Spectral Database of Pharmaceutical Common Excipients and Paracetamol API Using ASD Field Spec 4 Spectrordiometer

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Abstract

Adulteration in pharmaceutical products is common all over the world particularly in pharmaceutical oral dosage forms like tablets, gelatin capsules. According to previous studies there were many techniques are available to recognize counterfeit medicines. Near Infrared Spectroscopic techniques is widely used in this area due to its numerous advantages. In this work, we used ASD Field Spec4 Spectroradiometer having broad spectral range (350-2500 nanometer) and its supporting software's to create Spectral library of pharmaceutical common drug Paracetamol and some basic excipients used in pharmaceutical industry as formulation process of tablets and capsules and finally also showed the absorption bands of Paracetamol API and Excipients.

Keywords: *Active Pharmaceutical Ingredient (API), Nanometer (nm), Near Infrared Spectroscopy (NIR), Spectral Signature, ASD Field Spec4 Spectroradiometer.*

Introduction

Counterfeiting of medicine is one of the worst current pharmaceutical burden. In pharmaceutical the counterfeiting of medicine can be type of overdose, under dose or wrong Active Pharmaceutical Ingredient (API) or even with toxic compound added in medicine(1). The issue of counterfeit medicine and adulteration in pharmaceutical formulation is a serious problem all over the world(2,3). According to the world health organization (WHO) approximately 10% of medicines worldwide are substandard or counterfeit, as well as up to 50% medicines purchased from the internet may be of poor quality(4). To figure out this counterfeiting problems in pharmaceutical industry we have to ensure the quality of product qualitatively and quantitatively and for that there were many techniques are available in pharmaceutical industry but we can categorized them basically in Chromatographic, Hyperspectral Imaging, and Spectroscopic technique. Chromatographic technique is widely used in pharmaceutical industry from many decades but this technique has some major disadvantages, due to this reason it shows that from past decades the pharmaceutical industry are taking interest in spectroscopic techniques. In spectroscopic techniques the number of spectroscopic are available like, Near Infrared Spectroscopic, Raman Spectroscopic, UV-VIS, FT-NIR, FT-IR, etc. In previous study, the NIR spectroscopic is widely used and showed his efficiency in pharmaceutical research. As Process Analytical Tool (PAT) NIRS is extensively used to monitor the complete development process of pharmaceutical tablet (6). NIRS is noninvasive and nondestructive feature the sample can be recollected for further analysis or can be used as approval purpose for forensic. NIRS is analytical method and used for analyzing the pharmaceutical material qualitatively and quantitatively(10). NIRS showed many advantages in this area, It is fast, noninvasive and nondestructive technique that helps to provide the physical and chemical information of analyzed samples, identification of various contents available in medicines and pharmaceutical product as well as to detect the counterfeit and substandard medicines and product, due to its massive advantages NIRS showed its acceptance in pharmaceutical domain(7). NIRS is not used only in pharmaceutical industry but also used in various remote sensing applications like Agriculture, Food, Mining, Petrochemical, etc(9) NIRS is a type of vibrational spectroscopy and its range is 700 to 2500 nanometer. The spectra of NIRS is generated due to the vibrations of –CH, -OH, -NH and –SH bonds. NIRS techniques has a limitation that is overlapping of NIR bands and NIR spectra is quite difficult to understand,

to understand this spectra and process on it, the NIRS is combined with chemo metric tools[11]. Chemo metric tools is combination of statistical method, Classification techniques and Regression method that helps spectra interpretation and to improve the variations between the spectra of material given by NIRS. Classification techniques are PCA, SIMCA, PLSR it useful for classification of spectra according to the material and three linear regression method are PCR, PLR, Nonlinear regression model based on ANN is used to determination of concentrations chemical compounds in pharmaceutical field using NIRS. In pharmaceutical application NIRS is mainly used for solid material preparations including tablets, gelatin capsules or powder mixtures for identification and quantification of API components and excipients [5].Pharmaceutical tablet is type of solid dosage from it is made by combination of active pharmaceutical ingredients and raw material (excipients substances). API is active ingredient, primary component in a drug producing intended effect on human body, while excipients is an inactive ingredient, secondary components helps for binding and making process of pharmaceutical tablet. Paracetamol or Acetaminophen API is widely used all over the world. It shows its effectiveness for the relief of headaches and other aches, pain and fever, cold and flu in children and adults. Paracetamol can be used with combination of other medication for the management of several pain. Paracetamol is safe if it is used by recommended doses (1000mg per single dose and up to 4000mg per day for adults), overdose of paracetamol can cause liver damage and cannot be safe for alcoholic person [12]. Pharmaceutical material spectral library can be useful for identification of components available on particular pharmaceutical medicine. Spectral library is a collection of spectra's generated by standard or pure materials comes in the pharmaceutical category. Spectral library can be developed for various applications. In remote sensing domain, spectra is collected by using spectroscopic device and that can be useful for mapping of materials. The developed spectral library can be useful for various applications in remote sensing like, soil, vegetation, mineral, rocks, water, plant, microorganism identification, etc. The purpose of the present work to developed a spectral library by using a device ASDFieldSpec4 Spectroradiometer and standard or pure pharmaceutical excipients and API, that can be used for identification of API and excipients present in the pharmaceutical medicines.

Material and Method

Samples: The standard Paracetamol drug as an API and the standard Excipients (Microcrystalline Cellulose, Magnesium Stearate, Maize Starch Powder, Talc, Lactose, Sucrose, Sorbitol Powder, Mannitol, Acacia Gum, Hydroxypropyl Methylcellulos) are obtained from Department of Chemical Technology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (MS), as a gift samples for this research work.

NIR Spectroscopy: The previous study has shown that NIR Spectroscopic devices is useful for pharmaceutical research and also helps to develop the spectral library of pharmaceutical materials. To develop the spectral library of Pharmaceutical API and various excipients, ASD FieldSpec4 Spectroradiometer is used that has broad spectral range in between 350-2500 nanometer and it has sampling rate 0.2 seconds per spectrum. ASD FieldSpec4 Spectroradiometer includes three sensors VNIR (350-1000nm), SWIR (1000-1800 nm) and SWIR2 (1800-2500 nm).

NIR Measurement: The API and Excipients was collected in air pack bag in 50 gram quantity. ASDFieldSpec4 Spectroradiometer was used for the measurement of pharmaceutical excipients and API in the Multispectral Research Lab, Department of Computer Science and IT, Dr. B.A.M. University, Aurangabad (MS), India. For avoid the disturbance of external light the sample scanning was done using reflectance mode in the completely setup dark room. As a light source Tungsten halogen light matched with Spectroradiometer was used with 45 degree incident angle. Petri dish and black paper having 10mm*90mm was used for sample holder. Standardized Spectralon panel was used to optimized device signals and calibration accuracy and sensors response. Excipients and API sample is place one by one in the petri dish and was collect it spectral signature by using spectral gun. 20 scans were taken per sample spectrum with sampling rate of 1.4 nm per spectrum at wavelength range 350-100 nm and 1.1 nm at wavelength range 1001-2500 nm. The ASDFieldSpec4 device sample scanning time per sample is 100 milliseconds.

Figure 1: Lab Setup

Software's: The ASDFieldSpec4 instrument is controlled by RS3 software comes with the device to help data acquisition in the form of spectral signature[18, 19]. After acquisition of data spectral signature can be viewed and to processed by using some chemometric and statistical method was done by using ViewSpec Pro software that also comes with the ASDFieldSpec4 Spectroradiometer.

Preprocessing of Spectra: All excipients and Paracetamol API was scanned by ASDFieldSpec4 Spectroradiometer and spectral signature of each sample was acquired through RS3 software. For every sample 20 scans was taken and convert it into the single Mean file and this is used for further processing. At beginning, Paracetamol API was taken for preprocessing and statistical analysis.20 spectral signatures of paracetamol API was taken in the laboratory and viewed by ViewSpecPro software, the signatures are not clearly showing where absorptions and reflectance in bands. All Spectral signature files are putted into ViewSpecPro software and converted into one single file that is mean of 20 scan files and again viewed it in ViewSpecPro software. Fig.2 shows the Mean Spectra of 20 spectral signatures of paracetamol API.

In Fig.2, Splice correction and smoothing is required for the exploration of spectral bands for this 1st and 2nd derivative with 7 as derivative gap was chosen as preprocessing technique. After applied preprocessing techniques on Paracetamol Mean Spectra the Splice correction and smoothing was done, below Figure 3 and 4 shows the Spectral signature of Paracetamol API after 1st and 2nd derivative as preprocessing step.

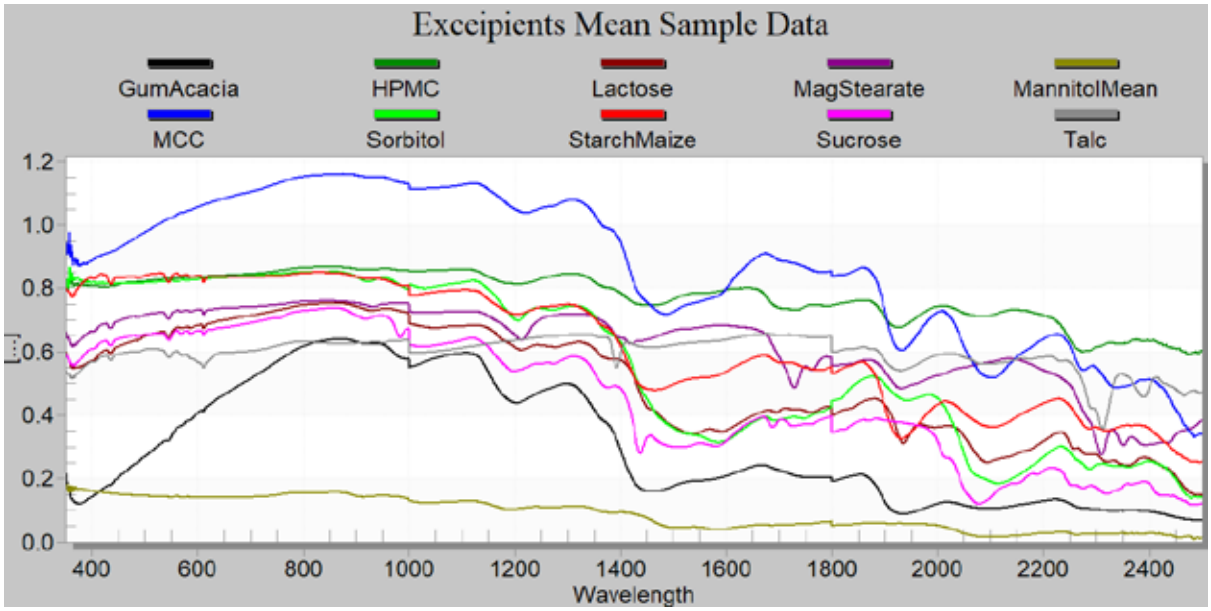

Figure 2: Paracetamol Mean Spectra

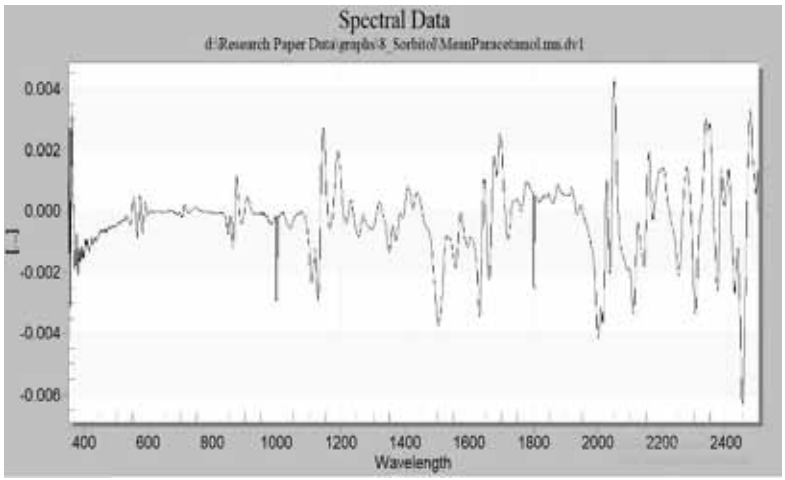

Figure 3: Ist Derivative Spectra

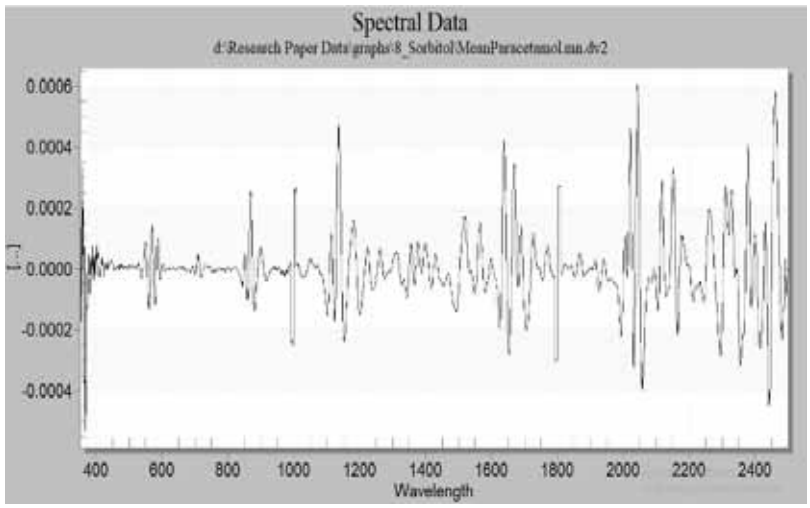

Figure 4: IInd Derivative Spectra

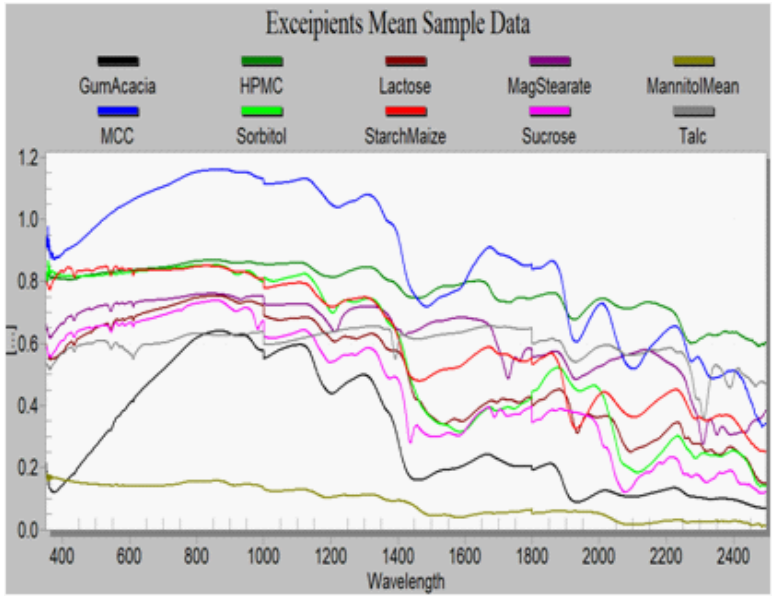

Figure 5: Excipients Mean Spectral data

Same process were applied for all the basic excipients. In the first stage we take all 20 scans of each sample and showed it by using ViewSpec pro spectral signature preprocessing software. Second stage, we take all 20 samples scanned Mean file and consider that mean file as a final sample, Fig. 5 showed the all 10 excipients spectral signatures.

Third stage, after observing the Mean spectra of sample we processed it to I^{st} and II^{nd} derivative as a preprocessing technique for splice correction and to clearly visualize the Absorbance and reflectance bands in it. Likewise, this same process is applied to all 10 Excipients.

Result and Discussion

In the previous work we observed that the authors used various types of Spectroscopic techniques with having limited Spectral range to show the absorption and reflectance in spectral signature for various pharmaceutical materials. Paracetamol as active component and basic excipients we observed throughout its spectral data and we found absorptions in various bands that we showed in the following Table 1.

Table 1: Absorption Bands

API and Excipients	Absorption bands (In nanometer)
Paracetamol API	1650-1700,2150,2250-2400
Microcrystalline Cellulose (MCC)	1850,2000-2200,1450
Magnesium Stearate	1650,2100,2300
Starch Maize	1400,1850,2100
Talc	1400,2300-2350
Lactose	1900,2150,1450
Sucrose	1400-1450,2025-2100
Sorbitol	1600,2150
Mannitol	1600,2100
Acacia Gum	1450,1850-1900
Hydroxypropyl Methylcellulose (HPMC)	1450,1850-1900,2100

In Table.1, we can see all the pharmaceutical materials that can be either active ingredients or raw material can be get in the Near Infrared Spectral range that is 750-2500 nanometer (nm). In the table we can see every material has its own spectral absorption bands. Paracetamol API has strong absorptions in the range of 1650-1700 nm and 2250-2400 nm. Likewise Table.1 showed all excipients strong absorption bands.

Conclusion

Spectral bands of various Inactive components and Paracetamol as active pharmaceutical ingredients commonly used as pain killer in pharmaceutical product is showed in this paper and also showed the Spectral library in ViewSpecPro software. In order to identification of components from pharmaceutical oral dosage forms. Paracetamol API as active component and 10 different types of basic excipients (Inactive components) commonly used in tablet and capsules formulation. Spectral data is acquired through ASDFieldSpec4 Spectroradiometer and with the help of its RS3 Spectra acquisition software. After acquisition of Spectral signature for various samples (Paracetamol API and Common Excipients) some preprocessing steps are required as smoothing and splice correction on Spectral database for visualization and exploration of reflectance as well as absorption bands, it was done with the help of ViewSpecPro software that came with Spectroradiometer as statistical and chemometric tool. As Preprocessing techniques First and Second derivative with having 7 as derivative gap is used and the output of spectral database is showed with the help of ViewSpecPro software in the form of figures for every sample.

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Ethical Clearance: Not required

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Conflict of Interest: Nil

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