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REVIEW OF RECENT APPLICATIONS OF FLOW INJECTION SPECTROPHOTOMETRY TO PHARMACEUTICAL ANALYSIS

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ABSTRACT

Drug examination is perhaps of the main field in logical science. The disclosure of new medications and the on-going update of global guidelines for the security and adequacy of drug definitions request the ceaseless improvement of new insightful techniques. Unavoidably, computerization assumes a significant part, particularly when a great deal of tests must be dissected in the base of time. The current review audits the utilizations of stream infusion (FI) spectrophotometry to the assurance of dynamic drug fixings (APIs) in their particular definitions. Nonetheless, the point canvassed in this study is significant not exclusively to drug scientific researchers. The standards, figures of legitimacy.

what's more "science" of the introduced strategies can bear some significance with bio-scientific and clinical physicists too for the examination of organic examples, to ecological experts that concentrate on the exceptional interest of the assurance of the destiny of drugs in the climate and even to toxicologists and measurable researchers. This audit covers logical commitments distributed later than 2000. An assortment of FI strategies in view of homogeneous (direct UV estimations, variety shaping responses, metal-drug communications) and heterogeneous (optical sensors and strong stage reactors) frameworks are examined. A third segment covers on-line test pretreatment (strong stage extraction, fluid extraction, on-line processing, and so forth.).

Keywords: Flow Injection Analysis; Spectrophotometry; Active Pharmaceutical Ingredients; Pharmaceutical Formulations; Quality Control.

I. INTRODUCTION

Mechanization is a critical interest of present day modern scale drug examination. New item improvement, approval of fabricating cycle and routine quality control include the examination of a lot of tests to guarantee consistence of the definitions as far as possible laid out by global specialists. Common quality control tests that include theexamination of many examples include:

(1) Test of eventual outcomes.

(2) Disintegration profiles during creation and approval of fabricating processes.

(3) Dose consistency tests.

(4) In-process mixing consistency for strong and semi-strong definitions.

Stream infusion examination (FI) is a deep rooted mechanized strategy with various and far reaching applications in quantitative substance examination. It is trademark that in excess of 12,000 FI papers have been distributed in logical diaries starting around 1975 - when it was initially proposed by Ruzicka and Hansen - counting many general or analyte-orientated surveys. In short, an ordinary FI arrangement includes infusion of a characterized volume of the example into a moving stream of an answer which fills in as a transporter and propelles the example zone to a course through identifier. Between the infusion and identification focuses, the analyte of interest is synthetically or truly changed to discernible specie. FI is for the most part a basic and economical method utilizing normal instrumentation, for example, peristaltic siphons and low-pressure infusion valves. Contrasted with cluster techniques it offers expanded testing rate, lower reagents utilization, better accuracy and high adaptability. The previously mentioned benefits of FI have prompted a constantly expanding interest in drug examination and quality control applications. The vitally synthetic methodology in

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applying FI to drug examination is through robotization of derivatization responses. Then again, more convoluted methodology like on-line strong stage and dissolvable extraction, optical sensors, enzymatic responses, and so on, will quite often draw in researchers, in view of the developing requirement for additional touchy and specific scientific strategies. In spite of the fact that FI can be coupled to any location framework fit for course through activity covering a range that reaches out from straightforward Drove based optical frameworks to modern mass spectrometers, UV-vis spectrophotometry is by all accounts the strategy of decision for FI drug applications. UV-vis spectrophotometry offers the benefits of straightforward, minimal expense instruments that are accessible at all labs. Running expenses are negligible and no exceptionally gifted staff is expected for their activity. That's what another huge benefit is previous bunch instruments can be effortlessly changed over completely to flowthrough by either home-made or industrially accessible cells. The current review surveys the ongoing utilizations of FI spectrophotometry to drug examination, covering the period 2000-today. The audit is partitioned in three segments. The main arrangements with homogeneous FI frameworks what's more, incorporates techniques in light of:

(a) immediate UV estimations,

(b) metal-drug associations and

(c) different variety shaping responses.

The subsequent area covers the heterogeneous FI frameworks and explicitly the utilization of strong stage reactors and the FI optical sensors. At last, the third part of the audit is committed to on-line test arrangement plans.

II. HOMOGENEOUS FI FRAMEWORKS

2.1. FI techniques in light of direct UV discovery

The least difficult and more direct method for deciding a build of drug interest is by UV spectrophotometry, in light of the estimation of its local absorbance (if of course the compound has optical properties) at a pre-characterized frequency. Robotization of such a methodology by means of FI is effortless and subsequently famous among scientific and drug physicists [13-27]. From instrumentation and complex design point of view a solitary diverted arrangement is for the most part required. Since no response happens, even HPLC instrumentation can be utilized, by just supplanting the scientific segment with reasonable tubing associating the infusion valve to the course through indicator [13]. While fostering a FI strategy in view of direct UV measurement, extraordinary consideration ought to be paid on the decision of the transporter stream. To keep away from framework impacts (for example pseudo-tops produced by the Schlieren impact, and so forth) or even possible precipitation of the analytes and obstructing of the stream channels, the transporter and the dissolvable of the example should be essentially as reliable as could really be expected. For this explanation, parts of natural solvents (for example MeOH or EtOH) are every now and again utilized as transporters.

The primary hindrance of these strategies is the absence of selectivity of the identifier utilized. It is in this way important to apply these measures to tests with a known framework. This is obviously not issue in drug examination, since the excipients that coincide with the analyte in the examples are subjectively and quantitatively known. Exhaustive approval of these strategies in terms of selectivity is of essential significance. The most appropriate method for doing so is to set up a fake treatment blend containing all excipients with the exception of the dynamic fixing. The created FI technique should endure satisfactory measures of the fake treatment, while its exactness should be checked by investigating engineered tests spiked with known measures of the analyte.

2.2. FI techniques in light of metals-drugs associations

An impressive gathering of FI techniques for the assurance of dynamic drug fixings depends on the co-operations among metals and medications. These strategies can be arranged into two principal gatherings.

The principal bunch incorporates FI techniques in view of Red-Bull reactions. An exceptionally "well known" convention among researchers includes oxidation of the analyte by Fe(III). Fe(II) created by the not set in stone through a subsequent step utilizing reasonable reagents, for example, 1,10-phenanthroline, 2,2-bipyridyl and 2,2-dipyridyl-2-pyridylhydrazone (DPPH). This two-step aberrant methodology has been as of late applied to the FI assurance of N-acetyl-l-cysteine utilizing the "combining zones" system [28], captopril , indapamide and

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an assortment of cephalosporins. On the other hand, Misiuk and Halaburda revealed a direct FI technique for the assurance of perazine in view of its on-line oxidation by Ce(IV) in acidic medium. The hued free extremist created by the response was checked at 510 nm.

The second gathering of distributed FI techniques depends on the on-line arrangement of shaded buildings between the pharmaceutical accumulates of interest and metal particles. Common models showed up as of late incorporate antibiotic medication — Al(III) in Tris-cradle (pH 7.0, λmax = 376 nm), ofloxacin — Fe(III) in sulfuric corrosive medium (λmax = 420 nm) , methyldopa — Mo(VI) (λmax = 410 nm), cimetidine — Cu(II) in acetic acid derivation cradle (pH 5.9, λmax = 330 nm) and epinephrine/isoproterenol — Fe(II) in aminoacetic-carbonate cushion (pH 8.3, λmax = 530 nm). The benefits of involving metal particles as complexing specialists in FI incorporate straightforward manifolds, promptly accessible and savvy reagents, while the testing rate is by and large exceptionally high running between 60 h−1 and 210 h−1. Elective FI approaches in view of metal-drug collaborations incorporate the roundabout assurance of captopril in light of its inhibitory impact on the perplexing development between Co(II) furthermore, 2,2 - dipyridyl-2-pyridylhydrazone (DPPH). FernadezGonzalez et al. likewise revealed a FI technique for the assurance of - lactamic anti-infection agents (amoxicillin and ampicillin) in view of the reactant impact of Cu(II) particles on the hydrolysis of the medications. The hued hydrolysis items displayed improved absorbance in micellar medium.

2.3. FI strategies in light of different variety shaping responses

FI techniques in view of homogeneous responses address the greater part of ongoing spectrophotometric applications to drug investigation. The chose substance frameworks rely upon the design and properties of the drug mixtures of interest. An assortment of FI techniques depend on the response of hexacyanoferrate(III) with drug compounds. Olazanpine was resolved in a roundabout way founded on the estimation of the unreacted oxidant at 425 nm. The notable response of phenolic compounds with 4-aminoantipyrine in the presence of hexacyanoferrate(III) was the reason for a FI strategy for the assurance of salbutamol. Robotization of the response through FI dispensed with the dissolvable extraction step which is fundamental in clump strategies. In light of a comparative component, Al-Abachi et al. detailed a FI measure for amoxicillin utilizing N,N-dimethylp phenylenediamine in soluble medium . On the other hand, diclofenac and mefenamic corrosive can be oxidized by hexacyanoferrate(III) undercurrent conditions to shape shaded items which are observed spectrophotometrically.

The possibilities of FI are brought up to an incredible broaden when temperamental reagents must be utilized. These reagents can be delivered in situ in the FI complex, offering the upsides of straightforwardness, rate and wiping out the requirement for incessant normalization and capacity under unambiguous circumstances. Bromine can be created on-line by oxidation of bromide by bromate in acidic medium. Not entirely settled in drugs in a roundabout way, in light of the lessening of bromine absorbance. Essentially, the diminishing of the absorbance of on-line created iodine by a gathering of mixtures (amoxicillin, cephalexin, ampicillin, cephadrin) was the reason for the improvement of a FI measure. On-line triiodide particle age was accomplished by blending iodate and iodide arrangements. The diminishing of the absorbance of the complex between triodide particle and starch by metamizol was utilized by Pereira et al. for the assurance of the last option.

III. HETEROGENEOUS FI FRAMEWORKS

3.1. FI techniques in view of strong stage reactors

Despite the fact that FI in its beginning phases of improvement was committed to homogeneous frameworks, there is a rising examination interest in the joining of strong stage reactors to nonstop stream manifolds. The "idea" of strong stage reactors is based on the immobilization of the reagents - that stream in a separate stream or direct in typical FI - at a pre-characterized point of the complex. The example zone is driven by the transporter stream through the reactor and change of the analyte happens at the strong arrangement interface. The benefits of the utilization of strong stage reactors in FI can be summed up to the accompanying:

(1) Transformation of the analyte happens quicker since mass transfer is more proficient in the strong fluid connection point, while the convergence of the reagent is greatest at the point of interaction.

(2) The stream manifolds are more straightforward, since less stream channels are required. This additionally brings about less scattering of the example zone and expanded responsiveness and testing rate.

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(3) Utilization of the reagents is limited, since they don't stream persistently towards the finder and just the required sum responds on section of the analyte.

A large portion of the new FI techniques using strong stage reactors in drug examination depend on the immobilization of either a metal oxide (PbO_2 or MnO_2) or salt ($CoCO_3$ and $FePO_4$) in a polymeric framework. A regular immobilization strategy includes blending of the metal with polyester sap followed by the expansion of an impetus (methylethyl ketone). After blending the combination becomes thick, while a couple of hours later an unbending strong is gotten. Breaking, establishing and sieving steps follow the immobilization interaction. The subsequent particles are loaded inside a segment with pre-characterized aspects. The generally methodology is basic and simple to follow. The security of the subsequent strong stage reactors shifts from 400 to 600 tests infusions. Elective strong backings incorporate particle trade pitches (for entanglement of I_3^- particle), while strong CuO can be pressed and utilized straightforwardly, with practically no adjustments.

3.2. FI optical sensors

FI optical sensors depend on the "strong stage spectrophotometry" (SPS) procedure which was initially revealed by Yoshimura et al. in 1976 and has been applied from that point forward to different sorts of analytes. Albeit insightful methodology in view of SPS are for the most part touchy and basic, might be difficult and tedious also. The recently referenced constraints can be overwhelmed by the execution of SPS to FI frameworks.

Mechanized FI-SPS sensors include the utilization of a reasonable strong support (normally silica gel or cation/anion trade tars) stuffed in the stream cell of an optical finder. Broke down examples are infused in the transporter stream of the FI framework and driven towards the identifier where the analyte or a reasonable response item is held and distinguished on the strong help. The key highlights of this approach is that all vital advances including (a) maintenance of the analyte and detachment from test lattice, (b) preconcentration of the analyte and (c) location continue all the while. The investigation cycle is finished by quantitative elution of the held species and recovery of the packing material by either the actual transporter or a reasonable eluent.

FI optical sensors consolidate the upsides of SPS (improved selectivity and awareness, effortlessness, broadly accessible instrumentation) and FI (computerization, expanded testing rate, cost-adequacy and adaptability). Late applications in drug examination are summed up. Normal models as far as analytes incorporate ciprofloxacin, sulfonamides, methyl xanthines, and so forth. Contrasted with homogeneous FI frameworks with UV location, FI optical sensors are supposed to be significantly more delicate due to pre centralization of the analytes on the strong help. As of late distributed information report a 10-overlay signal improvement for trimethoprim also, sulfonamides, 25-overlap for salicylic corrosive and antibiotic medication anti-infection agents and, surprisingly, 32-crease for paracetamol. Then again, no similar information on selectivity upgrade are accounted for in the distributions of the analyzed period (2000-2006).

An extremely intriguing gathering of techniques in light of the utilization of FI optical sensors includes synchronous multi-analyte conclusions. These strategies exploit the distinctions in the maintenance conduct of the analytes on partition little sections situated before the detecting zone. Utilizing eluents of reasonable creation, successive appearance of the analytes to the finder can be accomplished. Trademark models incorporate the concurrent assurance of caffeine and theophylline, paracetamol and caffeine and paracetamol/caffeine/propyphenazone utilizing C18 silica-gel smaller than usual segments for the low-pressure partition of the analytes, while Sephadex cation trade tar was utilized for sulfamethoxazole and trimethoprim. As referenced over, the last step of a scientific cycle in FI-SPS strategies is quantitative expulsion of the analytes and recovery of the detecting zone. Nonetheless, this isn't generally a basic undertaking. In instances areas of strength for of the estimating species, the recovery methodology can be truly challenging, bringing about decreased execution of the detecting surface and restricted life-time. Globule infusion examination (BI) offers a rich and viable answer for this issue [80]. It depends on recharging of the detecting zone by infusion, transportation and catching of a characterized volume of "new" dots to the stream cell previously each analyte infusion. After the estimation is finished, the globules are disposed of to the waste. In view of this idea, RuedasRama et al. revealed as of late a strategy for the assurance of phenothiazines [81]. The proposed system included three steps:

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(a) 500 microliters of Sephadex QAE-A-25 dots are infused in the stream framework (infusion valve V1) and caught to the stream cell.

(b) Test and reagent (ferrozine) are infused all the while through valves V2 and V3 to the transporter stream (Fe (III)). Fe(III) is lessens by the analytes to Fe(II), andthe last option responds with ferrozine to frame a hued complex that is held on the strong help and checked at 567 nm.

(c) The globules are disposed of through a fourth valve (V4) and a new cycle is prepared to begin.

The above-portrayed logical plan offers an examining rate of 12 h−1 with a R.S.D. worth of under 2.0%.

IV. AUTOMATED SAMPLE PREPARATION

One of the most important advantages of FI is the possibility of automating a variety of sample pretreatment techniques, offering easy handling and enhanced throughput, accuracy and precision. Such techniques include solid-phase and liquid–liquid extraction, thermal induced digestion, gas diffusion, on-line dilution, etc.

4.1 Liquid–liquid extraction

Liquid–liquid (or solvent) extraction (LLE) is a wellestablished and effective separation/preconcentration technique, finding numerous applications in all areas of analytical chemistry. However, in its batch mode it has two main limitations.

It is time consuming, as several steps are necessary in order to achieve the highest extraction yield, while it requires the use of considerable volumes of generally toxic organic solvents.

Automation of LLE by FI proposed by Karlberg and Thelander made this technique very attractive to analytical chemists, since the above-mentioned limitations were eliminated to a great extend. A typical FI-LLE manifold is depicted. In brief, a fixed volume of the sample (S) is injected to a reagent stream (R), where it is converted to an extractable form. The aqueous and organic phase – which is usually propelled using a displacement bottle (DB) or solvent resistant tubes – is mixed through a suitable segmentor (SG). Extraction takes place on passage of the mixture through an extraction coil (EC), while the phases are separated by the aid of an on-line separator (SP) – usually a membrane-based one – prior to detection.

4.2. Strong stage extraction

Strong stage extraction (SPE) is an examples planning device with broad applications in present day scientific science, predominantly because of its effortlessness and the aversion of the poisonous natural solvents utilized in conventional dissolvable extraction. SPE can be combined to different procedures and recognition plans offering both example cleanup and responsiveness upgrade. In view of the assortment of pressing materials accessible (for example adjusted silica gels, anion and cation trade pitches, atomically engraved polymers, solid materials, and so on), uses of SPE reach out to both natural and inorganic investigation covering a wide range of tests (organic, ecological, food, drug, and so on.).

Notwithstanding the obvious benefits of SPE, activity in the cluster mode is a dreary and tedious interaction. A typical activity conspire includes (a) enactment of the section, (b) stacking of the example on the SPE smaller than normal section, (c) washing with proper answers for eliminate meddling parts of the test grid (generally more than one stages are required) and (d) quantitative elution of the analyte(s). By changing the volume of the eluent a few overlap pre concentration of the analyte (s) can be accomplished.

Clearly robotization of SPE through FI extends significantly the conceivable outcomes of this method, since the strategy is sped up, worked on with regards to human contribution, while accuracy is moved along. Ongoing utilizations of FI-SPE with spectrophotometric discovery in drug examination incorporate the assurance of phenylaphrine, bopindolol and salbutamol. As far as complex setup, there are predominantly two methodologies.

4.3. On-line absorption/hydrolysis/photolysis

Different late distributions for the FI spectrophotometric assurance of drug compounds depends on their on-line pretreatment in conditions of assimilation, hydrolysis and photolysis. A progression of studies has been distributed by the creators of this survey managing the assurance of phosphorus-containing drug compounds. The rule of these techniques is straightforward yet successful, in light of the cleavage of the C P or then again C O P securities and ensuing assurance of the yielded orthophosphate particles by the molybdenum blue

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methodology. C P bonds (for example in fosfomycin) can be divided on-line by thermal actuated absorption at 90 ◦C within the sight of persulfate particles. Then again, C O P bonds (for example in fosfestrol) can be hydrolyzed by either a similar system referenced above, or on the other hand enzymaticaly by soluble phosphatase. More mind boggling particles, for example, fosinopril require the utilization of more radical conditions like UV-helped absorption within the sight of ammonium peroxodisulfate as the oxidizing specialist. A fascinating feature of a portion of the techniques referenced above is the accomplishment of quantitative hydrolysis, permitting the utilization of an orthophosphates alignment diagram for quantitative estimations. An on-line hydrolysis step was likewise taken on by CapellaPeiro et al. for the assurance of nicotinic corrosive furthermore, Metwally et al. for the assurance of cephalosporins (cefadroxil and cefotaxime). In the previous, nicotinic corrosive was hydrolyzed on-line within the sight of cyanogen bromide to shape glutaconic aldehyde. The last option was infused into a stream containing the coupling reagent (aniline) in micellar mechanism for responsiveness upgrade. The response item - polymethine color - was observed spectrophotometrically (λmax = 440 nm) at an inspecting pace of 95 h−1. The last option methodology depends on the on-line hydrolysis of the examined cephalosporins in NaOH medium. Hydrogen sulfide delivered is resolved photometrically founded on response with by the same token N,N-diethyl-p-phenylenediamine and Fe(III) (λmax = 670 nm), or then again p-phenylenediamine and Fe(III) (λmax = 597 nm).

V. CONCLUSION

Stream infusion examination with spectrophotometric location offers essentially vast potential outcomes to the mechanization of analytical techniques devoted to drug examination. The definite investigation of the current writing and the writers' experience to the quality control of drugs in modern scale, have prompted the accompanying ends:

(1) Direct UV location of the dynamic fixings involving singlechanneled FI manifolds is the most alluring arrangement in standard, modern scale applications. Nonetheless, careful approval as far as selectivity is vital to demonstrate the adequacy and "practicality" of such methodology.

Strong stage spectrophotometry utilizing economically available supports can be considered when upgraded responsiveness is required.

(2) When the previously mentioned systems offer deficient selectivity basic on-line response plans with more specific reagents can be applied.

(3) Consolidation of strong stage reactors in FI manifolds offer benefits from an "scholarly" perspective. Notwithstanding, the absence of economically accessible, prepared to-utilize pressing materials, make them ugly to modern applications.

(4) On-line test readiness plans are more confounded what's more, normally require multi-diverted manifolds. Notwithstanding, the upgraded selectivity and responsiveness of the created techniques offer promising bases for growing their applicability to more muddled and "requesting" grids such as organic material and ecological examples.

(5) A basic field of the quality control of pharmaceutical plans is virtue control. Up to this point, this field was not "available" by FI, since it requires partition of fundamentally comparative mixtures, and consequently HPLC prevailed. As of late, commercialization of monolithicbased fixed stages, offers opportunities for very compelling partitions at low tensions. the best of our insight, the chance of low-pressure pollutants profiling utilizing either FI or SI has not yet been investigated.

VI. REFERENCES

[1] J. Ruzicka, E.H. Hansen, Anal. Chim. Acta 78 (1975) 145–157.
[2] J.M. Calatayud, Flow injection analysis of pharmaceuticals, in: Automation in the Laboratory, Taylor & Francis, London, 1996.
[3] C.B. Ojeda, F.S. Rojas, Sensors 6 (2006) 1245–1307.
[4] S. Matsuoka, K. Yoshimura, Bunseki Kagaku 54 (2005) 1137–1147.
[5] W. Xu, R.C. Sandford, P. Worsfold, A. Carlton, G. Hanrahan, Crit. Rev. Anal. Chem. 35 (2005) 237–246.
[6] M. Miro, W. Frenzel, Microchim. Acta 148 (2004) 1–20.
[7] A. Moreno-Cid, M.C. Yebra, X. Santos, Talanta 63 (2004) 509–514.

[8] J. Wang, E.H. Hansen, TrAC Trends. Anal. Chem. 22 (2003) 836–846.
[9] M.C. Yebra-Biurrun, Talanta 52 (2000) 367–383.
[10] K. Pyrzynska, S. Gucer, E. Bulska, Water Res. 34 (2000) 359–365.
[11] L. Hlabangana, S. Hernadez-Cassou, J. Saurina, Curr. Pharm. Anal. 2 (2006) 127–140.
[12] P. Pavlina, M. Polasek, Cesk. Slov. Farm. 50 (2001) 107–112.
[13] P.D. Tzanavaras, A. Verdoukas, T. Balloma, J. Pharm. Biomed. Anal. 41 (2006) 437–441.
[14] N.O. Can, G. Altiokka, H.Y. Aboul-Enein, Anal. Chim. Acta 576 (2006) 246–252.
[15] D. Yeniceli, D. Dogrukol-Ak, M. Tuncel, J. Liq. Chromatogr. Relat. Technol. 28 (2005) 1693–1701.
[16] P.D. Tzanavaras, D.G. Themelis, Anal. Lett. 38 (2005) 2165–2173.
[17] Z. Atlosar, G. Altiokka, J. Liq. Chromatogr. Relat. Technol. 29 (2006) 849–856.
[18] S. Liawruangrath, J. Makchit, B. Liawruangrath, Anal. Sci. 22 (2006) 127–130.
[19] P.D. Tzanavaras, A. Verdoukas, D.G. Themelis, Anal. Sci. 21 (2005) 1515–1518.
[20] C. Ozlu, H. Basan, E. Satana, N. Ertas, N.G. Goger, J. Pharm. Biomed. Anal. 39 (2005) 606–611.
[21] A.G. Dal, D. Dogrukol-Ak, M. Tuncel, J. Liq. Chromatogr. Relat. Technol. 28 (2005) 619–629.
[22] D. Yapar, A.G. Dal, M. Tuncel, U.D. Uysal, J. Liq. Chromatogr. Relat. Technol. 27 (2004) 2593–2601.
[23] G. Altiokka, K. Kircali, Anal. Sci. 19 (2003) 629–631.
[24] G. Altiokka, Z. Atkosar, N.O. Can, J. Pharm. Biomed. Anal. 30 (2002) 881–885.
[25] G. Altiokka, Z. Atkosar, J. Pharm. Biomed. Anal. 27 (2002) 841–844.
[26] G. Altiokka, Z. Atkosar, E. Sener, M. Tuncel, J. Pharm. Biomed. Anal.25 (2001) 339–342.
[27] D. Yeniceli, D. Dogrukol-Ak, M. Tuncel, J. Pharm. Biomed. Anal. 36 (2004) 145–148.
[28] A.L. De Toledo-Fornazari, W.T. Suarez, H.J. Vieira, O. Fatibello-Filho, Acta Chim. Slov. 52 (2005) 164–167.
[29] P.D. Tzanavaras, D.G. Themelis, A. Economou, G. Theodoridis, Microchim. Acta 142 (2003) 55–62.
[30] J.C. Rodriguez, J. Barciela, S. Garcia, C. Herrero, R.M. Pena, J. AOAC Int. 88 (2005) 1148–1154.
[31] I.F. Al-Momani, J. Pharm. Biomed. Anal. 25 (2001) 751–757.
[32] W. Misiuk, P. Halaburda, J. Trace Microb. Tech. 21 (2003) 95–102.
[33] S. Liawruangrath, B. Liawruangrath, S. Watanesk, W. Ruengsitagoon, Anal. Sci. 22 (2006) 15–19.
[34] M.S. Garcia, M.I. Albero, C. Sanchez-Pedreno, M.S. Abuherba, Eur. J. Pharm. Biopharm. 61 (2005) 87–93.
[35] P.R.S. Ribeiro, J.A.G. Neto, L. Pezza, H.R. Pezza, Talanta 67 (2005) 240–244.