

On the interaction of Narcotine with ammonium vanadate, Johansson's test

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Abstract

In this communication the reaction route of the interaction of narcotine with ammonium vanadate in sulphuric acid is provided (Johansson test). Besides the theoretical interest of know what is happening in the test tube at molecular level, the blood-red colour developed in this assay is a good approach to narcotine which can be confirmed by a positive result with another colour test. The chemistry is as follows: The active species is protonated meta-vanadic acid, formed in situ. Nucleophilic attack of an oxygen atom of the methylenedioxy group present in narcotine to the positive species, eliminates a water molecule and an oxonium ion is formed. This is neutralised by ring opening via concerted reaction of a water molecule and the $\delta+$ methylene group. An organometallic vanadate and a hemiacetal result. Finally, acidolysis of the ester gives rise to a degradation. Vanadous acid and formaldehyde are eliminated and in the organic part an ortho-benzoquinone is formed. The production of the last three compounds involves six electron shifts in a concerted reaction mechanism.

Keywords: Acidolysis; Halochromism; Organometallic Intermediate; Oxidation; Reactive Intermediates

1. Introduction

Narcotine is the second opioid alkaloid according to its density in raw *Papaver somniferum*, was first isolated by Robiquet in 1817. It is used to suppress cough frequency and intensity in bronchial asthma and pulmonary emphysema, similar to codeine, [1].

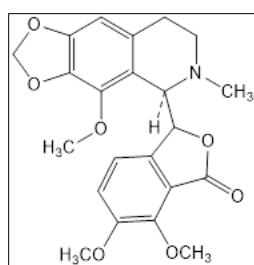


Figure 1 Narcotine structure

In 1831 Robiquet published a note about narcotine where he remarked that this substance, although perfectly neutral, has the property of combining with acids, largely neutralising them and forming crystallizable salts, [2, 3].

It is the first alkaloid to appear in the poppy plant, and may be detected three days after the seeds have sprouted. The mother liquors from morphine production contain narcotine in considerable quantities. It crystallizes from alcohol in

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colourless prisms, and melts at 175°. Narcotine has no effect on litmus and may be extracted by organic solvents from strongly acid solutions, [4]. Figure 1.

In this communication we provide the reaction route of narcotine with ammonium vanadate in sulphuric acid.

This paper is a follow up of our studies on reaction mechanism, [5-9].

2. Antecedents

The reaction under study is due to Professor Johannson [10, 11]. He used Mandelin Reagent, a 1% solution of ammonium vanadate in concentrated sulphuric acid, [12-15].

Johannson employed the same, as well as, different substrates in order to obtain colour reactions.

Some notes about the reagent. Ammonium vanadate (metavanadate) is NH_4VO_3 , a pentavalent-vanadium salt. It is a white or slightly yellow crystalline substance, $d=2.3 \text{ g/cm}^3$, [16]. Exposure to it can cause headache, tremors and dizziness. Inhaling ammonium vanadate can irritate the lungs, [17]. The solution in sulphuric acid can be used as a spray colour-revealing device in analytical toxicology of drugs, [18]. It is most frequently used for illicit drug testing.

In this communication we provide the reaction route, at molecular level, of Johannson blood-red colour test for narcotine. Each step is fully commented and the electron flow is also given.

3. Discussion

The dissolution of ammonium vanadate in sulphuric acid forms meta-vanadic acid whose protonation gives the reactive species. Figure 2. Narcotine shows a methylenedioxy group, three methoxy groups, a lactone, and a tertiary amine. The methylenedioxy group is more reactive than a methoxy, [19, 20]. Thus, one oxygen of the five-member cycle reacts with the protonated vanadic acid (nucleophilic reaction), with elimination of a water molecule and formation of an oxonium salt (ammonium oxonium sulphate) which explains the red-blood colour observed in the test and due to halochromism, [21, 22].

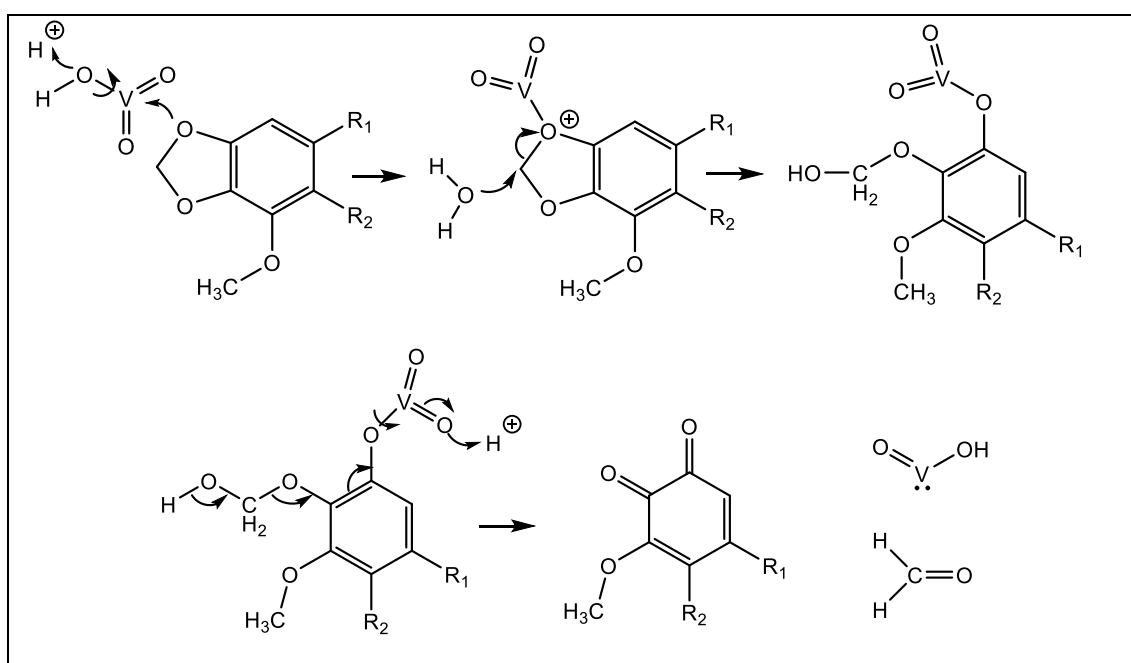


Figure 2 Oxido-degradation of narcotine with ammonium vanadate in sulphuric acid

Reaction with water at the δ^+ methylene group neutralises the oxonium ion by ring opening, with concomitant formation of an organic vanadate and a hemiacetal. Acidolysis of the vanadium ester gives rise to a concerted mechanism involving six electron shifts. Vanadous acid and an ortho-benzoquinone are formed (inorganic-organic redox-reaction), with elimination of formaldehyde.

4. Conclusion

The reaction route of the interaction of narcotine with ammonium metavanadate in sulphuric acid has been established. It is a redox-process in which vanadium (V) is reduced to vanadium (III), vanadous acid, and the organic compound is degraded (loss of formaldehyde) and oxidized to an ortho-benzoquinone. The electron flow of each step has been given.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

There is no conflict of interest to declare.

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