

## Cu(II) and Ni(II) Complexes of Rubrofusarin and 6-galactosyl Rubrofusarin

Cynthia Demicheli, Heloisa Beraldo and Lucia Tosi\*

*Departamento de Química, Universidade Federal de Minas Gerais  
30161 Belo Horizonte, MG, Brasil.*

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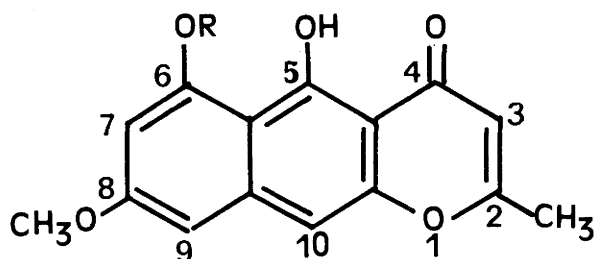
Os complexos  $\text{Cu(Rf)}_2$ ,  $\text{Cu(Rfg)}_2 \cdot 3\text{H}_2\text{O}$ ,  $\text{Ni(Rf)}_2 \cdot 2\text{H}_2\text{O}$  e  $\text{Ni(Rfg)}_2 \cdot 2\text{H}_2\text{O}$ , da rubrofusarina (Rf) e da rubrofusarina galactosilada (Rfg), foram isolados e caracterizados através de análise elementar e termogravimétrica e dos espectros RPE e infravermelho. Os valores de pK da Rf (7 e 11) e da Rfg (11) em solução de etanol/água e da Rfg em solução aquosa (10.2) foram determinados por espectroscopia de absorção na região UV - visível.

$\text{Cu(Rf)}_2$ ,  $\text{Cu(Rfg)}_2 \cdot 3\text{H}_2\text{O}$ ,  $\text{Ni(Rf)}_2 \cdot 2\text{H}_2\text{O}$  and  $\text{Ni(Rfg)}_2 \cdot 2\text{H}_2\text{O}$ , complexes of rubrofusarin (Rf) and 6-galactosyl rubrofusarin (Rfg), were isolated and characterized by elemental analysis, thermogravimetric measurements, EPR and infrared spectra. Both the pK of Rf (7 and 11) and that of Rfg (11.3) were determined in ethanol - aqueous medium as well as the pK of Rfg in aqueous solution (10.2) by using UV - visible spectroscopy.

**Key words:** rubrofusarin; 6 - galactosyl - rubrofusarin; Cu (I I) and Ni (I I) complexes.

### Introduction

*Cassia Machrantera* D. C. is a widely distributed Brazilian leguminosae from which Oliveira *et al.* isolated two compounds: rubrofusarin (2 - methyl - 5, 6 - dihydroxy - 8 - methoxy - naphtho -  $\gamma$  - pyrone), hereafter called Rf, and 6 - galactosyl rubrofusarin, hereafter called Rfg<sup>1</sup>. The structure of Rf(I), a metabolic product of the fungus *Fusarium culmorum*<sup>2</sup>, was established by X-ray crystallography by Stout and Jensen<sup>3</sup>.



Rf: R = H  
Rfg: R = galactosyl

Both compounds are potential chelators being able to form six membered ring complexes by coordination to metals through the phenolate and the carbonyl oxygens at C4 and C5 respectively. Rf, in addition, contains another potential binding site at C6.

Rf and Rfg were kindly supplied by Professor Alaide Braga de Oliveira, from the Department of Chemistry, UFMG. Rf is a red crystalline powder, m.p. (217 - 218) °C, insoluble in water, soluble in ethanol and DMSO; Rfg is a yellow crystalline powder, m.p. (202 - 204) °C, soluble in water, ethanol DMSO.

Rfg contains several chiral centers and displays a CD spectrum. In Table 1 are reported the absorption spectral data of Rf and Rfg and the CD spectrum of the latter at two pH values. The absorption at 340nm that is strongly enhanced upon deprotonation was used to determine the acidity constants of both ligands. Using Rf solutions at concentrations of the order of  $10^{-4}$  mol/l in ethanol - water (80:20, v:v), I = 0.05mol/l in KCl, only one value pK can be detected:

$$\text{pK}_1 = 7.24 \pm 0.29$$

At concentrations equal or lower than  $1 \times 10^{-5}$  mol/L two pK, clearly identified by their absorption spectra, may be determined:

$$\text{pK}_1 = 7.0 \pm 0.3$$

**Table 1.** Absorption data of Rf and Rfg, CD data of Rfg;  $\lambda$  (in nm);  $\epsilon \times 10^3 (\text{mol/l})^{-1} \text{cm}^{-1}$ ;  $\Delta\epsilon (\text{mol/l})^{-1} \text{cm}^{-1}$ .

Rf	pH 6.5 <sup>a</sup>	$\lambda_{\text{max}}$ :	222	248sh	275	330	340	408	—
		$\epsilon_{\text{max}}$ :	50.2	34.0	77.4	4.2	2.3	6.7	—
Rf	pH 12 <sup>a</sup>	$\lambda_{\text{max}}$ :	217	255sh	278	330	340	—	420
		$\epsilon_{\text{max}}$ :	46.5	40.0	81.7	5.0	7.4	—	9.2
Rfg	pH 6.5 <sup>b</sup>	$\lambda_{\text{max}}$ :	223	250sh	270	330	340	398	—
		$\epsilon_{\text{max}}$ :	20.4	21.6	26.8	2.0	1.5	3.75	—
		$\lambda_{\text{max}}$ :	228	247	281	—	345	378	432
		$\Delta\epsilon_{\text{max}}$ :	-6.2	-8.0	+7.8	—	-0.32	-0.28	+0.11
Rfg	pH 12 <sup>b</sup>	$\lambda_{\text{max}}$ :	214	257	277	330	340	—	420
		$\epsilon_{\text{max}}$ :	23.3	19.4	35.6	4.9	6.7	—	6.5
		$\lambda_{\text{max}}$ :	215	236	281	333sh	346	—	420
		$\Delta\epsilon_{\text{max}}$ :	-9.2	-4.6	-7.9	+0.27	+0.77	—	-0.93

a: ethanol - water ( 80:20, v/v ) KCl 0.05mol/l; b: KCl 0.05mol/l water; sh: shoulder.

**Table 2.** Analytical and Thermogravimetric Data of the Cu (II) and Ni (II) complexes of Rf and Rfg

Compound	Elemental Analysis <sup>a</sup>			Thermogravimetric Analysis <sup>b</sup>		
	C	H	Metal <sup>c</sup>	H <sub>2</sub> O	Ligand	Residue <sup>d</sup>
1	59.87 (59.45)	3.27 (3.66)	9.8 (10.48)	— —	350-500 (2L)	CuO (10.48)
2	55.21 (58.54)	3.31 (4.11)	9.9 (9.21)	180-200 (2H <sub>2</sub> O)	290-410 (2L)	NiO (8.6)
3	49.69 (51.14)	4.84 (4.91)	6.58 (6.43)	90-140 (3H <sub>2</sub> O)	240-290 (2L)	CuO (6.5)
4	52.5 (52.46)	4.94 (4.82)	5.8 (6.10)	80-120 (2H <sub>2</sub> O)	250-500 (2L)	NiO (6.4)

1. Cu ( Rf )<sub>2</sub>, brown reddish powder;

2. Ni ( Rf )<sub>2</sub>.2H<sub>2</sub>O, yellow powder;

3. Cu ( Rfg )<sub>2</sub>.3H<sub>2</sub>O, brown powder;

4. Ni ( Rfg )<sub>2</sub>.2H<sub>2</sub>O, brown powder;

<sup>a</sup>found ( calcd. ) %;

<sup>b</sup>temperature range ( decomposing moiety );

<sup>c</sup>atomic absorption data;

<sup>d</sup>( metal %).

**Table 3.** Infrared Absorption Frequencies of Rf, Rfg and their Cu (II) and Ni (II) Complexes. (KBr disks)

Rf	1	2	Rfg	3	4	Assignment
1658s	1640m	1645m	1650s	1642s	1650s	νCO...H
1622s	1605s	—	1625s	1616s	1620s	νCC
1580m	1570m	1575m	1580m	1555m	1560s	"
1505sh	1503m	1505s	—	1515s	1520s	"
1480m	1465s	1465s	1463sh	1455s	1460s	"
1450w	14440sh	—	—	—	—	"

<sup>s</sup> strong ; <sup>m</sup> medium; <sup>w</sup> weak; <sup>sh</sup> shoulder.

**Table 4.** EPR data of Cu (Rf)<sub>2</sub> and Cu (Rfg)<sub>2</sub>.3H<sub>2</sub>O

Complex	g <sub>⊥</sub>	g <sub>∥</sub>	A(Gauss)
Cu ( Rf ) <sub>2</sub>	2.064	2.296	154
Cu ( Rfg ) <sub>2</sub> .3H <sub>2</sub> O	2.071	2.292	167

$$pK_2 = 10.8 \pm 1.0.$$

In the case of Rfg the pK has been measured in ethanol - water and in aqueous solution in the presence of KCl 0.05mol/l:

$$pK = 10.20 \pm 0.06 \text{ (in aqueous solution)}$$

$$pK = 11.30 \pm 0.08 \text{ (in ethanol - water 80:20, v/v)}$$

The Cu (II) and Ni (II) complexes of Rf and Rfg were prepared following same technique: By means of a 0.1mol/L NaOH solution the pH of a 100ml solution, either of  $2 \times 10^{-3}$  mol/l Rf in ethanol - water (80:20, v/v), or of  $3.5 \times 10^{-3}$  mol/l Rfg in water, was raised to 11 and 1.5 ml of a 0.1mol/l solution of the corresponding metal perchlorate was added subsequently. A precipitate was immediately formed in ethanol - water media and gradually in water. After centrifuging and washing with water, it was dried under vacuum over  $CaCl_2$ . All compounds are insoluble in water and ethanol and slightly soluble in DMSO and DMF.

In Table 2 are reported the results of elemental and thermogravimetric analysis. The infrared absorption frequencies of the region particularly affected by coordination are illustrated in Table 3. The EPR data of the Cu(II) complexes are summarized in Table 4. The Ni(II) complexes do not give EPR spectra.

In the case of Rfg complexes coordination obviously takes place through the carbonyl and phenolate oxygens at C4 and C5 respectively, forming an approximately square planar arrangement about the metal. Owing to the similarity between the infrared, EPR and thermogravimetric data of Rfg and Rf complexes we may assume the same type of bonding in the case of Rf coordination.

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