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Research Article

ELUCIDATION OF CYCLIC VOLTAMMETRIC BEHAVIOUR OF N-HYDROXY-3-ISOPROPYL-2,6-DIFURYLPIPERIDIN-4-ONE SEMICARBAZONE AND THIOSEMICARBAZONE AND THE ANTIBACTERIAL STUDY OF THE PRODUCTS

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ABSTRACT

The electrochemical behaviour of N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one semicarbazone and N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one thiosemicarbazone have been evaluated using cyclic voltammetric method with variable scan rates. Based on the number of cathodic and anodic peak, peak current and number of stop crossing level it is concluded that an irreversible reduction taken place for both the synthesised compounds. The presence of the electron-donating carbonyl and thionyl group of semicarbazone and thiosemicarbazone leads to a shift of the irreversible reduction potential towards cathodic value. The products have been isolated and their structure is confirmed by ^{1}H NMR and ^{13}C NMR spectroscopy. Further the reduced products were screened for antibacterial activity. On comparison the semicarbazone compound showed high inhibition towards Pseudomonas aeruginosa among the eight test bacteria.

Keywords: Semicarbazone, Thiosemicarbazone, Cyclic voltammetry, ^{13}C and ^{1}H NMR, Antibacterial activity

INTRODUCTION

The synthesis of N-substituted piperidin-4-ones is of great interest due to their varied properties. Set of 2,6-diarylpiperidin-4-one were synthesised and the physico-chemical studies revealed the structure of the compounds. The ^{1}H NMR spectra of 3-alkyl-2,6-bis(o-methoxyphenyl)piperidin-4-one, 3,5-dialkyl-2,6-bis(o-methoxyphenyl)piperidin-4-one showed the influence of substituents in phenyl ring over the chemical shifts of hydrogens in piperidone ring[1-7]. The N-nitroso derivatives act as an excellent anti-oxidant reagent. The N-formyl, N-hydroxy compounds have corrosion inhibitory property. The piperidin -4-one derivatives of semicarbazones and thiosemicarbazones were thoroughly studied for the biological activities such as antimicrobial[10], antifungal[6], anticancer, antimalarial, antitumour, antiinflammatory etc. There are several reports[6-13] on the reduction of piperidin-4-one semicarbazones and thiosemicarbazones by conventional catalyst. The structure of 4-piperidin[3,4-d]-1,2,3-selenadiazole was proved by the ^{1}H and ^{13}C NMR studies[11-16]. The N-substituted 3-alkyl-2,6-diarylpiperidin-4-one semicarbazone and thiosemicarbazone have been subjected to electrochemical reduction. There are reports on pyridine-N-aldehyde thiosemicarbazone using gold electrode and the electro reduction of 2-formylpyridine thiosemicarbazone has also been studied[1-7]. But there was no report on the cyclic voltammetric behaviour of N-substituted 2,6-hetroarylpiperidin-4-one derivatives. In this paper the reduction behaviour of N-hydroxy-2,6-difuryl-3-isopropylpiperidin-4-one semicarbazone and thiosemicarbazone are studied by cyclic voltammetry. The reduced product is isolated and purified by column chromatography. The structure of the reduced product is proved by ^{1}H NMR and ^{13}C NMR spectra. The antibacterial property of the products was tested against eight select bacteria.

MATERIALS AND METHODS

All the chemicals used in the preparation of semicarbazone and thiosemicarbazone derivatives are of very high purity. Completion of reactions was monitored by thin layer chromatography on silica gel coated Aluminium sheet (Type 60 GF 254, Merck). The melting points were measured with open capillaries and uncorrected. ^{1}H NMR spectra(in DMSO-d_6/$CDCl_3$) on Varian 400 MHz instrument using TMS as the internal standard.

Synthesis of N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one(1)

The 3-isopropyl-2,6-difurylpiperidin-4-one and m-chloroperbenzoic acid (1:1) were mixed in 20ml chloroform at 0°C. The mixture was extracted and washed with 10% sodium bicarbonate solution. The chloroform layer was dried with anhydrous sodium sulphate and evaporated. The separated solid was subjected to column chromatography. The column was packed with silica gel(100-200mesh) in hexane. The eluting solvents used were benzene, and benzene-pet-ether (40:60) (8:2). The compound was found to be separated in benzene-pet-ether (8:2).

Synthesis of N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one semicarbazone(2a) and thiosemicarbazone(2b)

A mixture of N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one(1gm, 0.0027mol), semicarbazide hydrochloride (0.316gm, 0.0027mol) and sodium acetate (0.75gm) was dissolved in ethanol (40ml) and refluxed for two hours on a steam bath and cooled. The separated solid was filtered and washed with water and recrystallised from ethanol. Similarly N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one thiosemicarbazone was also prepared by the same reflux method using thiosemicarbazide hydrochloride (0.316gm, 0.0027mol). The physical data of the synthesized compound(2a) and compound (2b) are given in Table 1.

Elemental Analysis

The CHNS data analyses of reduced compounds are displayed in Table 2. There is good agreement between the experimental and calculated values. The C,H,N,S analysis was done on a CHNS rapid analyser.

Preparation of Media

Nutrient broth has been used to cultivate bacteria. Agar media has been prepared by adding 24% w/v agar in the nutrient broth for making agar slants. Bacteria have been sub-cultured on the nutrient agar slants. Different concentration of sample(250µL,500µL,1000µL) has been loaded in to the wells in Muller Hinton Agar plates[15-19]. The plates have been incubated at 37°C for 24hours. At 1000µg/ml concentration the conventional standard antibacterial drug chloramphenicol exhibited 15±3mm zone of inhibition against all the test bacteria.

Cyclic Voltammetry(CV)

The electrochemical experiment was conducted with a computerized instant VSM/EC/30.s potentiostat. The solution was deoxygenated by bubbling purified nitrogen gas for about 15mins and then a blanket of nitrogen gas was maintained throughout the reaction time. The reference electrode used was Ag/AgCl(3mKCl) electrode, and the auxiliary electrode was a platinum electrode. In this study a paraffin-impregnated graphite electrode was used as the working electrode. The electrochemical behavior of 0.01M N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one semicarbazone(2a) and N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one thiosemicarbazone(2b) were dissolved in respective mixed solvent of 0.1M of ethanol and distilled water[17-24] and it was studied with Cyclic voltammetric technique in the potential range -2100mV to 2100mV and with the variable scan rate range of (100mVs^{-1},150 mVs^{-1} and 200mVs^{-1}). The yield of the reduced products is listed in Table 3.

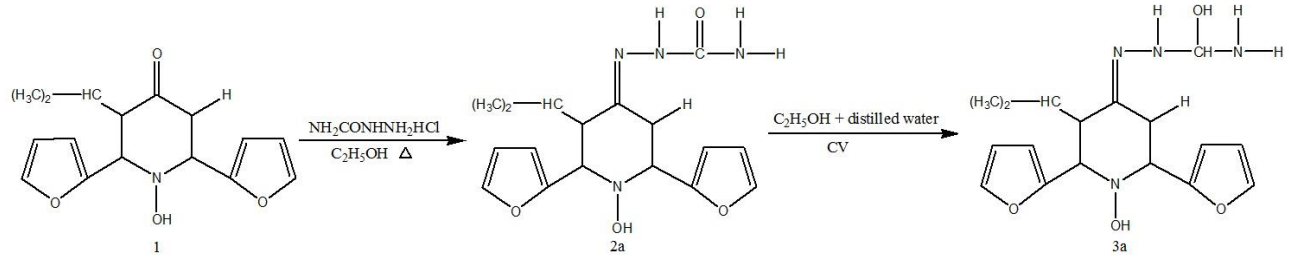
RESULTS AND DISCUSSION

The corresponding N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one and semicarbazide hydrochloride were refluxed in the presence of sodium acetate for two hours. The product obtained was N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one semicarbazone. Similarly N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one thiosemicarbazone was obtained. Then the semicarbazone and thiosemicarbazone were subjected to cyclic voltammetric study. The positions and shapes of the peaks were dependent on the scan rate but the numbers of peaks remain same. The results were indicative of an irreversible two electron transfer to electro reduction of semicarbazone and thiosemicarbazone moiety[19-25].

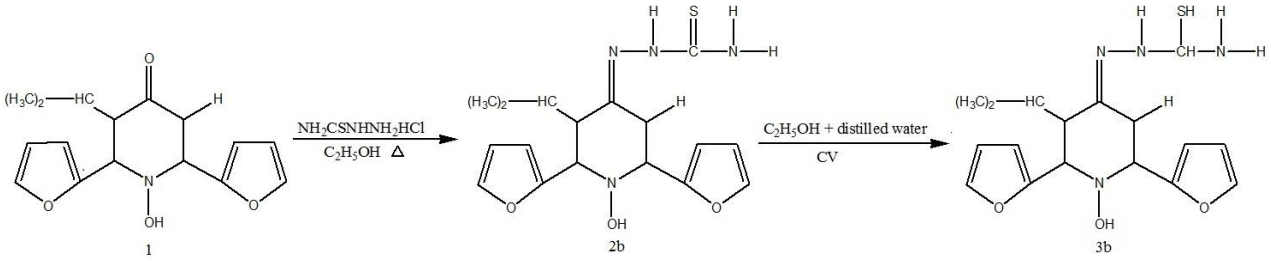
As the number of stop crossing level increased, the number of peaks doesn't change which indicated irreversible reduction has taken place in the N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one semicarbazone and thiosemicarbazone. Waltman who studied the influence of geometry distortion on redox properties and found that each geometric distortion leads to shift of the potentials towards more negative value. It was also found that the peak current for the semicarbazone and thiosemicarbazone compounds were higher due to the shift of peak potential towards more negative value. The presence of active carbonyl and thionyl group in the synthesised semicarbazones and thiosemicarbazone compound is the reason for the shift of peak potential to the more negative value. Thus the presence of heterocyclic substitution in semicarbazone leads to decrease in anodic peak current compared to the aromatic substitutes[12]. The reduced products were isolated and the structure is proved by ^{1}H NMR and ^{13}C NMR.

Synthesis of N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one semicarbazone(2a) and N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one thiosemicarbazone(2b)

The corresponding N-hydroxy-2,6-difurylpiperidin-4-one and semicarbazide hydrochloride were refluxed in the presence of sodium acetate for two hours. The product obtained was N-hydroxy-2,6-difurylpiperidin-4-one semicarbazone(2a). Similarly N-hydroxy-2,6-difurylpiperdin-4-one thiosemicarbazone(2b) was obtained when N-hydroxy-2,6-difurylpiperdin-4-one and thiosemicarbazide hydrochloride react in the presence of sodium acetate. Then the semicarbazone(2a) and thiosemicarbazone(2b) were subjected to CV study. The reactions a represented in scheme 1 and scheme 2 respectively.



Scheme 1



Scheme 2

Table 1: Physical data of the compound 2a and compound 2b

Name of the compound	Molecular Formula	Molecular Weight Kg/Kmol	Melting Point °C	Yield %
2a	$C_{18}H_{21}N_4O_4$	357	143-144	75
2b	$C_{18}H_{21}N_4O_3S$	373	137-138	77

Table 2: The physical data of the reduced product of n-hydroxy-2,6-difurylpiperidin-4-one semicarbazone(3a) and thiosemicarbazone(3b)

Compound	Molecular Formula	Molecular Weight Kg/Kmol	C %	H %	N %	S %
3a	$C_{18}H_{25}N_4O_4$	361	61.56(60.26)	4.89(5.23)	10.27(10.88)	-
3b	$C_{18}H_{23}N_4O_3S$	377	62.55(61.43)	4.94(5.65)	11.55(11.97)	9.23(10.11)

Table 3: List of reduced products obtained after cyclic voltammetric subjection

Compound	Name of the Compound	Melting Point °C	Yield %
3a	Amino(2-(N-hydroxy-2,6-difurylpiperidin-4-one ylidene)hydrazinyl)methanol	135	73
3b	Amino(2-(N-hydroxy-2,6-bis(p-methoxyfuryl)piperidin-4-one ylidene)hydrazinyl)methane thiol	143	72

Table 4: Cyclic voltammogram data of 0.01m n-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one semicarbazone(2a) and thiosemicarbazone(2b) dissolved with 0.1m of ethanol and distilled water with variable scan rate(100mvs^{-1}, 150mvs^{-1} and 200mvs^{-1})

Compound	Scan rate	Epc_1 (V)	Epc_2 (V)	Epc_3 (V)	Epa_1 (V)	Epa_2 (V)
2a	100mVs^{-1}	0.601	-0.510	-1.815	-1.135	0.129
	150mVs^{-1}	0.612	-0.513	-1.913	-1.167	0.134
	200mVs^{-1}	0.653	-0.579	-1.975	-1.174	0.147
2b	100mVs^{-1}	0.210	-0.512	-1.812	-1.051	0.104
	150mVs^{-1}	0.214	-0.564	-1.912	-1.126	0.107
	200mVs^{-1}	0.253	-0.612	-1.917	-1.128	0.109

Table 5: The In vitro zone of inhibition profile of the amino(2-(n-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one-ylidene)hydrazinyl)methanol(3a) and amino(2-(n-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one-ylidene)hydrazinyl)methane thiol(3b) against test bacteria

	Compound 3a(µg/ml)			Compound 3b(µg/ml)		
Organisms	250	500	1000	250	500	1000
Bacillus	2	4	8	3	7	9
Pseudomonas aeruginosa	9	9	12	7	9	9
Salmonella typii	7	9	9	7	8	9
Vibrio cholera	3	3	5	4	4	4
Escherichia coli	4	4	6	5	5	6
Staphaylococcus	6	6	7	5	5	6
Enterobacter	6	6	8	8	9	10
Klebsiella	5	5	9	8	8	9

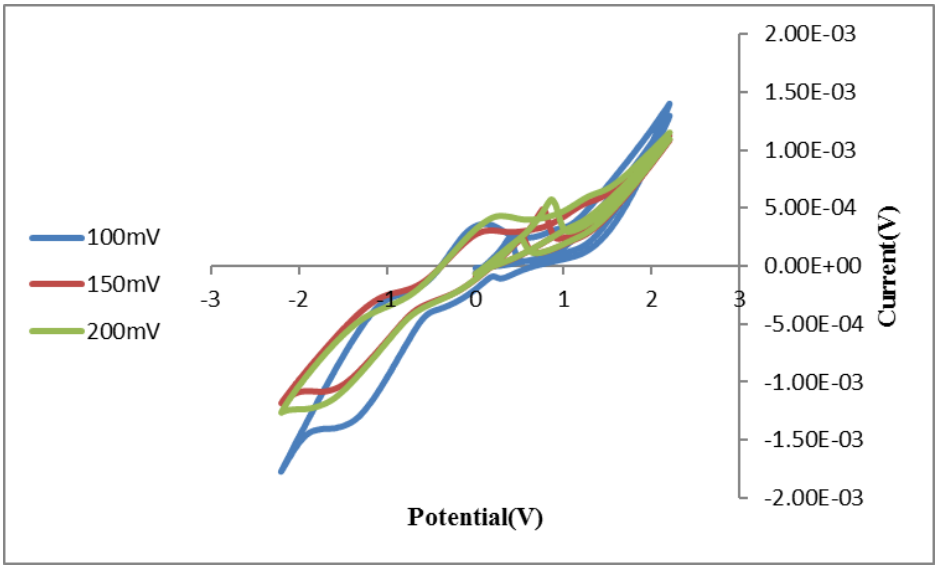


Figure 1: Cyclic Voltammogram of 0.01M N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one semicarbazone (2a) dissolved with 0.1M of ethanol and distilled water with variable scan rate (100mVs^{-1}, 150mVs^{-1} and 200mVs^{-1})

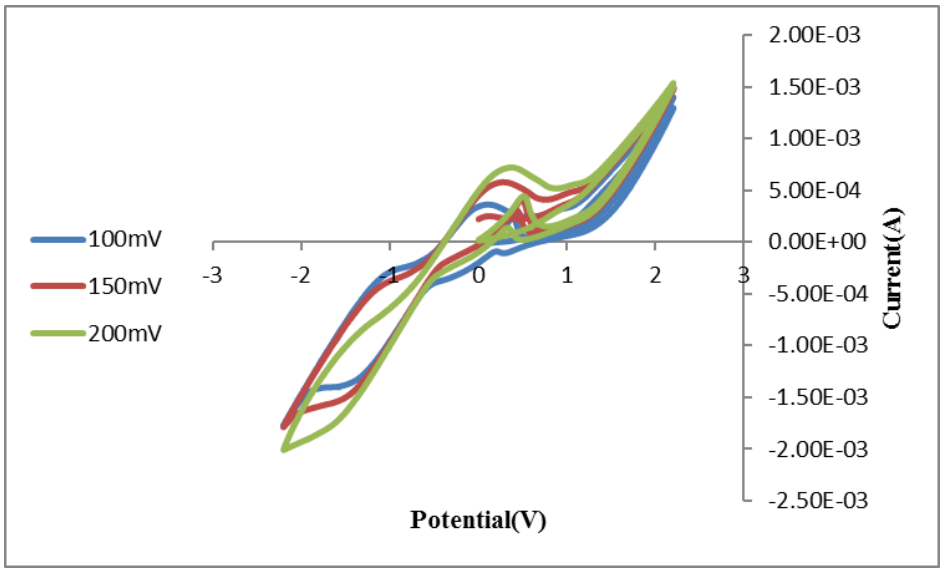


Figure 2: Cyclic Voltammogram of 0.01M of N-hydroxy-3-isopropyl-2,6-difuryl-4-one thiosemicarbazone(2b) dissolved with 0.1M of ethanol and distilled water with variable scan rate of 100mVs^{-1},150mVs^{-1}& 200mVs^{-1}

The electrochemical behaviour of N-hydroxy-2,6-difurylpiperidin-4-one semicarbazone(2a) and thiosemicarbazone (2b)

The cyclic voltammogram of the semicarbazone(2a) and thiosemicarbazone(2b) were studied at the potential range of -2200mV to 2200mV and the voltammetric data were analysed. The voltammogram(Figure 1-2) of the respective compound(2a&2b) showed three cathodic peak in the forward scan and two anodic peak during in the reverse scan. Since there is large difference in peak to peak potential separation, there has occurred irreversible reduction. Three different scan rates of 100mVs^{-1}, 150mVs^{-1} and 200mVs^{-1} were considered and the voltammetric data are given in Table 4.

The effect of scan rate upon the reduction was arrived from the analysis of peak potential values. As the scan rate increased the peak potential value shifted to more negative value. Further it has been observed that the number of peak has not changed even if the number of crossing levels increased. This indicated an irreversible reduction has taken place in both the semicarbazone and thiosemicarbazone compounds(2a&2b) at the active carbonyl and thionyl group respectively. The ease with which the reduction product formed is greater for semicarbazone(2a) as compared with that of thiosemicarbazone(2b) . The increase in ΔEp with increased scan rate indicated the absence of redox species and hence it was inferred that a new reduced compound(3a&3b) were respectively formed.

The ^{13}C NMR and ^{1}H NMR analytical data of N-hydroxy-3-isopropyl-2,6-difuryl-4-one semicarbazone(2a) before subjection to CV

Analysis of ^{13}C NMR: The ^{13}C NMR spectrum of the product(2a) was compared[3] with that of the reactant(1). The spectrum shows that the C-4 carbon has moved upfield to 205.67ppm from 209.53ppm. This proved the conversion of C=O to C=N due to the attachment of semicarbazone moiety at

C-4. At the same time, a new peak appeared owing to the carbonyl carbon in semicarbazone moiety. The rest of the ^{13}C chemical shifts (2C,6C,3C,5C) were comparable as that of compound(1).

^{13}C NMR ∂ values in ppm: ^{13}C NMR ∂ value: 50.86-56.49(2C,6C), 162.12(s,SZ-CO), 151.19-153.23(Ar), 20.23;20.87(CH_3), 23.56[CH-(CH_3)$_2$)], 51.23(3C), 46.81(5C), 205.67(4C)

Analysis of ^{1}H NMR: The ^{1}H NMR spectrum of the product(2a) when compared[3] with the reactant(1) showed peaks due to the protons present in semicarbazone moiety. The signal at 7.42ppm assigned to NH_2 proton whereas the signal at 1.45ppm was assigned to NH proton. Thus the ^{1}H NMR data also confirmed the conversion of N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one(1) to N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one semicarbazone(2a).

^{1}H NMR ∂ values in ppm: ∂ 8.22(s,N-OH), 4.22-5.68(d,2H,6H), 2.12-2.86(m,3H,5H), 7.09-7.12(s,Ar), 7.42(s,NH_2), 0.87;1.21(CH_3), 1.94(CH-(CH_3)$_2$)

The analytical data of the N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one semicarbazone(2a) after subjection to CV

The above synthesised semicarbazone was subjected to cyclic voltammetric study. The ^{13}C NMR and ^{1}H NMR spectrum was recorded for the reduced product(3a).

Analysis of ^{13}C NMR: The ^{13}C NMR spectrum of the product(3a) was compared with of the reactant(2a). The carbonyl carbon now appeared in the upfield region at 91.12ppm from 162.12ppm. This confirmed the reduction of C=O to CH-OH. Due to the reduction of carbonyl carbon to methine carbon, ^{13}C chemical shifts of C-3 and C-5 appeared in down field region where as C-2 and C-6 appeared in up field region when compared to the unreduced compound i.e, before subjection to the cyclic voltammetry.

^{13}C NMR ∂ values in ppm: ^{13}C NMR ∂ value: 52.34-55.49(2C,6C), 91.12(s,SZ-COH), 152.56(Ar), 21.54;21.76(CH_3), 25.12[CH-(CH_3)$_2$)], 52.62 (3C), 44.45(5C), 207.81(4C)

Analysis of ^{1}H NMR: The ^{1}H NMR spectrum of the reduced product(3a) was compared with the reactant(2a). There appeared a single peak around 2.79ppm for the product(3a) which is due to the reduction of keto group to secondary alcohol group. The multiplet around 2.56ppm is assigned to the methine proton. All other proton shifts are in accordance with the reactant(2a). Thus the ^{1}H NMR also confirmed the reduction of C=O to CH-OH.

^{1}H NMR ∂ values in ppm: ∂ 8.17(s,N-OH), 5.24-5.64(d,2H,6H), 2.64-2.71(m,3H,5H), 7.09-7.12(s,Ar), 7.42(s,NH_2), 0.67;1.54(CH_3), 1.86(CH-(CH_3)$_2$)
Thus the ^{1}H NMR study also supports the conversion of compound(2a) to the reduced product(3a).

The ^{13}C NMR and ^{1}H NMR analytical data of N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one thiosemicarbazone(2b) before subjection to CV

Analysis of ^{13}C NMR: The ^{13}C NMR spectrum of the product(2b) was compared[3] with that of the reactant(1). The spectrum shows that the C-4 carbon has moved upfield to 207.43ppm from ppm. This proved the conversion of C=O to C=N due to the attachment of thiosemicarbazone moiety at C-4. At the same time, a new peak appeared owing to the thionyl carbon in thiosemicarbazone moiety. The rest of the ^{13}C chemical shifts (2C,6C,3C,5C) were comparable as that of N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one is confirmed by ^{1}H NMR and ^{13}C NMR spectral data.

^{13}C NMR ∂ values in ppm: 46.87-51.23(2C,6C), 161.08(s,SZ-CS), 150.61-151.48(Ar-fur), 21.16;21.48(CH_3), 22.31[CH-(CH_3)$_2$)], 32.12-49.45(3C,5C), 207.43(4C).

Analysis of ^{1}H NMR: The ^{1}H NMR spectrum of the product(3b) when compared[3] with the reactant(2b) showed peaks due to the protons present in thiosemicarbazone moiety. The signal at 7.47ppm was assigned to NH_2 proton whereas the signal at 1.59ppm was assigned to NH proton. Thus the ^{1}H NMR data also confirmed the conversion of N-hydroxy-2,6-difuryl-3-isopropylpiperidin-4-one(1) to N-hydroxy-2,6-difuryl-isopropyl piperidin-4-one thiosemicarbazone(2b).

^{1}H NMR ∂ values in ppm: ∂ 8.22(s,N-OH), 5.34-5.67(d,2H,6H), 2.07-2.51(m,3H,5H), 7.35-7.59(s,Ar), 7.47(s,NH_2),0.77;1.14(CH_3), 1.89(CH-(CH_3)$_2$.

The ^{13}C NMR and ^{1}H NMR data of N-hydroxy-2,6-difuryl-3-isopropylpiperidin-4-one thiosemicarbazone (3b) after subjection to CV

The above synthesised thiosemicarbazone was subjected to cyclic voltammetric study. The ^{13}C NMR and ^{1}H NMR spectrum was recorded for the reduced product(3b).

Analysis of ^{13}C NMR: The ^{13}C NMR spectrum of the product(3b) was compared with the reactant(2b). The thionyl carbon bearing the sulphur (thio group) now appeared in the upfield region at 90.14ppm from 161.08ppm. This confirmed the reduction of C=S to CH-SH. Due to the reduction of thionyl carbon to methane thiol carbon, ^{13}C chemical shifts of C-3 and C-5 appeared in down field region where as C-2 and C-6 appeared in up field region when compared to the unreduced compounds i.e, before subjection to the cyclic voltammetry. The structure of the reduction product Amino(2-(N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one-ylidene)hydrazinyl)methane thiol(3b) is established by comparing the ^{1}H NMR and ^{13}C NMR with the reactant N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one thiosemicarbazone(2b).
There appeared a new singlet as around 3.17ppm for Amino(2-(N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one-ylidene)hydrazinyl)methane thiol(3b), which is due to the reduction of thio group to secondary alcohol group. The multiplet as around 2.56ppm is assigned to the methane thiol proton.

^{13}C NMR ∂ values in ppm: 45.23-51.36(2C,6C), 90.14(s,SZ-CSH), 149.34-153.16(Ar), 20.45;21.36(CH_3), 22.27[CH-(CH_3)$_2$)], 31.48(3C,5C), 203.17(4C).

Analysis of ^{1}H NMR: The ^{1}H NMR spectrum of the reduced product(3b) was compared with the reactant(2b). There appeared a single peak around 3.01ppm for $4b_1$ which is due to the reduction of thio group to secondary thiol group. The multiplet around 2.25ppm is assigned to the methine proton. All other proton shifts are in accordance with the reactant[5]. Thus the ^{1}H NMR also confirm the reduction of C=S to CH-SH.

^{1}H NMR ∂ values in ppm: ∂ 8.22(s,N-OH), 5.53-6.03(d,2H,6H), 2.14-2.66(m,3H,5H), 7.45-7.55(s,Ar), 7.13(s,NH_2), 0.79;1.64(CH_3), 1.83(CH-(CH_3)$_2$.

Thus ^{1}H NMR study also supports the conversion of the compound (2b) to the reduced product (3b).

Antibacterial Activity

The product Amino(2-(N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one-ylidene) hydrazinyl) methanol(3a) and Amino(2-(N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one-ylidene) hydrazinyl) methane thiol(3b) were screened for the antibacterial activity for eight test bacteria[21-28]. The bacterial strains used for inhibition study and the results were revealed in the table 5. The compound 3a inhibits highly on Pseudomonas aeruginosa among the eight test bacteria. Each value is an average of three determinations.

CONCLUSION

N-hydroxy-2,6-difuryl-3-isopropylpiperidin-4-one was synthesized. The N-hydroxy-2,6-difuryl-3-isopropylpiperidin-4-one were converted to semicarbazone and thiosemicarbazone(Table 1). The structure of these products was proved by ^{13}C NMR and ^{1}H NMR spectra. The N-hydroxy-2,6-difuryl-3-isopropylpiperidin-4-one semicarbazone and N-hydroxy-2,6-difuryl-3-isopropylpiperidin-4-one thiosemicarbazone were subjected to cyclic voltammetric study. It was proved that the irreversible reduction has taken place in both the synthesized compounds based on the number of cathodic peaks, current peaks, and difference in cathodic and anodic peak potential. Further if the number of stop crossing level increased, the number of peaks doesn't change which indicated irreversible reduction has taken place in the N-hydroxy-3-isopropyl-2,6-difurylpiperidin-4-one semicarbazone and thiosemicarbazone. The formation and the structure of the reduced products were confirmed by elemental analysis, ^{13}C NMR and ^{1}H NMR spectra. The reduced compounds obtained after CV subjection were screened for antibacterial activity. The results of antibacterial activity shows maximum inhibition against the Pseudomonas aeruginosa by the compound Amino(2-(N-hydroxy-3-isopropyl-2,6-difurylperidin-4-one ylidene)hydrazinyl) methanol(3a).

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REFERENCES

1. Antholine W, Knight J, Whelan H, Petering DH. Studies of the reaction of 2-formylpyridine thiosemicarbazone and its iron and copper complexes with biological systems. Molecular Pharmacology 1977; 13(1):89-98.
2. Barradas RG, Giordano MC, Sheffield WH. Electrochemical oxidation of piperidine at mercury and platinum. Electrochimica Acta 1977; 16(8):1235-1249.
3. Baskar G, Gopalakrishnan M, Winfred Jabaraj J. Conformational analysis of some N-hydroxypiperidin-4-one oximes. Indian Journal of Chemistry 2007; 48B(4):580-584.
4. Baskar G, Gopalakrishnan M, Winfred Jabaraj J. Synthesis and Conformational Analysis of Some 3-Alkyl-2,6-diarylpiperidin-4-one Semicarbazones. Asian Journal of Chemistry 2008; 20(7):5282-5288.
5. Allen J Bard, Larry R Faulkner, editors. Electrochemical Methods: Fundamentals and Applications. New York: Wiley; 1980.
6. Hemalatha T, Imran PK, Gnanamani A, Nagarajan S. Synthesis, antibacterial and antifungal activities of some N-nitroso- 2,6-diarylpiperidin-4-one semicarbazones and QSAR analysis. Nitric Oxide 2008; 19(4):303-311.
7. Jayalakshmi M, Balasubramanian K. Cyclic Voltammetric Behavior of Copper Powder Immobilized on Paraffin Impregnated Graphite Electrode in Dilute Alkali Solution. International Journal of Electrochemical Science 2008; 3:1277–1287.
8. Palaniappa M, Jayalakshmi M, Narasimhan BRV, Balasubramanian K. Double Step Chronocoulometric Studies on Industrial Copper Alloy in Acidic Copper Sulfate Electrolytic solutions - Part II. International Journal of Electrochemical Science 2008; 3:656.
9. Palaniappa M, Jayalakshmi M, Prasad PM, Balasubramanian K. Chronopotentiometric Studies on the Passivation of Industrial Copper Anode at Varying Current Densities and Electrolyte Concentrations. International Journal of Electrochemical Science 2008; 3:452.
10. Ramalingam C, Park YT, Kabilan S. Synthesis, stereochemistry and antimicrobial evolution of substituted piperidine-4-one oxime ethers. European Journal of Medicinal Chemistry 2006; 41(6):683-696.
11. Reddy, Raveendra Rao P, Brahmaji S. Polarographic and cyclic voltammetric reduction of o-chlorobenzaldehyde isonicotinoylhydrazone. Current Science 1989; 58(17):955-957.
12. Refaey SAM, Hassan AA, Shehata HS. Electrochemical Behaviour of Some Substituted Thiosemicarbazones and their Reaction Products with Tetracyanoethylene. International Journal of Electrochemical Science 2008; 3:325-337.
13. Rekha S, Vinay Kumar, Meena RC, Varshney AK, Varshney S. Cyclic Voltammetric Reduction of 2-Acetylpyridine Semicarbazone at Glassy Carbon Electrode. International Journal of ChemTech Research 2012; 4(1):180-184.
14. Sangtyani R, Rawat J, Verma PS. Electrochemical behavior of 4-acetylbiphenyl semicarbazone and 4-acetylbiphenyl thiosemicarbazone. Journal of Indian Chemical Society 2011; 88:1553-1560.
15. Rekha Sangtyani, Swati Soni, Varshney AK and Varshney S. Electrochemical Investigations of Some Semicarbazones and Thiosemicarbazones at Glassy Carbon Electrode. Chemical Science Review and Letters 2014; 3(11):224-230.
16. Sapna KM, Navin Kumar Sharma, Seema Kohli. Synthesis, Characterization and Antimicrobial studies of copper(II) complexes of semicarbazone and thiosemicarbazone of m-hydroxy benzaldehyde and p-hydroxy benzaldehyde. International Oriental Journal of Chemistry 2012; 28(2):969-974.
17. M Seeni Mubarak, Sirajudheen P, Muhammed Shebin KS, Muhasina M, Rishana T. Synthesis Characterization and Antimicrobial Activity of N-nitroso-2,6-diphenylpiperidin-4-one semicarbazone. IOSR Journal of Applied Chemistry 2015; 8(6):01-06.
18. Selvaraj K, Nanjappan P, Ramalingam K, Ramarajan K. Reactivities of variously substituted 4-heteracyclohexanones in the formation of oximes. Journal of Chemical Society 1983; 2(1):49-52.
19. Selvaraj, Ramalingam, Ramarajan. Kinetics of oxidation of epimeric piperidin-4-ols by vanadium(V). Journal of the Chemical Society 1983; 2(7):955-960.
20. Sharma Pratibha, Kumar Ashok, Sharma Shikha. Synthesis and comprehensive electrochemical investigations of 1-dichlorophosphino-2-phospa-3-phenyl-4-mercapto-5-aza-6-hydroxy-7-arylazoindolizines. Indian Journal of Chemistry 2004; 43B:2431-2439.
21. Surendra Nath Pandeya. Semicarbazone - a versatile therapeutic pharmacophore for fragment based

anticonvulsant drug design. Acta Pharmaceutica 2012; 62:263-286.
22. Sushil Mhaske, Sunil Pawar, Wadodkar SG, Pranjali Borkar. Synthesis of Novel 4-substituted Arylsemicarbazones of Menthone and Evaluation of its Anticonvulsant Activity. International Journal of Drug Design and Discovery 2013; 4(2):1093-1097.
23. Takehara Z, Namba Y, Yoshizawa S. Anodic oxidation of silver in alkaline solution. Electrochimica Acta 1968; 13(6):1395-1403.
24. Robert J Waltman, Joachim Bargon, Diaz AF. Electrochemical studies of some conducting polythiophene films. The Journal of Physical Chemistry 1983; 87(8):1459-1463.
25. Winfred Jebaraj J, Gopalakrishnan M, Baskar G. Synthesis and conformational analysis of some 3-alkyl-2,6-diarylpiperidin-4-one semicarbazones. Asian Journal of Chemistry 2008; 20(7):5282-5288.
26. Winfred Jebaraj J, Gopalakrishnan M, Baskar G. Synthesis and spectral analysis of some 4-substituted-5-7-diarylpyridino{3,4-d}-1,2,3selenadiazoles. Asian Journal of Chemistry 2008; 20(7):5215-5222.
27. Winfred Jebaraj J, Gopalakrishnan M, Baskar G. Synthesis and spectral analysis of some 4-substituted-5-7-diarylpyridino{3,4-d}-1,2,3thiadiazoles. Asian Journal of Chemistry 2008; 20(7):5209-5214.
28. Zhang X, Stewart S, Shoesmith DW, Wren JC. Interaction of Aqueous Iodine Species with Ag_2O/AgSurfaces. Journal of Electrochemical Society 2007; 154(4):F70-F76.

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