Using The Platinum as an Ion Association Complex in the Indirect Determination of Microgram Quantities of Some Alkaloids and Pharmaceutical Compounds by GET-AAS

Riyadh H. M. Ali

Department of Medical Laboratories Techniques, Al-Rafidain University College, Baghdad, Iraq
riyadh.dol@gmail.com

ABSTRACT

Determination of microgram quantities of some alkaloids and pharmaceutical compounds such as Berberine (BRB) Narcotine (NAR) and Cinconine (CNC) using PtI_4^{2-} ion. The method involves the formation of ion - association - Pt - complexes with these alkaloids and subsequent solvent extraction of the complexes produced followed by determination of the platinum concentration after inject 20 ul from the organic layer into the GET-AAS.

The optimum conditions such as the concentration of the PtI_4^{2-} ion, pH-value of the complexes formation, kinds of organic extraction solvents, volume and number of extractions as well as time of the consuming reaction were studied.
The linear dynamic range, precision, Accuracy, detection limits and relative standard deviation (n=5) have been computed for each alkaloid investigated.

The results achieved were satisfied comparing with a previous one using different metal.

Key words
Alkaloid, Indirect determination, GET-AAS, Ion-association-Pt-Complex, Solvent extraction.

1. Introduction

Atomic absorption spectrometry considered one of the best techniques among the analytical methods, extensively applied in the quantitative studies of metals [1].Graphite furnace atomic absorption with high –resolution continuum source was used to determine the content of cadmium, chromium, copper and nickel in 25 tea samples of china [2].The same technique was used to determined of some metals like Se, Cr, Mn, Co, Ni, Cd and Pb in whole blood samples [3].Content of lead in nine bay leaf samples was determined using ET-AAS [4].

Many attempts have been made to determine the different kinds of organic compounds, alkaloids and pharmaceutical compounds indirectly, both classical and instrumental methods have been used for their determination of the unknown species but the former suffers from deficiency in sensitivity.

Atomic Spectroscopy technique which is used for both quantitative and qualitative analysis of an element present in sample through mass spectrum [5].

There is a variety of analytical techniques such as titrimetric, spectroscopic and electrochemical and their corresponding methods used in the analysis of pharmaceuticals, further researches using the AAS in the pharmaceutical samples for the determination of trace elements [6].

Recent advances in the determination of elemental impurities in pharmaceutical stats, challenges and morise frontices [7].

A simple strategy using an AAS for the direct determination of organic compounds is proposed, the determination of Caffeine and Propanolol employing atomic absorption instrumentation was conducted using the emission lines of Fe and Mg elements respectively, and the Limits of detections were 0.46 and 0.56 mg/L for Caffeine and Propanolol, respectively [8].

The use of ion pair formation permits the combination of different analytical techniques, such as extraction and spectrophotometry, the use of metal complexes allows the indirect determination of organic compounds by atomic absorption spectrophotometry and increase the sensitivity [9].

The formation of ion-pair associate between the drug (doxazosinmesylate) and the inorganic complex, bismuth(III) tetraiodide was studied [10].

The Electro thermal Atomic Absorption technique have many advantages against the flame - AAS in determination of many elements [11].

Determination of some pharmaceutical preparations such as leucogen by indirect AAS by detecting the Cu^{2+} in the supernatant solution in AAS with linear range 10 -100ug/ml [12].

Methods of quantitative determination of the platinum content in high –salt solution have been developed using AAS [13].

Platinum was used in the determination of metals in AAS to give a good results in such kind of analytical procedure and as a group of metal can form ion – association complex as PtI_4^{2-}, $PtBr_4^{2-}$, $PtSCN_4^{2-}$ with other organic compounds.

The determination of trifluoperazine hydrochloride (TFPH) at trace levels in pharmaceuticals by formation a complex with the platinum using AAS [14].

The investigation of high-resolution source graphite furnace AAS for the direct determination of Pt in two samples of different nature [15].

PdI_4^{2-} ion was used for the indirect GET-AAS determination of some microgram quantities of alkaloids and pharmaceutical preparations [16].

A new procedure for determination of some alkaloids and other pharmaceutical compounds is described using the PtI_4^{2-} ion complex, the method consists of extracting an ion pair between the organic base (BRB, NAR and CNC) with the inorganic complex PtI_4^{2-}, and measuring the concentration of the Pt metal in the organic phase by AAS at 265.9 nm. The optimal experimental conditions; concentration of PtI_4^{2-}, pH-value, solvents of extraction, volume and shaking time, phase ratio and number of extractions were studied in the determination of these alkaloids.

2. Material And Methods / Experimental Details / Methodology

A shimadzu AA- 7000f Atomic Absorption spectrophotometer, ROM version 1.03 S/N A30945100295, Pt-HCl was used for measuring Pt (265.9)nmAA signal.

The reagents used were of analytical grade, Deionized water (DIW) was used throughout.

Stock standard solution of 1000 ug/ml Pt(II) was used from (BDH) company ,further diluting concentrations was prepared freshly by ten times dilution.
   Berberin sulphate (M.r. 822.85) Analar from Fluka.
   Cinchonine (M.r. 294.40) purum from Fluka.
   Narcotine (M.r.413.42) purum from Fluka.

Alkaloids stock standards (1000ug/ml) were prepared by dissolving 0.0250g of each of CNC and NAR in 25ml ethanol.

For BRB stock standard (0.0305) gm of Berberine sulphate in 25ml DIW volumetric flask was used. for more diluting intermediate standard solution were prepared by dilution ten times.

Working solution prepared freshly by diluting 0.5 ml of the stock solution of Platinum to 25 ml volumetric flask, then adding 15.0ml (4M) HCl with 5.0 ml solution of 4% (wt/v) KI, stand for 10 min and continue with (DIW)to the mark(9).

Analytical Procedures:

We placed appropriate aliquots of each of the three alkaloids in each 10 ml graduated test tube, the optimum conditions were adjusted to values specified in table (3) using different volumes of PtI_4^{2-} concetration each time as well as changing the pH –value using o.1M HCl or NaOH.

The ion-association complexes which formed was shaken for 1 minute with 1.0 ml of chloroform and 20ul portion of the organic layer was injected in the graphite tube, construction the calibration curve, each solution was analyzed in triplicate and blank. The ash/atomize curves of the three complexes have been constructed according the parameters in

(table 1), and the heating cycle as in (table 2).

Ash/Atomize curves:

Table 1shows the instrumental parameters in the determination of three PtI_4^{2-}- alkaloid complexes.

Table   2 indicates the Graphite furnace temperature program.

Figure **3** shows the ash/atomize curve of the three PtI_4^{2-}- alkaloids complexes which appears a little fluctuation in the absorbance values which probably due to thermal decomposition and phase change of PtI_2 and subsequent formation of platinum atomic cloud [17].

3.   Results and Discussion

Optimization of experimental parameters

The influence of varying parameters was studied; concentration of PtI_4^{2-}, pH-value, reaction time, number of extractions and time of shaking.

Figure 2 shows the effect of the concentration of PtI_4^{2-} ion on the formation of the complexes (PtI_4^{2-} - BRB), (PtI_4^{2-} - NAR) and (PtI_4^{2-} - CNC) formed.

Figure 3 shows the effect of pH-values on the absorbance of the three inquired ion- Association complexes of the alkaloids, At pH above 7 alkaloids don't ionize, therefore no ion- Association complexes formation is expected [18].
It has been shown experimentally that 1ml of organic phase is enough for entire depletion of organic-Pt-complex in the aqueous phase.

The nitrogen atom of the alkaloid ionizes in acidic medium what is known protonated alkaloid.

$$X\ Alkaloid^+ \ + \ ML_n^{x-} \longrightarrow \qquad Alkaloid\ xMLn$$

Since ML_n^{x-} represents the PtI_4^{2-} in this case.

One minute shaking time was shown to be sufficient for extraction of each of the three complexes.

Table 3 gives absorbance for one and two batch extractions, which it could be concluded that the former is the most suitable, the complexes formed are slightly soluble in aqueous media but are freely soluble in organic solvent, and a 10min interval is enough for PtI_4^{2-}- alkaloid complete reaction. And chloroform was found suitable for the extraction of these complexes.

Table 1 Instrumental parameters for the determination of Ion-association complexes

Parameters	BRB	CNC	NAR
Wavelength (nm)	266.0	266.0	266.0
Lighting mode	BGC-D2	BGC-D2	BGC-D2
Injected volume	20 ul	20ul	20ul
Current	14mA/0A	14mA/0A	14mA/0A
Slit width	0.5nm	0.5nm	0.5nm
Purg Gas	Ar	Ar	Ar

Table 2 Graphite furnace temperature program, Pyro lytic graphite

Stage	Temp.(C)	Time(sec)	(l/min)	Heat
1	120	20	1.0	Ramp
2	250	10	1.0	Ramp
3	600	10	1-0	Step
4	600	3	0.0H	Step
5	2600	3	0.0H	Step

- From 200 to 1700 C for construction of ashing curve.
- From 1500 to 2600 C for construction of Atomization curve.

Table 3 Effect of PtI_4^{2-} concentration and pH-values on the Absorbance found

Alkaloid Conc.(ppm)	Conc. of PtI_4^{2-} M	pH	A1 Extr,1	A2 Extr.2	A Blank
BRB (3.0)	6.5×10^{-5}	2.5	0.30	0.015	0.009
CNC (2.2)	7.7×10^{-5}	3.0	0.24	0.025	0.008
NAR (3.4)	4.5×10^{-5}	2.5	0.35	0.022	0.009

The results of analysis and parameters are shown in table (4) & (5).

From the data presented ,it is evident that GET-AAS could be successfully applied to the indirect analysis of pure alkaloids which contains at least one nitrogen in an amine – type structure as part of a ring of atoms, and have diverse and important physiological effects on humans and other animals, as well as in pharmaceutical preparations and in biochemical samples from different type such as urine, blood and tissues , the results shows that the Detection Limits (D.L) were 0.011 , 0.010 and 0.006 ppm to BRB , CNC and NAR sequentially , and it is a dramatic procedure on the trace and ultra trace level with an excellent sensitivity reach to a pico-gram (p.g) level in determination of drugs or biochemical fluids , table (4) appear the calibration curves in the ranges 0.2 – 4.1 , 0.5 – 3.9 and 0.15 – 4.2 ppm for BRB ,CNC and NAR consecutively .

In comparison the results with other published studies for Quinine (alkaloid) in pharmaceutical samples using the standard addition method using PdI_4^{2-} ion-association Quinine complex in GET-AAS , which found the Relative error percent E_{rel} % equal to 1.61 [16].

**Table 4** Analytical parameters; Linearity, precision, accuracy, limit of detection (LOD), Sensitivity

Comp.	Linearity (ppm)	RSD% N=5	Erel%	D . L (ppm)	Sensitivity (pg)	Confdence Limit
BRB	0.2- 4.1	2.69	0.58	0.011	932	o.171±0.001
CNC	0.5 – 3.9	0.73	0.45	0.010	806	2.200±0.022
NAR	0.15-4.2	1.39	1.11	0.006	720	1.800±0.035

Table 5 Regression values,Slops and Correlation Coeff.

| Sample	Regression $Y = BX + A$	Slop	Corr.Coeff. (r)
NAR	$Y = 0.124X - 8.0 \times 10^{-3}$	0.124	0.9940
BRB	$Y = 0.100X - 1.0 \times 10^{-2}$	0.100	0.9995
CNC	$Y = 0.100X + 1.0 \times 10^{-2}$	0.100	0.9994

Table 6. comparison between this procedure with the previous one using the PdI_4^{2-}

| Alkaloid	Inorganic complex	Linearity (ppm)	D.L (ppm)	RSD%
CNC	PdI_4^{2-}	1.25 - 7.50	0.24	1.56
CNC	PtI_4^{2-}	0.5 - 3.9	0.01	0.73
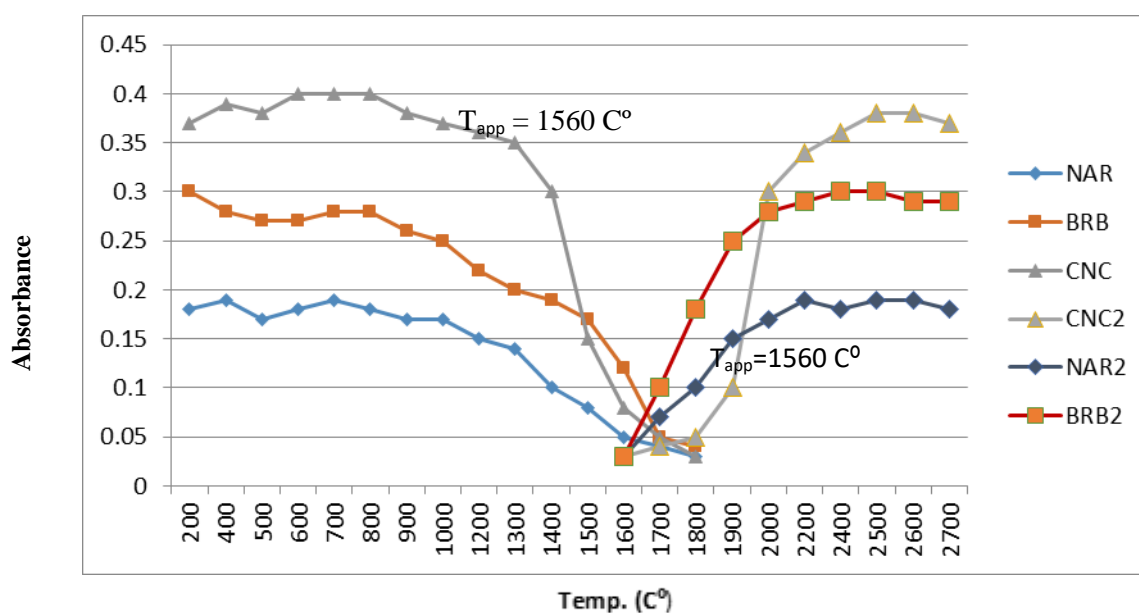
Fig. 1. Ash/Atomize curves of the three PtI_4^{2-}- alkaloids complexes using the indirect GET-AAS new proced
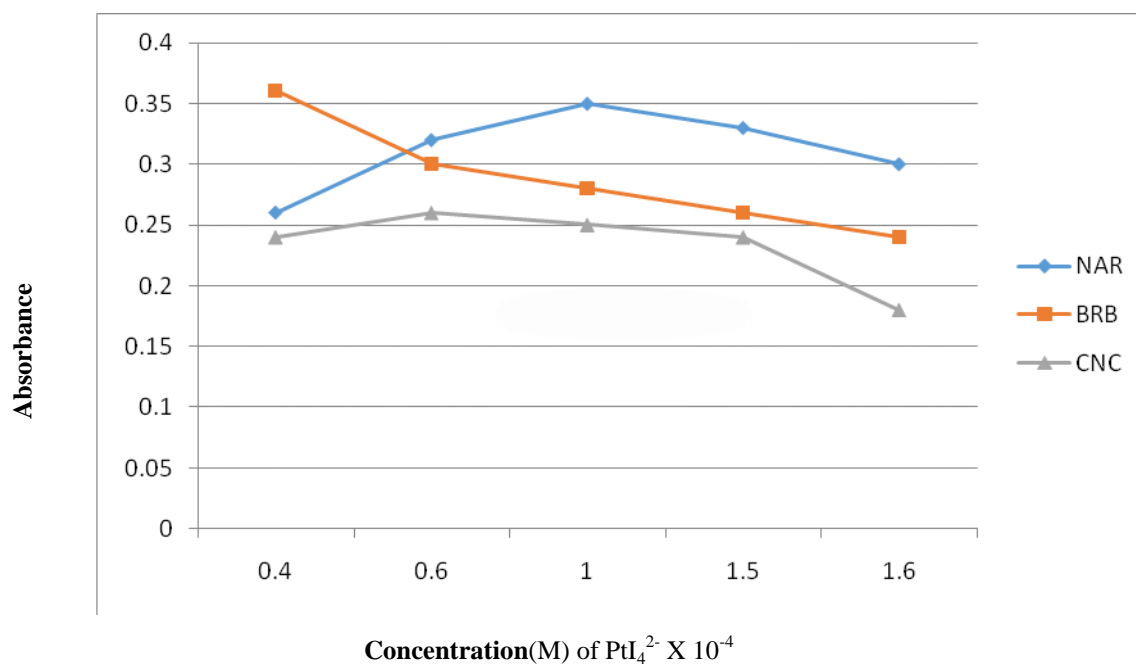
Fig. 2. Effect of PtI_4^{2-} concentration on the Atomic Absorbance signal to each BRB, CNC and NAR using the new procedure
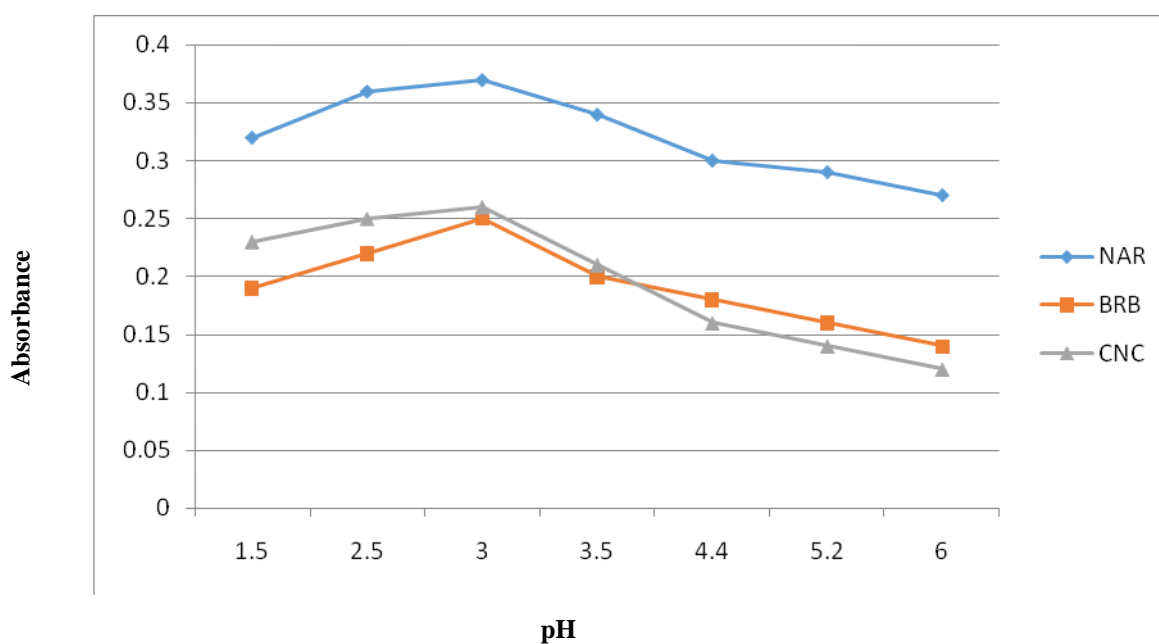
Fig. 3. Role of pH-values on the formation of each PtI_4^{2-}- alkaloids complexes employing the indirect GET-AAS new procedure.
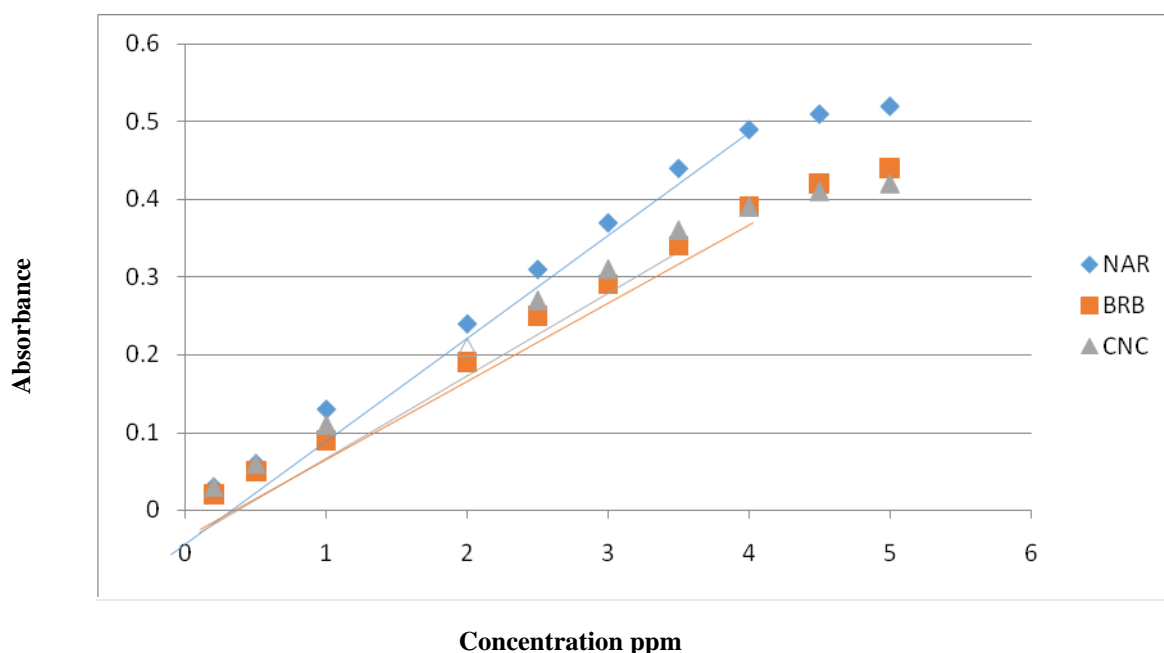
Fig. 4. The linearity of the determination of the three alkaloids BRB, CNC and NAR.

4. Conclusion

(1) It is evident from the data presented that we can use the PtI_4^{2-}ion in the formation ion-association -complexes and indirect GET-AAS analytical technique as a suitable one when we need to analyze a trace or ultra trace quantities of organic compounds such as alkaloids or pharmaceutical samples.

(2) Table 4 shows a very good results comparing with previous procedures using other metalssince the detection limits was found to be between (0.006 - 0.011) ppm, Precision (RSD% = 0.73 - 2.69 %), Accuracy (Erel.% 0.45 -1.11) for the three alkaloids detected.

(3) Table 5 shows a comparison between this procedure with the previous one using the PdI_4^{2-}ion complex with CNC in the same technique, which appear a dramatic analytical results.

(4) We suggest for further researches progress using different hybridized technique with GET-AAS to enhance the sensitivity.

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Competing interests

I have declared that no competing interests exist.

Authors' Contributions

I read and approved the final manuscript.

References

[1] Esther P, Juan L, Maria G. Atomic – absorption spectroscopy methods for analysis of   components from contaminates and biomedical applications. American journal of Biological chemistry/Abstract2019;7:16-25.

[2] Wen Z, Ting R, Li J. Determination of Pb (Lead), Cd (Cadmium), Cr (Chromium), Cu (Copper) and Ni (Nickel) in Chinese tea with high –resolution continuum source graphite furnace atomic absorption spectrometry. Journal of food and drug Analysis. 2016, 24: 46-55 .

[3] Magdalena W, Wojciech S, Maciej S, Zoltan W, Jan S, Ryszard K and et al.Optimization of high-resolution continuum source graphite furnace atomic absorption spectrometry for direct analysis of selected trace elements in whole blood samples. Talanta. 2017, 165: 351-356.

[4] Zatil A, Latifahtal H, Nuriathifahand D. Application graphite furnace atomic absorption spectroscopy (GF-AAS) on determination of Leadin bay (Syzgium polyanthum) leaves. AIP Conference 2175.[internet]. 020020;2019. https://DOI:10.1063/1.5134584.

[5] Masoon S, Zeid A, R Nafisur. Analytical techniques in pharmaceutical analysis. A review; Arabian journal of chemistry.[internet]. 2017 10(1): 1409-1421 http//DOI:10.1016/j.arabjc.2013.o4.016.

[6] Balaram V. Recent advances in the determination of elemental impurities in pharmaceuticals status, challenges and moving frontiers. Tr Ac Trends in Analytical chemistry. [internet].2016,80, 83 – 95. https://DOI:10.org/10.1016/j.trac.2016.`

[7] Bruno L, Luciano V, Eduardo C. Exploring the versatility of an Atomic Absorption spectrometer: Application to direct molecular determination of Caffeine and propranolol. J .Braz.chem.soc. [internet]. 2016 Apr, 27(4). print version ISSN 0103 – 5053 on-line version ISSN 1678 – 4790.https://dx.DOI:10.5935/0103-5053.20150312.

[8] Muhammad A, Kanwal R. Atomic spectroscopy.[internet].2019, 18.Essentials of pharmaceutical Analysis 81-84.Springer Nature Singapore pte Ltd.2020. http://DOI: 10.1007/978-981-15-1577-7-5.

[9]   Cristina N, Agustin G. Indirect determination of alkaloids and drugs by Atomic Absorption Spectrometry. Anal.chem.1985,571:34-38.

[10] Reda A. Determination of doxazosinmesylate by ion – pair complex formation with bismuth(III) tetra iodide using spectrophotometric and atomic absorption spectroscopic. Oriental journal of chemistry, An International Research journal of pure & Applied chemistry. Department of chemistry, college of science, princess Nourah Bint Abdul Rahman University, Riyadh, Saudi Arabia.[internet].2015.4. http://DOI:10.13005/ojc/310485.

[11] Fuller W. Electro thermal Atomization for Atomic Absorption spectrometry, Cieveland, England: Tioxide International Ltd. Cieveland,England.1977 .

[12] Jiao G, H Lang .Determination of Leucogen by Indirect Atomic absorption spectroscopy. Chinese journal of analytical chemistry.2002-01.[category Index] 0657.3 . www. Cnki. Com.cn.

[13] Volchenkova ,Kazenas, Kuvshinova, Petrakova,Smirnova, Andreeva and et al. Application of atomic absorption spectroscopy method for platinum content determination to study functionalization of bone substitute materials with anticancer drug. Jurnal of physics: conference series.[internet]. vol.1347;N0.1 .

[14] Ameen Q, Waleed, K Zuhair, A Ashraf, J Fadhel. An Indirect Atomic Absorption Spectrophotometric Determination of Trifluoperazine Hydrochloride. Arab Sci Eng.[internet]. 2011 36; 553-563.DOI 10.1007/s 13369-011-0058-4.

[15] Martin R ,Maria R F , Ignasi Q ,Eva M .Determination of palladium ,platinum and rhodium in used automobile catalysts and active pharmaceutical ingredients using high resolution continuum source graphite furnace atomic absorption spectrometry and direct solid sample analysis .Spectrochemica Acta part B : Atomic spectroscopy. 2015,105, 38 – 46 .

[16] A Riyadh A, Fadhil J. Determination of some Biologically active alkaloids using ion association palladium complexes and indirect electro thermal atomization AtomicAbsorption Spectrophotometry .Baghdad, .Iraq. J.sc.1999.4,1-20.

[17] Mohammed J. Chemical Analysis by Atomic Absorption spectroscopy , Part 1.Baghdad,Iraq. Dar AL- Hekma Ltd. 1989,87-102.

[18] Cristina N. ,G Agustin. Indirect determination of Nitrogenated drugs by Atomic Absorption Spectrometry. Anal. Chem. 1986,182619-2621.