaks obtained in FTIR has around a value of 100. High peaks were obtained around 455.20 per cm. Between 3956.65 and 2000 per cm, the peaks followed an uniform pattern layer

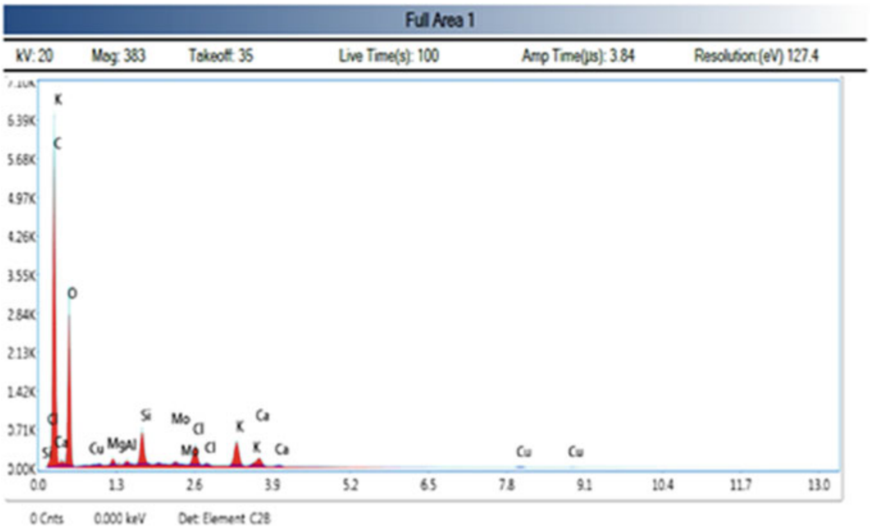
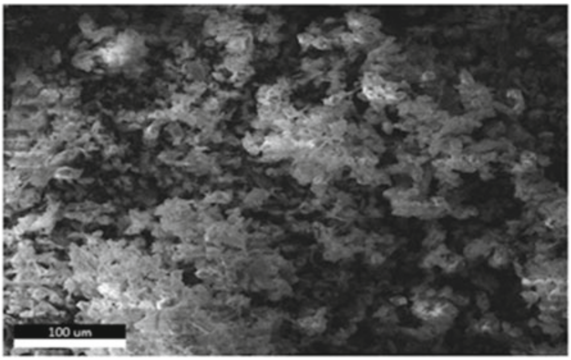


Fig. 2 Elemental analysis 1 SEM result

Fig. 3 Area 2 banana leaf powder SEM result



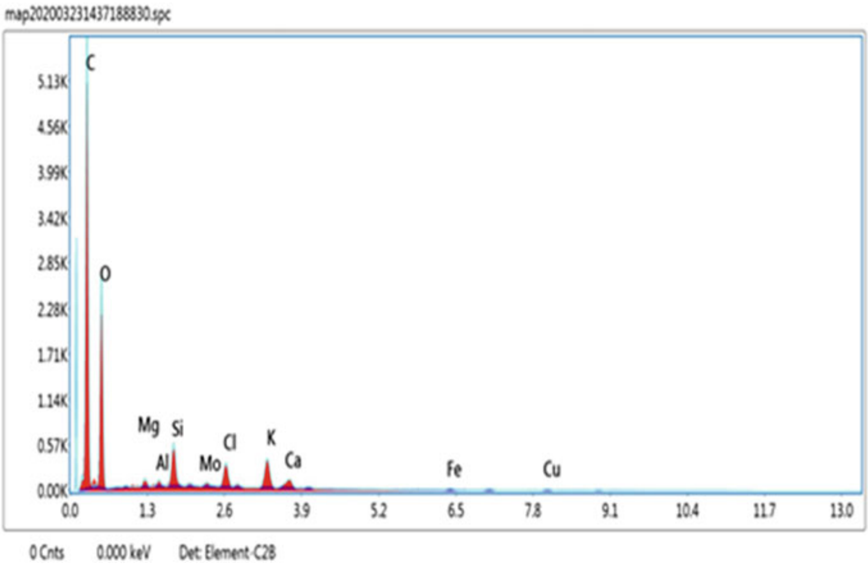


Fig. 4 Elemental analysis 2 SEM result

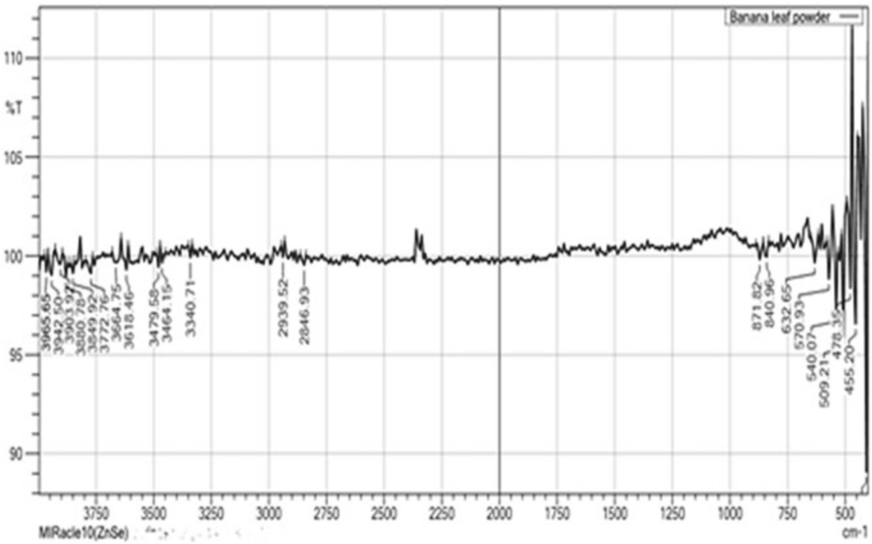


Fig. 5 FTIR result

of single bond, which varies from 2500 to 4000 per cm; the layer of triple bond varies from 2000 to 2500 per cm; the layer of double bond varies from 1500 to 2000 per cm; and the layer of fingerprint region varies from 600 to 1500 per cm. It contains methyl as band regions between 3650 and 3250 per cm exist, along with the presence of hydrogen bond. At above 3000 per cm, aromatic C–H stretch exists along with functional groups such as acetylenic (2140–2100), alcohol hydroxy compound (3570–3200 per cm), ether and oxy compound (2820–2810 per cm), tertiary amino(1210–1150 per cm), carbonyl compound (2100–1800 per cm) and others.

4 Conclusion

With the help of the above points, it is proved that Musa plant extract plays a vital role in effective green inhibition against high-yield strength deformed bar specimen. It is justified that with the help of WLT, corrosion inhibition of HYSD in acidic environment can be verified. Scanning the specimen treated with or without Musa extract using SEM and FTIR equipments, shows the increment in the activation energy values of the corrosion process; and also indicates this plant extract creates a hurdle to charge and mass transfer thereby producing decrement in the rate of corrosive action over HYSD bar specimen when 0.25 molarity Sulphuric acid medium used. With the above data, it is confirmed that both physical adsorption and chemical sorption are involved while treating the specimen with Musa. Thus, the study done confirms that the corrosion inhibition due to Musa extract over HYSD specimen using 0.25 molarity sulphuric acid is due to the adsorption mechanism of the extract.

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