

List of Tables

Table No.	Title	Page No.
2.1	Biomass extracts used as corrosion inhibitors for Mild Steel	18
2.2	Biomass extracts used as corrosion inhibitors for Aluminium	30
2.3	Insight into the components and efficiency of the tested Natural oils	39
4.1	Preliminary phytochemical screening of the crude extracts of HR/CI	66
4.2	Terpenoid profile of HRL and HRF	67
4.3	Flavanoid profile of HRL and HRF	70
4.4	Coumarin profile of HRL and HRF	73
4.5	FTIR-observed frequencies and peak assignmenst for HR/CI plant extracts	83
4.6	UV spectral data of crude HRL / HRF /CIL / CIF extracts	83
4.7	Potentiodynamic polarisation parameters for the corrosion of MS in the absence and presence of different concentrations of HRL / HRF extracts in 1 M HCl	85
4.8	Potentiodynamic polarisation parameters for the corrosion of MS in the absence and presence of different concentrations of CIL / CIF extracts in 1 M HCl	87
4.9	Electrochemical Impedance parameters for corrosion of MS in the absence and presence of different concentrations of HRL extract in 1 M HCl	92
4.10	Electrochemical Impedance parameters for corrosion of MS in the absence and presence of different concentrations of HRF extract in 1 M HCl	93
4.11	Electrochemical Impedance parameters for corrosion of MS in the absence and presence of different concentrations of CIL extract in 1 M HCl	93
4.12	Electrochemical Impedance parameters for corrosion of MS in the absence and presence of different concentrations of CIF extract in 1 M HCl	93
4.13	Potentiodynamic polarisation parameters for the corrosion of AA 1100 in the absence and presence of different concentrations of HRL/HRF in 1 M HCl	100

Table No.	Title	Page No.
4.14	Potentiodynamic polarisation parameters for the corrosion of AA 1100 in the absence and presence of different concentrations of CIL/CIF in 1 M HCl	102
4.15	Electrochemical Impedance parameters for corrosion of AA1100 in the absence and presence of different concentrations of HRL extract in 1 M HCl	106
4.16	Electrochemical Impedance parameters for corrosion of AA1100 in the absence and presence of different concentrations of HRF extract in 1 M HCl	107
4.17	Electrochemical Impedance parameters for corrosion of AA1100 in the absence and presence of different concentrations of CIL extract in 1 M HCl	107
4.18	Electrochemical Impedance parameters for corrosion of AA1100 in the absence and presence of different concentrations of CIF extract in 1 M HCl	107
4.19	Inhibition efficiency as a function of immersion time and concentration of HRL/HRF/MS/ 1 M HCl systems	114
4.20	Inhibition efficiency as a function of immersion time and concentration of CIL/CIF extracts/MS/ 1 M HCl	116
4.21	Relationship between Inhibition efficiency and concentration for HRL/HRF /MS / 1 M HCl systems at various temperatures	118
4.22	Relationship between Inhibition efficiency and concentration for CIL/CIF /MS / 1 M HCl systems at various temperatures	119
4.23	Inhibition efficiency as a function of immersion time and concentration of HRL/HRF on AA1100/ 1 M HCl	121
4.24	Inhibition efficiency as a function of immersion time and concentration of CIL/CIF on AA1100/ 1 M HCl	123
4.25	Relationship between Inhibition efficiency and concentration for AA1100/ 1 M HCl/ HRL/HRF extracts at various temperatures	125
4.26	Relationship between Inhibition efficiency and concentration of CIL/CIF on AA1100 in 1 M HCl systems at various temperatures	126
4.27 4.30	Adsorption parameters deduced from various adsorption isotherms - MS / 1 M HCl / HRL , MS / 1 M HCl / HRF, MS / 1 M HCl / CIL , MS / 1 M HCl / CIF	134-137

Table No.	Title	Page No.
4.31-4.34	Adsorption parameters deduced from various adsorption isotherms – AA1100 / 1 M HCl / HRL, AA1100 / 1 M HCl / HRF, AA1100 / 1 M HCl / CIL, AA1100 / 1 M HCl / CIF	138-141
4.35	The results of Statistical SPSS 16 package on adsorption isotherms and the various adsorption models obeyed by the investigated inhibitors and their highest F values	142
4.36	Activation parameters for MS / AA 1100 corrosion in 1 M HCl in the absence and presence of different concentrations of HRL/HRF/CIL/CIF extracts	144
4.37	Average values of activation parameters for MS / AA1100 corrosion in 1 M HCl in the absence and presence of different concentrations of HRL/HRF/CIL/CIF extracts	146
4.38	Thermodynamic adsorption parameters for MS / AA1100 corrosion in 1 M HCl in the absence and presence of different concentrations of HRL/HRF/CIL/CIF extracts	147
4.39	UV spectral details for crude plant extract and corrodent solution on MS in 1 M HCl	150
4.40	UV spectral details for crude plant extract and corrodent solution on AA1100 in 1 M HCl	151
4.41	FT-IR spectral details of HR for crude plant extract and corrosion product on MS in 1 M HCl	153
4.42	FT-IR spectral details of CI for crude plant extract and corrosion product on MS in 1 M HCl	155
4.43	FT-IR spectral details of HR for crude plant extract and corrosion product on AA1100 in 1 M HCl	156
4.44	FT-IR spectral details of CI for crude plant plant extract and corrosion product on AA1100 in 1 M HCl	158
4.45	Quantum chemical parameters for the selected phytoconstituents	173
4.46	Derived Quantum chemical parameters for the selected phytoconstituents	177

List of Figures

Figure No.	Title	Page No.
1.1	Different forms of corrosion	2
1.2	Schematic representation of electrochemical corrosion process for Mild Steel and Aluminium	3
1.3	Factors affecting corrosion	4
1.4	Cost of corrosion	5
1.5	Corrosion problems in different sectors	6
1.6	Losses due to Corrosion	7
1.7	Corrosion in various industries	9
1.8	Corrosion control methods	11
2.1	Articles published during 1950-2010 to explore green inhibitors	17
3.1	Chemical composition of metal specimen	51
3.2	Software Tools used	62
3.3	Proposed framework of Methodology	63
4.1	Terpenoid chromatogram of ethanol extracts of HRL and HRF before and after derivatization	68
4.2	Baseline and peak densitogram display of HRL extract with standard for Terpenoid profile.	68
4.3	Baseline and peak densitogram display of HRF extract and 3D display of all Tracks for terpenoid profile.	69
4.4	Flavonoid chromatogram of ethanol extracts of HRL and HRF before and after derivatization	70
4.5	Baseline and peak densitogram display of HRL extract with standard for Flavonoid profile	71
4.6	Baseline and peak densitogram display of HRF extract, 3D display of all Tracks for Flavonoid profile.	72
4.7	Coumarin chromatogram of ethanol extracts of HRL and HRF before and after derivatization.	74

Figure No.	Title	Page No.
4.8	Coumarin standard -Baseline and peak densitogram display	74
4.9	Baseline and peak densitogram display of HRL, HRF extracts and 3D display of all Tracks for coumarine profile.	75
4.10	Characterization of HRL extract	78
4.11	Characterization of HRF extract	79
4.12	Characterization of CIL extract	80
4.13	Characterization of CIF extract	81
4.14	Potentiodynamic polarization curves for MS in 1 M HCl in the absence and presence of (a) HRL (b) HRF (c) CIL (d) CIF extracts.	89
4.15	Nyquist and Bode diagrams for MS Electrode in 1 M HCl in the absence and presence of (a) HRL (b) HRF extracts	94
4.16	Nyquist and Bode diagrams for MS Electrode in 1 M HCl in the absence and presence of (a) CIL (b) CIF extracts	95
4.17	Equivalent Circuit model for MS/ 1 M HCl	97
4.18	Potentiodynamic polarization plots of AA 1100 in 1 M HCl in absence and presence of (a) HRL (b) HRF (c) CIL (d) CIF extracts	103
4.19	Impedance response of AA 1100 electrode in the absence and presence of (a) HRL (b) HRF extracts in Nyquist and Bode format	108
4.20	Nyquist and Bode plots of AA 1100 Electrode in the absence and presence of (a) CIL (b) CIF extracts	109
4.21	Proposed equivalent circuit model for AA1100 /Inhibitors / 1 M HCl	111
4.22	Inhibition efficiency as a function of time and concentration of HRL/HRF/CIL/CIF extracts on MS in 1 M HCl	117
4.23	Impact of temperature on corrosion rate and inhibition efficiency of HRL/HRF/CIL/CIF extract on MS in 1 M HCl	120
4.24	Variation of corrosion rate and inhibition efficiency with concentration of HRL/HRF/CIL/CIF extracts on AA1100	124

Figure No.	Title	Page No.
4.25	Impact of temperature on the corrosion inhibition of HRL/HRF/CIL/CIF extract on AA1100 in 1 M HCl	127
4.26	Comparison of IE of studied inhibitors using mass loss and electrochemical techniques on Mild steel and AA1100 in 1 M HCl with HRL/HRF/CIL/CIF extracts	128
4.27	Pictorial representation of durability of investigated inhibitors at room temperature for 3h of immersion	129
4.28	Langmuir Adsorption Isotherms for MS, AA1100/HRL/HRF/CIL/CIF extract /1 M HCl systems	143
4.29	Arrhenius plot and Transition plot for MS/AA1100/HRL/HRF/CIL/CIF extracts/1 M HCl	145
4.30, 4.31	Best fit curves of $-\Delta G^{\circ}_{ads}$ Vs T for MS/ HRL/HRF/CIL /CIF extract /1 M HCl; AA1100/ HRL/HRF/CIL /CIF extract /1 M HCl	148
4.32	UV spectra for crude plant extracts HRL/HRF /CIL/CIF, corrodent solution on MS in 1 M HCl	150
4.33	UV spectra for crude plant extracts HRL/HRF /CIL/CIF, corrodent solution on AA 1100 in 1 M HCl	152
4.34	FT-IR Spectrum of (a) HRL and corrosion products in the presence of HRL extract (b) HRF and corrosion products in the presence of HRF extract (c) CIL and corrosion products in the presence of CIL extract (d) CIF and corrosion products in the presence of CIF extract on mild steel.	154
4.35	FT-IR Spectrum of (a) crude HRL and corrosion products in the presence of HRL extract (b) crude HRF and corrosion products in the presence of HRF extract (c) crude CIL and corrosion products in the presence of CIL extract (d) crude CIF and corrosion products in the presence of CIF extract on AA1100	158
4.36	SEM images of MS corrosion in absence and presence of (c) HRL (d) HRF (e) CIL (f) CIF extract in 1 M HCl	160
4.37	SEM images of AA1100 corrosion in absence and presence of (c) HRL (d) HRF (e) CIL (f) CIF extract in 1 M HCl	162
4.38	EDX images of Mild steel corrosion in the absence and presence of (a) HRL (b) HRF (c) CIL (d) CIF extract in 1 M HCl	164

Figure No.	Title	Page No.
4.39	EDX images of AA1100 corrosion in the absence and presence of (a) HRL (b) HRF (c) CIL (d) CIF extract in 1 M HCl	165
4.40	XRD spectrum of a) Mild steel b) AA1100 corrosion in presence and absence of investigated inhibitors in 1 M HCl	166
4.41	3D profilometry images of MS corrosion in the absence and presence of (c) HRL (d) HRF (e) CIL (f) CIF extract in 1 M HCl	168
4.42	3D profilometry images of AA1100 corrosion in the absence and presence of (c) HRL (d) HRF (e) CIL (f) CIF extract in 1 M HCl	169
4.43 a,b,c	Optimised structures and Frontier molecular orbital distribution of selected phytochemicals	178
4.44	Schematic Illustration of Selected Phyto Constituents of <i>Canna indica</i> on MS Surface and General Illustration of Flavonoid and Terpenoid on MS Surface.	182
4.45	Schematic Illustration of Selected Phyto Constituents on AA1100 surface General Illustration of Flavonoid and Terpenoid on AA1100 surface	185

List of Abbreviations

CI	- <i>Canna indica</i>	τ	- Interface Time constant
HR	- <i>Heliconia rostrata</i>	f_{\max}	- frequency at Z' value maximum
CIL	- <i>Canna indica</i> leaves	mV	- milli Volt
CIF	- <i>Canna indica</i> flower	mpy	- mils per year
HRL	- <i>Heliconia rostrata</i> leaves	eV	- electron volt
HRF	- <i>Heliconia rostrata</i> flower	E_a	- Activation energy
MS	- Mild Steel	ΔH_a	- Enthalpy of activation
AA1100	- Aluminium alloy 1100	ΔS_a	- Entropy of activation
CR	- Corrosion Rate	$\Delta G^{\circ}_{\text{ads}}$	- Free energy of adsorption
HCl	- Hydrochloric acid	$\Delta H^{\circ}_{\text{ads}}$	- Enthalpy of adsorption
IE	- Inhibition Efficiency	$\Delta S^{\circ}_{\text{ads}}$	- Entropy of adsorption
θ	- Surface Coverage	E_{HOMO}	- Energy of the highest occupied molecular orbital
E_{corr}	- Corrosion Potential	E_{LUMO}	- Energy of the lowest unoccupied molecular orbital
I_{corr}	- Corrosion Current density	μ	- Dipole moment
b_a	- Anodic Tafel Slope	ΔE	- Energy gap
b_c	- Cathodic Tafel Slope	ΔN	- Number of electrons
R_p	- Polarisation Resistance	EA	- Electron Affinity
R_{ct}	- Charge Transfer Resistance	IP	- Ionization Potential
C_{dl}	- Double Layer Capacitance	η	- Global Hardness
R_s	- Solution resistance	σ	- Global Softness
CPE	- Constant Phase Element	χ	- Electronegativity
n	- CPE exponent	ω	- Electrophilic Index
Y₀	- CPE constant		