Synthesis and characterization of 5-benzyl-5-(4-benzyl-4-methyl piperazin-4-ium-l-yl)-1,3,5-dithiazinan-5-ium as corrosion inhibitor, antibacterial and antifungal.

Dr. Mushtaq J. Meften
Educational Directorate of Basrah, Ministry of Education.
Basrah, Iraq.
mushtak9791@yahoo.ca

Dr. Najlaa Z. Al - Ameri
Research Department and Quality Control, South Oil Company.
Ministry of Oil, Basrah, Iraq.
alameri124@yahoo.com

Abstract.

According to the domino reaction method, 5-benzyl-5-(4-benzyl-4-methylpiperazin-4-ium-l-yl)-1,3,5-dithiazinan-5-ium has prepared. The structure of the synthesized compound has been characterized by several techniques such as, Fourier Transform Spectroscopy (FT-IR), ^{1}H-NMR Spectroscopy, Elemental analysis (CHNS), and Mass spectroscopy. Finally, the synthesized compound has been tested as anti corrosion for carbon steel, antibacterial activity against Gram positive bacteria *Staphylococcus aureus*, Gram negative bacteria *Escherichia coli* and antifungal activity against *Candida albicans* (Human Pathogens) at concentrations 10, 20, 30, 40, and 50 µg/ml. The tests have been checked as antibacterial and antifungal according to the disk diffusion method, and it has been checked as anticorrosion by weight loss method in 15% HCl as corrosive medium at 3 hours. The mechanism of corrosion inhibition has been studied, and the adsorption of heterocyclic compound on the carbon steel surface has been studied which follows the Langmuir adsorption isotherm. On the other hand, the temperature affect on the corrosion rate has been studied. The results have shown that heterocyclic compound is a very effective to anticorrosion and moderate for antibiotic(antifungal and antibacterial).

Index: **Corrosion inhibitors, Antibacterial, Antifungal, Heterocyclic compounds, Domino reaction, Weight loss method.**

I. INTRODUCTION.

The corrosion of metal and its alloys is a common problem with economic implications costing billions of dollars in every year [1]. Metals and alloys are frequently used in industrial applications due to their convenience and low cost. Among these, carbon steel is one of the most important alloys which are widely used [2]. Corrosion degradation of steel reinforcement in concrete is due to aggressive agents present in the surrounding environment, which affects the durability of the structure and leads to the premature failure [3]. The inhibitors used are expected to be chemically stable to provide high protection [4].

Fungi and bacteria are everywhere: in the soil, on trees, in grass and in woodlands, the fur on our pets, our hair, they are on our skin and in our intestinal tract. Fungi, also known as mycophyta, include yeasts, moulds and rusts. Can be made up of single cells (such as the yeasts) or composed of multi-cellular filaments which are called hyphae (e.g. with the dermatophytes) [5]. Medicinal chemistry is the application of chemical research techniques for the synthesis of pharmaceuticals. Heterocyclic compounds their application obvious in pharmacy medicine, photography, agriculture, antioxidant such as corrosion inhibitors and also the other fields [6].

Heterocyclic compounds, that containing particularly on nitrogen, and sulfur atoms successfully tested against several diseases and therefore received special attention in medicinal field, pharmaceutical and industry field. Heterocyclic compounds for example 1,2,4-triazole derivatives are associated with biological activity such as pesticidal potentialities, herbicides fungicides and anti bacterial [7]. Bacterial and fungal infections have been for many centuries a major cause of death in humans. M. Pitucha, et al. studied the effect of pyrazole derivatives were tested in vitro against two Gram-positive bacteria, that is a drug susceptible strain, *Staphylococcus aureus* FDA 209P and a multidrug resistant strain, *S. aureus* KMP9 (MRSA), and against two Gram-negative bacteria that is a susceptible strain, *Escherichia coli* NIHJ JC-2 and a multidrug efflux pump mutant, *Escherichia coli* W3110 DacrA. The obtained results show that (3-chlorophenyl)-5-(4-phenoxyphenyl)-3-(3-piperidyl) pyrazole hydrochloride and 1-(3-chlorophenyl)-3-[3-(N- methyl) aminopropyl]-5-(4-phenoxyphenyl) pyrazole hydrochloride exhibits comparatively strong antibacterial activity against tested *Staphylococcus aureus* and *Escherichia coli* W3110 DacrA [8,9]. The main objective of this research is evaluation of new heterocyclic compound as anticorrosion through weight loss method, also its evaluation as an antibacterial and fungi through disk diffusion method, and study of mechanism of corrosion inhibition.

II. EXPERIMENTAL.

2.1. Materials.

1-Amino-4-methypiperazine 99%, 10% formaldehyde, chloroform 99%, sodium sulfate 98% and hydrochloric acid 37% were procured from Sigma–Aldrich. Di methyl sulfoxide DMSO, Benzyl chloride 99% were procured from Merck company, and absolute ethanol 99% were procured from BDH company. Double distilled water was used for all the experiments. Muller Hinton Agar was procured from Himedia, Carbon steel (pipeline) which used in the south oil company, Basra, IRAQ.

2.2. Synthesis of 5-benzyl- 5-(4-benzyl-4-methyl piperazin-4-ium-l-yl)-1,3,5-dithiazinan-5-ium.

A mixture of aqueous solution 10 % formaldehyde (45ml) 150mmol and 50ml absolute ethanol were stirred with 50mmol (6ml) from 1- amino-4-methylpiperazin for 3 hour at a temperature of 0°C, after that the reaction allowed to reach room temperature, then added 100mmol of hydrogen sulfide gas for 1 hour and the product is extracted and dried with Na_2SO_4 for about 5 hrs, then filtered and evaporated even dryness under nitrogen to produce 5-(4-methylpiperazin-1-yl)-1,3,5-dithiazinan.After that, 100mmol of benzyl chloride and 100 ml absolute ethanol have been added to 50mmol of 5-(4-methyl piperazin-1-yl)-1,3,5-dithiazinan for 24 hrs (overnight) at 50°C to produce 5-benzyl- 5-(4- benzyl-4-methylpiperazin-4-ium-l-yl)-1,3,5-dithiazinan-5-ium (white solid). The yield was 62%, m.p. 122-124 °C. Figure (1) shown the structure of heterocyclic compound.

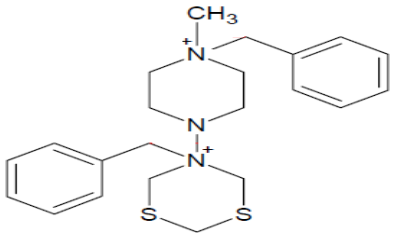

Fig. 1: General structure of heterocyclic compound 5-benzyl- 5-(4-benzyl-4-methylpiperazin-4-ium-l-yl)-1,3,5-dithiazinan-5-ium.

2.3 Instruments.

The mass spectrum was recorded on a Perkin-Elmer Hitachi RMU-6L QP2010 spectrometer at 70 e.V. and temperature 120 ^{0}C. Melting point was determined in open capillary tubes by a Gallenkamp apparatus, the IR spectrum obtained, was recorded in KBr disk on a Shimadzu FT-IR 8201 PC spectrometer in the region between 400 and 4000 cm^{-1}. The ^{1}H-NMR spectrum obtained, was recorded on a BRUKER spectrometer at 500 MHz in deuteron chloroform with TMS as internal reference. Elemental analysis for C, H, N and S, were carried out on elemental analyzer CHNS 628 from LECO company. Incubator, and autoclave apparatus.

2.4. Biological Activities.

The synthesized compound was studied and tested as (antibacterial and antifungal) activity by using agar disc diffusion method [10-12], against gram-positive bacteria *Staphylococcus aureus*, gram-negative bacteria *Escherichia coli* and antifungal, it was dissolved in DMSO-d_6 at a concentration 10, 20, 30,40 and 50 µg/ml, in test tube 20 ml. A filter paper, Sd400 type punched into 5 mm disc form and impregnated with different concentrations of the test compound for about 30 minutes (soaked in the test solution) with sterilized by autoclave apparatus, then dried. Muller-Hinton Agar medium was used for culturing bacteria and fungi, prepared from dissolved 38 gm per liter distilled water and neutralized to pH=8 under aseptic condition for about 15 minutes at 121°C and 15 lbs pressure, then it was cooled to 45°C, after that added to petri plates in depth about 5mm. The bacterial cells were suspended according to the McFarland protocol in 2ml from normal saline, they were stricken by cotton swab on Muller Hinton, and left about 15 minutes to dry, then the synthesized compound disk was put on it, then incubated at 37°C for 22 hrs.. In case of fungi don't differ from the bacteria, in only the activation period and temperature , which lasted 72 hours at 25°C [13-16].

2.5. Anti Corrosion Activities.

The carbon steel cuts into (7×2.5×0.3)cm for length, width, and thickness respectively, and were polished by SiC (grade 140, 320), washed with distilled water, then acetone and finally dry it in a desiccator. Corrosion rate(C_R) in unit (mg cm^{-2} h^{-1}), Inhibition efficiency(IE), and Surface coverage (θ) were calculated as follows [17]:

$$C_R = \frac{W_b - W_a}{At} \quad \text{----------(1)}$$

$$IE\% = \left(1 - \frac{W_i}{W_o}\right) x\ 100 \quad \text{----------(2)}$$

$$\text{Surface coverage } (\theta) = \left(1 - \frac{W_i}{W_o}\right) \quad \text{---------- (3)}$$

Where W_b and Wa are the specimen weight before and after immersion in the tested solution, W_0 and W_i are the values of corrosion right of carbon steel in uninhibited and inhibited solutions respectively. A is the total area of the carbon steel specimen in cm^2 (40.7cm^2), and ***t*** is the exposure time (h).

III. RESULTS AND DISCUSSION.

3.1. Characterization of 5-benzyl- 5-(4-benzyl-4-methyl piperazin-4-ium-l-yl)-1,3,5-dithiazinan-5ium.

Melting point of heterocyclic compound is 122-124 °C. ^{1}H-NMR, ($CDCl_3$) δ ppm: 1.993 (s, 3H,CH_3); 2.391-2.521 (t, 4H, CH_3-N-$\underline{CH_2}$ CH_2); 2.766-2.916 (t, 4H, N-$\underline{CH_2}$-CH_2 N^+-CH_3); 3.719 (s, 2H, S-CH_2-S); 4.128(s, 4H, N^+-CH_2-S); 1.780 (s, 4H, N^+-$\underline{CH_2}$-ph); multiple sgnal (dd, 10H, Ar-H) in the region 7.66-7982 ppm assigned to the aromatic protons of phenyl; 7.218(s,1H,$CDCl_3$). MS, *m / z* (I_{rel} ,%): 401 $[M]^+$ (13); 77 $[C_6H_5]^+$ (67); 134 $[C_4H_8NS_2]^+$ (26); 310 $[C_{15}H_{25}\ N_3S_2]^+$ (100); 91 $[C_7H_7]^+$ (17); 219 $[C_8H_{17}N_3S_2]^+$ (45); 247 $[C_{10}H_{21}N_3S_2]^+$ (37); 324 $[C_{16}H_{26}N_3\ S_2]^+$ (66); 190$[C_{12}H_{18}N_2]^+$(12);211$[C_{10}H_{13}NS_2]^+$(17); 295 $[C_{14}H_{21}N_3S]^+$ (17); 233 $[C_9H_{19}N_3\ S_2]^+$ (26); 386 $[C_{12}H_{29}N_3S_2]^+$ (25); 15 $[CH_3]^+$ (23). IR (KBr), υ_{max}/cm^{-1}: The stretching frequency at 690 corresponds to C-S; stretching frequency at 1301.95 corresponds to C-N; stretching frequency at 1051.2 corresponds to N-N; stretching frequency at 1585.49 corresponds to C=C; stretching frequency at 2989.66 corresponds to (C-H aliphatic); stretching frequency, almost at 3100.21 corresponds to (C-H aromatic); and frequencies at 1388.75 and 1415.75 corresponds to C-H bending [7], [18-22], and this pertinent details visible in spectra as shown in figures from (2) to (5) are as follows.

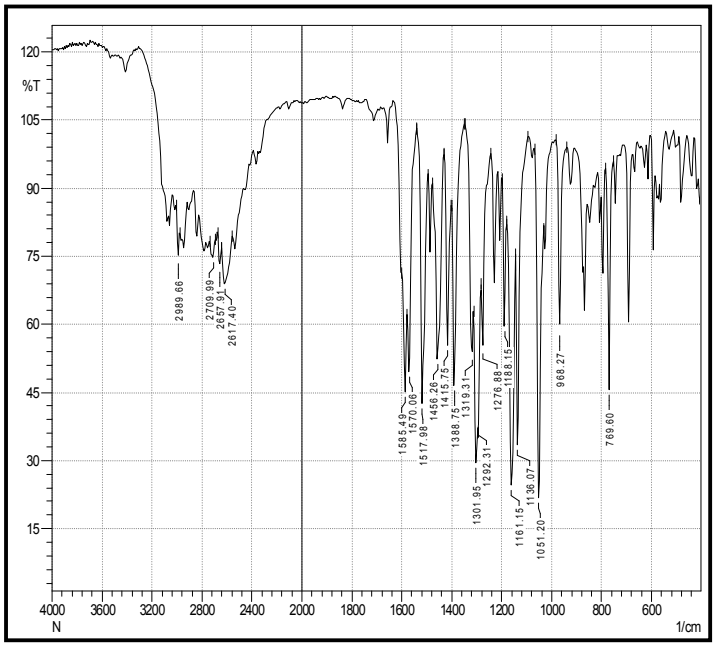

Fig. 2: IR spectrum of heterocyclic compound.

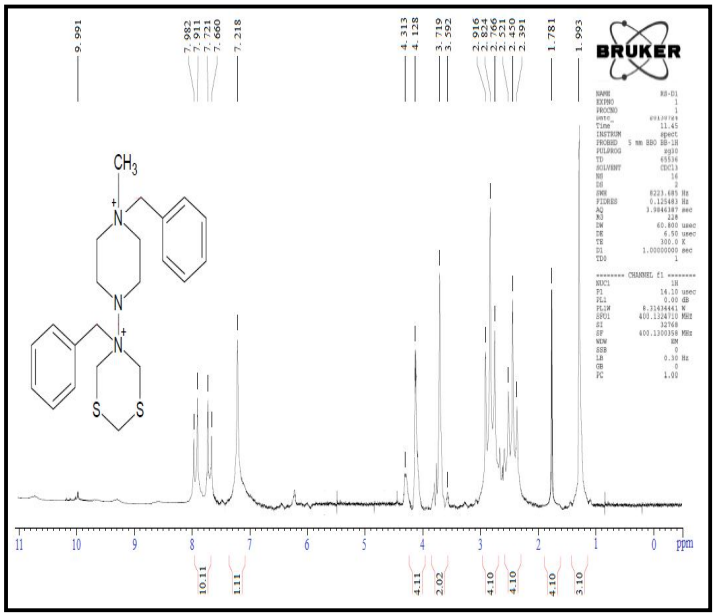

Fig. 3: ^{1}H-NMR spectrum of heterocyclic compound.

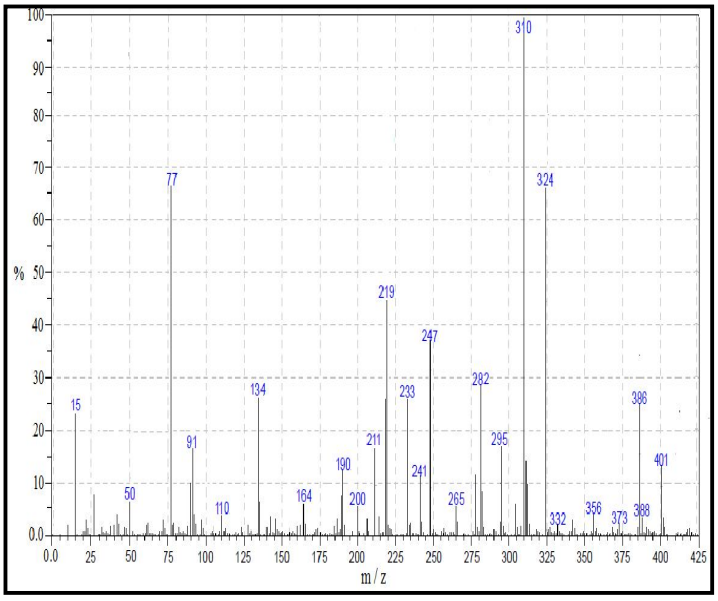

Fig. 4: Mass spectrum of heterocyclic compound.

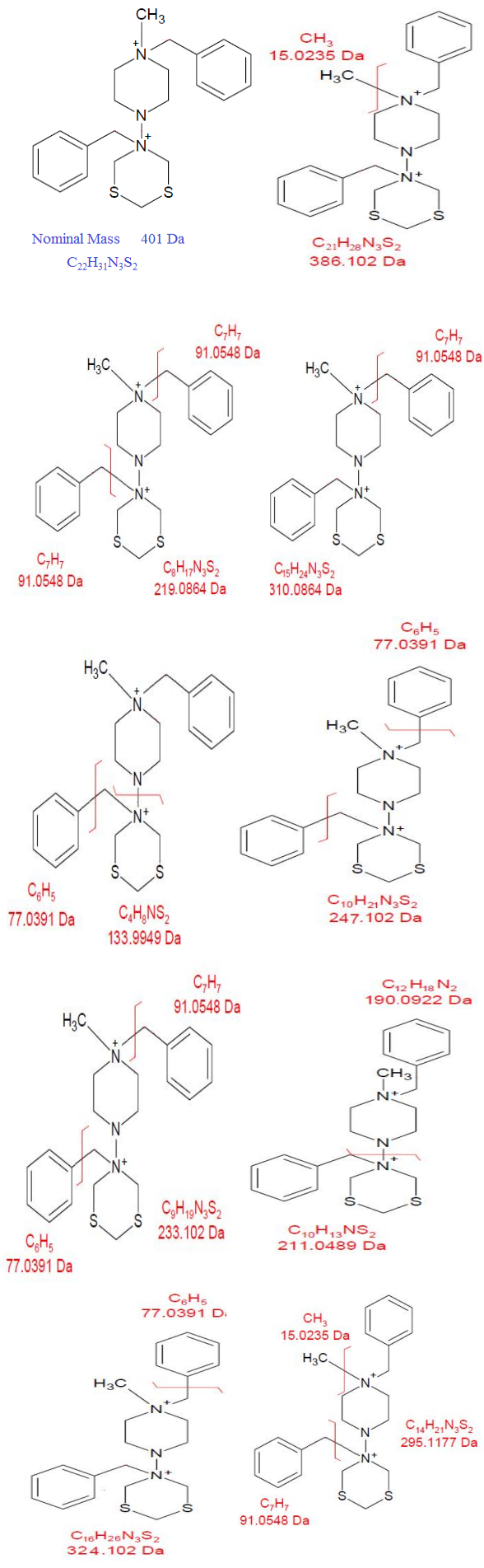

Fig. 5: The most important fragment structures in the mass spectrum of heterocyclic compound.

Besides, the results analysis of C, H, N and S of heterocyclic compound given in Table 1, and as shown that the practical percentages to be identical to large extent with the theoretical percentages, furthermore, the physical data of heterocyclic compound listed in Table 2

TABLE I
SHOWS CHNS ANALYSIS.

Molecular formula	C%		H%		N%		S%	
	Cal.	Found	Cal.	Found	Cal.	Found	Cal.	Found
$C_{22}H_{31}N_3S_2$ 401g/mol	65.83	65.87 65.91 65.81 Average 65.86	7.73	7.66 7.79 7.57 Average 7.67	10.47	10.44 10.82 10.32 Average 10. 52	15.96	15.99 16.13 15.54 Average 15. 88

TABLE II
SHOWS THE PHYSICAL DADT OF HETEROCYCLIC COMPOUND

Molecular formula	Molecular weight	Melting point	Nature of substance	Yield %
$C_{22}H_{31}N_3S_2$	401g/mol	122-123 °C	White solid	62

3.2. Anti Corrosion Measurements

Weight loss of carbon steel was calculated in the absence, and presence of different concentrations of inhibitor. Tables 3 and 4 have shown the results of weight loss method obtained in 15% hydrochloric acid solution as a corrosive medium. It was noted from these results that a decrease of both differences in weight loss, and corrosion rate when increasing concentration for both temperatures [23], as well as, they in 15% solution from hydrochloric acid (blank) more than inhibitor presence. Corrosion rate decreases with increasing inhibitor concentration as shows in Figure 6, thus the inhibition efficiency (% IE) increased. Subsequently, it can be concluded that the inhibitor has high efficiency for inhibition in acidic solution, reaching a maximum of (96.00).This may be due to the adsorption of heterocyclic compound onto the carbon steel surface through non-bonding electron pairs of sulfur, and nitrogen atoms as well as the JI- electrons in ring aromatic. Also, it is clear from results in Tables 3,4 and Figure 6, the corrosion rate, and differences in weight loss, increase with the raise of temperature in the absence, and presence of the inhibitor [11],[12],[24].

TABLE III
SHOWS RESULTS OF CORROSION , BY WEIGHT LOSS METHOD AT 298K AND PERIOD 3 HOURS.

Corrosion inhibitor Dosage	Specimen weight (before)	Specimen weight (after)	Difference in weight loss	Corrosion rate mg cm^2 h^{-1}	Inhibition efficiency IE%
15% HCl Blank	40.695	40.301	0.394	0.00322	----
10µg/ml	40.695	40.611	0.084	0.00068	78.90
20µg/ml	40.695	40.625	0.07	0.00057	82.30
30µg/ml	40.695	40.646	0.049	0.00040	87.60
40µg/ml	40.695	40.674	0.021	0.00017	94.80
50µg/ml	40.695	40.679	0.016	0.00013	96.00

TABLE IV
SHOWS RESULTS OF CORROSION, BY WEIGHT LOSS METHOD AT 308 K AND PERIOD 3 HOURS

Corrosion inhibitor Dosage	Specimen weight (before)	Specimen weight (after)	Difference in weight loss	Corrosion rate mg cm^2 h^{-1}	Inhibition efficiency IE%
15% HCl Blank	40.695	40.223	0.472	0.00386	-----
10µg/ml	40.695	40.578	0.117	0.00095	75.20
20µg/ml	40.695	40.591	0.104	0.00085	78.00
30µg/ml	40.695	40.633	0.062	0.00050	87.10
40µg/ml	40.695	40.654	0.041	0.00033	91.50
50µg/ml	40.695	40.666	0.029	0.00023	94.10

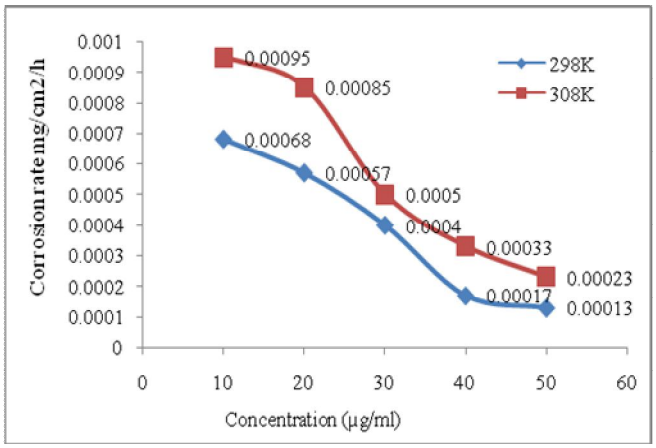

Fig. 6 : Shows decreases corrosion rate for carbon steel with increasing concentration at varying temperatures in 3 hours.

3.2.1. Adsorption Isotherm.

The adsorption depends on the structure of the inhibitor, type of the metal and the nature of its surface, the nature of the corrosion medium and its pH value, the temperature and the electrochemical potential of the metal-solution interface. Also, the adsorption provides information about the interaction between the adsorbed molecules with the metal surface [25]. It generally that the adsorption of the inhibitor on metal surface is an essential step to the explain of inhibition mechanism, and several adsorption isotherms were assessed such as, Langmuir, Temkin, Frumkin, and Freundlich isotherms. Langmuir adsorption isotherm was determined, by plotting C*inh*/θ versus C*inh* for various concentrations of inhibitor through using the equation (4) and was noted that it describes of the inhibitor adsorption behavior on the carbon steel surface. It can be concluded that concentration directly proportional with C*inh*/θ, as shows in Figure 7. Besides, standard free energy of adsorption was calculated from equation 5 [22],[26-31].

$$\frac{C_{inh}}{\theta} = \frac{1}{K_{ads}} + C_{inh} \qquad (4)$$

$$\Delta G^{o}_{ads} = -RT\ln(55.5K_{ads}) \qquad (5)$$

This equation can also be express in the form as follows

$$K_{ads} = \frac{1}{55.5}\exp\left(\frac{-\Delta G^{o}_{ads}}{RT}\right) \qquad (6)$$

Where K*ads* the equilibrium constant of the adsorption reaction, and its value calculated from the intercept line on the C*inh*/θ axis, and by using the value of *Kads* the value of $\Delta G^{o}ads$ was calculate by equation 5. C_{inh} is the inhibitor concentration in the bulk of the solution, R is the gases constant 8.314 J.mol^{-1} K^{-1}, T is the temperature in Kelvin 298K, and 55.5 is the concentration of water in solution in mol.L^{-1}. The intercept is represent 1/K*ads*, and all activation parameters are given in table 5.

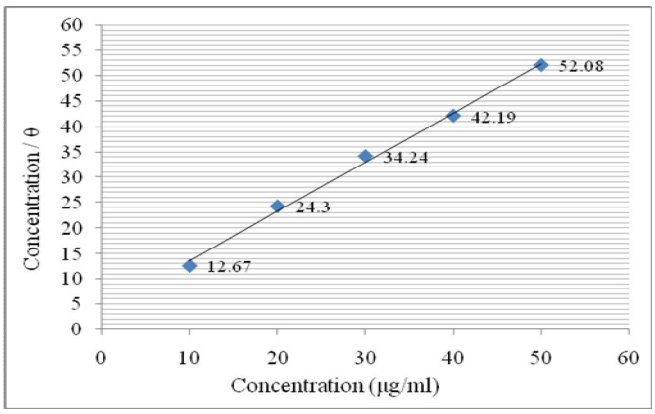

Fig.7 : Langmuir isotherm adsorption of heterocyclic compound on the surface of carbon steel in 15% HC at 298K.

TABLE V
SHOWS THE LANGMUIR ISOTHERM PARAMETERS OF INHIBITOR IN 15% HCl SOLUTION.

Slope	Intercept	R^2	K*ads*	- ΔG (KJ. mol^{-1})
0.9655	4.115	0.9979	0.243	-6.44

Generally, the value of Δ*Gads* if the -20 kJ.mol^{-1} or less value that are consistent with the electrostatic interaction between the charged metal and the charged molecules (physical adsorption), while those more negative than (-40 kJ.mol^{-1}) the adsorption is chemical adsorption, and Δ*Gads* values between (-20 and - 40 KJ.mol^{-1}) meaning they from type mixed- adsorption (physical adsorption and chemisorption occur tandem) [31-33].

The Δ*Gads* negative value indication of adsorption of inhibitor on the carbon steel surface is spontaneous. Results this study shown in Table 5 and Figure 7, noted the Δ*Gads* value obtained for heterocyclic compound on carbon steel surface in 15% HCl solution are -6.44 KJ.mol^{-1} ,this indicates that the adsorption of studied inhibitor is physical adsorption, and the negative value of Δ*Gads* indicate also a spontaneous adsorption process, and stability of the adsorbed film on carbon steel surface [34-35].The slope close to 0.9655, indicating that the adsorption of the inhibitor on the carbon steel surfaces is well depended to the Langmuir adsorption isotherm [36]. Also, in the present study found value of the adsorption equilibrium constant (K*ads* = 0.243), this indicating the strong adsorption of heterocyclic compound (inhibitor) on the carbon steel surface [34]. A plot of Cinh/θ versus Cinh as shown in Figure 7 gives a straight line at correlation coefficient is close to 0.9979 was used to determine the best fit (R^2=0.9979 for the compound), suggests that the adsorption of inhibitor molecules on the carbon steel surface obeys Langmuir adsorption isotherm, which can be expressed by the equation 4 previously mentioned [31-32],[37].

3.2.2. *Mechanism of Corrosion Inhibition.*

The results which obtained from characterization of heterocyclic compound which explained the structure is contain on nitrogen and sulfur hetero atoms, and Л bond in ring aromatic. In addition, from adsorption isotherm results, can be concluded the corrosion process inhibition and adsorption of heterocyclic compound molecules on carbon steel surface in 15% HCl solution, discussed they as a following (i) Interaction between unshared electron pairs of hetero atoms (N,S) in the inhibitor molecule and vacant d- orbital of iron surface atoms by coordination bonds (Chemisorption adsorption) [28],[38-42],(ii) Interaction of Л-electrons in aromatic rings with d-orbitals of iron surface atoms [40-41], (iii) Interaction between the positively charged molecules and the negatively charged metal surface by Vander Waals force [43-44], and (iv) A combination of mechanism the above- mentioned [45-46]. Besides possible explain the mechanism of inhibition according to the number of transferred electrons ΔN. If the value of ΔN< 3.6 the inhibition efficiency increased with increasing electron donating ability of inhibitor at the metal surface (Chemical adsorption). It is observed from Table (6) that the value of ΔN is 0.546, and less than 3.6 ,thus the inhibition efficiency increased with increasing electron donating ability, another words increasing electron donating ability meaning increasing inhibitor molecular. The number of transferred electrons ΔN is depending on the quantum chemical method and calculated using the equation 7 [47-50].

$$\Delta N = (\chi Fe - \chi inh) / [2 (\eta Fe + \eta inh)] \text{ ---------- (7)}$$

Where χFe and χ*inh* are denote the absolute electro negativity of iron and inhibitor molecule respectively; ηFe and η*inh* are the global hardness of iron and the inhibitor molecules respectively. The theoretical values of χFe and ηFe are 7 and 0 eV/mol respectively. The χ*inh* and η*inh* calculated using the equations 8 and 9 respectively.

$$\chi inh = -[(E_L + E_H)/2] \text{ --------(8)}$$

$$\eta inh = (E_L - E_H)/2 \text{ ----------(9)}$$

Where E_H is E_{HOMO} and E_L is E_{LUMO}. ΔE is energy of the gap and calculated using the equation10

$$\Delta E = (E_{LUMO} - E_{HOMO}) \text{ ---------(10)}$$

TABLE VI
QUANTUM CHEMICAL PARAMETERS OF THE INVESTIGATED INHIBITOR

E_{HOMO} (eV)	E_{LUMO} (eV)	ΔE (eV)	χ*inh* (eV mol^{-1})	η*inh* ΔE/2 (eV mol^{-1})	ΔN
-6.55	3.23	9.78	1.66	4.89	0.546

3.3. The Screening of Antibacterial and Antifungal.

The compound was tested as antibacterial and antifungal. The inhibition zones caused by the using various concentrations of heterocyclic compound were examined after 22 hrs for the bacteria and 72 hrs for fungus. It is clear from results as shown in Table 7 and Figures 8 and 9 that compound slightly active (moderate effectiveness) against gram negative bacteria *Escherichia coli* and against gram positive bacteria *Staphylococcus aureus*. But it more active in inhibition of fungi *Candida albicans*. The activity is may be due to that the compound contains on the hetero atoms like N and S which contenting electrons. It was found that molecules of inhibitor generally has passed through *Staphylococcus aureus* cell wall by passive diffusion but, the presence of outer membrane of peptidoglycon in *E. coli* may prevent the transport of molecules of inhibitor to the cell [57-58]. On the other hand, the passage across the outer membrane depended upon the chemical nature of inhibitor. The results shows that the varying concentrations of compound has given diameters of inhibitory zones different, and higher concentration 50 µg/ml has been given the maximum for inhibiting of bacteria and fungi, against the *Staphylococcus aureus*, *Escherichia coli* and *Candida albicans*, thus, the maximum inhibition zone was obtained in *Staphylococcus aureus*, *Escherichia coli* and *Candida albicans* at 50µg/ml are, 13 mm, 12 mm and 18 mm respectively. The diameter of inhibition zone of *Staphylococcus aureus* is similar to a large extent to *Escherichia coli*, and inhibition zone (in mm) includes the diameter of disc (5 mm). Also, results noted to that bacterial more resistant from fungi when using heterocyclic compound. However, the discrepancies in the results obtained, relied on various intrinsic and extrinsic factors, such as molecular weight, and pH. [51-58].

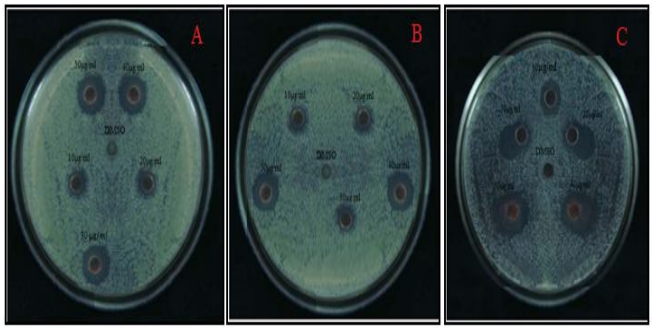

Fig.8: Inhibition zone of heterocyclic compound at different concentrations , against *Staphylococcus aureus* (**A**), *Escherichia coli* (**B**) and *Candida albicans* (**C**).

TABLE VII
DIAMETERS OF INHIBITORY ZONES OF HETEROCYCLIC COMPOUND.

Zone of Inhibition (in mm.)			
Concentrations	Gram- positive bacteria *S. aureus*	Gram- negative bacteria *E.coli*	Antifungal *C. albicans*
10 µg/ml	9	9	11
20 µg/ml	9	9	14
30 µg/ml	13	9	14
40 µg/ml	13	12	17
50 µg/ml	13	12	18
DMSO negative control	No zone	No zone	No zone

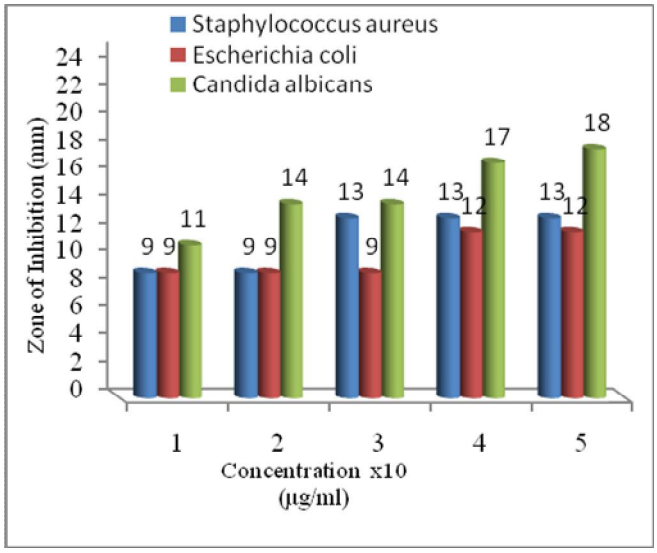

Fig. 9 : Shows the zone of inhibition of heterocyclic compound , against bacterial and fungal by disc diffusion method.

IV. CONCLUSIONS.

In the present study the heterocyclic compound has been evaluated for anticorrosion, antibacterial, and antifungal. The results of weight loss method explained that the heterocyclic compound has excellent inhibition properties for carbon steel. Furthermore, it has a moderate efficiency as a antibacterial and antifungal, in other words, its inhibition for corrosion more than antibiotics. The adsorption of heterocyclic compound on the carbon steel surface follows the Langmuir adsorption isotherm. ΔG_{ads} value obtained of heterocyclic compound on carbon steel -6.44 $KJ.mol^{-1}$ this indicates that the adsorption of inhibitor is physical adsorption. Besides, quantum chemical explained the inhibition efficiency increases with increasing electron donating ability of inhibitor to the metal surface (Chemical adsorption) thus the occurs chemical adsorption and physical adsorption together (mixture of both processes). It is observed that the inhibition efficiency decreases with increase temperature in acidic medium.

V. REFERENCES.

[1] R. G. Sundaram, and M. Sundaravadivelu; Electrochemical and surface investigation of quinoline-8-sulphonyl chloride as corrosion inhibitor for mild steel in acidic medium; International Journal of Chem Tech Research,Vol.9, No.03, pp. 527-539, 2016.

[2] M. Benahmed, N. Djeddi, S. Akkal, and H. Laouar; Saccocalyx Satureioides as Corrosion Inhibitor for Carbon Steel in Acid Solution, International Journal Ind Chem ,Vol. 7, pp. 109-120, 2016.

[3] K. Kavya, V. Kavyadharshini, M. Keerthana, S. Karthika, and S. Suresh; Effect of Corrosion Inhibitor in Mild Steel Bar, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 3, pp. 3835-3840, 2016.

[4] F. ElHajjaji, H. Greche, M. Taleb, A. Chetouani, A. Aouniti, and B. Hammouti; Application of Essential Oil of Thyme Vulgaris as Green Corrosion Inhibitor for Mild Steel in1MHCl, Journal Mater. Environ. Science, Vol. 7, No. 2, pp. 567-578, 2016.

[5] A.N. Boa; Antibacterial and Antifungal Drugs; Department of Chemistry, University of Hull, pp.1-59,2001.

[6] R. Banerjee, D. Roy, and M. Banerjee; Synthesis and Antibacterial Activity Study of Some New 1,3,4-thiadiazole derivatives; Der Pharma Chemica, Vol.8, No. 1 ,pp. 17-21, 2016.

[7] S. S. Syed Abuthahir, R. Marimuthu, K. J. Vikrant, R.Vignesh, A. Jamal Abdul Nasser, and S. Rajendran; Synthesis Characterization and Biological Activities of 1,3,4-thiadiazole derivatives, Journal of Chemical and Pharmaceutical Research, No.8, pp. 5-11, 2016.

[8] M. Pitucha, A. Pachuta-Stec, and A.A. Kaczor; New Five-membered ring Heterocyclic Compounds with Antibacterial and Antifungal Activity; Science, technology and education, pp.562-573, 2013.

[9] K Alagarasu, and P. Selvaraj; Immunogenetics of HIV and HIV associated tuberculosis Tuberculosis; Vol. 92, pp. 18-30, 2012.

[10] N. Savithramma, M. Linga Rao, K. Rukmini, and P. Suvarnalatha devi; Antimicrobial Activity of Silver Nanoparticles Synthesized by Using Medicinal Plants; International Journal of ChemTech Research, Vol. 3, No.3, pp 1394-1402, 2011.

[11] A. R. Shah, H. R. Dabhi, and A. K. Rana; Synthesis, characterization and biological screening of some novel heterocyclic compounds; Der Pharma Chemica, Vol.7, No.3, pp.158-162, 2015.

[12] C. Valgas, S. Machado de Souza, E. F .A. Smania, and A. Smania; Screening methods to determine antibacterial activity of natural products**;** Brazilian Journal of Microbiology, Vol. 38, pp. 369-380, 2007.

[13] C.P. Singh, P. K. Mishra, and S. P.Gupta; Investigation of Ethanolic leaf Extract of Tridax Procumbens Linn for Measuring Zone of Inhibition Against Clinical Pathogens; Worid J. of Pharmacy and Pharnaceutical Sciences, Vol.5, Issue 7, pp. 932-939,2016.

[14] B. Selvamuthu, S. Seetharaman, V. Indra , and A. Daisy; Worid J. of Pharmacy and Pharnaceutical Sciences; Vol. 5, Issue 7,pp. 1186-1193, 2016.

[15] S. Mani, and B. Bharathi; In Vitro Antibacterial and Antifungal Activities of Leaves of Plumeria alba Linn; International Journal of Pharma Sciences, Vol.6, No.1, pp. 1367-1370, 2016.

[16] S. Archana, and J. Abraham.; Comparative Analysis of Antimicrobial Activity of Leaf Extracts From Fresh Green tea Commercial Green tea and Black tea on Pathogens; Journal of Applied Pharmaceutical Science, Vol. 01, No.08, pp. 149-152, 2011.

[17] A. Salhi, A. Bouyanzer, I. El Mounsi, I. Hamdani, H. Bendaha, R. Rmili, H. Akichouh, A. Zarrouk, R. Touir, B. Hammouti, and J. Costa; Natural Product Extract as eco-friendly Corrosion Inhibitor for Mild Steel in1.0 M HCl; Der Pharmacia Lettre, Vol.8, No.2, pp.79-89, 2016.

[18] R. Sethi, and M. Ahuja; Synthesis Characterization and Antibacterial Activity of Cobalt Complex of 2-Pyrazoline with Pyridinyl Moiety; International Journal of Pharm Tech Research,Vol.9, No.1, pp. 35-40, 2016

[19] Jean-Rene Ella-Menye; Ph.D Thesis, Synthesis of Novel Chiral Heterocyclic Compounds for Antibacterial Agents and Peptidomimetics, University of New Orleans ,2007.

[20] Jean-de-Dieu Tamokou, J. Tsemeugne, E.S. Fondjo, P. Sarkar, Jules-Roger Kuiate, A.N. Djintchui, B. L. Sondengam, and P.K. Bag; Antibacterial and Cytotoxic Activities and SAR of Some Azo Compounds Containing Thiophene Backbone; pharmacologia, Vol. 7, No.4, pp. 182 -192, 2016.

[21] A. S. Salman, N. A. Mahmoud, M. A. Mohamed, A.Abdel-Aziem1, and D. M. Elsisi; Synthesis, Characterization and in vitro Cytotoxic Evaluation of Some Novel Heterocyclic Compounds Bearing the Indole Ring; American Journal of Organic Chemistry, Vol. 6, No.2, pp. 39-53, 2016.

[22] A. M. Asiri, and S. A. Khan; Synthesis and Anti-Bacterial Activities of a Bis-Chalcone Derived from Thiophene and Its Bis-Cyclized Products; Molecules, Vol. 16, pp. 523-531, 2011.

[23] H. Ma, X. Chang, G. Li, S. Chen, Z. Quian, and S. Zhao, L. Niu; The influence of hydrogen sulfide on corrosion of iron under different conditions; Journal Corrosion Science, Vol. 42, No.10, pp. 1669 –1683, 2000.

[24] M. Yadav , S. Kumar, T. Purkait, L.O. Olasunkanmi, I. Bahadur, and E.E. Ebenso; Electrochemical thermodynamic and quantum chemical studies of synthesized benzimidazole derivatives as corrosion inhibitors for N80 steel in hydrochloric acid ; Journal of Molecular Liquids,Vol. 213, pp 122-138, 2016.

[25] M. Abdallah, I. A. Zaafarany, B.A. AL Jahdalya ;Corrosion Inhibition of Zinc in Hydrochloric Acid Using Some Antibiotic Drugs; Journal Mater. Environ. Sciences, Vol. 7, No.4, pp. 1107-1118, 2016.

[26] C. Guo-hao , and Z. Jing-mao; Corrosion Inhibition of Imidazoline Derivates with Benzene Rings on Mild Steel in CO_2-Saturated Brine Solution; Chem. Res. Chinese universities, Vol. 28,No. 4, pp. 691-695, 2012.

[27] S. Chitra, K. Parameswari, and A. Selvaraj; Dianiline Schiff Bases as Inhibitors of Mild Steel Corrosion in Acid Media; International Journal Electrochem. Science, Vol.5, pp.1675 - 1697, 2010.

[28] Q. A. Yousif, and A. Abdu AL-zhara; Evaluation of Corrosion Inhibition of Carbon Steel in 0.25M H_2SO_4 ; Journal of Chemical and Pharmaceutical Research, Vol.8, No.3, pp. 64-70, 2016.

[29] Obike, I. Anthony, Emeruwa, N. Chigbundu, Ajiwe, I.E. Vincent, Igwe, and C. Jude; Corrosion Inhibition and Adsorption Behaviour of Methanol Extract of Spondias cytherea leaves on Mild Steel Corrosion in5.0M H_2SO_4; International Journal of Innovative Research in Science, Engineering and Technology, Vol.5, Issue 6, pp. 9501-9510, 2016.

[30] E.E. Oguzie; Inhibition of acid corrosion of mild steel by *Telfaria occidentalis extract*; Pigment Resin Technology, Vol. 34, pp. 321-326, 2005.

[31] Z. Tao, S. Zhang,W.Li, B.Hou; Corrosion inhibition of mild steel in acidic solution by some oxo-triazole derivatives; Corrosion Science, Vol. 51, No.11, pp. 2588- 2595, 2009.

[32] H. Zarrok, A. Zarrouk, R. Salghi, M. Assouag, N. Bouroumane, E. E. Ebenso, B. Hammouti, R. Touzani, and H. Oudda; Corrosion and Corrosion Inhibition of Carbon Steel in Hydrochloric acid Solutions by 2-[Bis-(3,5-dimethyl-pyrazol-1-ylmethyl)-amino]-3-hydroxy butyric acid; Der Pharmacia Lettre,Vol.5, No.3, pp. 327-335, 2013.

[33] T.Vennila, and P.Manjula; Corrosion Inhibition Adsorption behaviour and Thermokinetic Characteristics of 1-Benzyl-3-Hydroxy-1-H-Indazole on Mildsteel in Neutral Medium; International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 6, pp. 9407-9416, 2016

[34] M. Yadav, S. Kumar, and D. Behera; Inhibition Effect of Substituted Thiadiazoles on Corrosion Activity of N80 Steel in HCl Solution; Journal of Metallurgy; ID 256403,pp.1-14, 2013.

[35] J. D. Talati, and D. K. Gandhi, N-heterocyclic Compounds as Corrosion Inhibitors for Aluminium - Copper Alloy in Hydrochloric Acid, Corrosion Science, Vol. 23, No. 12, pp. 1315-1332, 1983.

[36] M. Dahmani, A. Et-Touhami, S.S. Al-Deyab , B. Hammouti, and A. Bouyanzer; International Journal of Electrochemical Science; Vol. 5, pp. 1060, 2010.

[37] L. Adardour, H. Lgaz, R. Salghi, M. Larouj, S. Jodeh, M. Zougagh, O. Hamed, and M. Taleb; Corrosion Inhibition of Steel in phosphoric acid by Sulfapyridine Experimental and Theoretical Studies; Der Pharmacia Lettre, Vol. 8, No.4, pp.173-185, 2016.

[38] F. El-Taib Heakal , M.S. Radwan. International Journal Electrochem. Sci., Vol.6, No. 5, pp. 3140 - 3163, 2011.

[39] P.Lowmunkhong, D.Ungthararak, and P.Sutthivaiyakit; Tryptamine as a corrosion inhibitor of mild steel in hydrochloric acid solution; Corrosion Science, Vol.52, No.1, pp. 30-36, 2010.

[40] B. Nammalwar, and R. A. Bunce; Recent Syntheses of 1 ,2 ,3, 4-Tetrahydroquinolines, 2, 3-Dihydro-4 (1H)-quinolinones and 4(1H)-Quinolinones Using Domino Reactions; Molecules ,Vol. 19, pp. 204-232 , 2014.

[41] L. F. Tietze; Domino Reactions; Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim, Germany, 2014.

[42] T. J. J. Muller, and D. M. D. Souza; Diversity-oriented Syntheses of Functional-Systems by Multicomponent and Domino Reactions; Pure and Applied Chemistry, Vol. 80, No.3, pp. 609-620, 2008.

[43] L.M. Rivera-Grau1, M. Casales, I. Regla, D. M. Ortega-Toledo, J.G. Gonzalez-Rodriguez, and L. M. Gomez; CO_2 Corrosion Inhibition by Imidazoline Derivatives Based on Coconut Oil; International Journal of Electrochemical Science, Vol.7, pp.13044-13057, 2012.

[44] S. Yoo, Y. Kim, K. Chung, S. Baik, and J. Kim; Synthesis and corrosion inhibition behavior of imidazoline derivatives based on vegetable oil; Journal Corrosion Science, Vol. 59, pp.42-54, 2012.

[45] A. A. Al-Amiery , A. H. Kadhum, A.M. Alobaidy, A. Mohamad, and P. S. Hoon; Novel Corrosion Inhibitor for Mild Steel in HCl, Journal Materials, Vol. 7, pp.662-672, 2014.

[46] A. K. Singh, and M. A. Quraishi; Study of Some Bidentate Schiff Bases of Isatin as Corrosion Inhibitors for Mild Steel in Hydrochloric Acid Solution ;Int. Journal of electrochemical Science, Vol. 7, pp.3222 - 3241,2012.

[47] A.M. Al-Sabagh, N. M. Nasser, A. A. Farag, M. A. Migahed, A. M.F. Eissa, and T.Mahmoud ; Structure effect of Some Amine Derivatives on Corrosion Inhibition Efficiency for Carbon Steel in Acidic Media Using Electrochemical and Quantum Theory Methods; Egyptian Journal of Petroleum, Vol.22, pp.101–116, 2013.

[48] N.O. Obi-Egbedi ,and I.B. Obot ; Xanthione A new and Effective Corrosion Inhibitor for Mild Steel in Sulphuric acid Solution; Arabian Journal of Chemistry; Vol. 6, pp. 211–223, 2013.

[49] B. Joseph, and A. Joseph; Inhibition of Copper Corrosion in 1 M Nitric Acid – Electro Analytical and Theoretical Study with(E)-(4-(4-Methoxy benylidene amino)-4H-1, 2, 4-Triazole-3, 5- diyl) Dimethanol (MBATD); Portugaliae Electrochimica Acta, Vol. 29, No.4, pp. 253-271, 2011.

[50] I. Elazhary, H. B. El Ayouchia, M. R. Laamari , M. El Haddad, S. Rafqah, H. Anane, M. L. E. Moubtassim, S. E. Stirib; Thermodynamic, Electrochemical and Quantum Chemical Investigation of Thiomorpholin-4-ylmethyl-phosphonic Acid as Corrosion Inhibitor of Iron in Sulphuric Acid Solution; Journal Mater. Environ. Science, Vol.7, No.4, pp. 1252-1266, 2016.

[51] N. Patel, F. B. Bux, L. V. Vyavahare, and A. Singh; Synthesis characterization and biological study of novel heterocyclic compounds; Der Pharmacia Lettre, Vol. 5, No.3, pp. 336-340, 2013.

[52] N. S Kumar, and N. Simon; In vitro antibacterial activity and Phytochemical Analysis of Gliricidia Sepium (L.) leaf Extracts, Journal of Pharmacognosy and Phytochemistry, Vol. 5, No.2, pp. 131-133, 2016.

[53] A. Sharma, and A. Kumar; Aantimicrobial Activtty of Justicia Adhatoda; Worid Journal of Pharmacy and Pharnaceutical Sciences,Vol.5, Issue 7, pp.1332-1341, 2016.

[54] P. Saranya, and S. Premalatha; Biosynthesis and Characterization of Gold Nanoparticles Using Leaves Extract of Piliostigma Thonningii and their anTimicrobial activity; International Journal of Advanced Research in Biological Sciences, Vol.3, Issue 7, pp.75-84, 2016.

[55] Y. Radha, A. Manjala, B. M. Reddy,and V. Rao; Synthesis and Biological Acitivity of Novel Benzimidazoles; Indian Journal of Chemistry, Vol. 50, pp.1762-1773,2011.

[56] H. J. Shah, and J. A. Chaudhari; Synthesis characterization and Biological Studies of Novel Heterocyclic; Research Journal of Recent Sciences, Vol.4, pp. 177-181, 2015.

[57] X. Shi, H. Han, R. J. Sanedrin, C. Galvez, D. G. Ho, B. Hernandez, F. Zhou, and M. Selke; Formation of Cobalt oxide Nanotubes Effect of Intermolecular Hydrogen Bonding Between Co(III) Complex Precursors Incorporated onto Colloidal Templates, Nano Letters, Vol.2, No. 4, pp.289-293, 2002.

[58] D. Raafat, and H. G. Sahl; Chitosan and its antimicrobial potential-a critical literature survey; Microbial Biotechnology, Vol.2, pp.186-201, 2009.