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H-Point Standard Addition Method for the Simultaneous Determination of Caffeine and Paracetamol in Pharmaceutical Samples

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Abstract: The H-Point standard addition method (HPSAM) based on Spectrophotometric measurement was applied to the simultaneous determination of caffeine and paracetamol in different wavelength pairs. Determination carry out in pH=5 and without addition of any reagent. Results showed that caffeine and paracetamol could be determined simultaneously in the rang of 0.26-15.40 mg L^{-1} and 0.17-13.50 mg L^{-1} respectively.The proposed method was successfully applied to the determination of caffeine and paracetamol in a pharmaceutical preparation.

Key words: H-Point Standard Addition Method, Simultaneous determination, of Caffeine and Paracetamol.

Introduction

Paracetamol (acetaminophen) a common analgesic and antipyretic drug that is used for the relief of fever, headaches and other minor aches and pains and a major ingredient in numerous cold and flu medication. Caffeine is a central nervous system (CNS) stimulant, having the effect of warding off drowsiness and restoring alerting. Several methods have been reported for the simultaneous determination of paracetamol and caffeine. these methods include : electrochemistry (DPV) [1], LC [2,3,4], HPLC [5,6] and Spectrophotometric methods[7,8]. H-Point standard addition method (HPSAM) is a modification of the standard addition method (MOSA) that transforms the incorrigible error resulting from the presence of a direct interference in determination of an analyte into a systematic error. This method also permits both proportional and constant errors produced by the matrix of the sample to be corrected directly [9, 10].

In 1988, bosch-reig and compins-falco [9] presented a new technique, the H-point standard addition method (HPSAM) based on the principle of dual–wavelength Spectrophotometric and standard addition method.

Since the HPSAM can remove an error resulting from the presence of interferent and blank reagents, thus it can determine two components simultaneously [11, 12].
In this paper HPSAM described as a rapid, simple, precise and accurate method for simultaneous determination of paracetamol and caffeine. The suggested method was successfully applied to the determination of those analytes in pharmaceuticals.

Experimental

Apparatus

A varian model carry 100 UV-Visible recording spectrophotometer with 1- cm quartz cell was used for absorbance measurements and measurement of pH were made with a Mettler Toledo MP-220 pH-meter using a combined glass electrode .

Reagents

Triply distilled water and analytical – reagent grade chemical were used. HCl and NaOH solutions made from Merck products in 0.01, 0.1, and 3 M concentrations for regulation of pH.

Procedure

In order to find the optimum pH for determination of paracetamol and caffeine influence of pH in the rang of 1-12 on their spectra was investigated. Results showed that pH in the rang 4-9 had no effect on the determination of paracetamol and caffeine. Therefore routine works were performed in pH 5.
Appropriate volumes of paracetamol and caffeine standard solutions were added in a 25 ml volumetric flask. The solution was diluted to the mark with water then by addition of HCl or NaOH in suitable concentration by a microcyrang and measure the pH by pH-meter, pH regulated at 5. It's being considered that additional volumes by microcyrang in 25 ml flask are so insignificant that change the concentration of analytes. Then a portion of the solution was transferred into 1-cm quartz cell to measure the absorbance at appropriate wavelengths.

The simultaneous determination of caffeine and paracetamol with HPSAM was performed by measuring the absorbance at 260 and 283 nm (when standard addition of paracetamol was added) or 231 and 251 nm (when standard addition of caffeine was added) for each sample solution. Paracetamol and caffeine can be determined simultaneously in rang 0.17-13.5 mg L^{-1} of paracetamol and rang 0.26-15 mg L^{-1} of caffeine. Synthetic samples containing different concentrations ratios of paracetamol and caffeine were prepared and standard addition of paracetamol (up to 13.7 mg L^{-1}) and caffeine (up to 17.44 mg L^{-1}) were made.

Results and discussion

Figure. 1 shows the absorption spectra of paracetamol and caffeine at pH=5. As can be seen the spectra of both compounds show a strong overlap with each other and therefore each component interferes with the Spectrophotometric determination of other. However the system is suitable for the simultaneous determination of paracetamol and caffeine using HPSAM.
Figure. 2 show the applicability of HPSAM to the simultaneous analysis of paracetamol and caffeine by the proposed system. As shown when paracetamol selected as the analyte, it is possible to select several pairs of wavelengths where there are the same absorbance values for caffeine species. The two wavelengths which gave the highest accuracy, was selected for further work. The criteria for choosing the best pair of wavelengths were as follows. The best pair of wavelengths should give the greatest slope increment [13] and also the change in absorbance related to caffeine concentration should be negligible. For this reason the two wavelengths 260 and 283 nm was employed for obtaining the highest accuracy. When caffeine selected as the analyte and paracetamol as an interfernt the best two wavelengths for determination are 231 and 251 nm.

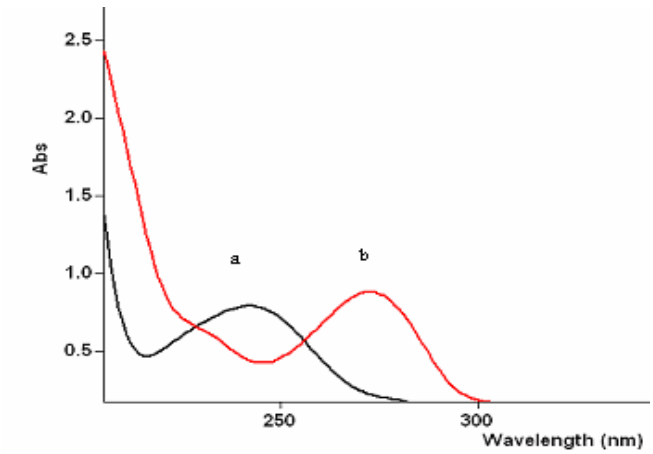


Figure 1.:Absorption spectra of a (paracetamol) 10 mg/L and b (caffeine) 16.32 mg/L in pH=5

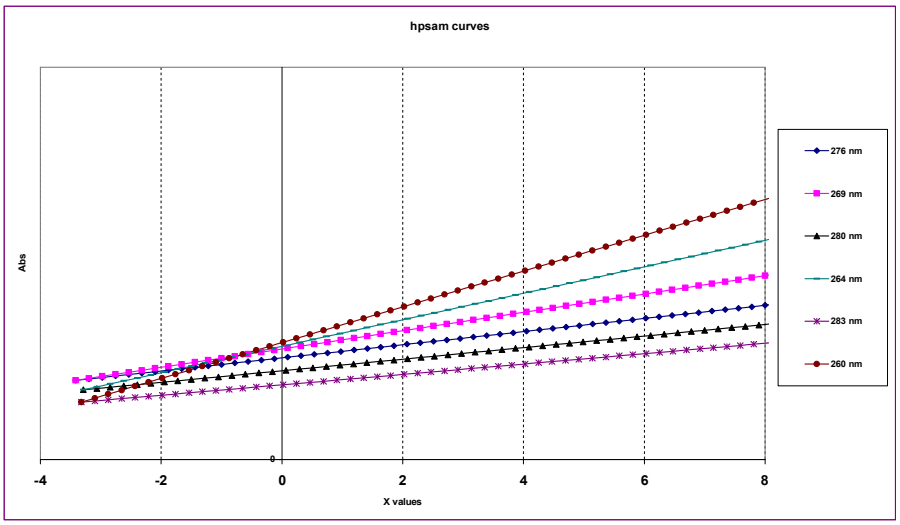


Figure 2.: HPSAM plot for selection of best two wavelengths for simultaneous determination of caffeine and paracetamol when paracetamol added

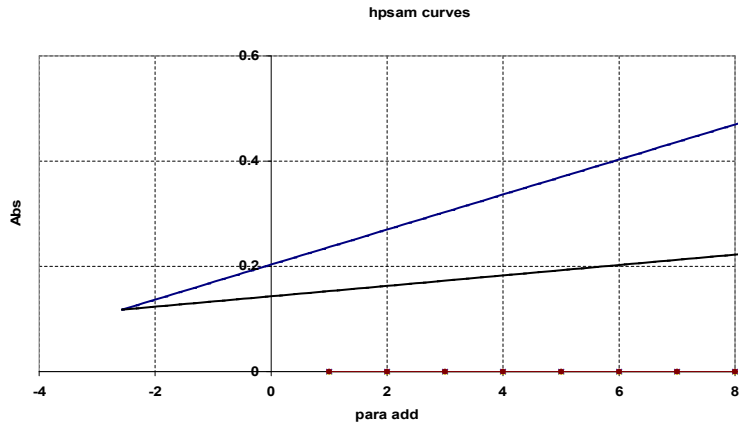
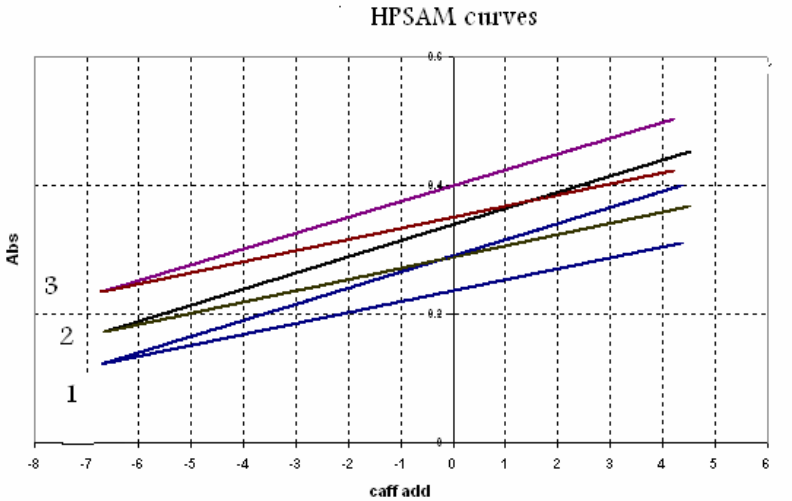


Figure 3.: The HPSAM plot for simultaneous determination of paracetamol and caffeine when paracetamol added (paracetamol= 2.74 mg L^{-1} and caffeine= 3.48 mg L^{-1})



Firure 4.: The HPSAM plot for simultaneous determination of paracetamol and caffeine when caffeine added (paracetamol=2.74 mg L^{-1} and caffeine=5.48 mg L^{-1})

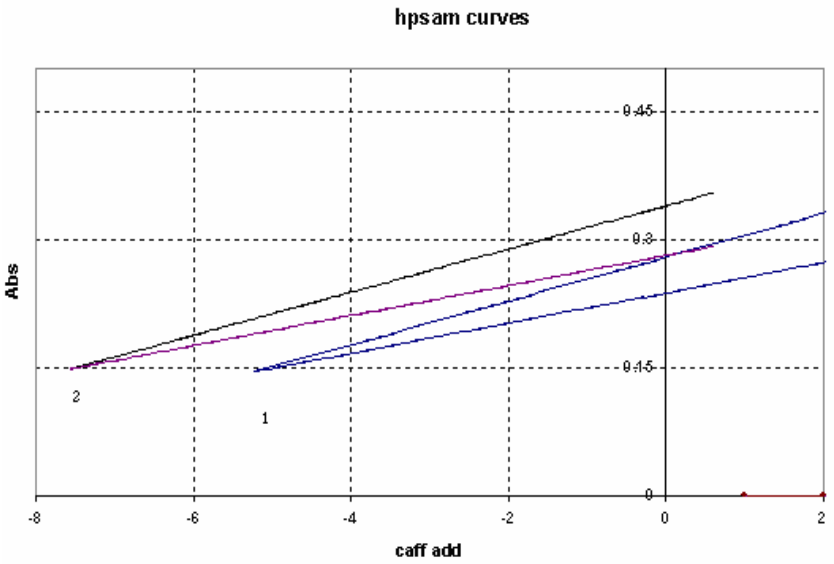


Figure 5. HPSAM plot for simultaneous determination of caffeine and paracetamol when caffeine added in a constant value of paracetamol (2.74 mg/L) (C1caff =5.48 mg/L and C2caff = 7.40 mg/L)

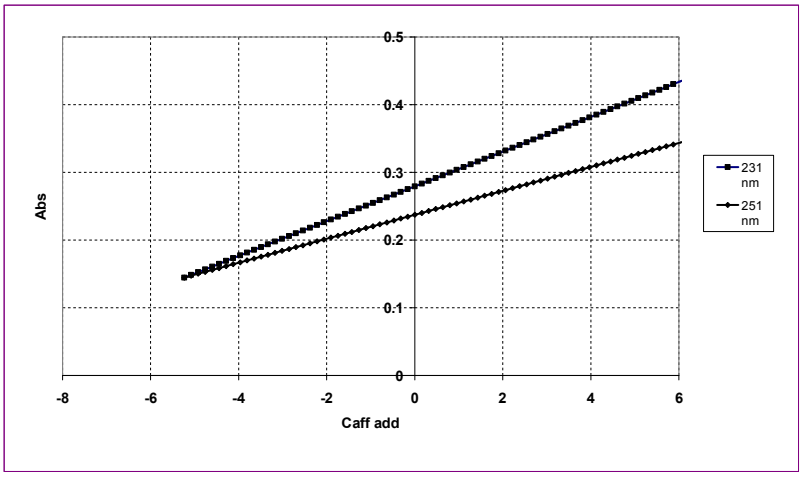


Figure 6. HPSAM plot for simultaneous determination of caffeine and paracetamol when caffeine added in a constant value of caffeine (6.96 mg/L) (C1para = 2.74 mg/L, C2para = 4.38 mg/L, C3para = 5.48 mg/L)

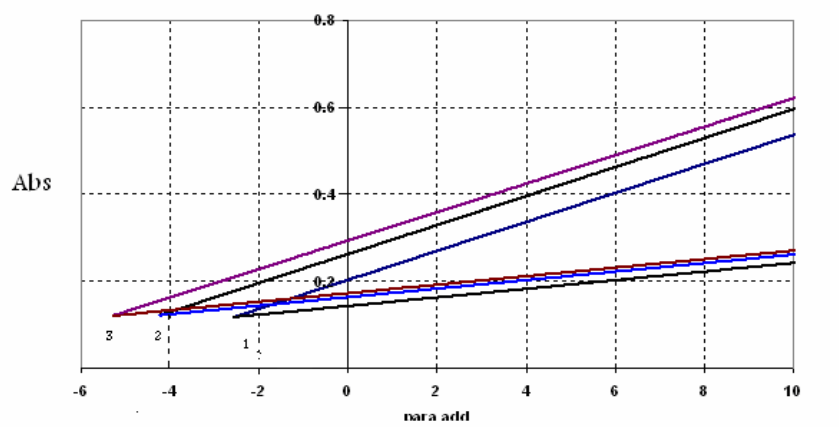


Figure 7. HPSAM plot for simultaneous determination of caffeine and paracetamol when paracetamol added in a constant value of caffeine (3.48 mg/L) (C1para = 2.74 mg/L, C2para = 4.38 mg/L, C3para = 5.48 mg/L)

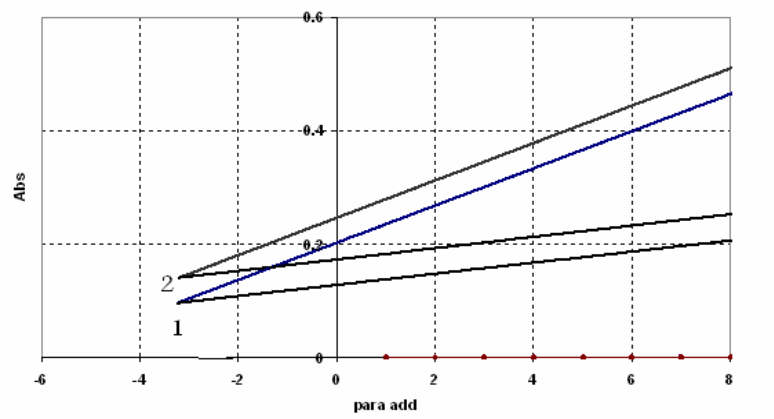


Figure. 8. HPSAM plot for simultaneous determination of caffeine and paracetamol when paracetamol added in a constant value of paracetamol (3.29 mg/L) (C1caff = 2.78 mg/L and C2caff = 4.18 mg/L)

Requirement for applying HPSAM

Consider an unknown sample containing an analyte X and an interferent Y. The determination of concentration of X by HPSAM under these conditions requires the selection of two wavelengths λ1 and λ2 at which the interfering species, Y, should have the same absorbance. Then known amounts of X are successively added to the mixture and the resulting absorbance are measured at the two wavelengths and expressed by equation (1) and (2) , where A(λ1) and A(λ2) are the analytical signals measured at λ1 and λ2 , respectively; b0 and A0 (A0≠ b0) are the original analytical signal of X at λ1 and λ2 respectively ; b and A , are the analytical signals of Y at λ1 and λ2 respectively ; M λ1 and M λ2 are the slopes of the standard addition calibration lines at λ1 and λ2 respectively ; Ci is the added X concentration .

The two straight lines obtained intersect at the so-called H-point (-CH, AH) (Fig 3 equation (1), (2))

At the H-point, since A(λ1) = A(λ2) , Ci = -CH from eq.(1) and (2) follow eq. (3) and (4) and from eq. (4) the following conclusions can be obtained : (i) if the Y component is the is the known b (at λ1) and A (at λ2) do not change with the additions of an analyte, X, that is b=A=constant, and thus see eqs. (5)- (8).

$$A(\lambda 1) = b0 + b + M\,\lambda 1\, Ci \qquad (1)$$

$$A(\lambda 2) = A0 + A + M\,\lambda 2\, Ci \qquad (2)$$

$$b0 + b + M\,\lambda 1\,(-CH) = A0 + A + M\,\lambda 2\,(-CH) \quad \ldots..(3)$$

$$-CH = [(A0-b0) + (A-b)] / (M\,\lambda 1 - M\,\lambda 2) \quad \ldots..(4)$$

$$CX = (A0-b0) / (M\,\lambda 1 - M\,\lambda 2) = b0 / M\,\lambda 1 = A0 / M\,\lambda 2 \quad \ldots..(5)$$

If CH = -CX then ,
-CH = (A0-b0) / (M λ1- M λ2) = b0/ M λ1 = A0/ M λ2 …..(6)

If the value of –CH is included in eq. (1) then
AH = b0 + b + M λ1 (-CH) …..(7)

b0 = -M λ1 CH (eq. (4)) , then
AH = b …..(8)

and similarly,
AH = A

Hence, AH value is only related to the signal of interference Y at the two selected wavelengths and CH is independent from concentration of interference. To evaluate the interferent concentration from the ordinate value of the H-point (AH), a calibration graph or the absorbance value of an interferent standard is needed. (ii) If component Y is the unknown interferent, eq (4) is tenable as long as the Y analytical signals (b at λ1 and A at λ2) remain equal with the addition of analyte X. According to the above discussion at H-point CH independent from the concentration of interferent and so AH is also independent from analyte concentration. For selection of appropriate wavelength for applying HPSAM, the following principles were followed. At two selected wavelengths, the analyte signals must be linear with the concentrations, the interferent signals must be remain equal, even if the analytical concentrations are changed, and the analytical signal of mixture composed from the analyte and the inerferent should be equal to the sum of individual signals of the two compounds. In addition, the slope different of the two straight lines obtained at λ1 and λ2 must be as large as possible in order to get good accuracy.

Application

To evaluate the analytical applicability of this method, HPSAM was applied to the simultaneous determination of caffeine and paracetamol in Novafen tablet a pharmaceutical preparation containing both compounds. The results are given in table 2. The good agreement between the results with the composition values indicated by the supplires indicates the successful applicability of the proposed method for the simultaneous determination of Caffeine and Paracetamol in pharmaceutical preparations.

Table 1 . Results for five replicate for the analysis of caffeine and paracetamol mixtures by HPSAM

		Present in sample mg L^{-1}		Found mg L^{-1}	
A-C Equation	**R^2**	**Para.**	**Caff.**	**Para**	**Caff.**
A260= 0.0330C+0.2463 A283= 0.0100C+0.1727	0.9999 0.9994	4.18	3.29	4.29	3.2
A260= 0.0326C+0.2479 A283= 0.0101C+0.1724	0.9995 0.9995	4.18	3.29	4.32	3.26
A260= 0.0325C+0.2482 A283= 0.0100C+0.1733	0.9993 0.9995	4.18	3.29	4.27	3.33
A260= 0.0331C+0.2515 A283= 0.0099C+0.1747	0.9994 0.9999	4.18	3.29	4.28	3.46
A260= 0.0325C+0.2485 A283= 0.0101C+0.1731	0.9991 0.9994	4.18	3.29	4.24	3.37
			mean	4.28	3.32
			SD	0.03	0.10
			RSD	0.7%	3.01%

Table 2 Results for Simultaneous determination of Caffeine and Paracetamol in Novafen Tablet

Analyte	Nominal value mg	Found mg	Recovery %
paracetamol	325	349	107
caffeine	40	41.9	104.8

References

1. OW.Lau, SF.Luk, YM.Chenng, Analyst,114(9),1047 -51 (1989).
2. N. R. Ramos-Martos, F. A. Gomez, A. Molina- Diaz and Luis F. Capitan- Vallvey, Journal of AOAC INTERNATIONAL , May/June 2001
3. D. Stanisky, I. Neto, P. Solich, H. Skienarova, M. Conceicao, B. S. M. Montenegro, A. N. Arajo, J. Sep. Sci., 27,529-536 (2004).
4. V. Pucci, R. Mandrioli, M. Augusta Raggi, S. Fanali,ELECTROPHORESIS 25(4-5),615-21(2004).
5. I. Muszalska, M. Zajac, K. Czajkowaski and M. Nogowska, chemical analysis, 45(6), (2000).
6. M. Prodan, E. Gere-Paszti, O. Farkas, E. Forgacs, Chem. Anal. (Warsaw), 48, 901 (2003).
7. Z. Bouhsain, S. Garrigues and M. de la Guardia, Analyst, 121 1935-38 (1996).
8. Z. Bouhsain, S. Garrigues and M. de la Guardia, Fresenius Journal of Analytical Chemistry, 357(7), 973-76 (1997).
9. F. Bosch-Reig, P. Campina, P. Campines-Falco, Analyst 113 (1988) 1011
10. F. Bosch-Reig, P. Campina, P. Campines-Falco, Analyst 115 (1990) 111
11. J. Pandey, J. Pawell, M. E. R. Mchale, and W. E. Acree, J.Chem. Edu.,1997, 79, 848.
12. P. Campines-Falco, F. Bosch-Reig, and F. Blasco-Gomez, Talanta, 1998, 47,193.
13. P. Campines-Falco, J. Verdu-Andres, F. Bosch-Reig, Anal. Chim. Acta 315 (1995) 267.

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