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The Impact of Nitric Oxide (NO) On the Biological System

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Abstract: As very earlier, it has been discussed that Nitric Oxide is basic requirement of human life, hence it is our prime duty to save them to avoid the disturbance of biological system. This molecule is involved in the regulation of plant growth and development, pathogens defense and abiotic stress responses. NO is rapidly induced potent plant growth regulator. In the present work, the compounds were synthesized by transition elements of VI group using different standard procedures and carried out to study the effect on the biological system. As a result, it was found that some transition elements are very useful to prevent the infectious disease

Keywords: Biological System, Nitric Oxide, Physico-Chemical Methods, Transition Elements.

ABBREVIATIONS

- NO - Nitric oxide
- DMSO – Dimethyl sulphoxide
- DMF- Dimethylformamide
- L- Ligand
- NOS- Nitric oxide synthase
- NR- Nitrate reductase
- NMR- Nuclear magnetic resonance

I. INTRODUCTION

Chromium Molybdenum and Tungsten are the transition metal members of group VI of the periodic table. Cr has the outer electronic configuration $3d^5 4s^1$ and forms a compound in oxidation states -II to + VI. Co-ordination comp. Of transition metals containing nitric oxide had been known for over a century and since then nitrosyl chemistry continues to be a source of interest to chemists. However, in comparison to the related metal carbonyl complexes, they are not investigated thoroughly investigated in past due to following reasons: The reasons for this inattention was almost certainly their apparent lack of reactivity. On the one hand, M-NO bond is very strong, and the ligand displacement reactions which are so important in the chemistry of metal carbonyl complexes were not found in the metal nitrosyl complexes.

The topic entitled "The synthesis and structural studies of coordination compound of chromium (1) with substituted uracil" are made on the synthesis and structural investigation of some mixed ligands viz. Substituted uracil. Hence it is proper to discuss briefly different physical methods used for the elucidation of structural aspect of the synthesized compound. The geometry of the co-ordination compounds is of great interest, which can account for indication of the relative strength of chemical re-activities of these complexes.

As a part of our programme to synthesize and characterize some neutral mixed legend cyanonitrosyl complexes of monovalent chromium, studies have been extended using some more benzothiazoles derivatives.

In recent years, a great deal of interest has been shown in the study of neutral mixed-legend cyanonitrosyl complexes of chromium having $\{CrNo\}^5$ electronic configuration. We, therefore, report here the first synthesis of neutral mixed ligand cyanonitrosyl complexes of chromium with 5-Fluoro uracil and 5-methyl uracil.

II. HENCE WE DESCRIBE THE RESULTS OF SUCH STUDIES

A. Material used

We used 5-Fluoro uracil and 5-methyl uracil was used as such supplied by Aldrich Chemical Company, USA. Hydroxylamine hydrochloride and Chromic acid were supplied by SD Fine Mumbai. KCN was procured from May and Baker Limited, Dagenham. Distilled water was used in all operations.

B. Analysis of the constituent elements

C, H, and N were estimated micro-analytically. Firstly we estimate of chromium as chromic oxide (Cr_2O_3)

Then we do measures conductance measurements, magnetic, infrared spectra, NMR measurement and the molecular weight. The conductances were measured in analytical grade dimethyl sulphoxide (DMSO) and dimethyl formamide (DMF) using dip type cell on Toshniwal Conductivity Bridge. At room temperature, magnetic susceptibility measurements of the investigated complexes were made by Gouy's method. And IR spectra ($4000\text{--}450\text{ cm}^{-1}$) of the unco-ordinated ligands and synthesized complexes were recorded in nujol mulls supported between KBr pellets on Perkin Elmer (RXI) spectrometer.

Then we prepared the parent compound (potassium pentacyanonitrosyl chromate (I) monohydrate by the method reported by Wilkinson *et al.*

PREPARATION OF COMPLEXES

The Complexes name are given in

TABLE: 1.1

S.No.	Compound	I.U.P.A.C. Name	Electron configuration
1.	$[\text{Cr}(\text{NO})(\text{CN})_2(5\text{-F Ur})_2(\text{H}_2\text{O})]$	Aquadicyanodi(5-Fluoro uracil) nitrosylchromium (I)	$\{\text{CrNO}\}^5$
2.	$[\text{Cr}(\text{NO})(\text{CN})_2(5\text{-M Ur})_2(\text{H}_2\text{O})]$	Aquadicyanodi(5-Methyl uracil) nitrosylchromium (I)	$\{\text{CrNO}\}^5$

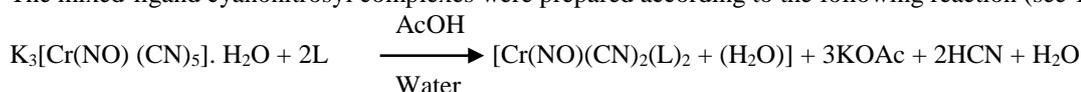
TABLE 1.2

All the complexes are coloured solids they are stable in air as shown in table 1.2

S.No.	Compound	Colour	Decomposition Temperature ($^{\circ}\text{C}$)	% Yield
1.	$[\text{Cr}(\text{NO})(\text{CN})_2(5\text{-F Ur})_2(\text{H}_2\text{O})]$	Yellow- brown	300	45
	$[\text{Cr}(\text{NO})(\text{CN})_2(5\text{-M Ur})_2(\text{H}_2\text{O})]$	Greenish -brown	300	50

III. RESULTS AND DISCUSSION

The mixed-ligand cyanonitrosyl complexes were prepared according to the following reaction (see 1.1 table for ligand name)



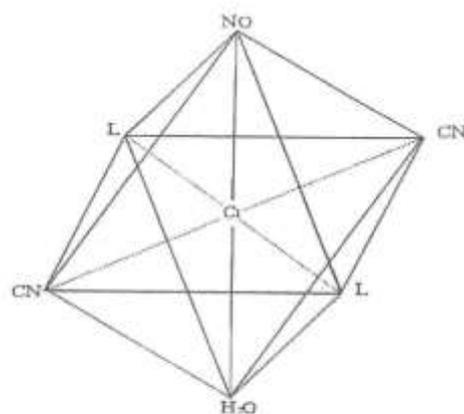
Where L = 5-Fluoro uracil and 5-methyl uracil.

The partial replacement of cyano groups in the parent complex, $\text{K}_3[\text{Cr}(\text{NO})(\text{CN})_5] \cdot \text{H}_2\text{O}$ by two molecules of ligand, L, is facilitated by the trans effect of the NO group.

A comparison of the IR spectra of the parent compound $\text{K}_3[\text{Cr}(\text{NO})(\text{CN})_5] \cdot \text{H}_2\text{O}$ and of the synthesized compound suggests that the appearance of the very strong band in the region $1700\text{--}1710\text{ cm}^{-1}$ in these compounds, is of co-ordinated NO^+ stretching. A positive shift of approximately 50 cm^{-1} in these compounds compared to the parent compounds indicates the non-electrolytic nature of these compounds.

Both of the synthesized compounds reported here show a strong band in the region $2140\text{--}2165\text{ cm}^{-1}$. The ligand 5-Fluoro uracil and 5-methyl uracil possesses 3 possible donor sites; (i) Two cyclic nitrogen and (ii) oxygen of the ketonic group in ring respectively. Out of these two, the cyclic nitrogen of ring system is supposed to be involved in co-ordination through the N atom in the IR spectra of a synthesized complex of 5-methyl uracil studied here. In the IR spectra of both the complexes with 5-methyl uracil, the bands at 640 cm^{-1} suffered a lower shift of 640 cm^{-1} indicating the metal-nitrogen co-ordination present in the synthesized compound.

The analytical data and all the evidence presented above suggest the formulation of these compounds as $[\text{Cr}(\text{NO})(\text{CN})_2(\text{L})_2(\text{H}_2\text{O})]$



Proposed octahedral structure of
 $[Cr(NO)(CN)_2(L)_2(H_2O)]$
 (where L = 5-Fluorouracil and 5-Methyluracil)

Fig. -1

Since all these synthesized compounds shows one CN stretching band and one NO stretching band it is reasonable to propose an octahedral structure where CN is *trans* to CN and L *trans* to L and NO is *trans* to water in *axial* position as shown in Fig.- 1

At last, we describe the Bio-chemical studies of co-ordination chemistry in bio-chem. Synthesis and biochem. Uses of Nitric oxide (NO) is of major importance in the signaling pathways leading to penile erections. NO is unique for a biochemical signaling molecule because it is a gas. NO displays free radical behaviour, and is formed from arginine by the enzyme nitric oxide synthase (NOS):



As a gas, NO is able to pass through cell membranes without the aid of dedicated transporters and its free radical character makes it particularly reactive with iron-containing proteins. Here explains the biochemical effect of NO. The role of NO in plants also has been discussed. Interaction of NO with mitochondria is mentioned briefly. It was found that chromium (I) in relatively low concentration, can prevent the growth of a larger number of different species of bacteria in a medium otherwise capable of supporting vigorous growth. In plants, nitric oxide can be produced by any of four routes: (i) L-arginine- dependent nitric oxide synthase^[11]^[12]^[13]

In mammals NO helps to maintain blood pressure by dilating blood vessels assists the immune system in killing invaders and is a major factor in the control of penile erection. In the brain NO plays a role in development neuron to neuron signaling, and probably contributes to the formation of memories.

SOME FUNCTIONS OF NO ARE DISCUSSED BELOW

BLOOD FLOW

NO relaxes the smooth muscle in the walls of the arterioles. At each systole, the endothelial cells that line the blood vessels release a puff of NO. This diffuses into the underlying smooth muscle cells causing them to relax and thus permit the surge of blood to pass through easily. Three of the *pioneers* in working out the biological roles of NO shared a Noble Prize in 1998 for their discoveries. The award to one of them, *Ferid Murad*, honoured his discovery that nitroglycerine works by releasing NO. Nitroglycerine, which is often prescribed to reduce the pain of angine, does so by generation NO. Nitric oxide might serve as an *infantometer* in conditions like Asthama, there has been increasing interest in the use of exhaled-nitric oxide as a breath test in diseases with airway inflammation. Reduced levels of exhaled NO have been associated with exposure to air pollution^[10]

IN KIDNEY FUNCTION

The release of NO around the glomeruli of the kidneys increases blood flow through them thus increasing the rate of filtration and urine formation.

OTHER BIOCHEMICAL USES OF NO

NO is produced by macrophages. These phagocytic cells of the immune system use NO to impair DNA synthesis and metabolism in microorganisms. NO can also react with other free radicals, in particular, the superoxide radical, to form peroxy-nitrites that are effective against bacteria, fungi, and other pathogens. Nitrites have been added as preservatives to meat for years; part of the effectiveness of added nitrites may be due to the antimicrobial action of generated NO. Nitric oxide (NO) is a free radical that had been known for many years simply as a toxic air pollutant. The discovery of enzymatic NO production in many living organisms has established a new paradigm: NO being an essential molecule endogenously produced in the cells. In plant science it has been suggested that NO acts as a plants hormone equivalent to ethylene; that is, a gaseous signal transmitter. Even

after experiencing such a scientific breakthrough, however, researchers may still feel difficulty in exploring plant NO signaling systems with conventional approaches. A major difference between plants and animals is that the growth and development of plants are closely linked to the surrounding environment where NO levels vary according to biotic and abiotic activities. Until the 1990s, in fact, most of our interests oriented toward research on the physiological impact of nitrogen oxides ($\text{NO}_x = \text{NO} + \text{NO}_2$) on plants. I propose the ONS hypothesis a novel concept for a better understanding of NO world in plants.

NO PRODUCTION MECHANISM IN PLANTS: SIMPLE OR COMPLEX

In figure summarizes the major NO-producing pathways in plants. Until now, two distinct pathways in plants have been elucidated: the arginine pathway and the nitrite pathway in figure-2. The former can be mediated by NO synthase (NOS) with the substrates L-arginine, O_2 , and NADPH. As the result of this reaction, the product L-citrulline is produced along with NO. The production of NO in the presence of L-arginine, NADPH and O_2 (Chandok *et al.* 2003; Guo *et al.* 2003). The findings of NOS unique to plants may provide explanations for precious studies that reported NOS-like activity in plants. Many bacteria have recently been found to possess the NOS gene and proteins but the biological function of bacterial NOS is largely unknown (Cohen & Yamasaki 2003) Ker *et al.* Have suggested that the primary role of bacterial NOS might not be for producing NO but rather for synthesizing specific molecules.

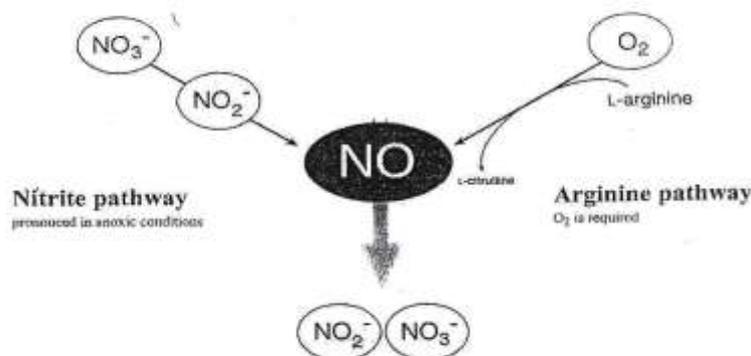


Fig: 2

Final Degradation Products

Two pathways for NO production in a plant system. There is two major mechanisms for NO production in plants. The nitrite pathway and the arginine pathway. The nitrite pathway is a simple way to produce NO through one-electron reduction of nitrite. This reaction also occurs with many enzymes that include a redox domain. Assimilatory nitrate reductase (NR) has been firstly confirmed as such an enzyme. The other is the arginine pathways that can be catalysed by nitric oxide synthase (NOS) with L-arginine, NADPH, and O_2 . The fundamental difference in the mechanism is that the arginine pathway requires O_2 in the reaction whereas the nitrite pathway does not.

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