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Inhibitive Potentials of Bitter Kola Stem (BKS) on Mild Steel in Acidic Media

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ABSTRACT

This paper deals with the inhibitive potentials of bitter kola stem extract (BKS) on the deterioration of mild steel in 1 M HCl and 1 M H_2SO_4 using gravimetric method. Coupons of dimension 5.0 cm x 4.0 cm were immersed in test solutions of uninhibited acid and also in those containing various amount of BKS (10, 25 and 40 %v/v) at 30 ^oC and 60 ^oC respectively. The results showed that the extract addition reduced mild steel corrosion in the acidic media. The inhibitive efficiency of 92.07 % was attained at 40 %v/v in 1 M H_2SO_4 at 30 ^oC temperature, while the efficiency of 89.19 % was realized at the same concentration in 1 M HCl at 60 ^oC temperature. Hence, BKS can be considered as a good and safe inhibitor against mild steel corrosion in both acidic media.

Keywords: Bitter Kola Stem, Inhibition, Corrosion, Weight loss, Mild Steel

INTRODUCTION

The search for an efficient inhibitor against corrosion in different aggressive media has in recent times taken a new dimension owing to clarion call for green technology. Inhibitors are mostly used to create corrosion resistance in acid descaling bathes to prevent not only metal dissolution but also acid consumption. They protect the metals by efficiency adsorbing on its surface and blocking the active sites for metal dissolution and hydrogen evolution, thereby hindering overall metal corrosion in aggressive environments (Bhat *et al.*, 2011). Green corrosion inhibitors such as extracts from many plants had been investigated and reported by several authors as being biodegradable and not containing heavy metals or other toxic compounds. In addition, plant products are organic in nature, and contain certain photochemical including tannins, flavonoids, saponins, organic and amino acids, alkaloids, and pigments which could be extracted by simple less expensive procedures. Extracts from

different parts of plant have been widely reported as effective and good metal corrosion inhibitors in various corrosive environments (Ji, *et al*., 2013; Umoren, *et al*., 2013). A lot of research had been done on the use of plant extracts as effective inhibitors, some of such work are: Cashew waste (Olawale *et al*., 2015); Jatropha stem (Olawale *et al.*, 2016) *Pentaclethra macrophylla Bentham* roots (Lebe, *et al*., 2016); *Cumimum cyminum* extract (Sribharathy and Rajendran, 2013); Papaya Leaves (Kavitha *et al*., 2014); Cassava leaf (Diah *et al*., 2015); Water melon wastes (Odewumi *et al.*, 2015); Coconut shell (Daramola *et al*., 2015) and vernonia amygdalina extract (Olawale *et al*., 2017).

Bitter Kola (*Garcinia kola*) is a tropical plant which grows in moist forest, it is commonly available in Africa. It seeds are edible and are consumed. Bitter kola stem is a waste because after harvesting the kola from pod the stem, root and other parts are disposed of. This present work investigate the effect of bitter kola stem extract (BKSE) as a corrosion inhibitor on mild steel using acidic media.

MATERIALS AND METHOD

Coupon preparation

Mild steel (BDH grade) containing: Carbon (C): 0.2%, phosphorous (p): 0.024%, silicon (Si): 0.03%, Manganese (Mn) 0.35%, and the rest Iron (Fe) was used in this research. Mild steel of 0.2 cm thickness were mechanically cut into 20 coupons of dimension 5.0 cm x 4.0 cm. The surface of the metal was treated by degreasing it using ethanol and distilled water. It was then dried in acetone and stored in the desiccator.

Preparation of Plant Extract

Bitter kola (*Garcinia kola*) Stem was dried for 14 days to attain uniform dryness and zero moisture content of stem. Then dried Bitter Kola Stem was grounded into powdery form and sieved. 40 g of BKS powder was measured into a 250 ml of 1 M H_2SO_4/ HCl solution containing 40 g of BKS powder. The solution formed was then refluxed for 3 h in a water bath at 90 °C to obtain extract of BKS components into the solution. The refluxed solution after being removed from the water bath was kept in a fume cupboard to cool for 12 h. The cooled solution in the beaker filtered to obtain the cake (solid) and the extract (Bitter Kola solvent).The extract obtained was then put in a beaker with a foil covering to prevent escape of constituents through evaporation and then stored in a fume cupboard. The inhibitor

concentration in the acidic media was varied by adding 10 %, 25 %, and 40 % by ml of the extract. The experiment was conducted for 4 hours. The tests were carried out in duplicate to ensure reproducibility. The corrosion rate (C.R.) of mild steel and inhibition efficiency (I.E.) were calculated using equation 1 and 2 respectively.

$$\text{Corrosion rate} = \frac{\Delta W}{AT} = \frac{W1 - W2}{AT} \quad (1)$$

$$\text{(I.E. \%)} = \left(\frac{C.B - C.I}{C.B}\right) \times 100 \quad (2)$$

Where W_1 is the initial weight of coupon before immersion in solution, W_2 is the final weight after immersion; A is the surface area of mild steel coupon; T is the period of immersion in h; I.E. (%) is the inhibition efficiency; C.I is the corrosion rate of mild steel coupons in the presence of inhibitor concentration; C.B is the corrosion rate of mild steel coupon in the absence of inhibitor concentration; A is area of mild steel coupon and T is time.

RESULTS AND DISCUSSIONS

Mass Loss

A representative trend of mass loss against variation in extract concentration is as presented in Figure 1 in various acidic media used under different temperature.

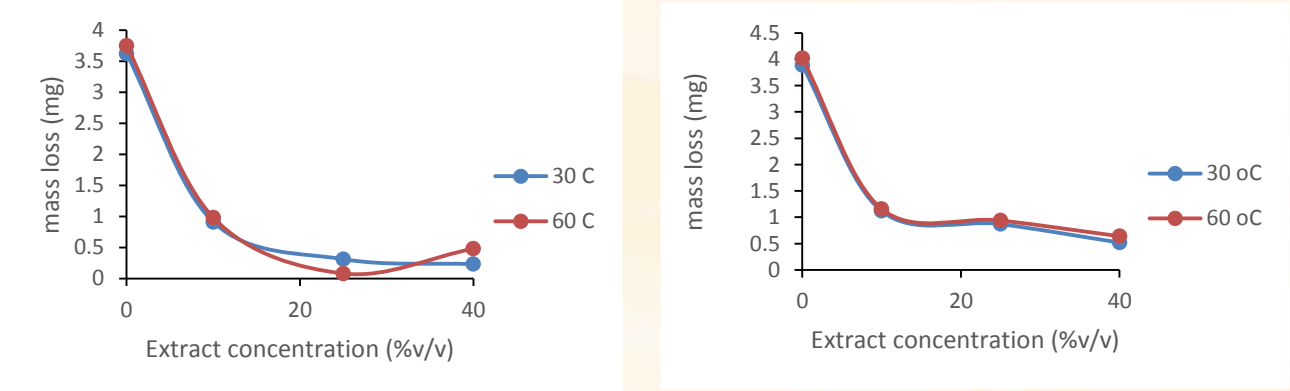

Figure 1a shows the variation in mass loss of mild steel in 1M H_2SO_4 and (b) 1 M HCl in the absence and presence of different concentrations of the BKS extract as a function of time

Figure 1a and 1b described the inhibiting effect of BKSE on the corrosion of mild steel in 1M H_2SO_4 and 1M HCl respectively after 4 hours at 30 °C and 60 °C. Firstly, the results showed that BKSE is a good inhibitor against mild steel deterioration in acidic medium such as H_2SO_4 and HCl. More so, the extract performance was almost the same after addition of 20 %v/v within the examined concentration range. Therefore, this amount should be enough to

inhibit mild steel corrosion in corrosion media. Secondly, the slight increased in temperature (60 °C) does not significantly affect the inhibitor performance. This observation provide the assurance that slight temperature variation will not negate the extract's ability to limit corrosion rate of mild steel in the corrosive environment.

Figure 2. Inhibition efficiency against extract concentration in: (a) 1 M H_2SO_4 (b)1 M HCl at 30 and 60 ^oC

Phytochemical Analysis

The phytochemical properties of Bitter Kola Stem plant extract were determined to check for the presence of inhibitive functional groups and the results obtained are shown in Table 1.

Table 1: Phytochemical constituents

S/N	Functional group	Relative presence
1	Alkaloids	++
2	Saponins	+
3	Tannins	++
4	Flavonoids	++++

The result shows the presence of alkaloids, tannins, flavonoids, saponins functional groups which accounts for the inhibitive behaviour of BKS extract in the acidic media (Rani and Bharathi, 2012).

CONCLUSION

Bitter Kola Stem extract is a good green inhibitor for limiting the corrosion of mild steel in acidic medium such as H2SO4 and HCl. An inhibition efficiency of 92.07 % in 1 M H_2SO_4 and 86.51 % in 1 M HCl was obtained in these experiment. However, the inhibitive efficiency of BKSE slightly decreased at 60 °C compared to 30 °C (i.e. from 92 % to 89 % in H_2SO_4 and 87 % to 85 % in HCl). Nevertheless, these results provide assurance that slight temperature variation will not significantly affect its performance.

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