

## Studies of different types of aspirin by spectrophotometric methods

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**Abstract:** Aspirin (acetylsalicylic acid) is an important anti-inflammatory and analgesic-pyretic drug. FTIR and UV-VIS spectroscopy were used in the present study. Using the FTIR spectroscopy and statistical data analysis the correlation between different types of aspirin was determined. The content of acetylsalicylic acid from the analysed samples was determined by the use of UV-VIS spectroscopy.

**Keywords:** Aspirins, UV-VIS analyses, FTIR spectra, Cluster analysis

### Introduction

Pharmaceutical industry is currently characterized by a high rate of global and national development, while the number of existing active substances is always increasing with new valuable products obtained by synthesis, biosynthesis, semisynthetic, or extraction from plants or animal organs.<sup>1-4</sup> Drugs are organic or inorganic substances, natural or synthetic which, in very small doses, have certain pharmacodynamic actions. A more precise definition was given by World Health Organization (WHO) "any

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substance or product used to modify or explore a physiological system or pathological condition in the interest of the individual to whom it is given, is called medicine".<sup>5-7</sup>

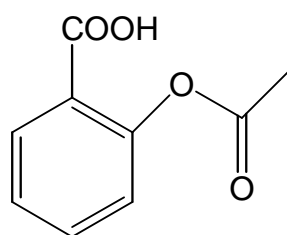
The large number of drugs, known and currently used clinically, raised the question of their classification. For this, many criteria have been proposed and only two of them were adopted: the classification by chemical structure and the classification after the pharmacological action.

Natural or synthetic organic substances acting on the central nervous system, producing suppression of pain, are known as analgesics, and those that produce pain suppression and reduced body temperature are called analgesics antithermal or anti-pyretic.<sup>8</sup> In April 1763, Edward Stone, reverend of the Royal Society, referring to salicylates, wrote: "this is a bark of an English tree, that I found through experience in order to be used as a powerful astringent, and very effective in the treatment of malaria and intermittent disturbances".<sup>9</sup> Edward Stone was the one who studied the medicinal properties of willow extract. However, it seems that salicylates' properties were known for centuries. Hippocrates, the Greek doctor, wrote in the fifth century BC about a bitter powder extracted from the willow bark that had the power to ease the pains and reduce the fever.<sup>10</sup>

Today, the most widely used salicylate derivative is the acetylsalicylic acid, a universal substance commercially known as aspirin.<sup>3,</sup>

<sup>11</sup> Aspirin (acetylsalicylic acid) is an important anti-inflammatory drug and analgesic-pyretic. In addition, the low-dose aspirin has an anticoagulant effect and is used long term to reduce the risk of heart attack.<sup>8</sup> The name of Aspirin is the name under which the company Bayer, from Germany, produced for the first time this drug. Today, this term is commonly used to name the drug, even including the variants that are not Bayer products.

There are countries where the word Aspirin refers only to the version produced by Bayer – any other version of the product being called "acetylsalicylic acid". Thus, in 1827 the french pharmacist Henri Leroux isolated the acetylsalicylic acid in crystalline form, called salicin, after the Latin name used for the white willow (*Salix alba*). In the sodium salicylates was introduced in the treatment of rheumatism, and in 1899 the aspirin is used as an analgesic and antipyretic.<sup>5</sup> Although the aspirins are on the market since 1899, for over 100 years, the controversy is still ongoing. Officially, the inventor of aspirin was Felix Hoffmann. On the other hand, Arthur Eichengrün said in 1949 that he planned and directed the synthesis of aspirin, since the role of Hoffmann was only the initial synthesis of the drug using the trial.<sup>2,6,7</sup>



**Figure 1.** Acetylsalicylic acid (aspirin) structure.

Aspirin can be seen in the form of colourless needle crystal or crystalline powder, without smell or odour of acetic acid and harsh taste. In moist air it hydrolyzes partially. It is soluble in 300 cold water parts, in 5 parts ethyl alcohol, in 20 parts ether, in 25 parts chloroform; it is dissolved in alkali hydroxides solutions or carbonates with formation of salts. Participates to the reaction of saponification in hot alkaline environment, in the reaction with sodium nitrite, and may take part in reactions of esterification, bromination, etc.<sup>4</sup>

This study aims to compare the differences between acetylsalicylic acid content from different aspirin tablets, from different manufacturers

using FTIR spectroscopy and statistical processing of the data. The quantitative determination of the pure substance from the selected tablets included in this study was performed by the use of UV-VIS spectroscopy.

## **Experimental**

### *Equipment*

The FTIR spectra of aspirin samples were obtained using a Jasco FTIR-660 Plus spectrophotometer. The UV spectra were obtained using a Cintra 101 GBC spectrophotometer and 1 cm quartz cuvette.

### *Materials and reagents*

Aspirin tablets were commercially purchased from different manufacturers. We used four 500 mg of active ingredients tablets ( $A_1$ - $A_4$ ), one buffered tablet ( $A_5$ ) and two effervescent tablets ( $A_6$  and  $A_7$ ).

### *Application process*

For the ultraviolet analysis, the procedure was as it follows: a sample amount equivalent to 0,01 g pure aspirin from the tablets was dissolved in 10 ml sodium hydroxide 0,1 N, in volumetric flask, 1 ml of this solution was diluted with 0.1N sodium hydroxide to 10 ml. The solutions' spectra were measured at 299 nm ( $\pm 1$ ), compared to the 0,1 N sodium dioxide.

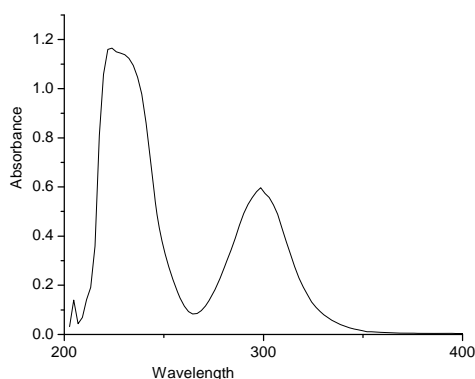
The FTIR spectra were obtained using KBr pallets, in the range 4000 and 400  $\text{cm}^{-1}$  with a 4  $\text{cm}^{-1}$  resolution.

## **Results and discussion**

Determination of the content of salicylic acid in the samples was made according to the method described by I Crucean and V. Georgescu.<sup>12</sup>

UV-VIS spectrophotometry was used in order to measure the acetylsalicylic acid concentration of the aspirin tablets. Using 0,1 N sodium hydroxide as solvent, the measurements were taken at 299 nm wavelength.

It should be noted that the excipients of the tablets do not interfere with the determination, Figure 2.



**Figure 2.** UV-VIS spectra for sample 3.

Determination of acetylsalicylic acid is based on the following equation:

$$g/\text{tablet} = \frac{E \cdot M \cdot 25}{195 \cdot g}$$

in which:

E = extinction of the analyzed sample

M = average weight of the tablets

195 =  $E_{1\text{cm}}^{1\%}$ , at 299 nm

g = weight used in the analysis

The obtained results are summarized in table 1.

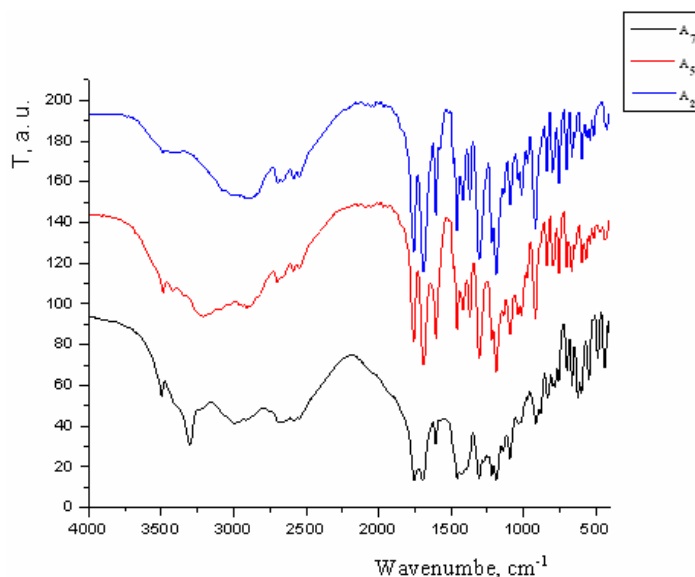
**Table 1.** The mass of active ingredient contained in the studied aspirin tablets

Samples	Weighed mass in g / tablet	Weight in g active substance / tablet
A <sub>1</sub>	0,6153	0,4091
A <sub>2</sub>	0,5989	0,3722
A <sub>3</sub>	0,5985	0,4083
A <sub>4</sub>	0,6922	0,4201
A <sub>5</sub>	0,8379	0,5133
A <sub>6</sub>	2,9197	0,3770
A <sub>7</sub>	3,2042	0,2868

It is noted that the masses of the aspirin samples included in this study varied between 0.5985 to 0.8379 g for tablets and for the effervescent samples between 2.9197 to 3.2042 g. From the quantitative determination of active substance in the samples analyzed, it is noted that this varies significantly (from 0,3722 to 0,5133 g for tablets), even if the amount of active substance, as indicated by the manufacturer, should be 0,500 g of active substance per tablet.

In the case of the effervescent samples, the amount of active substance related to the mass of the studs is much smaller between 0,2866 and 0,3770 g.

The IR spectrophotometry aims to identify the active substance and compare these types of aspirin. Figure 3 shows the IR spectra for three different types of aspirin tablets (simple ( $A_2$ ), aspirin buffered ( $A_5$ ) and effervescent aspirin ( $A_7$ )).



**Figure 3.** FTIR spectra of simple aspirin ( $A_2$ ), buffered aspirin ( $A_5$ ) and effervescent aspirin ( $A_7$ ).

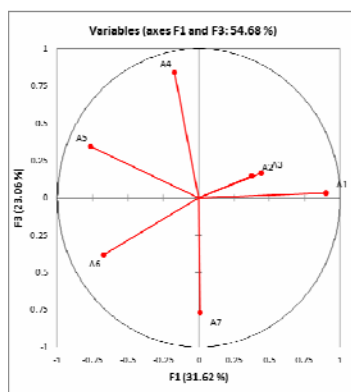
From the FTIR spectra of the analyzed samples it can be noticed that they are rather similar since it could be identified the main adsorption bands characteristic to the acetylsalicylic acid. Functional groups found in the

analysed samples, were identified and attributed to the vibrating bands by comparing them with the spectra of other similar samples. In the IR spectrum the characteristic bands of the C = O vibration from the vinyl ester group in the 1750-1730  $\text{cm}^{-1}$  region can be observed, C = O group of the aromatic acid appears around 1690  $\text{cm}^{-1}$ . It was also noticed that the valence vibrations of the aromatic core occur in the range of 1600-1400  $\text{cm}^{-1}$ . Around 1220-1190  $\text{cm}^{-1}$  appear the valence vibrations of the C-O group from acid and ester. The valence vibrations of the C-H are identified in the 3100-2850  $\text{cm}^{-1}$  region and the O-H valence vibrations appear in the 3600-3500  $\text{cm}^{-1}$  region.<sup>13</sup>

### Cluster analysis

The analysis of the main components analysis (PCA) is a statistical procedure that uses an orthogonal transformation to transform a set of observations of possible related variables in a set of values of uncorrelated linear variables called main components.<sup>14, 15</sup>

Figure 4 shows the main component analysis for the 7 analyzed samples. It can be noticed that factors associated to the samples from the A<sub>1</sub>, A<sub>2</sub>, A<sub>3</sub>, A<sub>4</sub>, A<sub>5</sub> manufacturers can be found in the same region, which means that there is a correlation between them. A<sub>6</sub> and A<sub>7</sub> are effervescent tablets and they appear separately grouped.

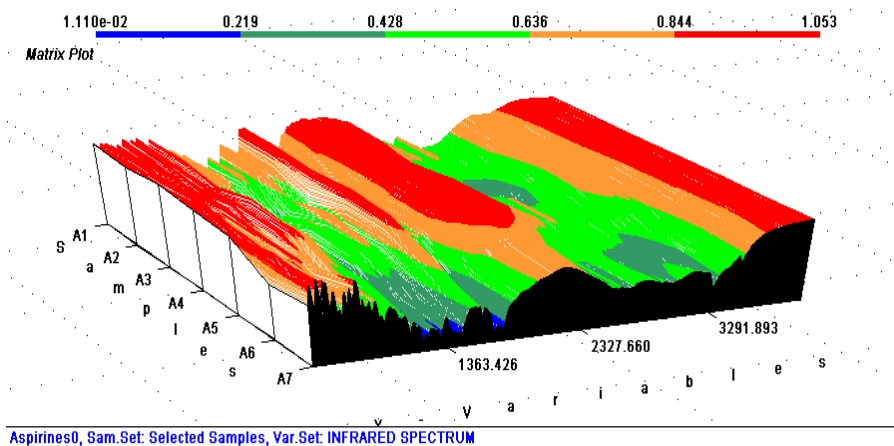


**Figure 4.** Principal component analysis for the aspirine tablets.

From Figure 3 it can be seen that the aspirin samples taken from the  $A_1 - A_5$  manufacturers make up a group, in contrast to the samples  $A_6$  and  $A_7$ . Samples  $A_2$  and  $A_3$  are similar in factors distribution, followed by sample  $A_1$ .  $A_4$  sample, which although simple can be found in a different region, meaning it differs from samples  $A_1$ ,  $A_2$  and  $A_3$ . The difference for  $A_5$  sample can be explained through the fact that this is a buffered aspirin. On the other hand,  $A_6$  and  $A_7$ , both effervescent, are found in the same region.

From the statistical data processing it was observed that the analyzed aspirin tablets are grouped into categories, simple, buffered and the effervescent aspirin samples. From Figures 3 it was noticed that  $A_4$  is situated in a different plane towards the group of the aspirin samples described above.

Figure 5 shows the highlighted differences between the aspirin analysis samples:



**Figure 5.** Aspirines – Matrix Plot.

Significant differences could be observed between the simple and the effervescent tablet groups between 3291-2809; 2340-1845; 1740-11580 and 1380-1100  $\text{cm}^{-1}$ , but there are no evident differences between samples from the same group.



## Conclusions

UV-VIS and FTIR spectra provide useful information about the analyzed samples. Determination of the amount of active substance, carried out by the use of UV-VIS spectrophotometry, showed that there are differences between the content of the active substance stated on the label and the one experimentally determined.

Statistical analysis of the data shows differences between the types of tablets, buffered and effervescent aspirin, and different manufacturers. On the other hand, such determinations may show samples with different composition that may be counterfeit.

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