DD-SIMCA and PLS regression models applied to NIR spectroscopy for identification and assay of ciprofloxacin tablets

C.A. Waffo Tchounga [1], P.Y. Sacre[2], P. Ciza[3], R. Ngono[4], E. Ziemons[5], Ph. Hubert[6], R.D. Marini[7]

[1] University of Liege (ULiege), LPAC, CIRM, cawaffotchounga@uliege.be
[2] University of Liege (ULiege), LPAC, CIRM, pysacre@uliege.be
[3]University of Liege (ULiege) LPAC, CIRM, pciza@uliege.be
[4]*University of Yaoundé I and National Drug Control and Valuation of Cameroon, rngono2002@yahoo.fr*
[5]University of Liege (ULiege), LPAC, CIRM, eziemons@uliege.be
[6]University of Liege (ULiege), LPAC, CIRM, ph.hubert@uliege.be
[7]University of Liege (ULiege), LPAC, CIRM, rmarini@uliege.be

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1 Introduction

Poor-quality medicines pose a threat to the health of populations but also constitute a hindrance to the socio-economic development of governments. Developing countries are the most affected, as they face enormous difficulties in ensuring the quality of medicines present in their markets [1].

Among other difficulties, the methods commonly advocated by pharmacopoeias using sophisticated techniques such as High-Performance Liquid Chromatography (HPLC) are not always obvious to apply. These methods are generally expensive, difficult to implement because of power shortages and logistic problems leading generally to significant results-reporting deadlines [2].

Apart from these laboratory techniques, vibrational spectroscopy is of particular interest because they are fast, easy to use, cheap and less polluting. This interest is also increased by the development of low-cost handheld devices. Nevertheless, the major difficulty lies in the interpretation of the results, which necessitates chemometric methods [3].

2 Material and methods

Considering all these points, it has been undertaken to develop and validate methods for the identification and assay of ciprofloxacin using near-infrared (NIR) spectrophotometry coupled with chemometric methods such as Data-Driven Soft Independent Modelling of Class Analogy (DD-SIMCA) and Partial Least Squares (PLS) regression. For this purpose, two types of low-cost handheld NIR devices were used, one in reflection mode (NIR-S-G1) and the other in transmission mode (NIR-M-T1) both from Innospectra Corporation (Taiwan).

3 Results and discussion

On the one hand, a qualitative DD-SIMCA model has been developed to confirm the presence of the active ingredient ciprofloxacin tablets regardless of the brand or formulation. This first step is performed on intact tablets with the reflective module and is envisaged as a screening phase applicable during an on-field inspection.

On the other hand, a quantitative PLS-R model was built for the determination of ciprofloxacin content in tablets of different brands with the announced content 500mg. The PLS model was then validated using the total error approach with the accuracy profile as a decision tool with 90.0%-

110.0% specifications and a risk β set at 5%. This second step is performed on dissolved tablets with the transmissive module and is envisaged as a pre-confirmatory technique. The main advantage is that it may be performed anywhere close to the inspection site.

These validated methods were then applied on 23 ciprofloxacin 500mg tablet samples collected in the Cameroonian legal and illegal market. Ciprofloxacin was correctly identified in all samples using the DD-SIMCA model. The latter allowed ciprofloxacin to be discriminated against other molecules belonging to the fluoroquinolone family such as norfloxacin, ofloxacin, moxifloxacin and levofloxacin. In addition, four substandard samples were detected using the PLS regression model. All spectroscopic results were confirmed with a validated HPLC method.

4 Conclusion

The applicability of the qualitative and quantitative methods developed and validated led to encouraging results as they were confirmed by HPLC used as a reference method. Because of their portability, these methods could be easily transported to areas where laboratory facilities are not present to assess the quality of medicines. Moreover, they can be used upstream of laboratory confirmation methods with a screening objective in resource-limited countries thanks to their low analysis cost.

5 References

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