Spectrophotometric Micro Determination of Gold by Formation of Ion Pair Association Complex with the Drug Ranitidine

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Abstract

The drug ranitidine (*N-[2-[[[5-[(dimethylamino) methyl] furan-2-yl] methyl]thio] ethyl]-N-methyl-2-nitroethene–1,1–diamine hydrochlorid*) forms (λ_{max}=260nm) ion-pair association complex with $[AuBr_4]^{-1}$ at pH range 2-3 extractable with 1,2-dichloroethane under the appropriate experimental conditions. A calibration plot was set up from which some analytical parameters are derived. These parameters include: linear dynamic range LDR (1-80μg.ml^{-1}), RSD (1.9 %), sandell sensitivity (0.0360), detection limit (0.11ppm), Corr. Coef (r) (0.9988), recovery (98.32 %), E_{rel} (-1.68 %) aqueous - to- organic phase ratio (5:4) and the mole-ratio method approved the $[AuBr_4]^{-1}$: RAN as being 1:1 .

الخلاصة

يكــون العقــار الرانتديــن (N-[2-[[[5-[(dimethylamino) methyl] furan-2-yl]
methyl]thio]ethyl] (260nm) -N-methyl-2-nitroethene–1, 1– diamine hydrochlorid)
عند رقم هيدروجيني يتراوح بين 2–3 معقد آيوني ترابطي مع $[AuBr_4]^{-1}$ قابل للاستخلاص بمذيب 1–2
ثنائي كلوروإ يثان تحت الظروف التجريبية الملائمة, حيث امكن إقامة منحني معايرة يتصف بأرقام الاستحقاق
ا لتحليلية الاتية : مرحلة الخطبة الحركية LDR (1–80 مـايكروغرام/مـل), RSD% (1.9), حساسية
سـاندل (0.0360 مـايكروغرام/سـم^2), حـدود الكـشف (0.1 جزء في المليـون), معامـل الارتبـاط (r) يـساوي
0.9988 , الاسترداد في مئة 98.3 %, الخطأ النسبي بالمئة 1.68%, نسبة الطور المائي الى العضوي (5
4 :) الصيغة التركيبية (المولية) $[AuBr_4]^{-1}$: RAN كنسبة 1:1.

Introduction

Ranitidine (RAN) is widely used as medicament for the treatment of stomach and intestine ulcers and cases accompanied by excessive secretion [1-3]. It is a white or pale yellow, crystalline powder, freely soluble in water and in methanol, sparingly soluble in ethanol, very slightly soluble in methylene chloride [4-6]. it has the following structure [7-8].

$C_{13}H_{22}N_4O_3S.\ HCl$
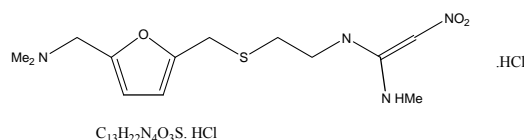
Gold (ɪɪɪ) such as $[AuBr_4]^{-1}$, react with RAN to form ion-pair association complexes suitable for micro determination of gold in varies matrices [9]. Various methods have been reported for the determination of Au(ɪɪɪ). These include ETA-AAS, HPLC, Spectrophotometric, ICP-MS, and chromatographic methods [10-15]. In this paper the newly developed Molecular Spectrophotometry has been used for the determination of Au(ɪɪɪ) by forming ion-pair association complex with RAN which has a maximum absorption at (260 nm). 1,2-dichloroethane was used as organic solvent for extraction of the complex.

Experimental
Apparatus

All spectral and absorbance measurements were carried out on a Shimadzu UV-Vis Spectrophotometer UV-160 A and Fourier Transform Infrared Spectrophotometer (FT-IR) Shimadzu (8300). Additional instruments like Mettler semimicro balance model HL52; pH meter, Orion research microprocessor ionalyzer 90, Perkin-Elmer 240 B Elemental (C.H.N) Analyzer, were used for further analysis.

Reagents

Ranitidine-HCl stock solution (1000 $\mu g.ml^{-1}$)
0.1gm of RAN was dissolved in water and diluted to 100ml in a volumetric flask.
$AuCl_3$ stock solution (1000 $\mu g.ml^{-1}$ Au)(BDH)
An atomic absorption standard solution (1000ppm) Au (ш) (BDH) were used.

$[AuBr_4]^{-1}$ stock solution [16]
This solution was prepared by treating 5ml of the Au (ш) stock solution (in 50ml measuring flask) with enough 40% KBr and diluting to volume with water.

Analytical procedure

An aliquot of the gold complex equivalent to (1-80) ppm Au (ш) was transferred to a 5ml volumetric flask then 1.9ml of the RAN solution (200ppm) was added. pH of solution was adjusted to 2.5 and the solution was set aside for one minute then diluted with water to volume. Extraction was carried out with 4ml of 1,2-dichloroethane with shaking for (1min.). Two layers were formed. The absorbance of the organic phase was measured at (λ_{max}=260nm). The concentration of the gold sample was deduced by regression from a calibration graph.

Absorption spectra
RAN stock solution

1ml of (1000 $\mu g.ml^{-1}$) ranitidine standard solution, was transferred to 10ml volumetric flask, and diluted to the mark with water, 4ml of this solution, was transferred to the absorption cell, then the absorption spectrum of this solution, was measured in region (200 to 600nm) using water as the reference. Fig (1) shows the absorption spectra of RAN, λ_{max} (228,314nm).
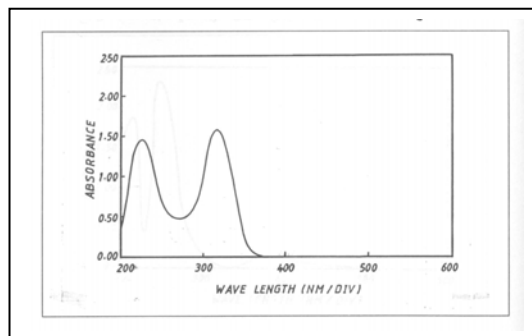

Fig (1) The absorption spectra of RAN

$[AuBr_4]^{-1}$ stock solution
Fig (2) shows the absorption spectra of $[AuBr_4]^{-1}$ with the maximum absorption at (380nm).
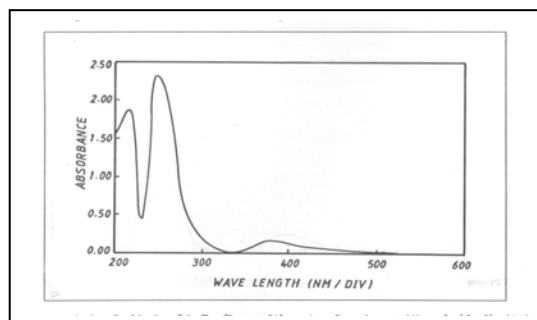

Fig (2) The absorption spectra of $[AuBr_4]^{-1}$

Complex of RAN with $[AuBr_4]^{-1}$
The absorption spectrum of extracted complex was measured in the region (200 to 600nm) using the extracting solvent as the reference, Fig (3).
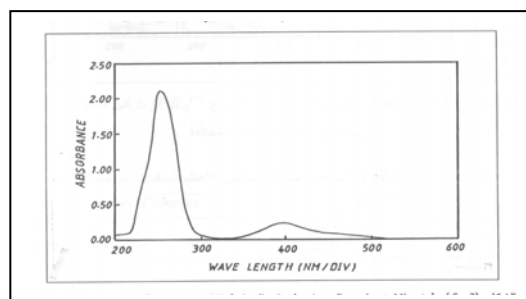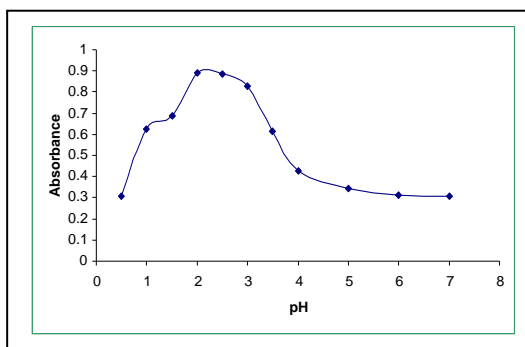

Fig (3) The absorption spectrum of Complex of RAN with $[AuBr_4]^{-1}$

Results and Discussion

Optimum conditions

Effect of pH values

The effect of pH on the formation of RAN-$AuBr_4$ ion-pair association complex is shown in fig (4), from which it appears that the best pH range is between (2-3).

Fig(4) Effect of pH on the determination of RAN-AuBr$_4$
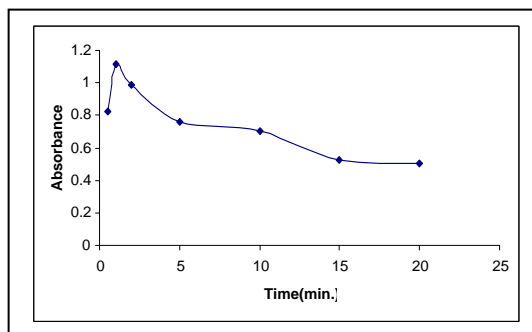
Effect of concentration of ranitidine

A concentration $(75\mu g.ml^{-1})$ of ranitidine and $(40\mu g.ml^{-1})$ of Au was found enough for complete formation of ion-association complex, fig (5).
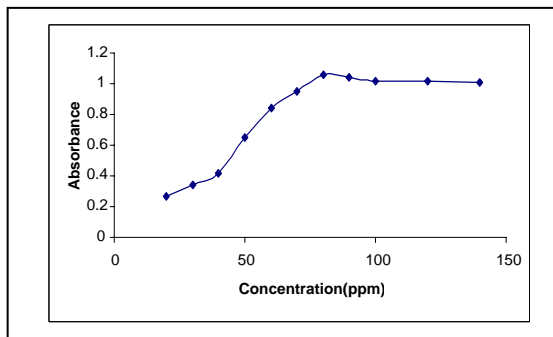
Fig(5) Effect of concentration of ranitidine on the determination of RAN-AuBr$_4$

Effect of reaction time

Fig (6) infers that a reaction time of (1min.) is enough for complex formation.

Fig(6) Effect of reaction time on the determination of RAN-AuBr$_4$

Organic solvent used in the extraction

Since, the method involves the measurement of complex in the organic phase, it is necessary to use a solvent, which will extract the complex, but not the unreacted excess of ranitidine used. $[AuBr_4]^{-1}$ is more soluble in water than in 1,2-dichloroethane, but RAN- $[AuBr_4]^{-1}$ is more soluble in 1,2-dichloroethane than in water.

Effect of extraction time

Fig (7) reveals that the complex of RAN with $[AuBr_4]^{-1}$, requires(1min.) of shaking to reach a state of equilibrium.
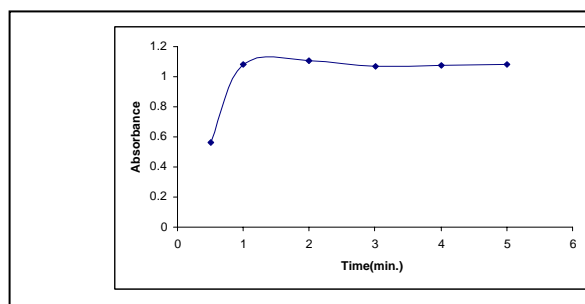
Fig(7) Effect of extraction time on the determination of RAN-AuBr$_4$

Effect of phase ratio

An aqueous-to-organic phase ratio of 5:4 gives the highest extractability and absorbance, fig (8).
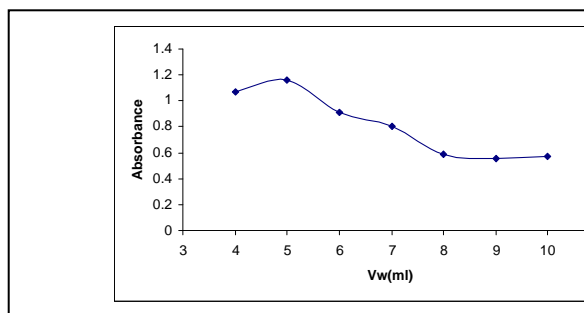

Fig (8) Effect of phase ratio on the determination of RAN-AuBr$_4$

Extraction Efficiency

Table (1) shows molecular absorbance values for the extracted ion-pair association complex of RAN with $[AuBr_4]^{-1}$ after the first and second extraction of the aqueous phase, and the extraction efficiency (%E=99.26) and the distribution coefficient (D=167.7).

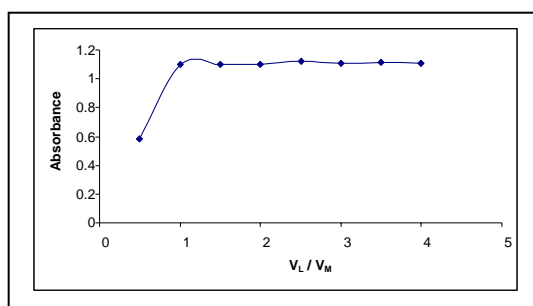**Table (1) absorbance of complex after the first and second extraction.**

$[AuBr_4]^{-1}$ ($\mu g.ml^{-1}$)	Ranitidine ($\mu g.ml^{-1}$)	pH	A1 (Ex.no.1)	A2 (Ex.no.2)	A_O (blank)
20	75	2.25	0.569	0.075	0.068

The mole ratio of ligand(L) to metal(M) complex

The molar-ratio method at (λ_{max}=260 nm) showed that a 1:1 ligand-to-metal was formed.

$$Au^{+3} + R^{+1} + 4Br^{-1} \rightarrow AuBr_4R$$

Fig (9) shows the molar ratio of ligand : metal.

Fig(9) the molar ratio plot, RAN-AuBr$_4$

Stability of complex

Table (2) shows the stability of complex RAN-$[AuBr_4]^{-1}$ at different durations.

Table (2) the stability of RAN-AuBr$_4$ complex

complex	Con. ($\mu g.ml^{-1}$)		Duration/hr.			
			0	1	24	48	72
RAN-$[AuBr_4]$	20	Abs.	0.562	0.561	0.514	0.469	0.422
		Rec.%	98.35	98.17	89.59	81.38	72.81

The FT-IR spectra for complex and drug RAN.

Figure (10) and (11) illustrate the Fourier transform-infrared spectroscopy (FT-IR) of free ranitidine and complex respectively.
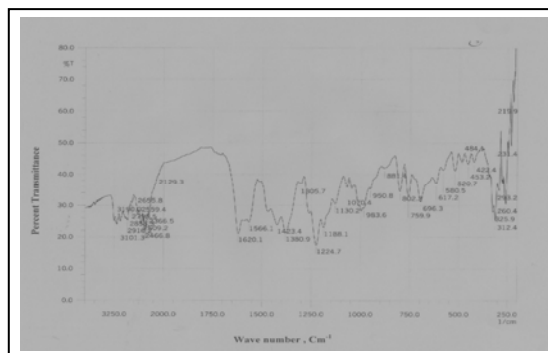

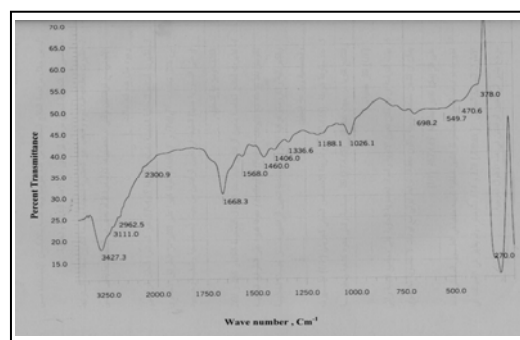**Fig (10) The Fourier transform - infrared spectroscopy (FT-IR) of free ranitidine**

Fig (11) The Fourier transform - infrared spectroscopy (FT-IR)

Calibration graph

Fig. (12) shows a calibration graph of $[AuBr_4]^{-1}$ established by plotting the absorbance of complex against RAN concentration. It is noticed that Beer's law is obeyed over the concentration range of (1-80 $\mu g.ml^{-1}$) and (λ_{max}=260nm).
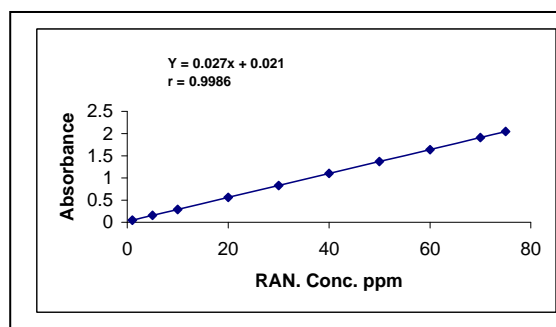

Fig (12) Calibration graph of determination of RAN-AuBr$_4$

Statistical calculations

Table (3) analytical figures of merits for determination of Au (ш) with RAN.

λ_max(nm)	Linearity (µg.ml⁻¹)	D.L (µg.ml⁻¹)	$\sum$ (l.mol⁻¹.cm⁻¹)	S (µg.cm⁻²)	Conf.lim. (µg.ml⁻¹)
260	1-80	0.11	5459.92	0.0360	25±0.0274

Table (4) regression equation, correlation coefficient (r), two tailed t-test and confidence limit for the slope and for the intercept at 95% confidence limit and (n-2) degree of freedom for the calibration graph.

Regre.eq. Y=BX+A	Corr. Coef. (r)	Two tailed t-test	Tabulated t-test N=2 p=0.05	Confi. Limi. for the slope b± ts_b	Confi.limi.for the intercept a± ts_a
Y=0.0274x+0.022	0.9988	49.95	2.447	0.0274 ± 0.00136	0.023 ± 0.0688

Table (5) the relative standard deviation RSD%, E_rel%, recovery%.

Amount of Au⁺³ taken (µg.ml⁻¹)	Amount of Au⁺³ found (µg.ml⁻¹)	Recovery (%)	E_rel. %	RSD%
25	24.58	98.32	-1.68	3.16

Interferences

The effects of interferents have been checked by adding to constant amounts (40 µg.ml⁻¹) of Au(ш) to different amounts (20,40 and 60 time more than analyte) of cations such as (Al^{+3}, Ni, Pt, Fe^{+3}, Fe^{+2}, Co, Bi, Cu^{+2}, Cd, W, Li, Cr, Zn, Pb, Pd, Ca) under similar experimental conditions. No interference has ever been detected.

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