Kinetic study by UV Spectrophotometry of Carzol degradation in aqueous medium

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Abstract: This paper deals with the kinetic hydrolysis in aqueous media of Carzol or (E) 3-dimethylamino- methylene aminophenyl-N-methylcarbamate hydrochloride. The Carzol is a bifunctional compound which belongs to the chemical families formamidine and carbamate. This work is carried out by UV Spectrophotometry. The successive determination of 3-aminophenyl-N-methylcarbamate and 3-aminophenol, as the main products of the formamidine and the carbamate groups of Carzol hydrolysis gives evidence for the significant reactivity of this insecticide-acaricide in aqueous media. The obtained negative activation entropy \( \Delta S^\neq = -32.39 \text{ J mol}^{-1}\text{K}^{-1} \) indicates a B_AC\(\text{2} \) mechanism involving bimolecular collapse of the formamidine group of Carzol. While, the obtained positive activation entropy \( \Delta S^\neq = +100.24 \text{ J mol}^{-1}\text{K}^{-1} \) and the absence of basic general catalysis indicate an E1cB mechanism involving unimolecular collapse of the carbamate group of Carzol via a methylisocyanate intermediate.

Keywords: Carzol, formamidine, carbamate, kinetic, mechanism, spectrophotometric UV.

Introduction

Carzol or (E) 3-dimethylaminomethyleneaminophenyl-N-methylcarbamate hydrochloride is a bifunctional compound which belongs to the chemical families: formamidine and carbamate. Carzol is considered as an effective acaricide-insecticide, used for the treatment of citrus\(^1\text{–}^3\) (grapefruit, lemon, lime, orange), seeds, and some fruits (apples, pears, nectarines and peaches)\(^4\text{–}^6\). Carzol acts by inhibition of the enzyme acetylcholinesterase\(^7\text{–}^9\), as all carbamate insecticides, and inhibition of octopamine\(^10\text{–}^13\) as all formamidine acaricides. According to the literature, it appears that carbamates which do not have a mobile proton in \( \alpha \) position relative to the carbonyl, hydrolyze in aqueous media following two reaction schemes B_AC\(\text{2} \) or E1cB\(^14\). Christopher B. Divito and al., showed by \(^1\)HNMR spectroscopy and \(^13\)C NMR spectroscopy, that the carbamate function of Carzol is more stable in alkaline medium that the formamidine function\(^15\). The kinetic study of the hydrolysis reaction of Carzol in aqueous medium is carried out by UV absorption Spectrophotometry.

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Results and Discussion

Kinetics and mechanism of the alkaline hydrolysis of the formamidine group of Carzol

Determination of 3-aminophenyl-N-methylcarbamate obtained at the end of the hydrolysis reaction of the formamidine group of Carzol in aqueous medium

The determination of 3-aminophenyl-N-methylcarbamate formed during the hydrolysis of the formamidine function of Carzol at $pH = 9.64$, at $T = 25^\circ C$, and at $\mu = 1M$ was confirmed by the good superposition of the UV absorption spectrum of the species produced (spectrum b) with that of a reference (spectrum c) obtained under the same experimental conditions (Figure 1).

![Figure 1](image1.png)

**Figure 1.** UV absorption spectra of 3-aminophenyl-N-methylcarbamate (c), of the hydrolysis product of Carzol (b) and of Carzol (a) ($5 \times 10^{-5} M$). $[\text{Carzol}] = [3\text{-aminophenyl}] = 5 \times 10^{-5}M$; at $pH = 9.64$, $T = 25^\circ C$, and $\mu = 1M$.

Determination of the rate constant $k_{obs}$ of the hydrolysis reaction of the formamidine function of Carzol

The UV spectra show an isosbestic point at 251nm, indicating that there is no accumulation of intermediates and the constant rate of hydrolysis of the formamidine group of Carzol followed the pseudo-first order kinetics model (Figure 2).

![Figure 2](image2.png)

**Figure 2.** UV spectra of the hydrolysis reaction of the formamidine group of Carzol ($5 \times 10^{-5}M$) in function of time; in alkaline solution at $pH = 9.64$, $T = 25^\circ C$ and $\mu = 1M$. 
The absorption evolution of Carzol solution contained in a thermo regulated tank, corresponds to the disappearance of the substrate \((\lambda = 267 \text{ nm})\) or the appearance of 3-aminophenyl-N-methylcarbamate \((\lambda = 235 \text{ nm})\) in function of time (Figure 3).

\[
\log(A_\infty - A_t) = -\frac{k_{\text{obs}}}{2.303} t + \log(A_\infty - A_0) \quad \text{Eq. (1)}
\]

where \(A_0\), \(A_\infty\) and \(A_t\) represent respectively the initial absorptions, final and at time \(t\) of the reaction mixture (Figure 4).

**Effect of pH on the rate constant of the hydrolysis reaction of the formamidine function of Carzol**

The rate constants of pseudo first-order hydrolysis reaction of the formamidine function of Carzol in aqueous medium were determined at 235nm in buffered solutions at different \(pH\) values (from 8.16 to 11.75); by measuring the evolution of UV absorption of (E)-3-dimethylaminomethyleneaminophenyl-N-methylcarbamate versus time at 25°C and at a constant ionic strength \(\mu = 1\text{M}\) (Figure 5).
Figure 5. Effect of pH on the rate constant $k_{obs}$ of the hydrolysis reaction of Carzol ($5 \times 10^{-5}$M) at 25°C and $\mu = 1$M.

The obtained results are shown in Table 1:

Table 1: Rate constants $k_{obs}$ of pseudo first-order hydrolysis reaction of the formamidine function of Carzol versus pH at 25°C and at ionic strength $\mu = 1$M.

<table>
<thead>
<tr>
<th>pH</th>
<th>$k_{obs} \times 10^2$ (min$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.16</td>
<td>0.02</td>
</tr>
<tr>
<td>9.64</td>
<td>0.73</td>
</tr>
<tr>
<td>10.09</td>
<td>2.07</td>
</tr>
<tr>
<td>11.75</td>
<td>55.46</td>
</tr>
</tbody>
</table>

The graphic representation of the logarithm of the observed rate constant $k_{obs}$ of the hydrolysis reaction of the formamidine function of Carzol versus pH at 25°C, is a straight line which is represented by the following equation:

$$\log k_{obs} = 0.993 \cdot pH - 11.78 \quad \text{Eq. (2)}$$

with a regression coefficient $R^2 = 0.992$ (Figure 6).

Figure 6. Logarithmic variation of the observed rate constant of the hydrolysis reaction of the formamidine function of Carzol versus pH at 25°C and at ionic strength $\mu = 1$M.

The obtained slope of the line is close to the unity, so it is in perfect agreement with the limiting form of the rate law:

$$k_{obs} = k_2 [\text{OH}^-] \quad \text{Eq. (3)}$$

corresponding to the $B_{AC}2$ mechanism.
Determination of the activation entropy $\Delta S^\neq$ of the hydrolysis reaction of the formamidine function of Carzol

Generally, the thermodynamic parameters of activation may be an argument in favor of one or the other mechanism, $B_{Ac2}$ or $E1cB$.

We therefore investigated the influence of temperature on the rate constants of the hydrolysis reaction of the formamidine function of Carzol in a phosphate buffer solution at $pH = 10.9$ and at ionic strength $\mu = 1$ M to determine its activation entropy $\Delta S^\neq$.

The experimental rate constants $k_{obs}$ measured at different temperatures are reported in Table 2 and Figure 7.

**Table 2.** The rate constants of the first hydrolysis reaction of Carzol versus the temperature at $pH = 10.9$ and at ionic strength $\mu = 1$ M.

<table>
<thead>
<tr>
<th>Température (°C)</th>
<th>20</th>
<th>25</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>$k_{obs}.10^3$ min$^{-1}$</td>
<td>6.08</td>
<td>11.05</td>
<td>29.24</td>
<td>40.27</td>
<td>63.24</td>
</tr>
</tbody>
</table>

**Figure 7.** Effect of the temperature on the rate constants $k_{obs}$ for the hydrolysis reaction of the formamidine function of Carzol.

The value of the activation entropy $\Delta S^\neq = -32.39$ J mol$^{-1}$K$^{-1}$ is derived from that of the activation energy $E_a = 71.13$ kJ mol$^{-1}$, calculated from the slope of the linear equation

$$\log k_{obs} = -3.720 \frac{10^3}{T} + 11.49,$$

Eq. (4)

with a regression coefficient $R^2 = 0.997$ (Figure 8).

**Figure 8.** Logarithmic variation of the observed rate constant $k_{obs}$ of the hydrolysis reaction of the formamidine function of Carzol versus the temperature at $pH = 10.9$ and at $\mu = 1$ M.
The variation of the activation entropy of the hydrolysis reaction of the formamidine function of Carzol has a negative sign, which is in perfect agreement with the bimolecular addition mechanism $B_{AC}^2$.

Indeed, According to the data in the literature, it appears that $B_{AC}^2$ mechanism occurs by the addition of $OH$ ion on the carbon of the formamidine function, lead to a tetrahedral intermediate$^{16}$. The proposed $B_{AC}^2$ mechanism for the hydrolysis reaction of the formamidine function of Carzol is presented in the following scheme 1.

\[\begin{align*}
\text{(H}_3\text{C)}_2\text{N} & \quad \text{OH}^\ominus \\
\text{C} & \quad \text{H}_2\text{O} \\
\text{O} & \quad \text{H}_2\text{N} \\
\text{O} & \quad \text{H}_2\text{O} \\
\text{HCOOH} + & \quad \text{H}_2\text{N} \quad \text{O} \quad \text{NHCH}_3 \\
\text{O} & \quad \text{NHCH}_3 \\
\text{H}_2\text{O} & \quad \text{H}_2\text{N} \quad \text{O} \quad \text{NHCH}_3
\end{align*}\]

**Scheme 1.** $B_{AC}^2$ Hydrolysis mechanism of the formamidine function of Carzol.

The hydrolysis of the formamidine function of Carzol in basic medium leads to the formation of (E)-3-dimethylaminohydroxymethylaminophenyl-N-methylcarbamate. This adduct is converted to dimethylamine and m-formamidophenyl-N-methylcarbamate which decomposes to turn to give 3-aminophenyl-N-methylcarbamate and formic acid.

**Kinetics and mechanism of the alkaline hydrolysis of the carbamate function of Carzol**

**Determination of 3-aminophenol obtained at the end of the hydrolysis reaction of the carbamate group of Carzol in aqueous medium**

The determination of 3-aminophenol formed during the hydrolysis of the carbamate function of Carzol was confirmed by the good superposition of the UV absorption spectrum of the species produced (spectrum b) with that of a reference (spectrum c) (Figure 9).

**Figure 9.** UV absorption spectra: of the product (c) $(5\times10^{-5} \text{M})$, of 3-aminophenol (b) and of the hydrolysis products (a) in solution at $pH = 12.4$, $T= 50^\circ \text{C}$ and $\mu = 1 \text{ M}$. 
UV spectra in Figure-10 have been stored in a phosphate buffer solution at \( pH = 12.4 \), at ionic strength \( \mu = 1\) M and at temperature \( T = 50^\circ C \). They show that the Carzol (spectrum a) is hydrolyzed quantitatively in 3-aminophenol and methylamine.

**Determination of the rate constant \( k_{obs} \) of the hydrolysis reaction of the carbamate function of Carzol**

UV spectra recorded in function of time in phosphate buffer solution at \( pH = 12.4 \), at a temperature \( T = 50^\circ C \) and at an ionic strength \( \mu = 1 \) M exhibit an isosbestic point at \( \lambda = 230 \) nm. This indicates that there is no intermediate accumulation and the rate constant for the alkaline hydrolysis of the carbamate function of Carzol is pseudo-first order (Figure 10).

![Figure 10. UV spectra in function of time of the hydrolysis reaction of the carbamate function of Carzol (5×10^{-5} M) in phosphate buffer at pH = 12.4, at T= 50^\circ C, and at \( \mu = 1\) M.](image)

The absorption evolution of the Carzol solution contained in a thermostated tank corresponds to the appearance of 3-aminophenol in function of time (Figure 11).

![Figure 11. Absorption Variation of Carzol by UV spectrophotometry in function of time at \( \lambda = 235\) nm, \( pH = 12.4\), \( \mu = 1\) M and at 50^\circ C.](image)

The rate constant \( k_{obs} = 0.23 \times 10^{-2} \) min\(^{-1} \) was determined graphically from the slope of the linear equation:

\[
\log (A_\infty - A_0) = -\frac{k_{obs}}{2.3} t + \log (A_\infty - A_t) \quad \text{Eq. (5)}
\]

where \( A_0, A_\infty \) and \( A_t \) are respectively the initial absorption, the final and absorption at time \( t \) of the reaction mixture (Figure 12).
Figure 12. Determination of the observed rate constant \( k_{\text{obs}} \) of the hydrolysis reaction of the carbamate function of Carzol.

**Effect of pH on the rate constant of the hydrolysis reaction of the carbamate function of Carzol**

The rate constants for the pseudo-first order of the hydrolysis reaction of the carbamate function of Carzol in aqueous medium at 50°C and for an ionic strength \( \mu = 1 \text{M} \) were determined in buffered solutions at different pH (from 11.93 to 13.7) (Figure 13).

![Graph showing the effect of pH on the rate constants \( k_{\text{obs}} \) of the hydrolysis reaction of the carbamate function of Carzol (5×10⁻⁵M) at 50°C and \( \mu = 1 \text{M} \).]

The experimental results are shown in Table 3:

**Table 3.** The rate constants \( k_{\text{obs}} \) of pseudo-first order hydrolysis reaction of the carbamate function of Carzol versus pH at 50°C and at ionic strength \( \mu = 1 \text{M} \).

<table>
<thead>
<tr>
<th>pH</th>
<th>( k_{\text{obs}} \times 10^2 \text{min}^{-1} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.93</td>
<td>0.073</td>
</tr>
<tr>
<td>12.4</td>
<td>0.230</td>
</tr>
<tr>
<td>12.8</td>
<td>0.461</td>
</tr>
<tr>
<td>13.18</td>
<td>1.610</td>
</tr>
<tr>
<td>13.7</td>
<td>4.018</td>
</tr>
</tbody>
</table>

The graph of the logarithmic variation of the observed rate constant \( k_{\text{obs}} \) of the hydrolysis reaction of the carbamate function of Carzol in function of pH at 50°C, is a straight line which represented by the following equation: \( \log k_{\text{obs}} = 0.999 \times \text{pH} - 15.06 \) Eq. (6) with a regression coefficient \( R^2 = 0.992 \) (Figure 14).
Figure 14. Logarithmic variation of the observed rate constant for the hydrolysis reaction of the carbamate function of Carzol versus pH at 50°C and at ionic strength $\mu = 1$M.

The value of the slope of this line is almost equal to unity. This is in perfect accordance with the limiting forms of the rate laws:

$$k_{obs} = \frac{k_1 K_a}{a_H} \quad \text{Eq. (7)}$$

and

$$k_{obs} = k_2 [\text{OH}^-] \quad \text{Eq. (8)}$$

Corresponding respectively to E1cB and B_{AC2} hydrolysis mechanisms for N-monosubstituted carbamates (Scheme 2).

Scheme 2. Hydrolysis of the carbamate functions of Carzol according E1cB and B_{AC2} mechanisms.

Both mechanisms E1cB and B_{AC2} differ mainly by the formation of methylisocyanate, the only formal proof of E1cB process. The identification of this intermediate in the reaction
medium is very difficult because of its high chemical reactivity compared with the hydroxyl ion to form the N-methylcarbamic acid\textsuperscript{17}.

**Possibility of a bimolecular elimination reaction E2– Search for general basic catalysis**

For hydrolyzing the carbamate function of Carzol, a bimolecular elimination mechanism E2 in accordance with the formation of methylisocyanate, may be considered.

This mechanism was mentioned by Homer and Bender\textsuperscript{18} for the hydrolysis of p-nitrophenyl-N-methylcarbamate. The formation of the p-nitrophenyl-N-methylcarbamate anion then, is the limiting step. In the case of Carzol, the elimination E2 leads to aminophenyl-N-methylcarbamate anion during the slow step of the mechanism (Scheme 3).

![Scheme 3. E2 elimination mechanism for the hydrolysis reaction of the carbamate function of Carzol.](image)

E2 mechanism was investigated from the study of the effect of the phosphate buffer concentration at pH = 12.4 on the rate of the hydrolysis reaction of the carbamate function of Carzol at temperature \( T = 50^\circ\text{C} \) and at ionic strength \( \mu = 1 \text{ M} \) (Table 4).

**Table 4.** Effect of the concentration of phosphate buffer solution at \( pH= 12.4 \) on the rate constant \( k_{\text{obs}} \) of the hydrolysis reaction of the carbamate function of Carzol at \( T = 50^\circ\text{C} \) and \( \mu = 1 \text{ M} \).

<table>
<thead>
<tr>
<th>[HPO(_4^{2-})].10(^2) mol L(^{-1})</th>
<th>1</th>
<th>0.8</th>
<th>0.6</th>
<th>0.4</th>
<th>0.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>( k_{\text{obs}}.10^2\text{ min}^{-1} )</td>
<td>0.230</td>
<td>0.236</td>
<td>0.237</td>
<td>0.232</td>
<td>0.229</td>
</tr>
</tbody>
</table>

According to the found experimental results, we concluded that the observed rate constants of the hydrolysis of the carbamate group of Carzol in function of the phosphate buffer concentration remain unchanged. So there is no general base catalysis and it doesn’t seem that the E2 mechanism can be retained. These results are consistent with those obtained for methiocarb, Bendiocarb, Zectran, Ethiofencarb and landrin\textsuperscript{19-23}. 
**Determination of activation entropy ΔS° of the hydrolysis reaction of the carbamate function of Carzol**

According to the data in the literature, the activation entropy can be an argument in favor of one or the other E1cB and B_{AC}2 mechanisms\textsuperscript{24-26}.

We therefore proposed to study the influence of temperature on the rate constants \(k_{\text{obs}}\) of the hydrolysis reaction of the carbamate function of Carzol to determining the activation entropy \(ΔS°\).

The observed rate constants were measured at different temperatures (from 35°C to 70°C) in a buffer solution at \(pH = 12.8\) and at ionic strength \(μ = 1\text{M}\) (Table 5) (Figure 15).

**Table 5.** Rate constants of the hydrolysis reaction of the carbamate function of Carzol versus the temperature in a buffer solution at \(pH = 12.8\) and at ionic strength \(μ = 1\text{M}\).

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>35</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>(k_{\text{obs}}\times10^2\text{ min}^{-1})</td>
<td>0.06</td>
<td>0.12</td>
<td>0.46</td>
<td>2.66</td>
<td>9.57</td>
</tr>
</tbody>
</table>

**Figure 15.** Influence of temperature on the rate constants \(k_{\text{obs}}\) of the hydrolysis reaction of the carbamate function of Carzol.

The value of the activation entropy \(ΔS° = +100.24\text{ J mol}^{-1}\text{ K}^{-1}\) is derived from that of the activation energy \(E_a = 128.65\text{ kJ mol}^{-1}\), calculated from the slope of the linear equation

\[
\log k_{\text{obs}} = -6.728 \times \frac{10^3}{T} + 18.57 \quad \text{Eq. (9)}
\]

with a regression coefficient \(R^2 = 0.994\) (Figure 16).

**Figure 16.** Logarithmic variations of the observed rate constants \(k_{\text{obs}}\) of the hydrolysis reaction of the carbamate function of Carzol versus the temperature at \(pH = 12.8\) and at \(μ = 1\text{M}\).
The obtained positive activation entropy $\Delta S^\neq$ indicates an E1cB mechanism for the hydrolysis reaction of the carbamate function of Carzol. For a process in which

$$k_{\text{OH}} = \frac{k_1 K_a}{K_e / Y} \quad \text{Eq. (10)}$$

The ionization entropies relative to $K_a$ and $K_e$ are negative while the value of $\Delta S^\neq$ is positive. Anyway, the positive entropy cannot be related to $B_{AC2}$ mechanism.

Indeed in this case, the bimolecular rate constant $k_{\text{OH}} = k_2$ is not composite and the slow addition of $\text{OH}^-$ at the carboxyl group results in a negative activation entropy as that observed for the Pirimicarb$^{27}$.

**Conclusion**

We discussed in this work the kinetic study and the degradation mechanism in aqueous medium of formamidine and carbamate functions of Carzol by UV spectrophotometry. The UV spectroscopic follow-up of Carzol degradation in aqueous medium reported that the formamidine function is more reactive than the carbamate function.

The formamidine function of Carzol hydrolyzes according to $B_{AC2}$ bimolecular process. Indeed, the negative activation entropy ($\Delta S^\neq = -32.39 \text{ J mol}^{-1}\text{K}^{-1}$) is in favor of this mechanism.

Based on literature data and obtained kinetic results on other N-methyl carbamates$^{28}$, E1cB hydrolytic degradation has been attributed to the carbamate function of Carzol.

Thus, the obtained positive activation entropy ($\Delta S^\neq = +100.24 \text{ J mol}^{-1}\text{K}^{-1}$) and the absence of basic general catalysis indicate an E1cB mechanism involving unimolecular collapse of the carbamate function of Carzol via a methylisocyanate intermediate which is converted to 3-aminophenol and methylamine.

In conclusion, the alkaline hydrolysis mechanism of the two functions formamidine and carbamate of Carzol is given by the following scheme 4:

**Scheme 4.** Hydrolysis of Carzol in alkaline medium.
Acknowledgement

The authors praise the Ministry of Higher Education, Scientific Research and Technology of Tunisia for financial and technical support.

Experimental Section

Reagents and Solvents
- Ultrapure water
- Carzol (Supelco) of 99.5% purity
- Buffer solutions prepared in the laboratory
- Carbonate NaHCO₃
- Phosphate Na₂HPO₄
- Borax Na₂B₄O₇, 10 H₂O Merck
- NaOH Across
- KCl Fluka
- HCl Merck
- Spectroscopic grade methanol (Lab-Scan, Ireland)

Instrumentation
- pH-meter: Digital pHmeter Ph 744
- UV double beam spectrophotometer: Beckman DU 640B

Preparation of solutions
The stock standard solution of Carzol of 10⁻² M was prepared by dissolving 0.0644 g in 25mL of spectroscopic grade methanol solution. The various aqueous solutions were prepared at different pH by the dilution of the stock standard solution at a concentration of 5×10⁻⁵ M in the appropriate buffer. The ionic strength µ of these solutions was kept constant by addition of KCl. The various buffers used were obtained from the following mixtures:
- Na₂HPO₄ (0.05 M) + NaOH (0.1 M) - NaHCO₃ (0.05 M) + NaOH (0.1M)
- Na₂B₄O₇, 10 H₂O (0.025 M) + NaOH (0.1M)
- Na₂B₄O₇, 10 H₂O (0.025 M) + HCl (0.1M)
- KCl (0.2 M) + NaOH (0.2M)

Calculation of activation entropy ΔS^≠
The activation free enthalpy is given by the following equation:

\[
\Delta G^≠ = - RT \log \frac{k_{obs} h}{K_B T}
\]

Eq. (11)

Where hand K_B represent respectively the Planck and Boltzmann constants (h = 6.63×10⁻³⁴Js, K_B = 1.38×10⁻²³ JK⁻¹). Using the reactions such as

\[
\Delta G = \Delta H - T\Delta S
\]

Eq.(12)

and

\[
\Delta H = E_a - RT
\]

Eq. (13)
(for a reaction in homogeneous liquid medium), we can relate the rate constant $k_{\text{obs}}$ to the activation entropy:

$$\Delta S^\ne = 2.3 \, R \left( \log k_{\text{obs}} - \log e^\frac{E_a}{R} - \log T \right) + \frac{E_a}{T} \quad \text{Eq. (14)}$$

with $\log e^\frac{E_a}{R} = 10.755$ and $\Delta S^\ne$ for each temperature. The activation energy $E_a$ can be determined from the slope $\frac{E_a}{2.3 \, R}$ of the line $\log k_{\text{obs}} = f \left( \frac{1}{T} \right)$ where $T$ and $R$ represent respectively the absolute temperature and the gas constant.

**Physico-chemical characteristics of Carzol**

The physico-chemical characteristics corresponding to Carzol are shown in the following Table 6:

**Table 6. Summary of physico-chemical properties of Carzol**

<table>
<thead>
<tr>
<th>Name</th>
<th>(E) 3-dimethylaminomethyleneaminophenyl-N-methylcarbamate hydrochloride</th>
</tr>
</thead>
<tbody>
<tr>
<td>semi developed Formula</td>
<td><img src="image" alt="Chemical Structure" /></td>
</tr>
<tr>
<td>Molecular formula</td>
<td>C$<em>{11}$H$</em>{16}$Cl N$_3$O$_2$</td>
</tr>
<tr>
<td>Molar mass</td>
<td>257.8 g mol$^{-1}$</td>
</tr>
<tr>
<td>Melting point</td>
<td>202°C</td>
</tr>
<tr>
<td>Appearance</td>
<td>White crystalline solid</td>
</tr>
<tr>
<td>Toxicity</td>
<td>14.8 mg/kg</td>
</tr>
<tr>
<td>Solubility in water</td>
<td>Very slightly soluble</td>
</tr>
<tr>
<td>Purity</td>
<td>99.5%</td>
</tr>
<tr>
<td>Biological property</td>
<td>Acaricide-insecticide</td>
</tr>
</tbody>
</table>

**References**