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Highlights

- Synthesis of Bridgehead
- Infrared Studies on Samarium
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- Synthesis of New Pyrazolinic

Discovering Thoughts, Inventing Future

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Thermogravimetric, X-Ray Diffraction and Infrared Studies on Samarium and Praseodymium Hexadecanoate in Solid State

By Darshana Rodric, Kirti Vishwakarma & S. K. Upadhyaya
S. S. L. Jain P. G. College, INDIA

Abstract- The kinetics of thermal decomposition of samarium and praseodymium hexadecanoate (palmitate) was found to be of zero order and the energy of activation for the decomposition reaction for samarium and praseodymium hexadecanoate was in the range of 30-35 KJ mol-1 .The X-ray analysis showed that samarium and praseodymium hexadecanoate soaps have double layer structure with molecular axis slightly inclined to the basal plane. The IR results confirmed that the fatty acids exists with dimeric structure through hydrogen bonding between the carboxyl groups of two acid molecules, whereas the metal soaps have an ionic character.

Keywords: samarium hexadecanoate, praseodymium hexadecanoate, ir spectra, x-ray diffraction, thermogravimetry.

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THERMOGRAVIMETRICXRAYDIFFRACTIONANDINFRAREDSTUDIESONSAMARIUMANDPRASEODYMIUMHEXADECANOATEINSOLIDSTATE

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Thermogravimetric, X-Ray Diffraction and Infrared Studies on Samarium and Praseodymium Hexadecanoate in Solid State

Darshana Rodric [α], Kirti Vishwakarma [σ] & S. K. Upadhyaya [ρ]

Abstract- The kinetics of thermal decomposition of samarium and praseodymium hexadecanoate (palmitate) was found to be of zero order and the energy of activation for the decomposition reaction for samarium and praseodymium hexadecanoate was in the range of 30-35 KJ mol^{-1}. The X-ray analysis showed that samarium and praseodymium hexadecanoate soaps have double layer structure with molecular axis slightly inclined to the basal plane. The IR results confirmed that the fatty acids exists with dimeric structure through hydrogen bonding between the carboxyl groups of two acid molecules, whereas the metal soaps have an ionic character.

Keywords: samarium hexadecanoate, praseodymium hexadecanoate, IR spectra, x-ray diffraction, thermogravimetry.

I. Introduction

A metallic soap is a chemical combination of a metallic element with a fatty acid organic group. Because of the presence of both lyophillic and lyophobic moieties in the same molecule and their increased solubility in non polar solvents lend to them unique characteristics. Due to their unique characteristics, metal soaps found to be very important class of complexes in technological and academic fields. The alkaline, alkaline earth and transition metal soaps have been thoroughly investigated but the lanthanide and actinide soaps have remained overlooked class of complexes. These compounds have several interesting application based on the metal ion radius, hardness, softness, valency and alkyl chain structure. They find extensive applications in protective coating agents, paints, ink driers, polymer stabilizers, catalysts, waterproofing agents, lubricants, fuel additives and fungicides[1-2]. They are also used in photo thermogravimetry[3] and in manufacturing of pharmaceuticals.

Metal soap with elements of lanthanide series were synthesized for the first time by Mishra et al[4].Mehrotra et al[7-8] investigated acoustical and thermodynamic properties of lanthanide soaps and concluded that these soaps behave as weak electrolyte in dilute solutions. Koga and matuura[9] studied the X-ray diffraction pattern and IR spectra of alkaline earth metal soaps. The present paper deals with the studies of the structure of samarium and praseodymium hexadecanoate in solid state using X-ray, IR and TGA. The results have been used to evaluate various kinetic parameters.

II. Experimental

a) Materials

i. Fatty Acids

The fatty acids used in this studies were supplied from from Indian Rare Earth Limited, Kerala) were used for the present investigation. The purities of fatty acids were confirmed to be over 98.5%.

ii. Metal salts

The inorganic chemicals used in the preparation of metal soaps were analr.grade: samarium nitrate and praseodymium nitrate.

iii. Preparation of metal soap

The samarium and Praseodymium hexadecanoate were prepared by the direct metathesis of corresponding potassium soaps by pouring a slight stochiometric excess of aqueous metal salt solution into the clear dispersion at raised temperature with vigorous stirring. After initial drying in an air oven 50-60°C, final drying was carried out under reduced pressure. The precipitates was filtered off and washed with hot distilled water and acetone.

iv. Apparatus

Infrared absorption spectra of hexadecanoic acid corresponding to potassium, samarium hexadecanoate and praseodymium hexadecanoate were recorded with Fourier transform infrared spectrometer, Tensor 27, Bruker in the region 4000-400 cm-1 using potassium bromide disc method.

The X-Ray diffraction patterns of samarium hexadecanoate and praseodymium hexadecanoate were obtained with a Bruker AXS D8 Advance x-ray diffractometer using Cu-Kα radiations filtered by a nickel foil. The instruments yield an automatically recorded curve of intensity of diffracted x-rays vs. diffraction angle 2θ.

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The thermo gravimetric analysis of samarium metal soaps was undertaken at constant rate of heating (20°c/min) under nitrogen atmosphere in a thermo balance. The results of TGA of samarium metal soaps were obtained from Sophisticated Instrumentation Centre (S.I.C), IIT, Indore.

III. Result and Discussion

The infrared spectral bands (Figures 1 & 2) and their tentative assignments for samarium hexadecanoate and praseodymium hexadecanoate are assigned and compared with potassium hexadecanoate, as well as with corresponding fatty acid (hexadecanoic acid) Tables I& II.

The characteristic frequencies in the spectra of fatty acid at 2640 (O-H stretching vibrations), 1700 (C=O stretching vibrations), 1450 (O-H in plane bending and C-O stretching) and at 950 cm-1 (out of plane bending of O-H group) indicates the presence of carboxyl group in the form of dimeric12 structure and confirms the existence of intermolecular hydrogen bonding between two molecules of fatty acid.

The infrared spectra of potassium, samarium & praseodymium hexadecanoate illustrate marked difference with the spectra of corresponding fatty acids in some spectral region. Some characteristic vibrations of free fatty acids were found completely absent in their respective regions in the spectra of potassium, samarium & praseodymium hexadecanoate. The disappearance of carboxyl frequency (1700cm-1) in the spectra of these soaps indicate that there may be a complete resonance in the two C-O bonds of the carboxyl groups of the soap molecule.

Table 1 : Frequencies (cm^{-1}) of Absorption maxima with their Assignments of hexadecanoic acid, Potassium decanoate, Samarium hexadecanoate.

s.no	Assignment	Palmitic Acid	Potassium palmitate	Samarium palmitate
1	CH3, C-H asym. Stretching	2960ms	2960ms	2956.59vs
2	CH_2, C-H asym stretching	2920vs	2910vs	2918.80vs
3	CH_2, C-H sym stretching	2850s	2850s	2850.61s
4	O-H stretching	2654w	2650w	_
5	C=O stretching	1700vs	_	_
6	COO-, C-O asym stretching	1550vs	_	1529s
7	CH_2 deformation	1460ms	1460m	1466s
8	C-O stretch + O-H in plane deformation	1450ms	_	_
9	COO-, C-O sym stretching	1430ms	_	1423w
10	CH_2 (adjacent to COOH group),deformation	_	1410ms	_
11	CH_3 sym deformation	1380ms	1350w	1302w
12	Progressive bands(CH_2,Twist and wag)	1325-1190m	1340-1100vw	1191m
13	CH_3 rocking	1100w	1110vw	1110s
14	OH out of plane deformation	_	930vw	_
15	CH_2 rocking	720ms	720w	721s
16	COOH bending mode	690w	680w	686m
17	COOH wagging mode	550s	550ms	_

The appearance of the two absorption bands of the carboxyl group corresponding to the symmetric and asymmetric vibrations of two carboxylate ions lies in the vicinity of 1410-1438cm-1 and 1524-1600 cm-1, respectively in the spectra of potassium, samarium & praseodymium hexadecanoate confirms the formation of soaps and indicates that these soaps have an ionic character.

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Table 2 : Frequencies (cm^{-1}) of Absorption maxima with their Assignments of hexadecanoic acid, Potassium decanoate, Praseodymium hexadecanoate

S.N	ASSIGNMENT	Palmitic acid	potassium palmitate	praseodymium Palmitate
1	CH_3,C-H asymmetric-streching	2960 ms	2960 ms	2959 (m)
2	CH_2,C-H asymmetric-streching	2920 vs	2910 vs	2919.69 (Vs)
3	CH_2,C-H symmetric-streching	2850 s	2850 s	2850.55 (s)
4	OH,streching	2654 w	2650 w	-
5	C=O,streching	1700 vs	-	1713.07 (w)
6	COO^-,C-O asymmetric stretching	1550 vs	-	1536.79 (Vs)
7	CH_2, deformation	1460 ms	1460 m	1458.62 (
8	COO^-,C-O symmetric stretching	1430 ms	-	
9	C-O streching,O-H in plane deformation	1450 ms	-	
10	CH_2 (adjacent to COOH group),deformation	-	1410 ms	
11	CH_3,symmetric deformation	1380 ms	1350 w	
12	Prograsive bands (CH_2 twisting and wagging)	1325-1190 m	1300-1100 vw	
13	CH_3,rocking	1100 w	1110 vw	
14	OH ,out of plane deformation	-	930 vw	
15	CH_2 ,rocking	720 ms	720 w	
16	COOH,bending mode	690 w	680 w	
17	COOH, wagging mode	550 s	550 ms	

In the spectra of hexadecanoic acids, no bands corresponding to symmetric and asymmetric of carboxylate ions are observed. Naturally the OH stretching band near 2650-2550 cm-1 and OH deformation band at 940cm-1 observed in the spectra of fatty acids disappeared in the spectra of samarium & praseodymium soaps. The progressive bands of the medium and weak intensity observed in the region of 1360-1110cm-1 for samarium & praseodymium soaps are assigned to the wagging and twisting vibrations of the chains of successive methylene groups of the molecule of the soap and fatty acids.

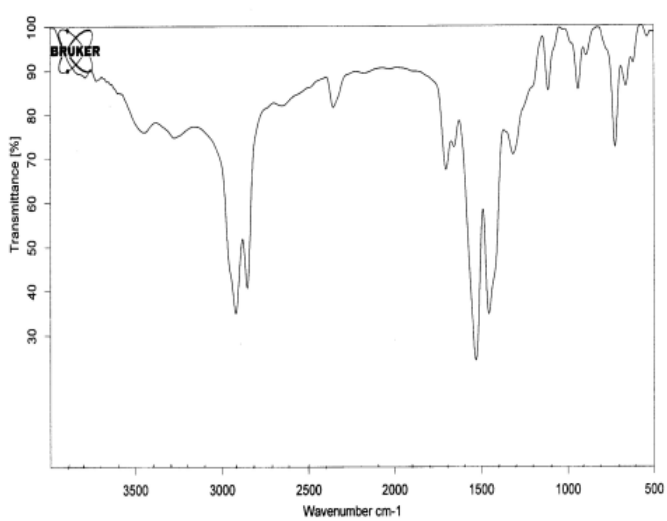

Fig. 1: IR of Samarium hexadecanoate

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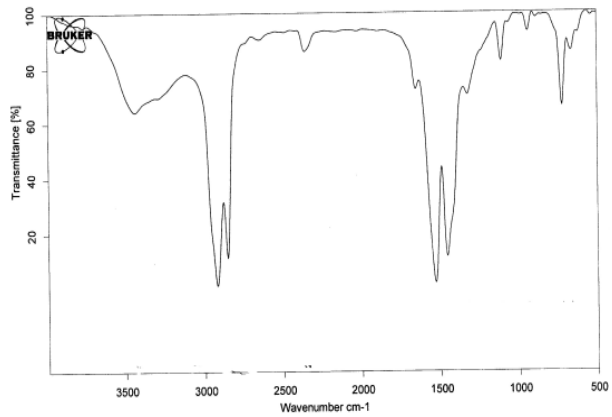

Fig. 2 : IR of Praseodymium hexadecanoate

These results confirm that the fatty acid (hexadecanoic acids) in the solid state exists with dimeric structure through hydrogen bonding whereas metal to oxygen bond in samarium & praseodymium soaps are ionic in nature. It is also proved that the soap molecules retain the resonance character of the carboxylic group. The infrared spectra of samarium soaps do not indicate any maxima in the region of 3500-3300 cm-1 which confirms the absence of any coordinated water molecules in the soaps. The assigned frequencies are in agreement with the results of other worker[5-6].

a) X-Ray Diffraction Analysis

The x-ray diffraction studies of samarium & praseodymium hexadecanoate has been done to characterize the structure in the solid state (table 3& 4). The intensities of diffracted x-ray as a function of diffraction angle,2(twice the Bragg angle) for samarium & praseodymium soaps were recorded with the help of x ray diffractometer and the recorded curves are reproduced over the range of 2-80°C corresponding to successive order of single long spacing [9-10].

Table 3 : X-Ray analysis of samarium hexadecanoate

S.no	2θ	θ	sin θ	λ/2 Sin θ	d (Å)	n
1	2.127	1.0635	0.0185	0.037	41.512	1
2	4.12	2.06	0.0359	0.0718	41.654	2
3	6.10	3.05	0.0532	0.1064	41.225	3
4	8.073	4.0365	0.0703	0.1406	41.385	4
5	10.085	5.0425	0.0878	0.1756	41.474	5
6	12.08	6.04	0.1052	0.2104	41.579	6
7	12.73	6.365	0.1108	0.2216	41.734	7
8	14.054	7.027	0.1223	0.2446	41.856	8
9	15.08	7.54	0.1312	0.2624	41.942	10
10	22.29	11.145	0.1932	0.3864	41.88	11
11	25.54	12.77	0.221	0.442	41.982	12

Average value of d = 41.656

Table 4 : X-Ray analysis of praseodymium hexadecanoate

S.no	2 θ	θ	Sin θ	λ/2 Sin θ	d (Å)	n
1	2.381	1.19	0.0207	37.212	46.92	1
2	3.887	1.943	0.0339	22.7227	47.43	2
3	7.11	3.555	0.062	12.4241	47.67	4
4	7.814	3.907	0.0681	11.3113	47.79	4
5	9.804	4.902	0.0854	9.0199	47.85	5

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6	12.677	6.338	0.1103	6.9836	47.39	7
7	13.76	6.88	0.1197	6.435	47.54	7
8	15.77	7.885	0.1371	5.6185	47.82	9
9	17.78	8.89	0.1545	4.9857	47.71	10
10	19.779	9.889	0.1717	4.4863	47.65	11
11	21.81	10.905	0.1891	4.0735	47.69	12

Average value of d = 47.580

On the basis of long and short spacing, it is proposed that the metal ions in transition and rare earth metal soaps are arranged in a parallel plane, i.e. a basal plane equally spaced in the soap crystal with fully extended zig zag chains of fatty acid radicals on both directions of each basal plane and these soaps possesses double layer structure. The double layer structure of some heavy metal soaps was also suggested by Vold et al[11]. The molecular axes of transition metal soaps were found to be more inclined to the basal plane than rare earth metal soaps [12-13].

b) Thermogravimetric studies

The thermal decomposition of samarium and praseodymium hexadecanoate was studied by thermogravimetric analysis. The heating rate 20°c/min and nitrogen atmosphere were used. The final decomposition product or residues left on heating these soaps were the samarium & praseodymium oxide as the weights of the residues were almost in agreement with the theoretically and calculated weights of samarium & praseodymium soaps and samarium & praseodymium oxide from the molecular formula of the corresponding soap. The thermal decomposition of samarium& praseodymium soaps may be expressed as:-

$$(RCOO)_3Sm \rightarrow Sm^{3+} + 3RCOO^-$$

$$2(RCOO)_3Sm \rightarrow 3RCOR + Sm_2O_3 + 3CO_2$$

$$(RCOO)_3Pr \rightarrow Pr^{3+} + 3RCOO^-$$

$$2(RCOO)_3Pr \rightarrow 3RCOR + Pr_2O_3 + 3CO_2$$

Where R = C11H23 and C13H27

The results of thermal decomposition of samarium & praseodymium soaps were explained in the light of some well known equations, the Freeman-Carroll's[14]and Coats Redfern's [15] equations expressed as follows

$$\frac{\Delta[\log(dw/dt)]}{\Delta(\log W_r)} = -\frac{E}{2.303R} \cdot \frac{\Delta(1/T)}{\Delta \log(W_r)} + n$$

The plots of the loss in weight of the soaps, w, against time, t are shown in fig 3 & 4 and values of (dw/dt) are obtained from the curves by drawing tangents at appropriate times. The plots of Δ [log(dw/dt)] / Δ(log w_r) versus Δ(1/T)/Δ(log w_r) provide linear relationship. Slope of this enables us to calculate activation energy for the decomposition process and intercept provides n. The order of the reaction which was found zero and the values of the activation energy for the decomposition were found to be lie between 30-35 KJ mol-1.

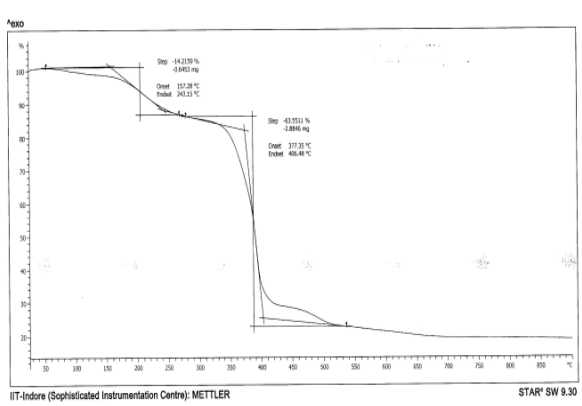

Fig. 3 : Thermal decomposition of samarium hexadecanoate

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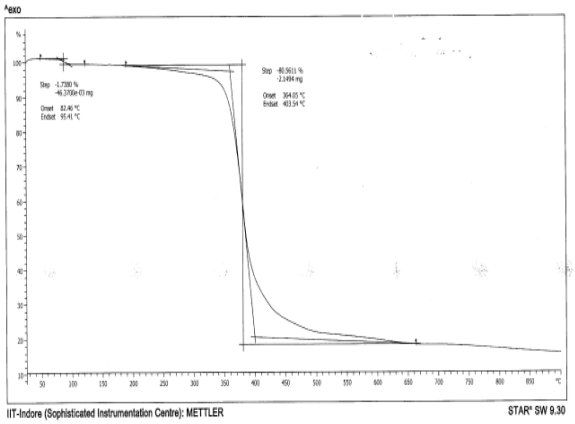

Fig. 4 : Thermal decomposition of praseodymium hexadecanoate

IV. Conclusion

The IR results showed that fatty acid exists in a dimeric structure as a result of hydrogen bonding between the carboxyl groups of two fatty acid molecules, whereas samarium& praseodymium soaps possess ionic character. The X-ray analysis showed that samarium & praseodymium soaps have double layer structure with molecular axes slightly inclined to the basal plane. The thermal decomposition of these soaps was found to be zero order and the energy of activation for the decomposition process was in the range 30-35 KJ mol-1.

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Synthesis, Spectroscopic, Thermodynamic and Biological Activity Studies of Schiff Base and Metal Complexes Derived from 2-[1H-Pyrrol-2-Ylimino Methyl]- 5-Phenyl-1,3,4-Oxadiazole

By Nazk Mohammed Aziz, Naser Dhiya Shaalan & Dr. Sahar Sabeeh Hassan
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Keywords: schiff base, microwave synthesis, thermodynamic parameters, biological activity.

GJSFR-B Classification : FOR Code: 030306p

SYNTHESISSPECTROSCOPICTHERMODYNAMICANDBIOLOGICALACTIVITYSTUDIESOFSCHIFFBASEANDMETALCOMPLEXESDERIVEDFROM21HPYRROL2YLIMINOMETHYL5PHENYL134 OXADIAZOLE

Strictly as per the compliance and regulations of :

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Synthesis, Spectroscopic, Thermodynamic and Biological Activity Studies of Schiff Base and Metal Complexes Derived from 2-[1H-Pyrrol-2-Ylimino Methyl]- 5-Phenyl-1,3,4- Oxadiazole

Nazk Mohammed Aziz [α], Naser Dhiya Shaalan [σ] & Dr. Sahar Sabeeh Hassan [ρ]

Abstract- New metal complexes of the ligand (HL) 2-[1H-Pyrrol-2-ylimino methyl]- 5-phenyl-1, 3,4-oxadiazol with the metal ions Co(II), Ni(II) and Cu(II), were prepared in alcoholic medium. The Schiff bases were condensed by using [Pyrrolcarboxaldehyde] with[2-amino-5-(phenyl-1, 3,4-oxadiazole] in alcoholice medium. As the Schiff base prepared was tridentate ligand, it was used for forming complexes with Co^{+2}, Ni^{+2}, Cu^{+2} and Zn^{+2} ions of type M $(HL)_2$. All the synthesized Schiff base and their metal complexes were characterized by FTIR Spectroscopy, Electronic Spectroscopy, Elemental Analysis, Magnetic Susceptibility Measurements, Thermal Analysis , 1H-NMR Spectra, and Mass Spectra. The Activation Thermodynamic Parameters, such as ΔE*, ΔH*, ΔS* and ΔG*were calculated from the TGA curve using Coats-Red fern method. From the spectral measurements, structures for the complexes were proposed. Preliminary in vitro tests for antimicrobial activity showed that all prepared compounds displayed good significant activity to *Staphylococcusaureus, Escherishia coli, Pseudononasaeroginosa and Cndidaalbicans.*

Keywords: schiff base, microwave synthesis, thermodynamic parameters, biological activity.

I. Introduction

Increasing physiological importance of donor organic compounds including nitrogen and oxygen have active roles played by certain coordinated metal ions. These compounds have magnificent characteristics in synthesizing and studying structural aspects of metal complexes with some oxygen and nitrogen donor ligands.

Literature survey reveals that out of various isomers particularly 1,3,4-oxadiazole derivatives exhibit wide range of biological activities. Various methods for the synthesis of 1,3,4-oxadiazole have also been reported[1-4]. These biological activities are probably due to the presence of the –N=C–O group [5]. Pyrrole, oxadiazol and its derivatives form an important class of organic compounds due to their chemical structure and biological activities as analgesic, antipyretics and anti-inflammatory [6]. Even the simplest Pyrrole derivatives are widely used for analgesic medicines. Pyrroles are efficient extractants of metal ions and they have potential to form different types of coordination compounds. In addition, a pyrrolecan form a variety of Schiff bases and are reported to be superior reagents in biological, clinical and analytical applications [8,7]. The present study confines itself to study the metal complexes of Schiff bases encompassing some new metal ions such as Co(II), Ni (II) , Cu (II) and Zn (II), derived from Pyrrole and 2-amino-5-(2-hydroxy-phenyl-1,3,4-oxadiazole. Preparation, characterization and antibacterial activity of above metal complexes with this Schiff bases are reported here. Where, HL is a Schiff base of 2-amino-5-(2-hydroxy-phenyl-1,3,4-oxadiazolre acting with Pyrrole along with complexes with some oxygen and nitrogen donor ligands [9]. From the TGA curves recorded for the successive steps in the decomposition process of these ligands and complexes, it was possible to determine the following characteristic of the thermal parameters for each reaction step: initial point temperature of decomposition (T_i) stands for initial temperature point at which TG curve starts deviating from its base line. Final point temperature of decomposition (T_f) at which TG curve returns to its base line. Peak temperature, i.e. temperature of maximum rate of weight loss: the point obtained from the intersection of tangents to the peak of TG curve, whereas (DM) stands for the mass loss at the decomposition step which is the amount of mass that extends from the point T_i up to the reaction end point T_f on the TG curve, i.e. the magnitude of the ordinate of a TG curve. The material released at each step of the decomposition is identified by attributing the mass loss (Dm) at a given step to the component of similar weight calculated from the molecular formula of the investigated complexes, comparing with literatures of relevant compounds considering their temperature. This may assist identifying the mechanism of reaction in the decomposition steps taking place in the complexes under question. Activation energy (E) of the composition

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step: the integral method used is the Coats-Redfern equation [10]. For reaction order n≠1or n= 2, which when linearised for a correctly chosen n yields the activation energy from the slop:

$$\log\left[\frac{1-(1-\alpha)^{1-n}}{T^2(1-n)}\right] = \log\frac{ZR}{qE}\left[1-\frac{2RT}{E}\right]-\frac{E}{2.303RT} \quad \ldots\ldots n\neq 1$$

$$\log.\left[\frac{-\log.(1-\alpha).}{T^2}\right] = \log.\left[\frac{AR}{\beta E}\left(1-\frac{2RT}{E}\right)\right]-\frac{E}{2.303RT} \quad \ldots\ldots n=1$$

$\Delta S^* = 2.303R\ [\mathrm{Log}\ (Ah/K\ T_{max})]$, $\Delta H^* = E - RT_{max}$, $\Delta G^* = \Delta H^* - T_{max}\ \Delta S^*$where: α = fraction of weight loss, T = temperature (°K), n = order of reaction, A or Z = pre-exponential factor, R = molar gas constant, E = activation energy and q = heating rate. Order of reaction (n) is the one for which a plot of the Coats-Redfern expression gives the best straight line among various trial values of n that are examined relative to that estimated by the Horovitz-Metzger method [11].

II. Experimental

All chemicals used were of reagent grade (supplied by either sigma Aldrich or fluka) and used as supplied. The FTIR spectra in the range (4000-400) cm^{-1} cut were recorded as KBr disc on FTIR.4200 Jasco Spectrophotometer. The UV-Visible spectra were measured in ethanol using Shimadzu UV-Vis. 160 A-Ultra-violet Spectrophotometer in the range (200-1000) nm. Magnetic Susceptibility measurements for complexes were obtained at room temperature using (Magnetic Susceptibility Balance) Jhonson Mattey Catalytic Systems Division. Gall encamp M.F.B600.010 F melting point apparatus were used to measure the melting point of all the prepared compounds. Elemental microanalysis was carried out using CHNO Elemental Analyzer Model 5500 Carlo-Elba Instruments (Italy).

a) Synthesis of [2-amino-5-(2-hydroxy-phenyl-1,3,4-oxiadiazole][12] [L]

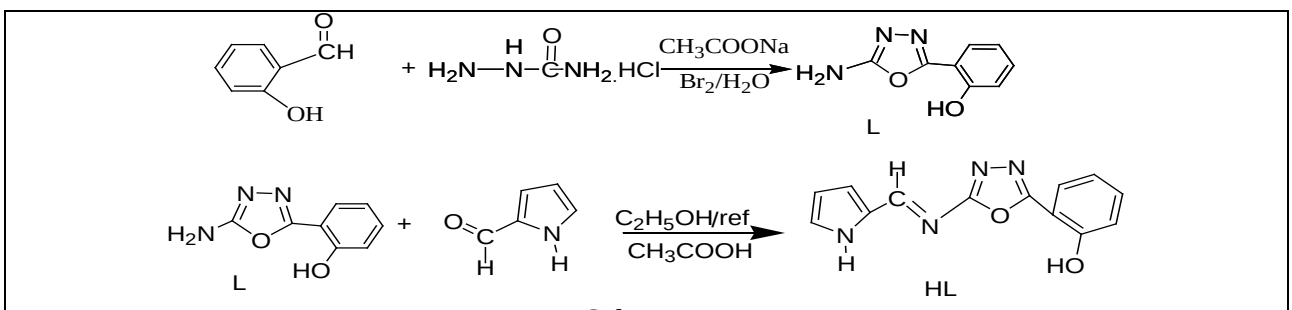
A. Synthesis Semicarbazone: Semicarbazide Hydrochloride (0.1M) and sodium acetate (0.2M) were added and dissolved in 15-20mL of distilled water placed in flat-bottomed flask. In a separate beaker containing required Salicylaldehyde (0.1M) was dissolved in free alcohol. This ethanolic aromatic aldehyde solution was added slowly to the solution of semicarbazide hydrochloride. The precipitate, which was separated, was filtered, dried and recrystallized from 95% hot ethanol.

B. Semicarbazone (0.1M) and sodium acetate (0.2M) were dissolved in 300-400 mL of glacial acetic acid with continuous stirring. Bromine (7 mL in 50 mL of GAA) was added slowly to it. The solution was stirred for an hour and then poured on crushed ice the resulting solid was separated, dried and recrystallizedfrom hot ethanol (95%). Thetable (1)showsC.H.N.S analysis of the yielded.

b) -2-[1H-Pyrrol-2-ylimino methyl]- 5-phenyl-1,3,4-oxadiazol[13][HL]

Method (1): A mixture of equal molar amounts (0.05 mol.) of both appropriate [Pyrrolcarboxaldehyde] and the [2-amino-5-(2-hydroxy-phenyl-1,3,4-oxiadiazole], in absolute ethanol (25 ml) with (3) drops of glacial acetic acid was refluxed (4)hours. The reacted mixture was then allowed to cool at room temperature, and the precipitate was filtered, dried, and recrystallized from mixture (methanol and ethanol) (1:1) to give yellow powder.

Method(2): A mixture of equal molar amounts (0.05 mol.) of appropriate [Pyrrole-2-carbaldehyde] and the (2-amino-5-(2-hydroxy-phenyl-1,3,4-oxadiazole), were ground with a mortar, mixed, dried and subjected to microwave irradiation 280W for (10) minutes, after completion the reacted mixture was cooled to room temperature, then the solid obtained was recrystallized twice from mixture (methanol and ethanol) (1:1) to get yellow powderyield. The table (1) shows C.H.N.S analysis of the yielded.



Scheme 1

III. Preparation of Complexes

Method(1) : An ethanol solution of the metal salts of Co(II), Ni (II), Cu (II) and Zn (II) was added to an ethanolic solution of (HL) in 1:1 (metal : ligand) molar ratios. After stirring for 2 hours with heating 70 °C, crystalline colored precipitates formed cooling at room temperature, the resulting solids were filtered off, washed with distilled water, dried and recrystallized from ethanol and dried at 50 °C.

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Method(2) : An ethanol solution of the metal salts of Co(II), Ni (II), Cu (II) and Zn (II)were added to an ethanolic solution of (HL) in 1:1 (metal : ligand) molar ratios. Then it was put in ultrasonic bath heated to 65^{0}C After 50 minutes crystalline colored precipitates formed, cooling at room temperature, the resulting solids were filtered off, washed with distilled water, dried and recrystallized by using ethanol and dried at 50 ^{0}C. Thetable (1) shows C.H.N.S analysis of the yielded.

IV. Result and Discussion

The synthetic procedure of Schiff base ligand is presented in Scheme 1. Then, the divalent transition metal ions *viz.*, Co (II), Ni (II), Cu(II) and Zn(II) reacted with the ligand. The composition of the complexes formed in solution has been established by mole ratio and job methods. In both cases, the results reveal (2:2) metal to ligand ratio yielded the corresponding metal chelates. Shows the decomposition point, color and electronic absorption bands for ligand and complexes are shown in Table (1, 2). The bands are classified into three distinct groups: The intermolecular transitions appeared in the UV region, charge transfer from ligand to metal, and d-d transitions appeared in the UV-Visible region.

a) [2-amino-5-(2-hydroxy-phenyl-1, 3,4-oxiadiazole] [L]

The reaction of Semi-carbazide Hydrochloride with Salicylic aldehyde in presence of sodium acetate/Br_2 afforded 2-amino-5-phenyl-1, 3,4-oxiadiazole [11]. The structural assignment of the product was based on its melting point and spectral (FT-IR and UV/Vis.) data as shown in table (1). The FT-IR spectrum of compound (L) exhibited significant two bandshaving the range (3402–3213)cm^{-1} which could be attributed to asymmetric and symmetric stretching vibrations of the NH_2 group. Stretching vibration band of (OH) occurs in the (3428) cm^{-1}. Besides this, band ranges at about (1475-1423 cm^{-1}) due to cyclic (C = N) stretching is also observed. Other bands occurring at (1518 cm^{-1}) and (1484 cm^{-1}) are due to the (N-H) bending and (C-N) stretching vibrations, respectively [14].

b) [2-[(1H-Pyrrol-2-ylimino methyl)]- 5-(2-hydoxy-phenyl)-[1,3,4-oxiadiazol] [HL]

The FT-IR spectra shows the disappearance of the two absorption bands due to (-NH2) stretching of amino oxadiazole [HL] showed all the suggested bonds for olefin (C-H), (C=C) aromatic, endocyclic (C=N) and exocyclicimine group. All the prepared compounds (Schiff bases) exhibited the stretching band near the region (1475-1423) cm^{-1}, this is due to the (=N-N=C-) cyclic group; 3426 cm^{-1} (υ OH Stretching), a band at 3155 cm^{-1} attributed to NH stretching (pyrrole ring), 1595cm^{-1} (υ C=N Stretching of amine), 1229 cm^{-1}, 1468 cm^{-1} (Characteristic bands of oxazole ring).All the spectral data for other compounds are listed in table (2).

^{1}H-NMR spectrum of compounds [HL], shows the following characteristic chemical shift, (CDCL3-d_6) ppm. The four aromatic ring protons of phenyl (δ 6.95 - 7.55) (s, 4H, Ar), and three pyrrole ring appeared at (δ 6.00 – 7.45) ppm, the signal at (δ 8.78)was attributed to (N=C-H) proton (azomethine). Beside the signal at (δ 9.56) ppm, was attributed to (N-H) proton, δ=11.95(s, 1H, OH),δ 1.584(organic solvent).

The positive ion mass spectral analysis of (HL) observed at m/z 255. (M+1) (Figure5), confirms the theoretical molecular weight i.e. 254.1.

Table 1 : The characterization data of the prepared compounds

Compound Formula,	Yield %	C	H	N	O	Cl	M
L $C_8H_7N_3O_2$	70	54.60 (54.24)	3.82 (3.98)	23.39 (23.72)	18.19 (18.06)	---	--
HL C13H10N4O$_2$	81	61.74 (61.41)	3.91 (3.96)	22.15 (22.04)	12.65 (12.59)	---	--
$[Co_2 (HL)_2.4(H_2O)]Cl_2$	72	40.94 (40.81)	3.22 (3.16)	14.85 (14.64)	16.91 (16.73)	9.13 (9.27)	14.95 (15.40)
$[Ni_2 (HL)_2.4(H_2O)] Cl_2$	67	40.96 (40.83)	3.12 (3.16)	14.99 (14.65)	16.57 (16.74)	9.20 (9.27)	15.16 (15.35)
$[Cu_2 (HL)_2.4(H_2O)]Cl_2$	65	40.49 (40.32)	3.11 (3.12)	14.31 (14.47)	16.69 (16.53)	9.03 (9.15)	16.37 (16.41)
$[Zn_2 (HL)_2.4(H_2O)]Cl_2$	55	40.32 (40.13)	3.17 (3.11)	14.25 (14.40)	16.22 (16.45)	9.23 (9.11)	16.94 (16.81)

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Table 2 : some physical data electronic spectra for ligands and complexes in DMF

Symbol	Dec. Point ^0C	Conductivity $ohm^{-1}cm^2mol^{-1}$	MagneticMo ment (B(B.M)	Color	Absorption Bands (nm)	AssignedTransition
L	244	-	-	White-yellow	209	$\pi\rightarrow\pi^*$
					285	$n\rightarrow\pi^*$
HL	285	--	-	yellow	215	$\pi\rightarrow\pi^*$
					390	$n\rightarrow\pi^*$
Co(II)	295d	146	4.78	Pale -Red	775	$^4T_1g \rightarrow {}^4A_2g$
					545	$^4T_1g^{(F)}\rightarrow {}^4t_1g^{(p)}$
					350	Charge Transfer
Ni(II)	300d	136	3.22	Pale green	230	$\pi\rightarrow\pi^*$
					290	$n\rightarrow\pi^*$
					375	Charge Transfer
					650	$^3A_2g \rightarrow {}^3t_1g^{(p)}$
					940	$^3A_2g \rightarrow {}^3t_1g^{(F)}$
Cu(II)	300d	139	1.92	Light Brawn	225	$\pi\rightarrow\pi^*$
					290	$n\rightarrow\pi^*$
					370	Charge Transfer
					425, 610,640	$^2B_1g \rightarrow {}^2B_2g$
Zn(II)	300d	161	Dia	Purple White	315	Charge Transfer

V. Infrared Spectral Analysis of Metal Complexes

The infrared spectra of the ligands show (υO-H) (weakly H-bonded) at 3429cm^{-1} and (υN-H) at 3151 cm^{-1}. The absence of this band in all the metal complexes indicates the removal of a proton of hydroxyl group of benzene ring and a proton of NH group of pyrrole ring during the chelation. The sharp intense band at 1593 cm-1 in the ligands can be assigned to υC=N (azomethine). A shift ∆ υ = 7-15 cm^{-1}) in υC=N (azomethine) is observed upon the coordination indicating that the nitrogen of azomethine group is involved in coordination. All the complexes show broad band in the region(3285-3378) cm^{-1} which may be assigned to (υ O-H) of coordinated water [15]. To account for the octahedral stereochemistry of the metal complexes, the coordination of two water molecules is expected.

The bands at 561cm^{-1}in Co(II) complexes, 579 cm^{-1} in Ni(II) complex , 588 cm^{-1} in Zn(II) complex and 587cm^{-1} in Cu(II) complex may be due to metal-nitrogen stretching vibration[16,17]. In the free ligand, the band at 1606 cm^{-1} is assigned to the stretching of C=N(oxazole ring). On complexes, this band was shifted to a lower frequency region. This shift is probably due to the lowering of bond order of the carbon-nitrogen bond resulted in forming complexes of the metal ion to the ligand through nitrogen in (υC=N) compared to its respective ligands. This suggests that the nitrogen atom of the ring has not participated in the chelation. However, in water containing chelates, this band is observed as a broad band. This may be due to coupling of the bending mode of coordinated [18].

Table 3 : Infrared data of Ligand and its metal complexes (cm^{-1})

Symbol	ν(C=N)	ν(N-H) pyrrol	ν(C-N=N-C)	ν(M-O)	ν(H2O)	ν(O-H)	ν(M-N)
HL	1594(s)	3155	1475-1423	-	-	3426	-
Co(II)	1610(s)	-----	1490-1429	477(s)	3275	-	561(s)
Ni(II)	1617(s)	-----	1485-1430	444(s)	3281	-	579(s)
Cu(II)	1603(s)	-----	1484-1427	437(s)	3241	-	588(s)
Zn(II)	1611(s)	-----	1460-1430	447(s)	3255	-	587(s)

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VI. Thermal Analysis

To understand thermal decomposition process, the Schiff base and its metal complexes were examined by thermo gravimetric analysis in the temperature range of 35–700 °C. The obtained thermo analytical results from TGA curves for all these compounds which are given in table (4). The decomposition was completed at 693 °C for all the complexes. The data from the thermo gravimetric analyses indicated that the decomposition of the complexes (three steps) and the ligand proceeds in (two) steps. The final decomposition products were metal oxide mixture formed above 598 °C for the metal[19].

Table 4 : Thermodynamic parameters of the ligands and metal complexes

Sample (step)	T.range °C	N	R^2	T_{max} °K	Ea K.J mol^{-1}	Δ H* KJ mol^{-1}	ZSec^{-1} x10^5	Δ S* J mol^{-1}K^{-1}	Δ G* KJ mol^{-1}
HL(1)	37-300	1	0.99	512.79	170.4906	166.2344	1.7762	-34.0617	183.700
HL(2)	300-700	0.9	0.99	780.77	-7.87418	-14.3548	4.82	-354.698	262.5828
Co(1)	37-368	0.9	0.99	476.4	31.57044	27.61632	7.25	-289.758	165.6572
Co(2)	368-467	0.9	1	643.09	-6.84804	-12.1857	5.6	-351.864	214.094
Co(3)	368-700	0.9	0.99	766.6	-6,58243	-13.0282	6.35	-352.37	260.6221
Ni(1)	37-150	0.9	0.99	384	19.3764	16.1892	0.00381	-312.457	136.1727
Ni(2)	150-390	0.9	0.99	507	36.5	32.2919	0.017	-283.109	175.828
Ni(3)	390-700	0.9	0.99	775.12	-11.19	-17.6235	35.4	-257.205	259.2532
Cu(1)	37-180	0.9	0.99	423	125.9	46.49	7.68	-222.79	135.39
Cu(2)	180-395	0.9	0.99	554	54.214	121.04	0.5357	-100.31	169.81
Cu(3)	395-700	0.9	1	726.35	12.696	-5.734	4.91	-359.81	306.7
Zn(1)	37-190	0.9	0.99	480.8	23.71	19.72	1.5x10^{-4}	-321.9	174.52
Zn (2)	190-450	0.9	0.99	550	98.17	92.77	258.69	-205.2	226.16
Zn (3)	450-700	0.9	0.99	819	-10.14	-17.78	3.7x10^{-6}	-358.3	311.69

VII. Biological Activity

With a view to explore the possibility of obtaining biologically useful complexes that contain 1,3,4- oxadizole and pyrrole ring system, such a biological activity encourages us to prepare some new series of compunds containing the above mentioned unit. The antimicrobial activity of these compounds was determined by the agar diffusion method[20]. These types of bacteria Staphylococcus aureus, Escherishia coli, Pseudononasaeroginosa and Cndidaalbicans were used to show the biological activities of the ligand and its complexes. In this method, a standard 5mm diameter sterilized filter paper disc impregnated with the compound. Then, (1 mg per 1 ml of acetone) was placed on an agar plate seeded with the test organism. The plates were incubated for 24 hours at 37 °C. The zone of inhibition formed was measured in mm and are represented by (+), (+ +) and (+ + +) depending upon the diameter and clarity, as presented in table (5).The preliminary screening results reveal that the compound contained thiadizole and pyrrolecomplexes exhibits highest antibacterial activity against Escherishia coli.

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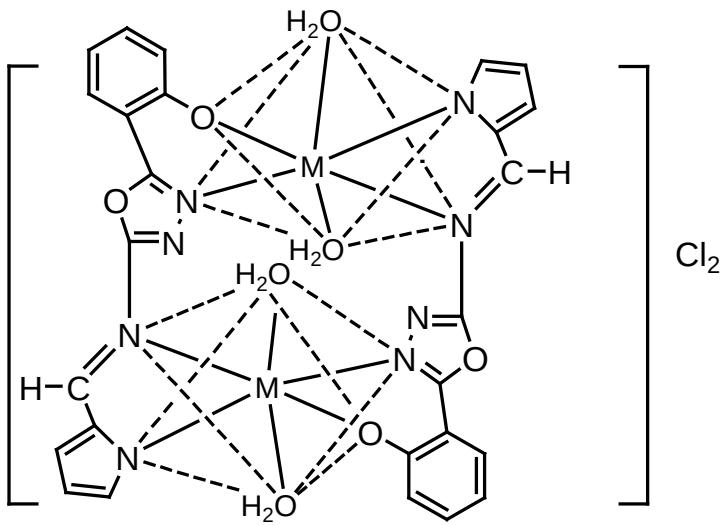
Table 5 : Antibacterial activity of the prepared compounds

Symbol	*Staphylococcus aureus*	*Escherishia coli*	*Pseudononas aeroginosa*	*Cndidaalbicans*
HL	+	+ + +	+	+
Co(II)	+	+ + ++	++	++
Ni(II)	+	+ + +	++	+
Cu(II)	++	+ ++	+++	++
Cu(II)	++	+ +	+++	++

Note (-) = no inhibition, (+) = (5-10) mm, (+ +)=(11-20) mm, (+ + +) = more than (20)mm

From the FTIR Spectroscopy, electronic spectroscopy, Elemental analysis, magnetic susceptibility measurements, thermal analysis suggest the structure.



[M2L2.4H2O]Cl2 ,M= Co (II), Cu (II), Zn (II)

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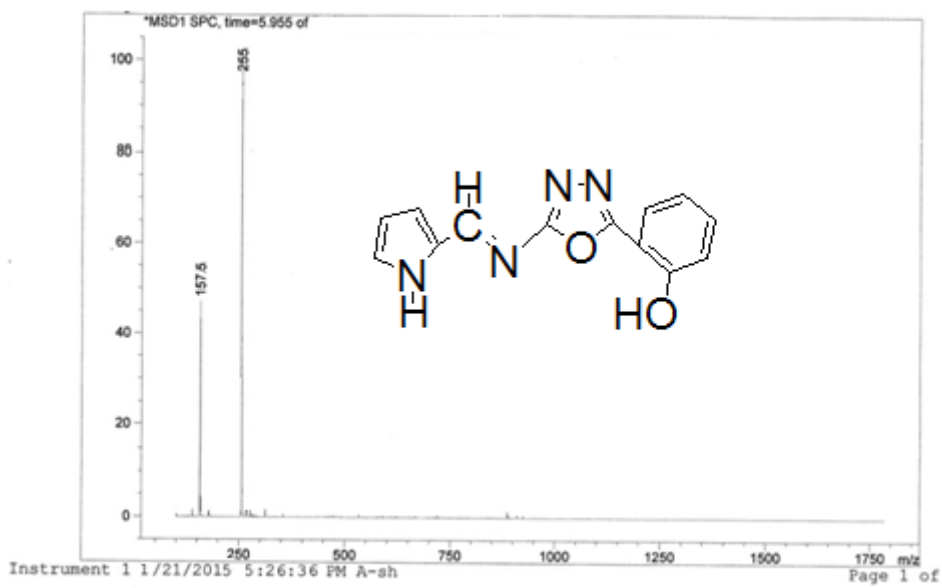

LC-MS

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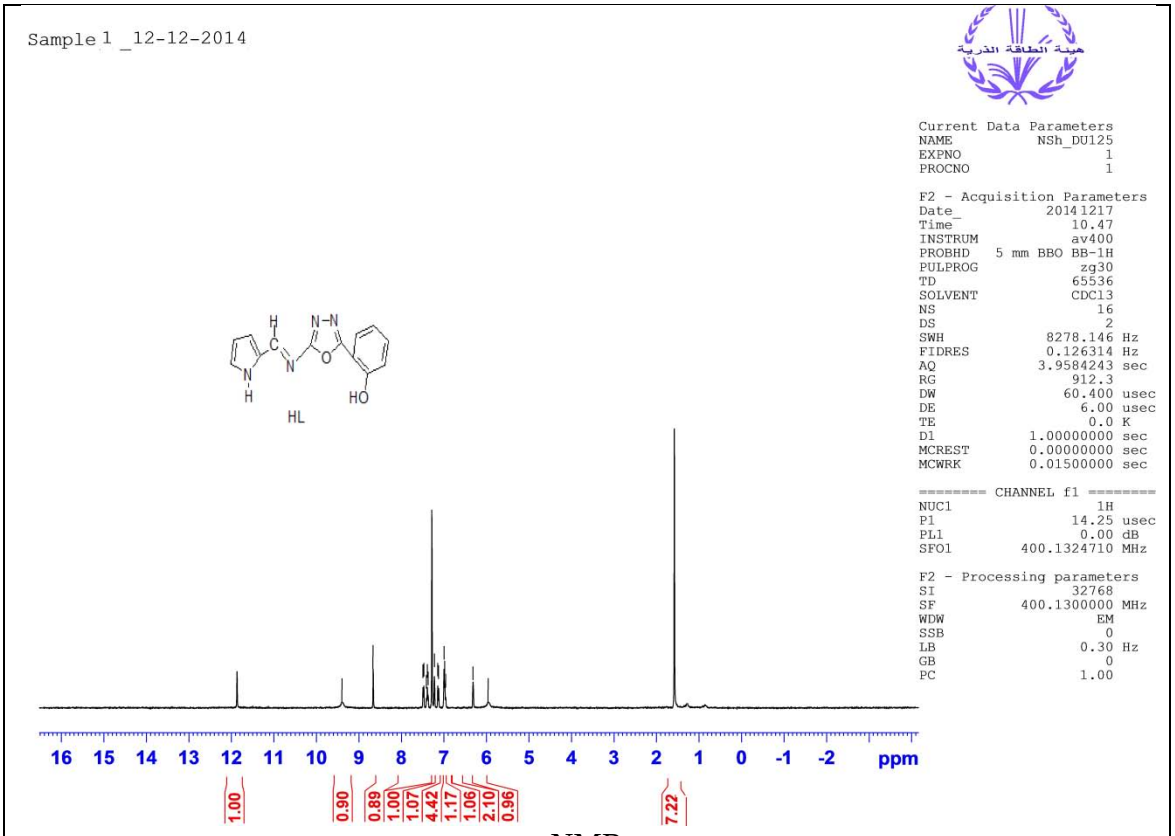

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Dipolar 1, 3-Cycloaddition: Synthesis of New Pyrazolinic Compounds Derived from Eugenol

By Fatima Rouda, Imane Lakhtib, Abdelmejid Bahloul, Abdelmajid Abourriche, Abdelfettah Sebban & Said Kitane

Hassan II Mohammedia, Morocco

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In our laboratory, many studies have been made on the synthesis, stereochemistry, the complexing power and biological properties of various pyrazolic and pyrazolinic structures.

The new pyrazolines presented in this work were prepared by cycloaddition of 1,3-dipole (the diarylnitrilimine) on eugenol and acetyleugenol which are two natural extracted dipolarophiles from cloves.

The structures of the obtained cycloadducts have been studied and confirmed on the basis of IR spectroscopic parameters, NMR-1H and 13C.

Keywords: dipolar 1,3-cycloaddition; synthesis; eugenol; pyrazolinic compounds.

GJSFR-B Classification : FOR Code: 030399p

DIPOLAR13CYCLOADDITIONSYNTHESISOFNEWPYRAZOLINICCOMPOUNDSDERIVEDFROMEUGENOL

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Fatima Rouda [α], Imane Lakhtib [σ], Abdelmejid Bahloul [ρ], Abdelmajid Abourriche [Ѡ], Abdelfettah Sebban [¥] & Said Kitane [§]

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The structures of the obtained cycloadducts have been studied and confirmed on the basis of IR spectroscopic parameters, NMR-1H and 13C.

Biological tests, Complexity trials and synthesis using the rest of the series diarylnitrilimines are in progress.

Keywords: dipolar 1,3-cycloaddition; synthesis; eugenol; pyrazolinic compounds.

I. Introduction

Since its development by Huisgen and al. Dipolar cycloaddition reaction appears among the most applied reactions for the synthesis of heterocyclic compounds not readily accessible by other synthetic methods [1-8].

In our laboratory, the synthesis of new pyrazolinic and pyrazolic heterocycles via such cycloaddition with diary lnitrilimines (DANI) as a dipole has been the subject of several theoretical and experimental studies [9-13].

Furthermore several cycloadducts, or derivatives thereof, synthesized showed very interesting biological activities.

These compounds have in fact antimicrobial, antifungal and antileishmanial [14-16]. In order to continue this work and to broaden the scope of investigation of our research team, we diversify the nature of used dipolarophiles (natural instead of synthetic), we have opposed DANI to two dipolarophiles eugenol and acetyleugenol which are extracted from a natural substance "nails chanterelle."

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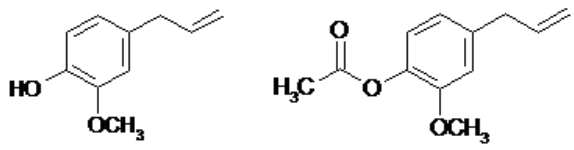
II. Bibliographic Details

Cloves are the dried buds, unhatched, the clove and are among the oldest spices and drugs described in the story. They have antiseptic, analgesic and are widely used in dentistry against toothache. They are also antibacterial, antifungal and prevent infectious diseases and helps to eliminate intestinal parasites.

Eugenol 1 and acetyleugenol 2 are natural compounds that can be extracted from natural oil of cloves.

They belong to a class of compounds called vanilloid. They are known for their antioxidant properties and may reduce the risk of diseases such as cancer, cardiovascular disorders and also malaria, AIDS and the effects of aging [17-20].



1 2

Cycloaddition Reaction

To develop essential oils and compounds 1 and 2 whose structures have activated ethylenic dipolarophiliques sites similar to the 7-allyl-8-hydroxyquinoline studied in our laboratory [13], we have opposed them to 1,3-dipole : the diarylnitrilimine (DANI) 3.

In fact, heating at reflux in dry benzene for 48 hours, eugenol 1 or acetyleugenol 2 with DANI 3, generated "in situ" by means of triethylamine after reaction with the precursor 3' gives in regiospecific manner both single cycloadducts with a good yield varying from 50 to 67%.

The structure of the compounds obtained was established on the basis of spectroscopic data of IR, 1H NMR (300 MHz), 13C NMR (50 MHz) and DEPT (Distortionless Enhanced Polarization Transfer).

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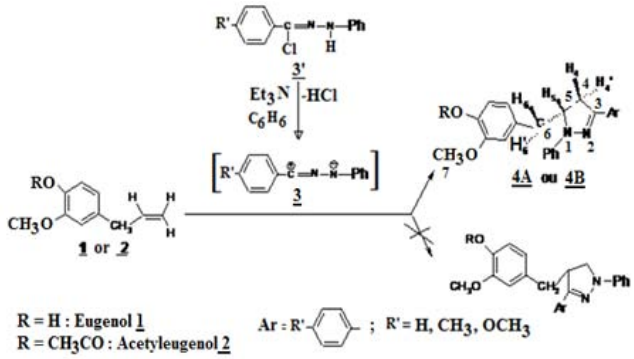

Eugenol and Acetyleugenol structures

III. Results and Discussion

On the IR spectrum of cycloadducts 4A (we note the absorption bands, which are characteristics bands due to C = N vibration around 1600 cm^{-1} and OH vibration at about 3475 cm^{-1} (Table 1).

The ^1H NMR spectrum of all compounds 4A in $CDCl_3$ at 300 MHz (Table 1) has four split doublets. We discuss the cycloadduct A1 for example. Indeed, we assigned the two split doublets centered at 2.63 and 3.20 ppm respectively protons H_4 and H'_4, and the two split doublets centered at 3.07 and 3.28 ppm respectively in two protons H_6 and H'_6. The transitions 12 which degenerates multiplet centered at 4.69 ppm characteristic of a proton bound to a carbon adjacent to a heteroatom which cannot be that the H_5 proton bound to a heteroatom. Protons H_4, H'_4, H_5, H_6 and H'_6 thus form a ABMXY system. As the most intense peak at 3.87 ppm; we attributed to the methoxy protons 3. It should also be noted that another intense peak at 3.22 ppm result of a union between two transitions, the H'_4 and H'_6.

We can also note that the protons H_6 and H_4 are respectively more armored than H'_6 and H'_4.

On the other hand the four values of the coupling constants characterizing H_4 and H_6 protons show that H_6 and H_4 are in cis position relative to the H_5 proton while H'_4 and H'_6 are in transposition compared to the same proton. Indeed, protons H6 and H4 have values larger coupling constant respectively, found $^3J_{H6-H5}$ = 10.8 Hz; $^3J_{H4-H5}$ = 9.6 Hz, H'_6 and H'_4 give respectively $^3J_{H'6-H5}$ = 4,5 Hz and $^3J_{H'4-H5}$ = 3,3 Hz (Table 2).

The structure 4A was also confirmed after examining the parameters 13C NMR (50 MHz) (Table 3). In case of cycloadduct 4A (R'=H), the signals corresponding to the pyrazolinic carbon C^4, C^5 and méthylenic C^6 are 37.36; 60.91 and 37.06 ppm, with respect to the carbon of methoxy function, it resonates at 56 ppm. DEPT spectrum further confirms the proposed structure since we observe reversal of carbons C^4 and C^6.

Regarding the adducts 4B, its IR spectrum (Table 1) shows in addition to the C = N band, another characteristic band at 1700 cm-1 corresponding to the vibration of C=O.

The ^1H NMR spectrum at 300 MHz of cycloadducts 4B (Table 1) were substantially identical to that of cycloadducts 4A, only one difference in that a single corresponding to the methyl group of acetyl is observed.

Furthermore the 13C NMR spectrum at 50 MHz cycloadducts 4B (Table 3) shows, in addition to signals attributable to carbons pyrazoliniques C^4, C^5 and C^6 methylenic carbon two significant signals to 20.69 ppm and 168 ppm respectively corresponding to the carbon of the methyl group acetyl and of carbonyl carbon C=O.

Table 1 : IR & ^1H NMR Characteristics of cycloadducts 4A and 4B

		NMR ^1H (δ in ppm)							Infra Red (ν in cm^{-1})	
		R'	*H_4*	*H'_4*	*H_5*	*H_6*	*H'_6*	*H_7*	$\nu_{C=N}$	ν_{O-H}
4A	*4A1 (R'=H)*	----	2,63	3,20	4,69	3,07	3,28	3,87	1597	3476
	4A2 $(R'=OCH)_3$	3,78	2,65	3,32	4,70	3,11	3,36	3,92	1596	3475
		R'	*H_4*	*H'_4*	*H_5*	*H_6*	*H'_6*	*H_7*	$\nu_{C=N}$	$\nu_{C=O}$
4B	*4B1 (R'=H)*	----	2,6	3,15	4,70	3,03	3,24	3,96	1596	1700
	4B2	2,34	2,58	3,10	4,76	3,00	3,20	3,82	1600	1700
	$(R'=CH_3)$									

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Table 2 : Values of the coupling constants

	J (Hz)					
	H_4-H'_4	H_4-H_5	H'_4-H_5	H_6-H'_6	H_6-H_5	H'_6-H_5
4A1 (R'=H)	14,6	9,6	3,3	17,1	10,8	4,5
4B1 (R'=H)	13,98	9,1	2,89	17,28	10,92	4,62

Table 3 : ^{13}C NMR Characteristics of cycloadducts 4A and 4B

		NMR^{13}C (δ in ppm)					
	R'	C_4	C_5	C_6	C_7	R = $O\underline{C}H_3$ R = $\underline{C}H_3\underline{C}=O$	R' = CH_3
4A1	H	29,75	60,9	37,06	59,99	56,12 --------	--------
4A2	OCH_3	29, 79	61,02	37,17	58,79	55,86 -------	--------
4B1	H	37 ,1	60,45	29,7	58,96	56,15 20, 76; 168,65	--------
4B2	CH_3	37 ,0	60,5	30,0	58,86	56,10 20, 96; 170,0	21,5

IV. Experimental

a) Extraction of eugenol A and acetyleugenol B

We place in a 250 ml three ground cloves mixed with water and we proceed to a steam distillation. The distillated essential oil being transferred to a separator funnel and extracted three times with dichloromethane, and will be finally collected.

The collected organic layer contains the mixture of the two main constituents eugenol A and acetyleugenol B.

To separate the mixture, the organic phase is treated in a separator funnel, two times with a solution of 5 % sodium hydroxide.

The thus obtained organic phase, containing the acetyleugenol B, dried over anhydrous magnesium. Acetyleugenol B is recovered after evaporation of dichloromethane in a rotary evaporator.

Furthermore, the aqueous phase containing eugenol A as eugenolate sodium, is treated with concentrated hydrochloric acid until about pH = 3.

We Dry over magnesium sulphate or anhydrous sodium. The removal of solvent on a rotary evaporator recovers the Eugenol A.

V. Cycloaddition : General Procedure

In a 100 ml flask equipped with a condenser and a CaCl2 guard are successively introduced 6,6 mmol of eugenol A or acetyleugenol B and 6 mmol of hydrazonoyle chloride in 40 ml of anhydrous benzene. 4 ml of triethylamine was added through a dropping funnel.

Magnetic stirring this mixture was heated to reflux for 48 hours after complete addition of triethylamine. The triethylamine hydrochloride formed is filtered hot and the benzene and excess triethylamine are removed in a rotary evaporator. The oil obtained crystallized from ethanol in a refrigerator. The crystal of cycloadducts obtained are filtered and washed with cold ethanol (Table 4).

Table 4 : Yield and physical caracteristics

	F° C	yield%	Aspect
4A1	150	67	Pale yellow crystals
4A2	162	63	Pale yellow crystals
4B1	158	58	Beige Crystals
4B2	160	50	Beige Crystals

VI. Conclusion

Cycloaddition of arylnitrilimine with eugenol or acetyleugenol is a regiospecific reaction whose sense of direction resulting steric effects theoretically expected. The structure of obtained adducts and the regiochemistry of the reaction was confirmed on the basis of spectroscopic parameters IR, 1H NMR (300 MHz) and 13C NMR (50 MHz) are in perfect agreement with literature data. Biological tests and tests of complexation are in progress as well as the synthesis using the rest of the series diary Initrilimines (DANI).

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By Odin, E.M. & Onoja, P.K
Kogi State University, Nigeria

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Keywords: bridgehead-fused1,2,3-trizolo[1,5-c]1,2,4-triazines, novel therapeutic systems, anti-inflammatory, egg-albumin, oedema.

GJSFR-B Classification : FOR Code: 250599

SYNTHESISOFBRIDGEHEADFUSED123TRIAZOLO15C124TRIAZINESNOVELANTIINFLAMMATORYANDANALGESICTHERAPEUTICSYSTEMS

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Odin, E. M. [α] & Onoja, P. K. [σ]

Abstract- An efficient method has been developed for the preparation of three novel heterocyclic compounds: Bridgehead-fused-5-methyl-6-methylketone-1, 2, 3 triazolo [1,5- c]-1, 2, 4-triazine(12),Bridgehead-fused-5-methoxyl -6-methylester-1, 2, 3-triazolo-[1,5-c]-1,2,4-triazine (14) and Bridgehead - fused - 5-methyl- 6-methylester-1,2,3-triazolo-[1,5-c] -1,2,4-triazine (16). The new heterocyclic systems were obtained utilizing 1H -1,2,3 – triazolo -5- diazonium salt (10) which was produced via thiourea sulphanilic acid(7). A mixture of this compound(7) with hydrazine in anhydrous acetonitrile, followed by continuous stirring afforded a solid compound: hydrazine carboximidamide (8). Addition of this hydrazine derivative to trimethyl orthoformate in a sealed vessel gave 5-amino – 1H- 1, 2,3 – triazole (9). Diazotization of this aminotriazole compound while maintaining the pH at 2, yielded the 1H – 1,2,3 – triazole -5- diazonium salt (10) in excellent yield.

The three fused heterocyclic systems were produced by coupling compound (10) with active methylene compounds: β-diketone, β-diester (dimethyl malonate) and β-keto ester respectively and heated under reflux in acetic anhydride. Recrystallization of the products in DMF – water, afforded pure colourless compound 12, light yellow system 14 and colourless fused compound 16 respectively. Structures were established by analytical and spectral data. The results of the anti-inflammatory and analgesic screening data revealed the potential analgesic values residing in the novel compounds which placed them as very strong drug candidate. The dose and time dependant effects of these compounds in the egg-albumin induced paw oedema showed the effect was real. The average inflammation was below 0.20 mm in the first 20min. At time 120min, there was a complete inhibition of oedema by 91.38%, 84.48% and 63.79% from the compounds(16,14 & 12) respectively, while the standard drug acetyl salicylic acid showed inhibition by 41.38%.The effect of substituent on inhibition was also recorded. The suppression of oedema by the compounds was correlated with anti-inflammatory potential.

Keywords: bridgehead-fused1,2,3-trizolo[1,5-c]1,2,4-triazines, novel therapeutic systems, anti-inflammatory, egg-albumin, oedema.

I. Introduction

Triazolo-Triazines are well known class of aza-bridgehead fused heterocyclic compounds which have miscellaneous pharmaceutical applications (Akpanisi, 2004, Katrizky *et al*, 2004; Mohammed, 2009). Their structural pattern is well established in pharmaceutical agents, particularly psychotropic agents such as risperidone and paliperidone (Khan. 1997; Jeste *et al* 2000).

Triazolo heterocycles occupy a central position in modern heterocyclic chemistry, because they form an important recognition element in biologically active molecules (Romain *et al*.,2010).

Bridgehead-fused triazolo triazines contain three nitrogen atoms in both a five membered ring and a six membered ring fused together to form a bridgehead-fused ring system (Akpanisi, 2004).The triazolotriazine is capable of exhibiting diazoakyllideneamine-triazole ring chain tautomerism. This isomerism is also known as the Dimroth rearrangement (Akpanisi, 2004). These heterocyclic fused systems have attracted much interest since the last decades.

The global effort to eradicate cancer has motivated us to search for new products with analgesic and anti-inflammatory activities that could join the list of non steroidal anti-inflammatory drugs (NSAIDs) that could provide better therapeutic activity. Research into inflammation has shown that it is a complex process involving many biochemical pathways and a variety of agents and mediators (Davies et al, 1989). Inflammation is a tissue reaction by the body to injury which is classically characterized by swelling (tumor), pain (dolor), redness (rubor) as well as loss of function (Macpheson, 1992). The anti-inflammatory activities of bridgehead-fused heterocycles have been attributed to their ability to irreversibly inhibit prostaglandin G/H synthase by acting on the active site of the enzyme (Laurence, *et al*,1997).

The chemistry of bridgehead fused 1,2,3-triazolo [1,5-a] pyrimidine **(1)** is well documented (Akpanisi, 2004 and Odin & Akpanisi, 2007).

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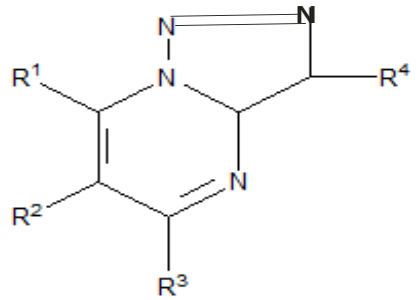
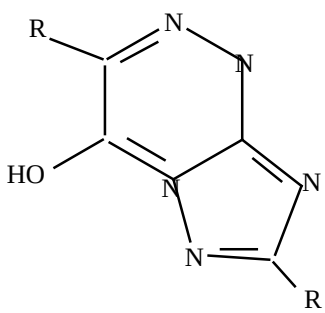


[1]

The bridgehead-fused triazolo triazines systems of types (2) : 1,2,4-triazolo[3,4-c]-1,2,4-triazine (Reda *et al*, 2010 and Duanis *et al*,1975; (3):2,4-diarylpyrazolo[1,5-a]-1,3,5-triazine (Sun, 2013); (4): 2-amino-4-thioxo-3-aryl-pyrazolo[1,5-a]-triazine (Sun, 2013); (5): 1,2,4-triazolo[1,5-a]-1,3,5-trizine (Federica *et al*, 2011) and their known pharmacological applications have previously been prepared.

In continuation of our research programme directed towards the preparation of heterocycles with pharmaceutical importance (Odin, *et al*, 2013), Bridgehead-fused-1,2,3,triazolo[1,5-c]-1,2,4-triazines of types 12,14 and 16 to the best of our knowledge have not been reported . In this paper we report the total synthesis of these novel fused heterocyclic systems (12, 14 and 16) and their analgesic/anti-inflammatory properties.



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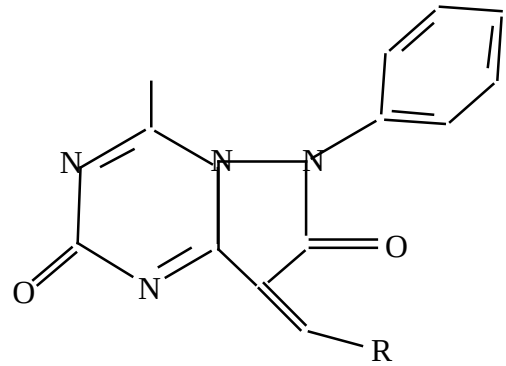
[2]



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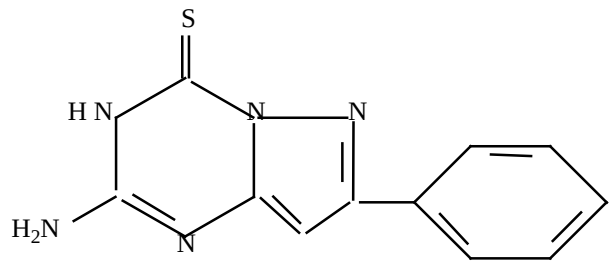

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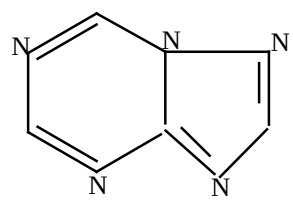

[5]

II. Materials and Methods

All chemicals were obtained from different sources and were used without further purification. The melting points were determined on a SMP3 melting apparatus and are reported in °C uncorrected. Column chromatography was performed in Scharian silica gel 60 (70-230 mesh). HPLC separations were performed in a Bulk scientific 500 apparatus using a reverce phase lichrosper 100RP-18 (5μm) column at room temperature (eluent: methanol :water 8:2 v/v).

a) Spectra analysis

The methods of Predrag et al, 2000; Hujo et al, 1957 and Sigites et al, 2005 were adopted and modified.

The identity of the compounds was confirmed by IR and MS methods as reported by Predrag et al,

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2000, Mohammed et al, 2009 and were recorded in Cm^{-1} on a Bulk Scientific 500 Spectrophotometer and Schimadzu GCMS-QP-1000E mass spectrophotometer at 700eV respectively. Elemental analysis was on a Perkin-Elmer analyzer 2400. Proton Spectra (^1H NMR) and ^{13}C NMR were recorded on a Varian Gemini 2000 spectrophotometer operating at 200 and 50 MHz respectively.

b) Animals

In this study we followed the" principle of laboratory animal care" (NIH publication No 85-23, revised 1985). We employed Swiss Albino mice (16-40g) for the toxicity and analgesic studies, while the anti-inflammatory studies employed adult Wister rats (16-300g). All the animals were maintained at the Animal Facility Centre of Kogi State University at standard conditions and temperature (25°C) and fed with standard diet (Pfizer feed, PLC, Lagos) and water *adlibitum.*

c) Synthesis

The synthetic routes for all the compounds are outlined in scheme 1. The details are given below:

d) Thioureasulphanilic acid(7)

This compound was produced according to the methods of Maryanoff *et al*, 1986 and Romain *et al*, 2010. Thiourea (4 g, 0.08 mol) and sodium molybdate (5.2 g, 0.057 mol) were dissolved in a 1:1 mixture of chloroform/methanol (16 ml). This solution was added to H_2O_2 (0.5 ml, 12 mmol). The reaction mixture was stirred at 25°C for 1h and was separated by preparative silica gel thin layer chromatography (eluent: 40-60 petroleum ether/ethyl acetate (2:3 v/v) to give thioureasulphanilic acid. Yield :15.72 g (82.4%). m.p. 163-164°C. IR: 3290 (NH_2), 2990 (C-N), 3600 ($O\text{-}H_{aliphatny}$). ^1H NMR: 2.4 (s, NH_2), 5.26 (s, C-H). ^{13}C NMR: 90 (C). Anal. Cal. For $C_1H_6N_2O_3S$: C, 8,20, H, 4.14, N,32.86, O, 48.0, S, 21.94%. Found: C, 8.18, H,4.12, N, 32.84, O, 47,1, S, 21.93%.

e) Hydrazine carboximidamide (8)

The The method of Romain *et al*, 2010 was adopted and modified. 300 mg, 1.5 mmol of thioureasulphanilic acid (7) was mixed with hydrazine (110 mg, 1.1 mmol) in anhydrous acetonitrile (1.2 mL). The mixture was stirred at 35°C for 2 h. The reaction mixture was concentrated to a faint blue crystals. Yield: 7.8 g (76.3%). m. p 159-161°C. 1R: 3292 (NH_2), 3351 (NH), 1650 (C=N)

^1H NMR : 4.62(s.NH_2), 4.65(s.NH).

^{13}C NMR :163 (C-NH) .

Calculated for $C_1H_6N_4$: C, 16.21,H, 8.07, N,75. 63%. Found : C, 16.19, H, 8.05, N,75.60%

f) 5-amino-1H-1,2,3-triazole (9)

The method of Romain *et al*, 2010 was employed. Trimethylortho formate (1.5 ml) was added to 420 mg, 2.8 mol compound **(8)** and heated for 24 h at 145°C in a sealed vessel. The resulting mixture was cooled to room temperature and filtered. The filterate was washed with 30% ethanol in CH_2Cl_2, concentrated and purified using column chromatography (eluent : n-hexene/ethyl acetate 5:2 v/v). The result was yellow solid. Yield 180 mg, 70%. m.p 143-147°C. IR: 3293 (NH_2), 3311 (NH), 3021 (C-N). ^1H NMR: 3.9 (d 4H), 4.0 (m, NH protons), 4.20 (m, NH_2 protons), 5.8 (m. C-H). ^{13}C NMR: 79.9 (CH), 80.2 (CNH).

Calculated for $C_2H_6N_4$: C,27.90, H,7.03, N,65.08%. Found: C,27.70, H,7.02, N,65.06%.

g) 1H-1,2,3-triazolo-5-diazonium salt (10)

This was prepared according to Draganov and Naicheva, 1981 and Odin *et al*, 2004. 200 ml of 8% aqueous HCl was added to 0.10 mol 5-amino-1H-1,2,3-triazole **(9)** in a reaction vessel while stirring. The mixture was cooled to 5-10°C for a period of 1 h. At this temperature, a solution of sodium nitrite (3.5 g dissolved in 20 ml H_2O) was added while the pH was held at 2.

h) Reaction of 1H-1,2,3-triazolo-5-diazonium salt(10) with active methylene compounds

i. *General Procedure*

The methods adopted were that of Akpanisi, 2004, Ahmad et al, 2004 Nataliya et al, 2010, Kin and Yoon, 2004, Brehme et al, 2007, Parmeter, 1959 and Patentent US 7122548, 2006. A solution of compound **10** (0.88 g, 0.006 mol) in aqueous ethanolic solution (20.0 ml) was added to cooled solutions of β-diketone (0.2 mol), β-diester (0.2 mol) and β-keto ester (0.2 mol) respectively. The diazonium salt was added proportion-wise while stirring over a period of 35 min at temperature 0-5°C. The pH of the reaction medium was lowered by adding sodium acetate. At the end, the reaction mixtures were intermittently stirred for another 2.5 h. The crude products were filtered, washed with cooled water and recrystallized from dimethylformamide-water to afford the corresponding hydrazones **(11)**, **(13)** and **(15)** respectively.

i) 1H-1,2,3-triazolo-2-methyl-2-hydrazonoketone (11)

Yield: 2.1 g (63%), m.p. :283-285°C. IR: 3020 (C-N arom), 1670 (C=O), 3252 (CH arom), 2929-2861 (C-H stretch), 2385(CH_3 groups), 3140-3138 (2NH), 3022 (C-N), 1645 (C=N). ^1H NMR: 9.11 (s, NH), 7.21-7.19 (d, Ar-H), 10.12 (s, CHOO), 2.16 (s, CH_3). ^{13}C NMR: 169.4 (-$COCH_3$), 138 (C=N), 88.6 (CH_3). Anal. Calculated for $C_6H_{10}N_5O$: C, 42.84, H, 6.0, N, 41.65, O, 9.51%. Found: C,42.82, H, 5.9, N,41.63, O,9.49%.

j) 1H-1,2,3-triazolo-2-methoxy-2-hydrazonoester (13)

Yield: 3.2 g (71%), m.p. 289-290°C. IR: 3159, 3143 (2NH), 1623 (C=O), 3024 (C-N), 1644 (C=N), 2928-2918 (C-H stretch). ^1H NMR: 9.14 (s, NH), 2.14 (s, CH3), 720-756 (Ar-H). ^{13}C NMR: 69.5 (C=O), 149 ($COCH_3$), 139 (C=N). Anal. Calculated for $C_6H_{10}N_5O_3$: C,

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36.00, H, 5.04, N, 35.03, O,23.98%. Found: C,35.98, H,5.02, N, 35.01, O, 23.96%.

k) 1H-1,2,3-triazolo-2-methyl-2 hydrazonomethylester (15)

Yield: 2.9 g (77%), m.p. 294-298°C. IR: 3154, 3148 (2NH), 1620 (C=O), 3023 (C-N), 1644 (C=N), 2927-2867 (C-H stretch). ^{1}H NMR: 9.16 (s, NH), 2.16 (s, CH_3), 721-725 (Ar-H). ^{13}C NMR: 69.8 (C=O), 148 ($COCH_3$), 138 (C=N). Anal. Calculated for $C_6H_{10}N_5O_2$: C, 39.12, H, 5.47, N, 38.03, O, 17.37%. Found: C, 39.10, H, 5.45, N, 38.01, O, 17.35%.

l) Synthesis of Bridgehead-fused heterocyclic compounds 12, 14 and 16

i. *General Procedure*

We employed the general procedures of Akpanisi, 2004; Ahmad, *et al*, 2004 and Nataliya, *et al*, 2010. A solution of the hydrazones **11**, **13** and **15** (2 mmol) respectively in acetic anhydride was refluxed for 4 h. The mixture was allowed to cool to room temperature, the solvent evaporated and the residue left was re-crystalized from dimethyformamide-water to afford the corresponding fused heterocyclic systems **12** (pure colourless), **14** (pure light yellow) and 16 (pure colourless).

m) Bridgehead-fused-5-methyl -6- methylketoне 1,2,3-triazolo[1,5-c]-1,2,4-triazine (12):

Yield: 1.8 g (70%).
m.p. 298-300°C. IR: 1500 (C=Carom), 3020 (C-Narom), 1690 (C= 0), 3250 (CH arom),
2929-2861(C-H stretch), 2 671 (C=0 stretch),
2385 (CH3 groups).
^{1}H NMR :7.21-7.59 (d, Ar-H),
4.6 (d,2H), 3.7 (m, 4H),
^{13}C NMR :
111.20 (C=C) , 67.0 (C=0), 88.6 (CH).
Anal. calculated for :$C_7H_7N_5O$
C, 47.45, H, 3.98, N 39.54, O, 9.03%
Found: C, 45.43, H, 3.96, N, 39.52, O.9.01%.

n) Bridgehead-fused -5- methoxy -6- methylester,1,2,3 triazolo[1,5-c]-1,2,4-triazine (14)

Yield: 2.2 g (73%). m.p. 299-301°C. IR: 1500 (C=C arom)
1501 (C=C), 3021 (C-N arom), 1692 (C=0), 3250 (CH arom)
2928-2860 (C-H stretch), 2691, (C=0 stretch)
2385 (CH_3 groups)
^{1}H NMR :
4. 62 (S, 1H), 3.7 (m, 2H), 6.1 (m, CH2), 5. 76 (m, CH3)
^{13} C NMR : 159.0 (C- arom), 111.2 (C=C),
169.4 (-O-C=O), 67.0 (C=O), 64.4 (-CH2), 16.2 , 55. 0 (CH_3), 88. 6 (CH).
Anal calculated for $C_7H_7N_5O_3$
C, 40.19, H, 3.37, N,33.49, O,22.95%
Found: C, 40.17, H,3.35, N,33.45, O, 22.93%

o) Bridgehead-fused-5-methyl-6-methylester-1,2,3-triazolo[5,1-c]-1,2,4-triazine (16)

Yield: 2.45 g (77.3%).
m.p. 297-299°C. 1R : 2911-2818 (Arom, C-H).
714 (C-H out of plane bending). 1096 (C-H in a plane bend).
1504 (C=C arom), 3022 (C-N arom), 1093 (C=0), 2928-2860 (C-H stretch).
^{1}H NMR : 4. 62 (s, 1H), 3.7 (m, 2H)
6. 19 (m, CH2), 5.76 (m. CH3, 9.07, (d.3H), 9.23 (d, 4H),
9.07 (s.5H), 9.23, (s.6H), 9.07, (3.H)
^{13} C NMR : 159.0. (C triazine), 113.4 (C=C), 169.4 (-COO), 67.0 (C=O), 64.4 (-CH2), 16.2 (CH3), 131.2, 127.6, 123.6, 151.4 (CH and C).
Anal. calculated for: $C_7H_7N_5O_2$:C,43.12,
H, 3.65, N, 36.26, O, 16.56%
Found: C,43.10, H, 3.35, N, 33.45, 0.22.93%.

p) Acute toxicity test (LD_{50})

This was determined in Swiss Albino mice by intraperitoneal (i.p) and oral routes according to the methods of Amos et al ,2002, Azuine et al, 1996,Gurad et al, 2011and Lork, 1983 .The animals were divided randomly into seven groups of five mice each. Widely differing doses of 10, 100, 1000, 1500, 2000, 3500 and 5000 mg/kg were administered intraperitoneally and orally. The animals were monitored for 72 h. At the end of the experiment, the animals were sacrificed and then autopsied and examined microscopically for any pathological changes. This was established for the three compounds **12, 14** and **16**.

q) Test for Analgesia

The analgesic property of the compounds was determined on Swiss Albino mice intraperitoneally as described by Koster *et al*, 1959 and Azuine *et al*, 1996. Twenty four (24) mice were treated with compound 12 (100 and 200 mg/kg) intraperitoneally 30 min, 60 min and 90 minutes prior to injection of 0.75% acetic acid (10 ml/kg i.p) (Tables 1and 2). This was to determine the dose and time dependence of the compound. The degree of suppression of writhen episodes were measured and compared to the negative control (10 ml/kg) acetic acid. Indomethacin (10 mg/kg) treated animals were used as the positive control. The test was also repeated for compounds **14** and **16** respectively. This was to establish the effect of substituent on analgesia (Tables 3 and 4).

r) Anti-inflammatory Studies

The methods of Winter *et al*,1962 and Azuine *et al*, 1996 and Ratheesh and Helen, 2007 were employed and modified. Wister rats of either sex weighing between 160-275 g were divided into six groups of five rats each. Inflammation of the right hind paw was induced by injecting 0.05 ml of 50% solution of fresh egg albumin into the sub planter surface. Group 1 animals received

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normal saline (20 ml/kg) and were designated as negative control. The second and third groups were administered compound **12** doses of 100 mg/kg and 200 mg/kg respectively by intraperitoneal route. Groups four and five animals were administered compounds **14** and **16** doses of 200 mg/kg respectively. While group six animals were given acetyl salicylic acid (200 mg/kg) injected intraperitoneally and served as positive control. All the drugs were administered 30 min before the subplanter injection of the phlogistic agent. The paw volume was measured after every 20 min for a period of 120 min by a volume displacement method (Azuine *et al*, 1996) using a plethysmometer (Table 5). The average inflammation, percentage inflammation and percentage inhibition of oedema were calculated on each dose and recorded (Tables 6,7 and 8). According to the method of Azuine *et al*, 1996, the average inflammation was calculated from the formular: L_t-L_O. Where L_t is the linear circumference at time t and L_O, the linear circumference at zero time (Table 6). The percentage inflammation was calculated as follows:

A/B x100. Where A is the average inflammation of treated group at time t, while B is the average inflammation of control at the same time (Table 7) (Azuine *et al*, 1996). The percentage inhibition of oedema (Table 8) is calculated as follows: 100-Percentage inflammation.

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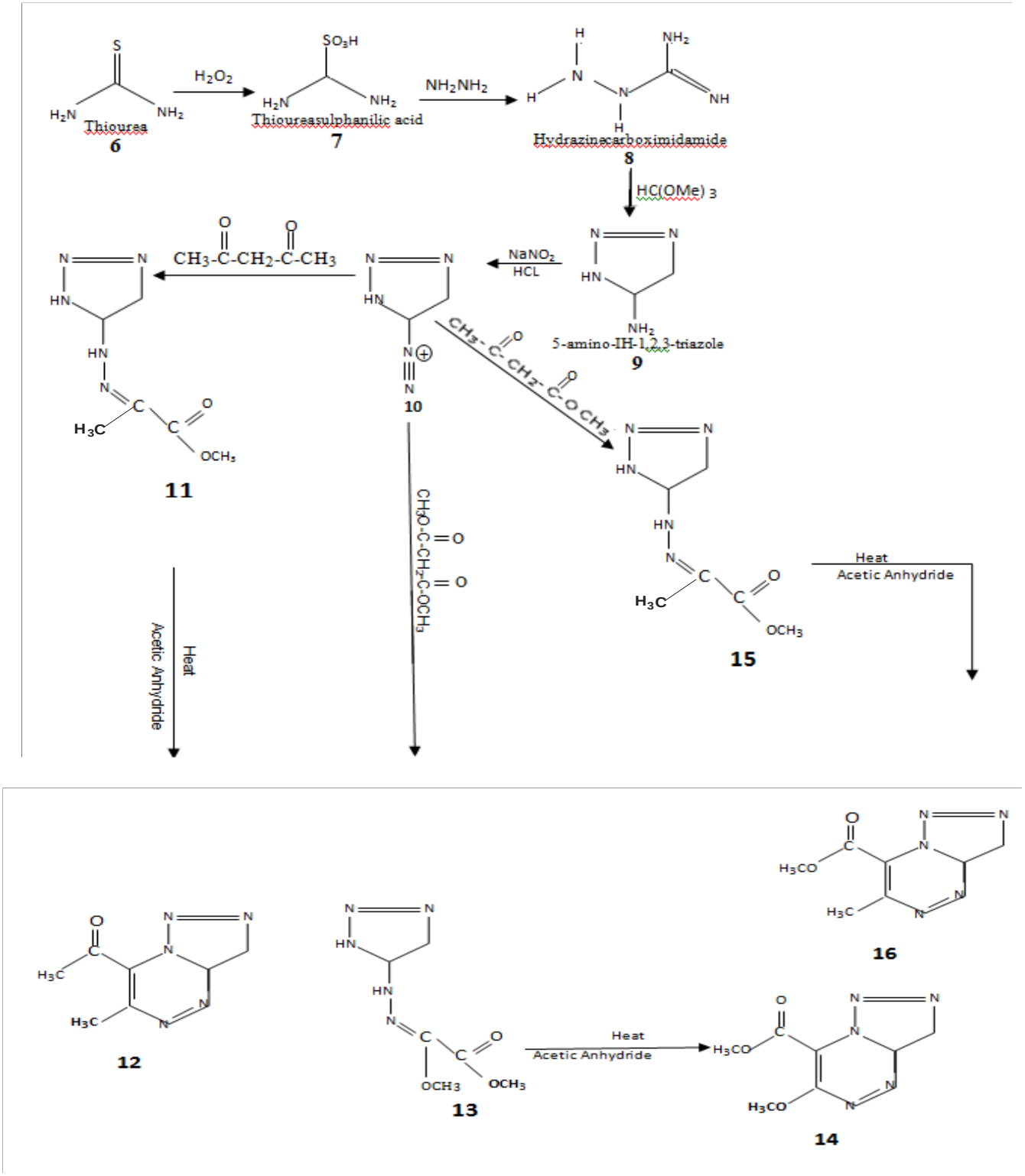

Scheme 1 : Synthesis of bridgehead-fused 1,2,3 triazolo [1,5-c] 1,2,4-triazines

III. Results

Thioureasulphonic acid (2) was produced by reacting thiourea with sodium molybdate dissolved in a mixture of chloroform/methanol. The solution which was added to aqueous H2O2was separated by preparative silica gel thin layer chromatography. Compound (2) when mixed with hydrazine in anhydrous acetonitrile gave a solid hydrazinecarboximidamide **(3)**. Addition of trimethyl orthoformate to compound (3) and heated for 24 h in a sealed vessel afforded 5-amino-1H-1,2,3-triazole **(4)**, which was subsequently added to aqueous HCl and a solution of sodium nitrite. This reaction furnished 1H-1,2,3-triazolo-5-diazonium salt **(5)**. A

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solution of compound (5) in aqueous ethanolic solution was separately added to cooled solutions of β-diketone, β- diester and β-keto ester respectively. The crude products were filtered, washed with cold water. Recrystalization from dimethlformamide-water afforeded the corresponding hydrazones **(11), (13)** and **(15)**. Refluxing the hydrazones for several hours and recrystalizing the residue from DMF/H_2O yielded the three novel products: Pure colourless bridgehead-fused-5-methyl-6-methyl ketone-1,2,3-triazolo-[1,5-c]-1,2,4-triazine (12), Light yellow bridgehead-fused-5-methoxy-6-methylester-1,2,3-triazolo-[1,5-c]-1,2,4-triazine (14) and pure colourless bridgehead-fused-5-methyl-6-methylester-1,2,3-triazolo-[1,5--c]-1,2,4-triazine(16). (scheme 1).

The structural assignment of the synthesized compounds is based on the spectral data. In the IR spectrum of compound (7), absorption band at 2990 represents C-N stretching. The NH_2 absorption band appeared at 3290 cm^{-1}, while 3600 cm^{-1} represents OH aliphatic ring indicating complete oxidation.

^1H and ^{13}C NMR studies of this compound confirmed the structure. In ^1H NMR spectra data, compound (7) shows a singlet at δ 2.4 due to NH_2 proton. The –CH protons in the compound showed a singlet at δ5.26.

In compound **(8)**, the hydrogen bonded N–H stretching appeared at 3351 cm^{-1}, while the NH_2 absorption band appeared at 3292 cm^{-1}, and that at 1650 cm^{-1} is characteristics of C=N stretching. In the 1H NMR spectrum, the singlet for HN_2 and NH protons appeared in the region δ4.62 and δ4.65 respectively; while in ^{13}C NMR spectrum, a characteristic signal appeared for (CNH) in the range of δ163.

Addition of trimethyl ortho formate to compound (8) yielded compound (9). The IR spectrum of (9) showed broad bands at 33ll and 3293 cm^{-1} for hydrogen bonded N–H and NH_2 stretching respectively. The band at 3021 cm^{-1} indicating C–N stretching for NH and NH_2 protons were noticed in the regions δ4.0 and δ4.20 respectively. The C–H protons appeared at δ5.8. a characteristic signal for CHN in the ^{13}C NMR appeared at δ80.2, while that of (CH) was at δ79.9.

The three hydrazones: (11), (13) and (15) were produced when compound (10) was coupled with active methylene compounds: β-diketone, β-diester and β-ketoester respectively.

The IR spectrum of (11) showed a broad band at 3140-3138 cm^{-1} for hydrogen bonded 2NH stretching. The band at 3022 cm^{-1} indicated C-N stretching, while the band at 3252 cm^{-1} appeared for aromatic C-H stretching. The bands at 2929-2861 cm^{-1} were for C-H stretching, while that at 2385 cm^{-1} indicated CH_3 groups. The absorption band at 1645 cm^{-1} were located for C=N. The C=O stretching appeared at 1670 cm^{-1}. In the ^1H NMR spectrum of compound **(11)**, the singlet for –NH protons appeared in the region δ 9.11. The –CHOO protons and –CH_3 protons of the compound showed a singlet in the region δ 10.12 and δ 2.116 respectively. A characteristic signal appeared for (-$COCH_3$), (-C=N) and (CH_3) in the range of δ 169.4, δ 138 and δ 88.6 respectively in the ^{13}C NMR spectrum.

In compound **13**, 2NH stretching showed at 3159 and 3143 cm^{-1}. The band at 1623 cm^{-1} is assigned to C=O stretching, while the absorption bands at 3024, 1644, and 2928- 2918 cm^{-1} are characteristic of C-N, C=N and C-H stretching vibrations. In the ^1H NMR spectrum, the singlet for NH and CH_3 protons appeared at δ 9.14 and δ 2.14 respectively, while Ar-H protons were noticed at δ 720- 756. The ^{13}C NMR studies of this compound confirmed the structure. A characteristic signal appeared for C=O and $COCH_3$ in the range of δ 69.5 and δ149 respectively, while that of C=N were seen in the range of δ139.

In the IR spectrum of compound **15**, the absorption bands at 3154 and 3148 cm^{-1} represent the hydrogen bonded N-H stretching. There were number of peaks at 1620 cm^{-1}, 3023 cm^{-1},1644 cm^{-1}, and 2927-2867 cm^{-1} representing C=O, C-N, C=N, and CH stretching respectively. In the 1H NMR spectra data, compound 15 showed a singlet at δ 9.16 due to N-H protons. The Ar-H protons appeared in the region of δ 7.21-7.55, while the –CH_3 protons in the compound showed a singlet at δ 2.16. In ^{13}C NMR spectrum, a characteristic signal appeared for –C=O, -$COCH_3$, and –C=N in the range of δ 69.8. δ148, and δ 138 respectively.

Compounds **12**, **14** and **16** were synthesized from the general procedure by refluxing the solutions of the hydrazones **11**, **13** and **15** respectively in acetic anhydride.

The IR spectrum of compound (12) showed C = C aromatic at 1500 cm^{-1}, while that of C–N aromatic appeared at 3020 cm^{-1}. The bands at 2929 – 2861 cm^{-1} appeared for C –H stretching while bands at 3250 and 2385 cm^{-1} were for C – H aromatic and CH_2 groups. The bands at 2671 cm^{-1} and 1690 cm^{-1} is characteristic of C=O stretching and C=O groups. In the ^1H NMR spectrum, the duplet for 2H and 4H protons appeared at δ4.6 and δ 3.7 respectively, while in ^{13}C NMR spectrum, a characteristic signal appeared for C=C and C = O in the range of δ111.2 and δ67.0 respectively.

The IR spectrum of compound **(14)**, there were numbers of peaks at 3021cm^{-1} , 1692cm^{-1},3250cm^{-1} and 2691cm^{-1} for C – N aromatic, C = O, CH aromatic and C = O stretching. The absorption band at 2928 – 2860 cm^{-1} were for aromatic C –H stretching.

In the ^1H NMR spectra data, compound (14) showed a multiplet at δ6.19 to 5.76 due to CH_2 and CH_3 protons.

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Some characteristic signals appeared for –C – O – O -, -(C=O) in the range of δ 169.4 and δ 67.0 respectively, while in the 13C NMR spectrum, that of CH_2, CH_3 and CH were located at δ 64.4, δ 55.0 and δ 88.6 respectively.

In the IR spectrum of compound (**16**), the absorption band at 2911 -2818cm^{-1} was for aromatic C – H stretching, while 714cm^{-1} represented C – H out of plane bending and 2928 – 2860 cm^{-1} was for C – H stretching. There were other peaks at 1504cm-1, 3022cm^{-1} and 2693cm^{-1} which were for aromatic C=C, aromatic C – N stretching and C = O stretching. In the ^{1}H NMR spectrum, compound (16) showed multiplets for CH_2 and CH_3 at δ6.19 to δ5.76 respectively.

In the ^{13}C NMR spectrum, some signals were noticed at δ113.4, δ169.4 and δ67.0 for C=C, -C-O-O- and C=O respectively. That of –CH_2 and CH_3 were located at δ64.4 and δ16.2 respectively.

The mass spectrophotometric studies performed on the synthesized compounds confirmed the molecular weight values.

The results of the analgesic and anti-inflammatory test are a s presented in figs. 1 and 2, tables 1,2,3,4,5,6,7 &8.

IV. Discussion

The structural assignment of the synthesized compounds was based on spectra data. The IR spectrum of compound **12** showed bands at 2671 cm^{-1} and 1690 cm^{-1} characteristic of C=O stretching and C=O groups, while that of compound **14** was noticed at 2691 cm^{-1} for C=O stretching. Similarly, the IR spectrum of compound **16** was observed for C=O stretching at 2693 cm^{-1}. This confirmed that the three heterocyclic systems have common functional groups.

Differing doses of 10mg/kg to 5000 mg/kg of compound **12**, **14** and **16** were selected so that the entire range of toxicity from high acute toxicity to virtual non-toxicity could be tested.

The weight of the animals after the text showed that they all gained weight. This was taken as a sign of having survived the acute intoxication.

The mice treated intraperitoneally up to 2000 mg/kg did not show signs of toxicity compared with control animals. Similarly, no significant effects were detected in animals treated orally with the compounds up to 5000mg/kg. This high dose only produces intense quietness. This effect was reversed within 3 hours. All the animals survived the test. That is, no death was recorded. This clearly demonstrates that the three synthesized compounds (**12**, **14** & **16**), even at high doses of 5000 mg/kg (5g/kg) were non-toxic to man.

From fig.1, it could be seen that the Bridgehead-fused compounds reduced the acetic acid induced writhing in mice. In control mice treated with 100mg/kg i.p acetic acid, the average writhing movement determined was 31 ± 1 (n = 3) (Table 1).

Pretreatment with 100mg/kg compound 12 30 min, 60 min and 90 min before the administration of the acid reduced the number of writhes to 56.98%, 31.18% and 23.81% of control. This is an indication that the effect of the compound (12) on pain increases with time as shown in fig 1 and table 1.

From fig. 1 and table 2, it shown that, pretreatment with 200mg/kg of the same compound (12) 30 min, 60 min and 90 min before the administration of the acetic acid reduced the number of writhes to 55.56%, 26.67% and 22.22% of control. Similarly, pretreatment with 200mg/kg of compounds **14** and **16**, 30min, 60min and 90min before the administration of acetic acid, reduced the number of writhes to 55.56%, 25.56%, 20.0% and 51.11%, 22.22% and 15.56% of control respectively (Tables 3& 4).

From fig 1, it is seen clearly that the analgesic effect of the Bridgehead-fused compounds (**12**, **14** and **16**) is time and dose dependent. In indomethacin (10mg/kg) treated mice, the number of writhes was reduced to 58.24% of control after 30min (fig. 1).

It is important to draw from here that the potential analgesic values residing in the compounds placed them as very strong drug candidate. This level of potency is highly remarkable.

The effect of the Bridgehead-fused triazolotriazines (compounds **12**, **14** & **16**) on fresh egg albumin-induced oedema in rats are shown in Tables 5, 6, 7 and 8.

From Table 6, it can be seen that in control animals, the sub planter injection of egg-albumin produced a local oedema after 20min.

From fig. 2, it can be said that compound **12** at 100mg/kg and 200mg/kg demonstrated a significant anti-inflammatory effect. The dose dependent effects of this compound in the egg-albumin induced paw oedema showed that the effect was real and not due to counter irritant activity.

In fig.2, it clearly showed that apart from being dose and time dependent, the actions of the Bridgehead-fused compounds on fresh egg albumin induced oedema also depends on substituent effect (compounds **12** **14** & **16**) . The average inflammation was below 0.20mm when the rat was pretreated with compounds **14** and **16** in the first 20min (Table 6), while that of compound **12** was 0.29 mm. At time 120min, there seems to be a complete inhibition of oedema by 84.48% and 91.38% for compounds **14** and **16** respectively, while compound **12** showed inhibition by 63.79%. The standard drug acetyl ssalicylic acid showed inhibition by 41.38% (Table 8) at the same dose of 200 mg/kg. This significant changes was probably due to the nature of the substituent on the triazine ring. Compound **12** contains one moderately activating group and a weakly deactivating group. Compound 14 has two electron withdrawing groups that deactivate the triazine ring which probably enhanced the percentage inhibition

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above that of compound **12**. On the other hand, compound **16** showed an ester group that moderately deactivate and one alkyl group that also moderately activate the ring.

The results of this work as indicated in Tables 5, 6, 7 & 8 and fig. 1 and 2 clearly demonstrate the significant anti-inflammatory properties of the Bridgehead-fused compounds (**12**, **14** & **16**). The suppression of oedema by the compounds may be due to the fused triazolo-triazine rings.

The mode of action

The bridge head fused compounds (**12**, **14**, **16**) including Acetyl salicylic acid are among NSAIDs (Non steroidal anti – inflammatory drugs). The mechanisms of action of these systems may be due to their ability to irreversibly inhibit prostaglandin G/H synthesis by acting on the active site of the enzyme. They prevent the formation of products including thromboxane, prostacyclin and other prostaglandins (Laurence, *et al*, 1997).When a tissue is injured or stimulated, prostaglandin synthesis in that tissue increases.

The prostaglandins are mediators of inflammation and they also sensitize nerve endings, lowering their threshold of response to stimuli and the tenderness of inflammation (Laurence, *et al*,1997).

The fact is that a drug that prevents the synthesis of prostaglandins is likely to be effective in relieving pain due to inflammation of any kind. This is how acetyl salicylic acid (aspirin) and other non steroidal anti-inflammatory drugs (NSAIDs) act (Laurence, *et al*, 1997). Meaning that NSAIDs act by inhibiting cyclo-oxygenase (prostaglandin G/H synthase). This shows that the synthesized compounds will relieve pain when there is some tissue injuring with consequent inflammation.

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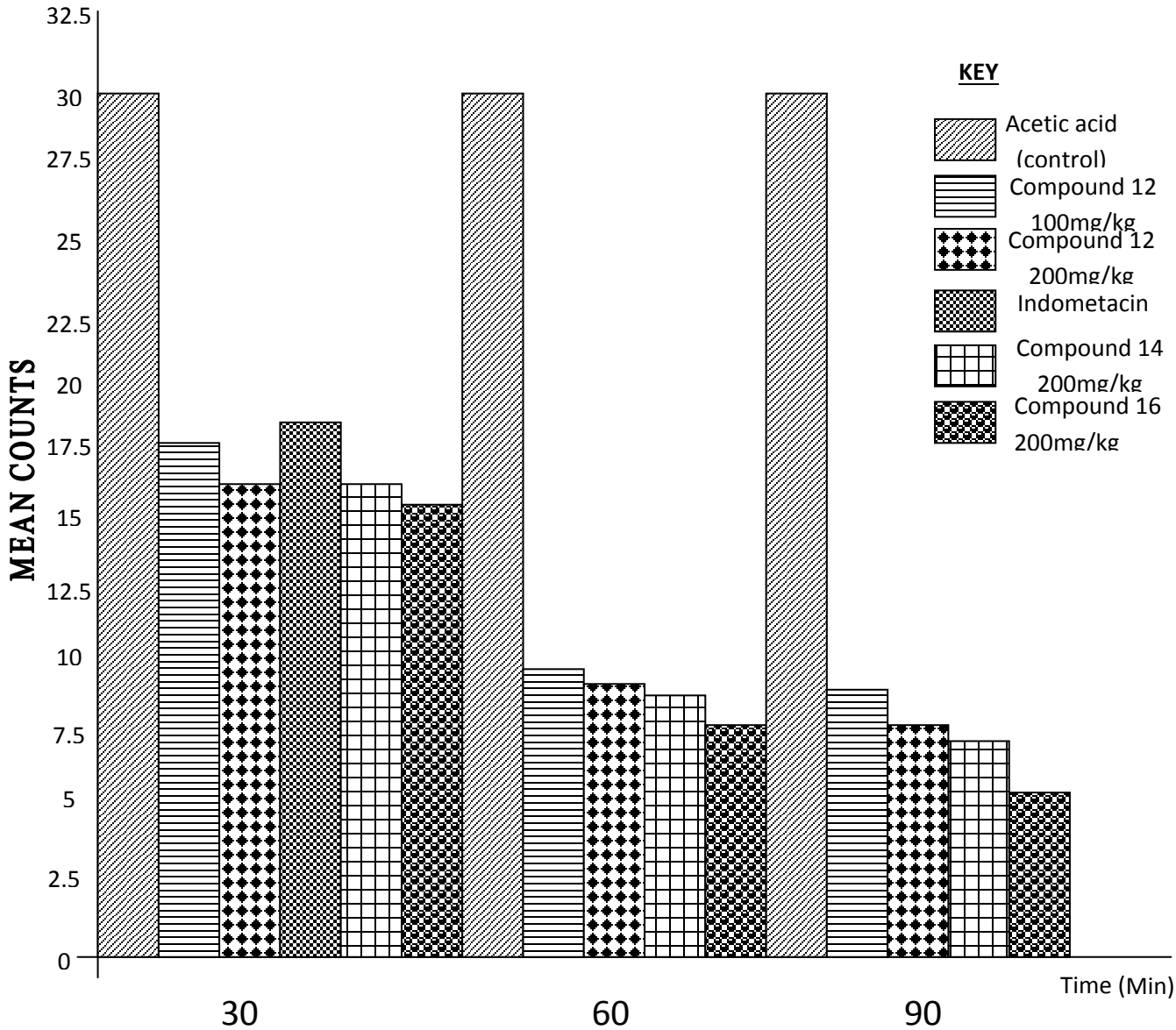

Figure 2 : Mean of Analgesic Writhing of 100 / 200 mg/kg

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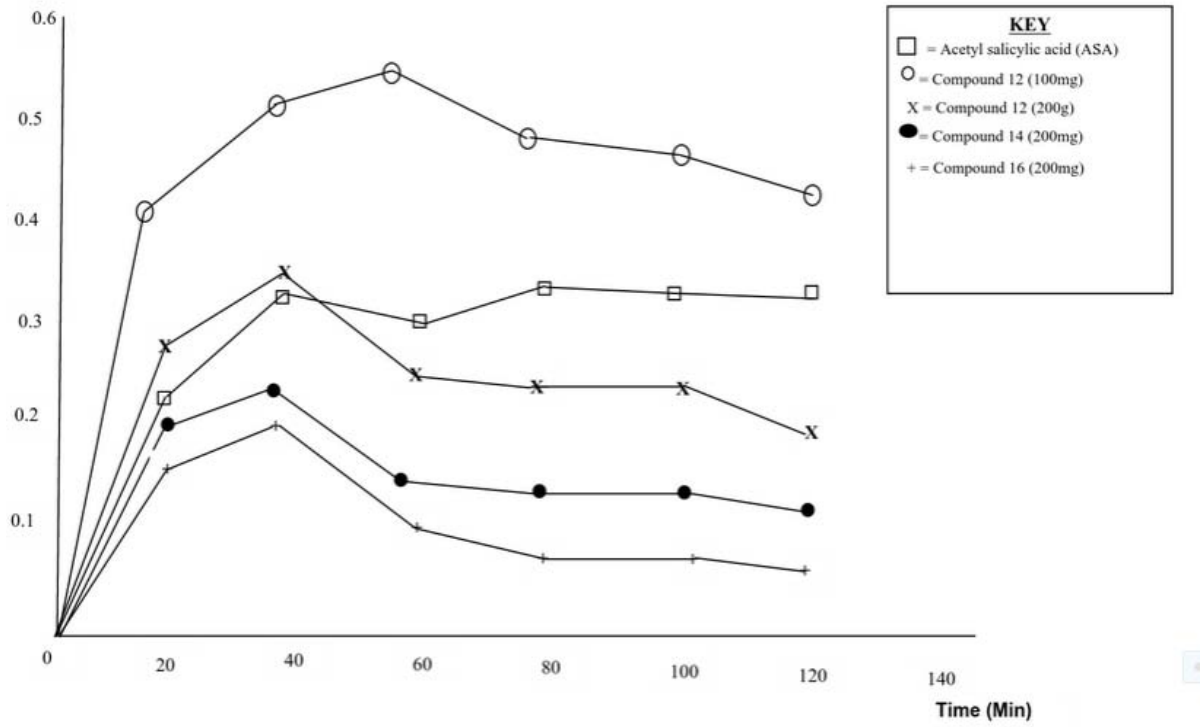

Figure 3 : Comparative test of Bridgehead-fused compounds on egg albumin induced paw oedema in rats. N = 5

Table 1 : Number of Writhing induced by 0.75% acetic acid in mice Pretreated with 100mg/kg Compound 12

Animal	Weight (g)	Dose (ml)	Time (min)	No. of Writhes
NMT	38.3	0.38	0	29 Negative
HDN	31.0	0.31		31 control (Acetic acid)
BKH	39.5	0.20		33
TLN	36.8	0.37		18
TL/BK	39.3	0.39	30	16
RH/TL	31.0	0.31		19
NM	37.7	0.38		10
HDM	31.8	0.32	60	11
BKN	29.1	0.29		8
TLM	30.0	0.30		6
HDT	30.5	0.31	90	9
BK/LE	30.6	0.31		9
RE	30.4	0.30		17
RHM	39.2	0.39	30	17
LHN	29.0	0.29		19
				Positive control (indomethacic)

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Table 2 : Number of Writhing induced by 0.75% acetic acid in mice pretreated with 200 mg/kg Compound 12

Animal	Weight (g)	Dose (ml)	Ti me (min)	No. of Writhes
HDN	35.5	0.18	0	28 Negative
BKH	34.6	0.17		30 control
LLT	40.0	0.20		32
RAE	40.1	0.20		17
RL/NT	37.2	0.19	30	15
LA/TL	37.5	0.19		18
TLE	39.8	0.20	8	
REN	40.1	0.21	60	9
LEN	34.1	0.17		7
HD	37.4	0.19		5
RL	36.5	0.18	90	10
BK/N	37.6	0.19	5	

Table 3 : Number of Writhing induced by 0.75% acetic acid in mice pretreated with 200 mg/kg Compound 14

Animal	Weight (g)	Dose (ml)	Time (min)	No. of Writhes
HD	36.5	0.18	0	27 Negative
RAE	35.4	0.17		32 control
LEN	39.5	0.20		31
RL	40.1	0.20		17
HDN	39.2	0.19	30	16
RL/NT	4.5	0.19		17
BK/N	39.8	0.20		7
LLT	40.1	0.21	60	9
TLE	39.1	0.17		7
REN	37.4	0.20		6
BKH	38.5	0.21	90	5
LA/TL	37.6	0.17		7

Table 4 : Number of Writhing induced by 0.75% acetic acid in mice pretreated with 200 mg/kg Compound 16

Animal	Weight (g)	Dose (ml)	Time (min)	No. of Writhes
HDN	35.7	0.19	0	29 Negative
BKH	34.8	0.17		28 control
LLT	42.7	0.21		33
RAE	40.3	0.20		16
RL/NT	37.4	0.19	30	16
LA/TL	37.7	0.19		14
TLE	40.0	0.20		6
REN	40.3	0.20	60	8
LEN	34.3	0.17		6
HD	37.6	0.19		4
RL	36.7	0.18	90	5
BK/N	37.8	0.19		5

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Table 5 : Paw Volume (mm)

Treatment Group	0 min	20 min	40 min	60 min	80 min	100 min	120 min
Control Normal Saline 20ml/kg	0.63	1.10±0.12	1.24±0.13	1.27±0.11	1.18±0.06	1.19±0.06	1.21±0.06
Compound 12 100mg/kg	0.64	1.04±0.04	1.18± 0.01	1.20±0.04	1.11±0.03	1.11±0.06	1.08±0.04
Compound 12 200mg/kg	0.65	0.94±0.06	1.03±0.06	0.91±0.06	0.90±0.06	0.90±0.06	0.86±0.05
Acetyl Salicylic Acid 200mg/kg	0.67	0.90±0.03	0.99±0.04	0.97±0.03	1.01±0.05	1. 01±0.05	1.01±0.04
Compd.14 200mg/kg	0.68	0.86±0.13	0.89±0.12	0.80±0.07	0.79±0.08	0.79±0.05	0.77±0.03
Compd.16 200mg/kg	0.68	0.83±0.09	0.86±0.08	0.77±0.04	0.74±0.03	0.74±0.02	0.73±0.02

Table 6 : Average Inflammation (mm) of the Right Hind Paw

Treatment Group	0 min	20 min	40 min	60 min	min	100 min	120 min
Control Normal Saline 20ml/kg		0.57	0.61	0.64	0.55	0.56	0.58
Compound 12 100mg/kg		0.40	0.54	0.56	0.47	0.47	0.44
Compound 12 200mg/kg		0.29	0.38	0.29	0.25	0.25	0.21
Acetyl Salicylic Acid 200mg/kg		0.21	0.32	0.30	0.34	0.34	0.34
Compound 14 200mg/kg		0.18	0.21	0.12	0.11	0.11	0.09
Compound 16 200mg/kg		0.15	0.18	0.09	0.06	0.06	0.05

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Table 7 : Percentage inflammation (%) of Right Hind Paw

Treatment Group	0 min	20 min	40 min	60 min	80 min	100 min	120 min
Compound 12 100mg/kg		70.18	83.53	87.50	85.45	83.9	75.9
Compound 12 200mg/kg		50.88	62.23	45.31	45.45	44.6	36.2
Acetyl Salicylic Acid 200mg/kg		36.84	52.46	46.88	61.82	60.7	58.6
Compound 14 200mg/kg		31.58	34.43	18.75	20.00	19.6	15.5
Compound 16 200mg/kg		26.32	29.51	14.06	10.91	10.71	8.62

Table 8 : Percentage inhibition of Oedema (%)

Treatment Group	20 min	40 min	60 min	80 min	100 min	120 min
Compound 12 100mg/kg	9.82	11.47	12.50	14.56	16.07	24.14
Compound 12 200mg/kg	36.12.	37.77	54.09	54.55	55.30	63.79
Acetyl Salicylic Acid 200mg/kg	23.16	27.59	33.12	38.18	39.29	41.38
Compound 14 200mg/kg	64.42	65.57	81.25	80.00	80.36	84.48
Compound 16 200mg/kg	70.49	73.68	85.94	89.09	89.29	91.38

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Triarylantimony(V) Dicarboxylates: Synthesis, Characterisation and Reactions

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Abstract- A series of new triarylantimony(V) dicarboxylates of the general formula Ar_3SbL_2 (where Ar = $C_6H_5$and L = $C_6H_5CONHCH_2COO^-$, $C_6H_2(OH)_3COO^-$, $C_6H_5COO^-$, $C_6H_5C_2H_2COO^-$, $C_6H_4(OH)COO^-$, $(C_6H_5)_2(OH)C.COO^-$) have been prepared by the reaction of triarylantimony(V) dichloride and a carboxylic acid in the presence of triethylamine as well as the metathesis of sodium or silver salt of the carboxylic acid andtriarylantimony(V) dichloride. The newly synthesized compounds have been characterized by conventional methods. A tentative trigonalbipyramidal structure is suggested in which (OCOR) group occupy axial position and the three organic groups are situated at the equatorial position. The melting points of compounds did not change even after prolong stirring with water at room temperature for several hours indicating their hydrolytic stability.

Keywords: Triarylantimony, Dicarboxylates, Hydrolytic stability, IR spectra, NMR spectra, Metathesis, Chelate.

GJSFR-B Classification : FOR Code: 259999

TRIARYLANTIMONYVDICARBOXYLATESSYNTHESISCHARACTERISATIONANDREACTIONS

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Keywords: triarylantimony, dicarboxylates, hydrolytic stability, ir spectra, nmr spectra, metathesis, chelate.

I. Introduction

Voluminous amount of work done on the chemistry of organic derivatives of antimony(III) and antimony(V) (Yadav 2012[a], Yadav 2013[a], Yadav 2014[a] and Yadav 2014[b]). As a result a variety of carboxylate derivatives, particularly organoantimony(V) were synthesized and characterized by various group of workers. The carboxylate derivatives were obtained by different routes, *e.g.* by oxidation of tertiary antimony(III), the anionic exchange or by salt precipitation reactions (Doak *et al.*1965).

The use of lead tetraacetate as oxidizing agents towards triorganoantimony(III) derivatives resulted in the formation of triorganoantimony(V) dicarboxylates.

$$Ar_3Sb + Pb(OCOR)_4 \rightarrow Pb(OCOR)_2 + Ar_3Sb(OCOR)_2 \ldots\ldots \quad (1)$$

Where, R= Me, Pr, or Bu

Interaction of triarylantimonydihydroxide with carboxylic acids, *viz*; formic acid could lead to the formation of triarylantimony(V) dicarboxylates (Chang *et al.*1975, Goal & Ridley 1972 and Hevyanek *et al.* 1978).

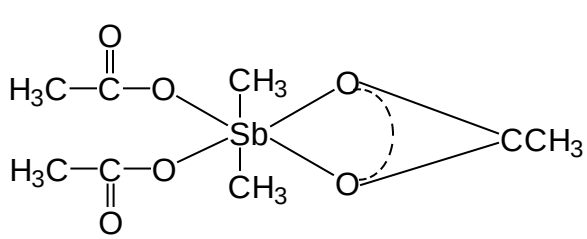
$$Ar_3Sb(OH)_2 + 2HCOOH \rightarrow Ar_3Sb(OCOH)_2 + 2H_2O \ldots\ldots \quad (2)$$

A series of triorganoantimony(V) dicarboxylates has been obtained by the reaction of triorganoantimony oxides with a number of carboxylic acids. Antimony oxides used in this reaction were preformed by the reaction of triorganoantimonydihalides with silver halides (Chang *et al.* 1975).

$$R_3SbO(\text{or } R_3SbX_2 + Ag_2O) + 2R'OOH \rightarrow R_3Sb(OCOR')_2 + H_2O \ldots\ldots\ldots\ldots \quad (3)$$

The above reaction does not go well with all the acids and it has been reported that the reactions with terphthalic acid, succinic acid and sebacic acids, however, result in the formation of polymeric products (Doak *et al.*1974). Goel and Ridley (Goel & Ridley 1972) were the first to make a systematic and comprehensive study on the physico-chemical parameters of trimethylantimony(V) derivatives of fluoro, chloro, bromo and cyano-acetic acid.

A few organoantimony(V) carboxylates of the type $R_2Sb(OCOR')_3$ and $R_4SbOCOR'$ have also been prepared. Based on the infrared and Raman data, an octahedral structure with two mono dentate and one chelating acetate groups has been proposed for $(CH_3)_2Sb(OCOCH_3)_3$ (Meinema & Noltes 1972).



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The synthesis, structure and biological activity of the tertiary substituted arylantimony(V) dicarboxylates

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has been reported by Kiran *et al.* (Singhal *et al.* 1987). Based on spectroscopic and some solution phase studies a trigonalbipyramidal structure has been suggested for tetraaryl antimony(V) carboxylate derivatives by Raj and co-workers as has been reported in case of tetraphenylformate (Premraj *et al.* 1984).

Kumar Swami (Kumara *et al.* 1999) synthesized mixed halo acetate derivatives of the general formula $R_2SbCl(OAc)_2$. The crystal structure study revealed that both the acetate group act as bidentate ligand leading to hepta coordination around antimony. This is in sharp contrast to $Me_2Sb(OAc)_3$ where coordination number of antimony does not go beyond six and only one carboxylate group act as bidentate moiety (Geol & Ridley1972). It may partly be ascribed due to steric hindrance of three acetate group preventing hepta coordination.

The main objective of this work was to ascertain the mode of bonding of COOH group to antimony atom, to investigate chemical behavior and constitution of triarylantimony(V) carboxylates linear or polymeric and change in the nature of triarylantimony(V) carboxylates on changing the organic group bound to antimony or change of carboxylic group and to investigate the antimicrobial and antiproliferatine activity (Yadav 2012[b] and Yadav 2013[b]) generally associated with organometal carboxylates.

With the above aim in the mind, we have synthesized a few new triarylantimony(V) dicarboxylates. The results of these studies are reported in this paper.

II. Results and Discussion

Under anhydrous oxygen free atmosphere triarylantimony(V) dicarboxylates have been prepared either by the interaction of triarylantimony(V) dichloride with a carboxylic acid in 1:2 molar ratio in presence of triethylamine using benzene as the solvent or by simple metathesis of triarylantimony(V) dichloride with the sodium or silver salt of the corresponding carboxylic acid using methanol as the solvent.

$$Ph_3SbCl_2 + 2HL \xrightarrow{C_6H_6/Et_3N} Ph_3SbL_2 + 2Et_3N.HCl. \quad (4)$$

$$Ph_3SbCl_2 + 2ML \xrightarrow{C_6H_6/MeOH} Ph_3SbL_2 + 2MCl. \quad (5)$$

[M= Na or Ag; L = $C_6H_5CONHCH_2COO^-$, $C_6H_2(OH)_3COO^-$, $C_6H_5COO^-$, $C_6H_5C_2H_2COO^-$, $C_6H_4(OH)COO^-$, $(C_6H_5)_2(OH)C.COO^-$]

The reactions were carried out in dried benzene/methanol at room temperature with constant stirring for about 2-3 h. The contents were also refluxed at the reflux temperature of the respective solvent to ensure completion of the reaction. The yields of the products were nearly quantitative except for the losses during the workup process. The complexes are moderately soluble in chloroform and acetonitrile. They are off-white crystalline solids with sharp melting points. The complexes remain unaffected by air and atmospheric moisture. In the representative cases the melting points of compounds did not change even after prolong stirring with water at room temperature for several hours indicating their hydrolytic stability.

The molecular weight measurement in freezing benzene suggests that these carboxylate derivatives have monomeric constitution. The molar conductance of 10^{-3} M solution of all the complexes at room temperature are in the range between 20-30 Ohm^{-1} cm^2 mol^{-1} in acetonitrile which shows the absence of ionic species in solution.

III. Infrared Spectra

As has been discussed above, organoantimony carboxylates display a variety of structures. The coordination number of the central metal atom and the mode of bonding of the ligand are largely affected by the physical state, the numbers of organic groups bound to antimony and nature of ligand. Thus, in Ar_2SbOAc the ligand is bridging giving infinite chain structure in solid state while in chloroform, it assumes a bipyramidal geometry. On the other hand, in $R_3Sb(OAc)_2$ and R_4SbOAc the carboxylate moiety is strictly unidentate imparting pentacoordination around antimony. In $SbO(Ac)_3$. One of the acetate groups is simultaneously chelating and bridging and two of the ligands are chelating. In case of dimethyl triacetate the presence of both monodentate and bidentate has been reported. Carboxylate groups have been observed in tetramethylstibonium acetate, formate, trichloroacetates, propionates bivalate and benzoates, carboxylate group behaving as a monodentate ligand in solution imparting penta coordination around antimony. On the other hand in solid state, carboxylate group behaves as a bidentate ligand in which antimony is hexacoordinated.

Thus, carboxylate group is capable of behaving as a monodentate as well as bidentate group. It can readily be distinguished with the aid of infrared spectra through a comparison with data previously given for the solid state in similar type compounds as well as for other organoantimony(V) carboxylates for example R_4SbOAc and R_2SbOAc_3 ($R=CH_3C_6H_4$ and C_6F_5) the difference in the position of asymmetric $\nu(CO)$ and symmetric $\nu(CO)$ is an important key factor in deciding the nature of carboxylate group. The appearance of medium strong band around 1680 cm^{-1} can readily be assigned to the $\nu(CO)$ mode of the monodentate 'ester like' carboxylate group. The absence of any band around 1500 cm^{-1} ruled out the possibility of the presence of a bidentate carboxylate group. The

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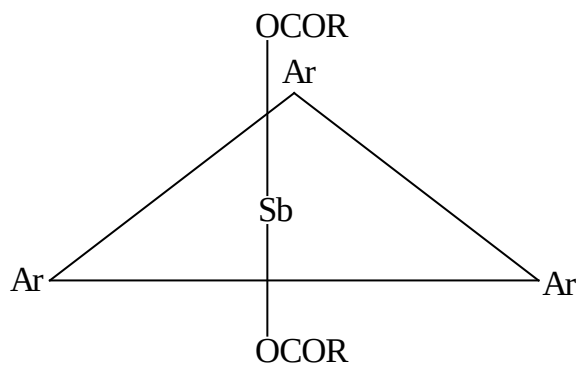
difference between ν_{asy}(CO) and ν_{sym}(CO) is more than 200 cm^{-1} ruling out polymeric nature of the carboxylate group. This is also supported by the fact the newly synthesized compound are soluble in chloroform, acetonitrile, methanol etc. Thus the infrared data, molecular weight and molar conductance measurement indicate that the carboxylate derivatives exhibit pentacoordination around antimony. The Sb-C bond corresponding to Y mode was observed between 440-460 cm^{-1}. A medium band appearing in the range 415-422 can tentatively assigned Sb-O bond.

a) ^1H NMR spectra

^1H NMR spectra of a representative compound triphenylantimonydisalicylate or $[(C_6H_5)_3Sb(O_2CC_6H_4OH)_2]$ was recorded in $CDCl_3$ at room temperature on a JEOL FX. 90 Q. spectrometer using TMS as internal indicator. The spectra showed a complex multiplet in the range 8.80 to 6.86 ppm. A singlet at 11.58 ppm is due to hydroxyl proton of the ligand (2H, s -OH).

Thus, on the basis of IR and NMR spectra aided by molecular weight and conductance measurement, the newly synthesized carboxylate derivatives are assigned a trigonalbipyramidal structure in which (OCOR) group occupy axial position and the three organic groups are situated at the equatorial position.



Ar= C_6H_5 and OCOR = $C_6H_5CONHCH_2COO^-$, $C_6H_3(OH)_3COO^-$, $C_6H_5COO^-$, $C_6H_5C_2H_2COO^-$, $C_6H_4(OH)COO^-$, $(C_6H_5)_2(OH).C.COO^-$

Figure : Suggested structure of Ar_3SbL_2.

IV. Experimental

a) Materials and Methods

Triarylantimony(V) dichloride was prepared by slowly passing chlorine for 30 min through a solution of triphenylantimony in pet-ether. Carboxylic acids used in the reactions were purified before use. Sodium/silver salts of the organic moieties were freshly prepared and dried in *vacuo* before use. All solvents were purified, dried and distilled before use as per the literature methods (Vogel 1989) and reactions were carried out under nitrogen atmosphere.

IR spectra were recorded in the range 4000-200 cm^{-1} using KBr/CsI pellets on a Perkin-Elmer 577 spectrophotometer. ^1H NMR spectra were recorded on an EM 360L Varian spectrometer in $CDCl_3$ containing TMS as an external standard at room temperature. The molar conductance of 10^{-3} M solutions was determined at 25°C with a PR-9500 Phillips conductivity assembly. Molecular weights were determined cryoscopically in benzene using a Beckmann thermometer of ±0.01°C accuracy.

b) Preparation of the Antimony(V) Derivatives

Details of the typical experiments are described below. Relevant IR assignments, analytical data and molar conductance values are listed in Table 1-4.

Table 1: Preparation and Properties for Triarylantimony (V) Dicarboxylates

S. No.	Complex Ar_3SbL_2	Ligand (g) Solvent (ml)	Ar_3SbCl_2(g) Solvent (ml)	Molar ratio	M.P. (°C)	Colour	Recrystallisation Solvent
	Ar=C_6H_5						
1.	$Ar_3Sb(OCOCH_2.NHCOC_6H_5)_2$	$C_6H_5CONHCH_2COOH$ (0.358) C_6H_6 (30)	0.424 C_6H_6 (30)	1:2	218	White	Hexane
2.	$Ar_3Sb(OCO(OH)_3C_6H_2)_2$	$C_6H_2(OH)_3COOAg$ (0.554) C_6H_6 (30)	0.424 C_6H_6 (30)	1:2	118	Off white	Petroleum ether (40-60°C)

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3.	$Ar_3Sb(OCOC_6H_5)_2$	C_6H_5COOH (0.244) C_6H_6 (30)	0.424 C_6H_6 (30)	1:2	160	Light brown	Petroleum ether (40-60°C)
4.	$Ar_3Sb(OCOC_2H_2C_6H_5)_2$	$C_6H_5C_2H_2COOH$ (0.296) C_6H_6 (30)	0.424 C_6H_6 (30)	1;2	197	Light pink	Hexane-petroleum ether (40-60°C)
5.	$Ar_3Sb(OCO(OH)C_6H_4)_2$	$C_6H_4(OH)COONa$ (0.320) C_6H_6 (30)	0.424 C_6H_6 (30)	1:2	142	White	Petroleum ether (40-60°C)
6.	$Ar_3Sb(OCO.C(OH)(C_6H_5)_2)_2$	$(C_6H_5)_2(OH)CCOOH$ (0.456) C_6H_6 (30)	0.424 C_6H_6 (30)	1:2	205	Light brown	Hexane

Table 2 : Elemental Analysis of Triarylantimony (V) Dicarboxylates

S. No.	Complex Ar_3SbL_2	Empirical formula	Found (Calcd.) %		
			C	H	N
	$Ar = C_6H_5$				
1.	$Ar_3Sb(OCOCH_2.NHCOC_6H_5)_2$	$C_{36}H_{31}O_6N_2Sb$	59.92 (60.95)	3.97 (4.37)	3.62 (3.95)
2.	$Ar_3Sb(OCO(OH)_3C_6H_2)_2$	$C_{32}H_{25}O_{10}Sb$	54.99 (55.59)	2.75 (3.62)	-
3.	$Ar_3Sb(OCOC_6H_5)_2$	$C_{32}H_{25}O_4Sb$	63.76 (64.56)	4.00 (4.20)	-
4.	$Ar_3Sb(OCOC_2H_2C_6H_5)_2$	$C_{40}H_{29}O_4Sb$	68.66 (69.09)	3.97 (4.17)	-
5.	$Ar_3Sb(OCO(OH)C_6H_4)_2$	$C_{32}H_{25}O_6Sb$	60.27 (61.27)	3.02 (3.99)	
6.	$Ar_3Sb(OCO.C(OH)(C_6H_5)_2)_2$	$C_{46}H_{37}O_6Sb$	67.92 (68.42)	3.29 (4.59)	-

Table 3 : Molar Conductance and Yield of Triarylantimony (V) Dicarboxylates

C. No.	Molar conductance (Ohm^{-1} cm^2 mol^{-1})	Yield (g)	(%)
1.	19	0.469	66
2.	22	0.477	69
3.	23	0.398	67
4.	26	0.486	70
5.	25	0.426	68
6.	22.2	0.573	71

Table 4 : IR Data for the Triarylantimony (V) Carboxylates (Cm^{-1})

C. No.	ν_{assy} (COO)	ν_{sym}(COO)
1.	1620	1340
2.	1625	1315
3.	1635	1320
4.	1630	1310
5.	1650	1290
6.	1665	1295

i *Reactions of Triarylantimony(V) Dichloride with Hippuric Acid (1)*

A solution of triphenylantimony(V) dichloride (0.424 g, l mmol) in benzene (~40 ml)and silver salt of hippuric acid (0.358 g, 2 mmol) in benzene (~30ml) was stirred together in dark conditions. A white precipitate of AgCl was formed which was filtered off. The filtrate on concentration yielded a white solid of triphenylantimony(V) dihippurate which was recrystallised by hexane. M.P.: 218°C; Yield: 0.468 g, (66%).

ii *Reaction of Triarylantimony(V) Dichloride with Silver Salt of Gallic Acid (2)*

In an oxygen free atmosphere, a solution of triphenylantimony(V) dichloride (0.424 g, 1 mmol) in benzene (~30 ml) and gallic acid (0.554 g, 2 mmol) in the same solvent (~30 ml) were stirred together in the presence of triethylamine at room temperature for 6 h. Et_3N. HCl was formed and filtered off. The filtrate on concentration in *vacuo* yielded a off white crystalline solid which was recrystallized from petroleum ether (40°-

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60°C) to a afford triphenylantimony(V) gallate. M.P.: 118°C; Yield: 0.477 g, (69%).

iii *Reaction of Triarylantimony(V) Dichloride with Sodium Salt of Salicylic Acid (5)*

A solution of triphenylantimony(V) dichloride (0.424g, 1mmol) in benzene (~30 ml) and sodium salt of salicylic acid (0.320 g, 2 mmol) in benzene (~30 ml) was refluxed for 6 h. The solution was cooled and after filtration, concentrated *in vacuo* to yield white solid, identified triphenylantimony(V) salicylate and recrystalised from petroleum ether (40°-60°C). M.P.: 142°C; Yield: 0.426 g, (68%).

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3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

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- To the point depiction of the research
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Approach:

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Approach:

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Approach:

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References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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