Journal of Applied Pharmaceutical Science Vol. 3 (02), pp. 109-114, February, 2013
Available online at http://www.japsonline.com
DOI: 10.7324/JAPS.2013.30219
ISSN 2231-3354

Development of a spectrofluorimetric method for determination of thiabendazole in tablets

Semahat Kucukkolbasi[1]* and Esma Kilic[2]
[1]Department of Chemistry, Faculty of Science, Selcuk University, Konya, TÜRKİYE.
[2]Department of Chemistry, Faculty of Science, Ankara University, Ankara, TÜRKİYE.

ARTICLE INFO

Article history:
Received on: 04/01/2013
Revised on: 19/01/2013
Accepted on: 01/02/2013
Available online: 27/2/2013

Key words:
Spectrofluorimetry, determination, thiabendazole, pharmaceuticals

ABSTRACT

In this study a spectrofluorimetric method has been developed for determination of thiabendazole drug active compound in tablets. For this purpose; thiabendazole drug active compound was measured fluorescence intensities at excitation (λ_{ex}) and emission (λ_{em}) wavelength in various solvents. Suitable solvent was determined for each compound from calibration graphs and tablets' excipients. Spectrofluorimetric method for the determination of thiabendazole in tablet was described under the optimum conditions. The wavelengths of excitation and emission were 370,0 nm and 428.8 nm respectively. The fluorescence intensity was linearly related to the drug concentration and the method was found to be highly accurate and precise, having a relative standard deviation of less than 0.8 %. This proposed method was applied to the determination of thiabendazole in tablet. The validity of the method was tested by the recovery studies of standard addition to pharmaceuticals and the result was found to be satisfactory. The results compared with official USP 24 HPLC method were in good agreement and statistical comparison by means of Student's *t*-test and the variance ratio *F*-test showed no significant difference between the two methods. The proposed method is simple and sufficiently precise for quality control purposes in routine analysis.

INTRODUCTION

Thiabendazole (TBZ; 2-(4-thiazolyl)-1H-benzimidazole) is a broad spectrum anthelmintic-effective against gastrointestinal nematodes in ruminants and lungworms in sheep (McKellar and Scott, 1990),(Fig 1). It is also a versatile fungicide and is widely used both pre- and post harvest to control arrange a pathogenic fungi affecting field crops and stored fruits and vegetables (Elespuru and et al, 1974; Sittig, 1981; Prichard and Ranjan, 1993; Papadopoulou-Mourkidou et. al., 1991). Since its introduction over 30 years ago, other benzimidazole anthelmintics with improved efficacy, such as fenbendazole, thiabendazole and triclabendazole, have been developed, but TBZ remains in use because it is relatively inexpensive in comparison with the never compounds.

The extensive development of the pharmaceutical field requires more regorous analytical methods for the control of drugs. Various methods in the literature for the determination of Thiabendazole include spectrophotometry, high performance liquid chromatography, mass spectrometry (Onur and Tekin, 1994; Onur and Dinc, 1996; Orsine, 2000; ; Canavan et al., 1998; Zamora, 2000; Andrade et al., 2003). When it comes to the routine determination in pharmaceuticals, the United State Pharmacopia (USP 24) prescribes HPLC.

Thiabendazole shows fluorescence and has determination methods in water (de Armas et. al., 2001), synthetic pesticide mixtures Rodr´ıguez-Cuesta et al., 2003). To our knowledge, no fluorimetric method for the determination of thiabendazole in pharmaceuticals has yet been reported inspite of the versatility of the technique in chemical analysis. Spectrofluorimetry has been found to be useful for the determination of trace amounts of different pharmaceuticals, showing several advantages, such as low detection limit, high sensitivity and the use of conventional instrumentation (Cruces-Blaco et al., 2000; Kucukkolbasi et al., 2008). It is obvious that quick, sensitive, accurate and reliable procedure is required for the determination of active compound in drugs. The purpose of the present investigation was to develop a spectrofluorimetric assay for the thiabendazole and to apply the procedure to pharmaceutical dosage form.

* *Corresponding Author*
Assoc. Prof. Semahat Kucukkolbasi
*S.U. Faculty of Science Department of Chemistry 42075 Campus-Konya/TURKIYE. ksemahat@gmail.com**Tel:** +90 332 223 38 51;*

EXPERIMENTAL

Apparatus

Fluorescence intensities were measured on a Perkin-Elmer Luminescence Spectrometer LS 50B with the excitation and emission slit controls set at 10 nm. The Spectrometer was equipped with a 150-W xenon arc lamb. All measurements took place in a standard 10 mm (path-length) quartz cell.

High performance liquid chromatograph, which consists Waters 600 liquid chromatography and Waters 486 ultraviolet dedector, was used for chromatographic measurements. Flow rate was adjusted 1,00 mL/min and UV dedector wavelenght was 254 nm.

An Orion 720A digital pH-ionmeter equipped with a combined pH-electrode (Ingold) was used for pH-measurements. All the analytical measurements were carried out at room temperature (22±2°C).

Materials

Thiabendazole obtained from Topkim Drug Company (Turkey) was of chemically pure laboratory working standards having purity 99.7% (Fig 1.).

Parbendazol obtained from Refik Saydam Hıfszıha Enstitüsü, Ankara (Turkey) was of chemically pure laboratory working standards and Rafoksanid is from Topkim-Topkapi Ilac Premiks San. ve Tic. A.S. (Turkey).

Rabenzol (TOPKIM Co) was labelled as containing thiabendazole equivalent to 2000 mg thiabendazole per tablet.

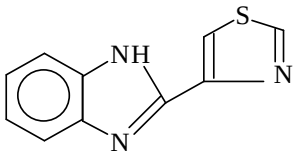

Fig. 1: Structure of thiabendazole

Solvents

Dioxane, chloroform, ethyl acetate, ethanol and methanol which were used in preparation thiabendazole and experimental solutions were purchased from Sigma, in extra purity.

Thiabendazole stock solutions

2.013 mg/L was prepared by exact weighing of thiabendazole obtained from Topkim Co. and dissolving in ethanol, dioxan and ethylacetate. Working solutions were prepared by appropriate dilutions with the same solvents.

Investigation of Fluorescence Properties of Thiabendazole

In order to determine the suitable solvents used in the assay of Thiabendazole (TBZ); below processes were applied. Samples have been taken from thiabendazole whose concentration would be 0.3 mg/L, and it was examined solubility of thiabendazole in water and various organic solvents. It was determined that Thiabendazole dissolves in ethanol, methanol, benzene, DMF, tetrahydrofuran, ethyl acetate, dioxan, acetone, acetonitril and DMSO. Fluorescence spectra have been taken in these solvents and solvent effect on flourescence intensity of Thiabendazole was tested. In order to determine fluorescence properties of thiabendazole in each solvent, multi-emission spectrums were taken in the spectrofluorometry excitation wavelength from the beginning of the 250 nm to 450 nm 10 nm ranges. In addition, multi- emission spectrum of solvent which we used was taken at the same wavelength range, too.

Optimum excitation wavelength (λ_{ex}) and emission wavelength (λ_{em}) were determined which fluorescence emission peak obviously was shown for thiabendazole and its fluorescence intensity was the highest wavelength was taken into account.

Construction of Calibration Graphs for Thiabendazole.

Calibration curves for Thiabendazole was drawn in the 0,201 - 2,01 μg/L concentration range. For this aim a serial of solution were prepared from stock thiabendazole solutions using dioxan, ethanol, ethyl acetate solvents, and their fluorescence intensities were recorded at optimum excitation and emission wavelengths. Versus thiabendazole concentration, flourescence intensities were drawn to the graphics and calibration curves were obtained.

Preparation Tablets for Analyze

Dosage forms containing thiabendazole were purchased from local commercial sources. Twenty rabenzol tablets were weighed accurately and their average weight calculated. All the tablets were finely powdered. The required amount of this powder was accurately weighed into a 250 mL erlenmeyer flask which has glass top, 100.0 mL of ethanol was added, and shaken thoroughly for about 4 hours at room temperature. Then, the tablet extract was filtered in to a volumetric flask. Since the most appropriate solvent rate was 40% ethanol- 60% water, 10 mL was taken from the final solution and diluted to 25.0 mL with deinoized water.

Determination of Thiabendazole Quantity in Tablet Using Calibration Graphs

Used calibration graphs drawn fluorescence emission intensities versus thiabendazole concentration, thiabendazole was directly determined in Rabenzol tablets. For this purpose tablet solutions prepared in ethanol/water were measured fluorescence intensity, using suitable excitation and emission wavelengths for thiabendazole. Thiabendazole concentration that equals this fluorescence intensity was found from calibration graphics and thiabendazole quantity was calculated in the tablets. Sample preparation and concentration finding process from calibration curves were repeated seven times.

Determination of Thiabendazole Quantity in Tablet Using Standard Addition Method

To compare the results which were obtained using calibration graphs and to investigate matrix effects, the amounts of

drug active compound in the same samples were also determined using standard addition method. For determination of thiabendazole in the tablets in ethanol-water media with standard addition method, solution with ethanol prepared by rabenzol was added 6,0 mL in to 5 pieces 25,0 mL volumetric flask. To this measured flasks from the stock thiabendazole solution respectively 0,0; 2,0; 4,0; 6,0 and 8,0 mL were added and volumes completed 25,0 mL with solvent. Fluorescence intensities of each of the solution at suitable excitation and emission wavelength were recorded and oppose to concentration of added standard graphic was drawn. Using intersection point which drawn line's from concentration axis, thiabendazole quantity in the tablets was calculated. This function for each sample repeated 5 times.

Determination of Thiabendazole Quantity in Tablet Using USP Method

In order to control the validity of the method, used high performance liquid chromatography (HPLC) method given in United States Pharmacopoeia, the determination of thiabendazole was made to compare with proposed method. (United States Pharmacopoeia, 2000).

RESULTS AND DISCUSSION

Fluorescence spectral properties of thiabendazole in some solvents

The three dimensional spectrum provides the best characterization of the compounds' fluorescence. In order to determine the fluorescence properties of thiabendazole in different solvents, three-dimensional spectra were recorded in which wavelength of excitation was changed from 250 nm to 450 nm. The three-dimensional spectrum of thiabendazole in ethanol is given Fig. 2. In the same way three dimensional spectra of solvents were also scanned. From these spectra excitation and emission wavelengths at the maximum fluorescence intensities were determined and given Table 1.

Moreover calibration graphs of standard thiabendazole in some solvents which have high relative fluorescence intensities were obtained. From statistical analysis for these calibration graphs, the correlation coefficient of calibration curve obtained from thiabendazole in ethanol is closer to 1 than the others. So ethanol was selected for the best solvent to determination of thiabendazole.

Table.1: Effect of solvent on the fluorescence of thiabendazole

Solvent	λ_{ex}	λ_{em}	Florescence Intensity[a]	
			Solvent	*Thiabendazole*
Ethanol	370	430,4	1,22	129,3
Methanol	370	440,0	0,91	33,3
Aceton	360	384,0	43,3	127,2
DMF	370	420,0	0,83	66,7
THF	370	425,0	10,2	82,2
Ethyl Acetate	380	436,5	2,48	83,3
Dioxan	370	422,4	0,67	169,0
Acetonytril	370	432,0	2,75	66,6
Chloroform	370	430,4	0,73	66,5

[a] Mean of three determinations

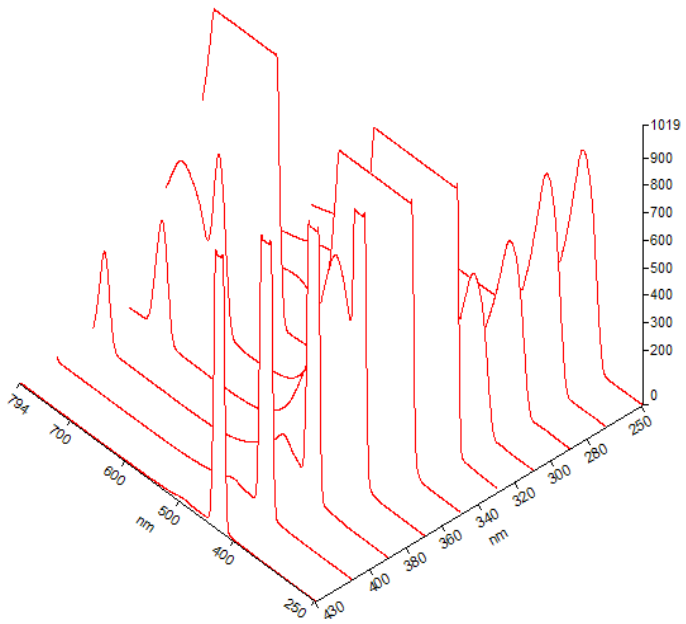

Fig. 2: Three-dimensional spectrum of thiabendazole in ethanol.

Selection of appropriate percentage of solvent

After best solvent was selected, it was investigated which rate of ethanol-water had high fluorescence intensity. Figure 3 shows fluorescence intensity of thiabendazole versus % ethanol. As it can be seen in this figure, it is necessary to maintain % 40 ethanol and % 60 water to obtain highest fluorescence intensity and the least organic solvent.

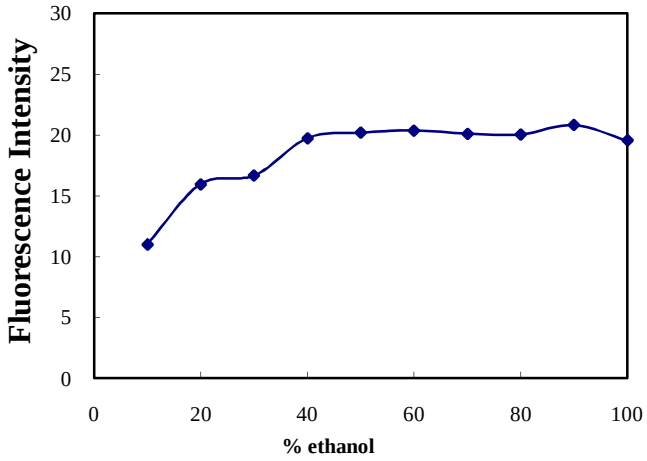

Fig. 3: Effect of % ethanol on fluorescence intensity of thiabendazole

Effect of pH on fluorescence intensity of thiabendazole

Figure 4 illustrates the fluorescence intensity of thiabendazole versus pH. As it can be observed in this figure, when the pH of final solution was adjusted in the 5.0-8.0, maximum fluorescence intensity was cared. Since pH of the solutions which we obtained Part 2.5 and 2.6 were between these values, it is not necessary to maintain a pH as optimum to obtain the highest fluorescence intensity.

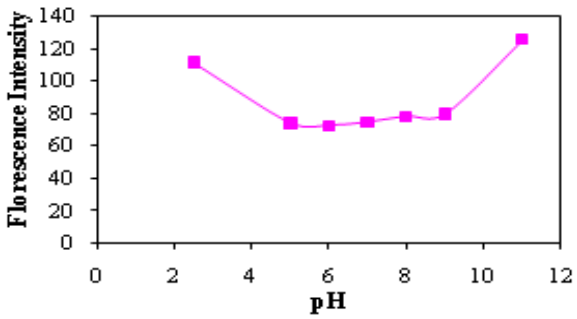

Fig. 4: Effect of pH on the fluorescence intensity of thiabendazole.

Effect of excipients (additives) in tablet on the fluorescence of thiabendazole

Fluorescence spectrum of solutions obtained from ethanol extraction of tablets was compared with the solutions of standard thiabendazole. In addition to this fluorescence spectrum of synthetic solutions prepared in the laboratory which are similar to formulation tablets was recorded. Fluorescence spectra of standard thiabendazole, tablet, synthetic solution and only ethanol were scanned at λ_{ex}= 370 nm and λ_{em}= 428.8 nm and given Fig 7.

When these spectra were examined, spectra of standard thiabendazole, synthetic mixture, tablet's solution in chloroform was similar to each other. Consequently, excitation and emission wavelengths determined for tablets prepared to analyze using ethanol is absolutely the same with excitation and emission wavelengths obtained from standard thiabendazole solutions. These studies were done, using all excitation and emission wavelengths and taking multi-spectra in the ethanol, and same fluorescence spectra were obtained for thiabendazole,tablet and synthetic samples at each excitation wavelength The excitation spectrum of thiabendazole in ethanol-water shows a maximum at about 370 nm, while the emission spectrum shows its maximum at about 428.8 nm. It's worth nothing that no significant change was observed in the position of the maxima of the excitation and emission spectra of the thiabendazole in the pharmaceutical preparations. The excitation and emission wavelength cited above were selected for subsequent experiments.

Determination of thiabendazole in pharmaceuticals

Under the described experimental procedures, samples were prepared. The amounts of thiabendazole were determined by using both calibration graphs and standard addition method .

Determination with Directly Calibration Graphs

In order to determine thiabendazole in the tablets from calibration graphs directly, benefited from calibration graphs given on Figure 5. Fluorescence intensities of solution with ethanol prepared from Rabenzol tablets were measured at 370 nm excitation and 428.8 nm emission wavelengths and thiabendazole concentration was determined from calibration curves. Obtained results were given on Table 2.

As it can be shown on table, recovery percentages obtained from directly calibration method, relative standard deviation and reproducibility of the results were highly good. Consequently, it was observed that quantative determination of thiabendazole in the tablets with this method could be do good precision and good repeatability.

Table. 2: Results obtained with calibration graphic method for thiabendazole in the tablets and statistics' evaluation.

Sample Number	Taken, µg/L	Found±s[a], µg/L	Recovery, %
1	0,344	0,335±0,001	97,4
2	0,449	0,438±0,002	97,6
3	0,445	0,428±0,002	96,2
4	0,460	0,447±0,002	97,2
5	0,621	0,606±0,003	97,6
6	0,699	0,675±0,002	96,6
7	0,505	0,484±0,002	95,8

Number of determinations, N = 7

Arithmetic Mean = $\overline{X}$ = % 96,9

Standard Deviation, s = 0,7

Relative Standard Deviation, BSS = (s/ $\overline{X}$)×100 = % 0,7

Confidence Limit[b] = $\overline{x} \pm ts/\sqrt{N}$ = % 96,9 ± 0,7

Repeatability, r = $ts\sqrt{2}$ = 2,5

[a] Average of ten determinations.

[b] % 95 confidence level.

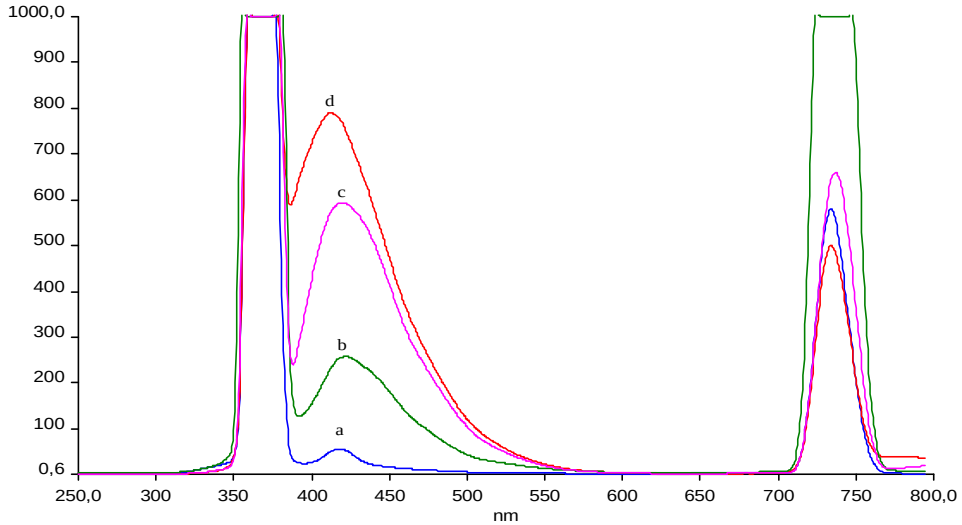

Fig. 7: Excitation and emission spectra in % 40 ethanol (λ_{ex} = 370 nm): emission spectra of (a) solvent, (b) standard thiabendazole, (c) synthetic mixture, (d) commercial tablet.

Determination with Standard Addition Method

Althought It was thought that matrix effect removed by chosen ethanol as a solvent, Thiabendazole in the tablets was also determined with standard addition method the aim of the matriks effects' whether It will be or not to be during preparing samples to analyze. An example for this was given on figure 6 and obtained results were given on Table 3.

When compared with figure 5 and 6, shown slope of two curves nearly same. This is thought us addition compounds which are in the tablets have not done spoiling effects on the method. Benefited data given on table 6, F and T tests were shown that there are no difference between these two methods and accuracies of two methods at %95 confidence level (Holme and Peck, 1998). As statistic results which was shown that no difference between these two methods, shown directly calibration method are simplier and shorter suitable to use for spectrofluorimetric determination of thiabendazole in the tablets. During quality controls, because many samples will have to be analyzed, it can be said directly calibration method is more suitable for determining thiabendazole in the tablets.

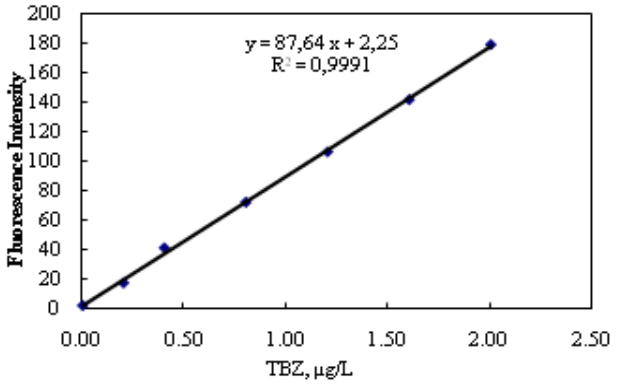

Fig. 5: Standart calibration curve of thiabendazole in % 60 - % 40 water-ethanol . (λ_{ex}=370 nm and λ_{em}=428.8 nm).

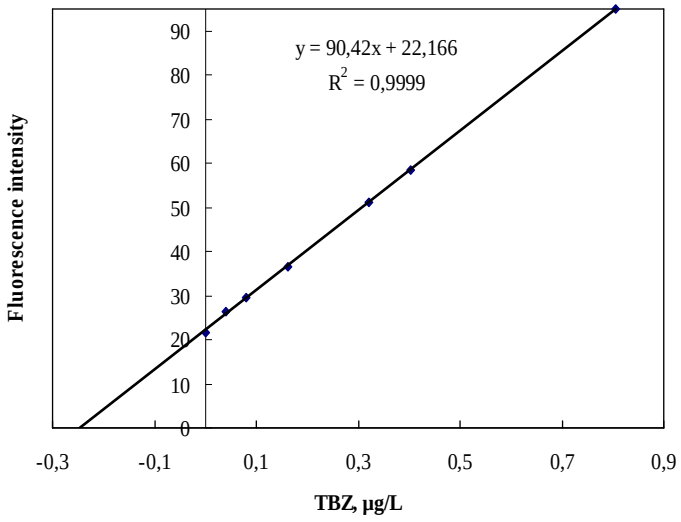

Fig. 6: Calibration graph of standard addition method for determination of thiabendazole in tablets. (λ_{ex}=370 nm and λ_{em}=428.8 nm).

Table. 3: Results obtained with standard addition method for thiabendazole in the tablets and statistics' evaluation.

Sample Number	Taken, µg/L	Found±s[a], µg/L	Recovery, %
1	0,520	0,501±0,019	96,3
2	0,322	0,314±0,019	97,5
3	0,167	0,162±0,017	97,0
4	0,258	0,252±0,012	97,7
5	0,546	0.533±0,012	97,6

Number of determinations, N = 5

Arithmetic Mean, $\bar{x}$ = % 97,2

Standard Deviation, s = 0,6

Relative Standard Deviation, BSS = (s/ $\bar{x}$)×100 = % 0,6

Confidence Limit[b] = $\bar{x} \pm ts/\sqrt{N}$ = % 97,2 ± 0,7

Repeatability, r = $ts\sqrt{2}$ = 2,3

[a] Average of ten determinations.

[b] % 95 confidence level.

Table. 6: Determination of thiabendazole in commercial tablet using the proposed method compared statistically with an official method.

Compound Formulation	Recovery $\pm ts/\sqrt{N}$ [a] The Proposed Spectrofluorometric Methods		Official Method[b]
	Calibration graph	Standard Addition	
Rabenzol tablets	96,9±0,7 n_1=7 F^d=0,73 t^c= 0.98	97,2±%0,7 n_2=5 F^d=1,00 t^c= 0.95	96,3±0,9 n_3=4

n = number of analysis

[a] = Mean±RSD for 95% cnfidence level

[b]= USP,2000.

[c]= Tabulated F- values for 95% confidence level and are 4,76 and 6,59

[d]= Tabulated t- values for 95% confidence level and nine and eight degrees of freedom are 2,26 and 2,31.

To check accuracies of spectrofluorimetric methods which were developed to determine thiabendazole in tablets, same samples were analyzed also with HPLC method given in USP, too. Results obtained with this method were given on table 4. When ıt was evaluated statistically the datas on table 2,3 and 4, It can be said improved method is accurate at %95 confidence level.

Table. 4: Results obtained with USP method for thiabendazole in the tablets and statistics' evaluation.

Sample Number	Taken, µg/L	Found±s[a], µg/L	Recovery, %
1	2,0000	1,908±0,018	95,4
2	3,0000	2,900±0,014	96,7
3	4,0000	3,858±0,013	96,4
4	2,0000	1,933±0,018	96,7

Number of determinations, N = 4

Arithmetic Mean, $\bar{x}$ = % 96,3

Relative Standard Deviation,BSS = (s/ $\bar{x}$)×100 = % 0,64

Confidence Limit[b] = $\bar{x} \pm ts/\sqrt{N}$ = % 96,3 ± 0,9

Repeatability, r = $ts\sqrt{2}$ = 2,8

[a] Average of ten determinations.

[b] % 95 confidence level.

Table. 5: Optic properties and statistical analysis data for spectrofluorimetric method of thiabendazole.

	Direct Calibration	Standard Addition
Lineer range (mg/L)	0-2,01 µg/L	0-0,81 µg/L
$\lambda_{excitation}$ (nm)	370	370
$\lambda_{emission}$ (nm)	428,8	428,8
Regression equation	y=87,64 x+2,25	y=85,74x+21,61
İntercept	2,25	21,61
Variance of intercept (S_a^2)	2,57	0,28
Slope (b)	87,64	85,74
Variance of slope (S_b^2)	2,01	10,27
Correlation coefficient (r)	0,9995	0,9979
Relative Standard deviation (RSD)	% 0,7	% 0,6
Mean±RSD for 95% confidence level	% 96,9 ± 0,7	% 97,2 ± 0,7

Optic properties and statistical analysis data for spectrofluorimetric method were given in Table 5. It is possible to say that depend on the statistical analysis data about developed spectrofluorimetric method for thiabendazole: in this study, active compound which was in benzimidazole derivative drugs containing thiabendazole which were mentioned can be determined easily with spectrofluorimetric method which we developed directly or by using standart addition method.

Moreover, we devoloped spectrofluorimetric method's as to USP method;

- Shorter time is been able to,
- Less quantity and less solvents are required,
- as internal standard addition compound doesn`t need to required as superior aspects were determined.

The performance of the method was also assessed by calculation of *t*-and *F*-values compared with the official method. Mean values were obtained in a student *t*-test and *F*-test at 95% confidence limits for ten degrees of freedom and the results recorded in Table 6 showed that the calculated *t*- and *F*-values did not exceed the theoretical values, and a good agreement with those of the USP (based on HPLC).

CONCLUSION

As a result of this study, the proposed method can be succesfully applied to the determination of thiabendazole and the assay of some of their pharmaceutical preparations. In conclusion, the accuracy, simplicity and precision of the spectrofluorimetric method indicate that this method is quite suitable for routine quality control analysis of pharmaceuticals preparations containing the drug. Moreover, it could be recommended as a topic of study for the analysis of thiabendazole in biological fluids.

ACKNOWLEDGEMENTS

We gratefully acknowledge the financial support of Selcuk University Research Fund (Project No: 2001/034).

REFERENCES

Andrade, S.R.C., Scarminio, I. S.,Nery, M.F., and de Oliveira Aline C. Comparison of multivariate calibration methods to determine simultaneously mebendazole-cambendazole and mebendazole-thiabendazole in pharmaceutical preparations by UV-visible spectrophotometry. *Journal of Pharmaceutical and Biomedical Analysis*, 2003; 33: 655-665.

Cannavan A, Haggan S A, Kennedy D G. Simultaneous determination of thiabendazole and its major metabolite, 5-hydroxythiabendazole, in bovine tissues using gradient liquid chromatography with thermospray and atmospheric pressure chemical ionisation mass spectrometry . *J. of Chrom. B.*, 1998; 718, 103.

Cruces-Blaco C, Corretero AS, Peinada SF, and Guiterrez AF. Spectrofluorımetric Determination Of Methyl Paraben İn Pharmaceutical Preparations By Means Of Its Dansyl Chloride Derivative *Microchimica Acta*, 2000;134: 107-111.

de Armas, G, Becerra E, Cladera A, Estela JM, Cerdà V. Sequential injection analysis for the determination of fuberidazole and thiabendazole by variable-angle scanning fluorescence spectrometry. *Analytica Chimica Acta*, 2001; 427, 83–92.

Elespuru R, Lijinsky W and Setlow Jane K. Nitrosocarbaryl as a potent mutagen of environmental signifi-cance, *Nature*, Lond. 1974; 247: 386-87.

Holme DJ andPeck H, *Analytical Biochemistry*, Third Edition, addion Wesley Longman, New York. (1998).

Küçükkolbasi S, Gündüz B, Kilic E. Development of a Spectrofluorimetric Method for Determination of Albendazole in Tablets *Analytical Letters*, 2008; 41:1-15.

McKellar A and Scott EW. The benzimidazole anthelmintic agents-a review. *J. Vet., Pharmacol. Therap*. 1990; 13: 223-247

Onur F and Dinc H. Four New Spectrophotometric Methods for Simultaneous Determination of Nclosamide and Thiabendazole in Tablets. *Scientia Pharmaceutica*, 1996; 64:151-172.

Onur F and Tekin N. Spectrophotometric Determination of Niclosamide *Analytical Letters*, 1994; 27: 2291-2301.

Orsine EMA, Kedor-Hackmann ERM, and Santoro M.I.R.M. Simultaneous Determination of Thiabendazole and Mebendazole in Tablets by High-Performance Liquid Chromatography. *Drug Develop. and Industrial Pharm.* 2000; 26: 879-883.

Papadopoulou-Mourkidou E. Postharvest-applied agrochemicals and their residues in fresh fruits and vegetables. *J. Assoc. Off. Anal. Chem.* 1991; 74:745-765

Prichard RK and Ranjan S. Anthelmintics. *Vet . Parasitol*., 1993; 46: 113-120.

Rodr´ıguez-Cuesta MJ, Boqué R, Picón Zamora D, Mart´ınez Galera M, Garrido Frenich A. Determination of carbendazim, fuberidazole and thiabendazole by three-dimensional excitation–emission matrix fluorescence and parallel factor analysis. *Analytica Chimica Acta*, 2003; 491: 47–56.

Sittig M. *Veterinary Drug Manufacturing Encyclopedia,*Noyes Publications, Park Ridge, NJ. (1981) pp. 456–457.

United States Pharmacopoeia, 24 Revision, United States Pharmacopoeial Convention, Board of Trustees. (2000): 1636-38.

Zamora D P, Galera M M, Frenich AG, Vidal J L. Trace determination of carbendazim, fuberidazole and thiabendazole in water by application of multivariate calibration to cross-sections of three-dimensional excitation–emission matrix fluorescence. *The Analyst*. 2000; 125: 1167-1174.

How to cite this article:
Semahat Kucukkolbasi and Esma Kilic., Development of a spectrofluorimetric method for determination of thiabendazole in tablets. J App Pharm Sci. 2013; 3 (02): 109-114.