Nota técnica

Thermogravimetry and differential scanning calorimetry as useful techniques to quality control in pharmaceutic industries: Ascorbic acid tablets analysis

Termogravimetria e exame diferencial calorimétrico num controle de qualidade para ácido ascórbico

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SUMMARY – Besides infrared spectroscopy and X-ray diffractometry, thermogravimetry (TG), and differential scanning calorimetry (DSC), are employed to analyze standard and tablets ascorbic acid samples. Is verified that TG as well as DSC can be successfully employed to determine the purity degree of ascorbic acid in the pharmaceutical formulations (tablets). Taking into account the relatively low cost, as well as the reliable results provided by TG and DSC analysis, is concluded that both techniques can be successfully employed in the pharmaceutical industry as a routine technique to assure the quality of pharmaceutical formulations.

KEYWORDS – Ascorbic acid, TG-DSC, quality control.

RESUMO *– Além da espectroscopia infravermelha e do RX difratométrico, a termogravimetria e exame diferencial calorimétrico podem ser utilizados para a análise do ácido ascórbico, para determinar o grau de pureza em comprimidos. Com custos relativamente baixos e resultados seguros, recomenda-se seu emprego na rotina de uma indústria farmacêutica.*

PALAVRAS-CHAVE *– Ácido ascórbico, termogravimetria, exame diferencial calorimétrico, controle de qualidade.*

INTRODUCTION

Ascorbic acid is one of the most sold chemical substances for therapeutic purposes, as well as in the food industry as an anti-oxidant agent. Ascorbic acid could suffer modifications on its physical appearance under storage. Such modifications could be provoked by factors such as temperature and humidity changes, oxidation and hydrolysis[1,2].

In the pharmaceutical industry, the use of excipients is of fundamental importance, since them exerts several prominent functions such as agglutination and make easier the tablets decomposition. However, the excipients must not interact chemically with the chemical therapeutic substance, since such interaction could exerts remarkable effects on the desired therapeutic properties[1,2].

In the present study, besides infrared spectroscopy and X-ray diffractometry, thermogravimetry (TG) and differential scanning calorimetry (DSC) are employed to analyze standard ascorbic acid samples as well as ascorbic acid tablets. Is demonstrated that TG and DSC can be successfully employed in the pharmaceutical industry as a routine technique to assure the quality of pharmaceutical formulations. Such information is of prominent importance to pharmaceutical industries.

EXPERIMENTAL

Standard ascorbic acid samples (Sigma), and ascorbic acid tablets (Shering do Brasil) were employed in the present study.

The thermogravimetric curves were obtained in the range 30-1200°C on a Shimadzu TGA-50) apparatus under nitrogen atmosphere. Samples of 4mg and a gas flow of 50cm^3 min^{-1} were employed, and a heating rates of 10°Cmin^1. The DSC curves were obtained in the range 30-500°C on a Shimadzu DSC-50H apparatus under nitrogen atmosphere, with a heating rate of 10°Cmin^{-1} and a gas flow of 50cm^3 min^{-1}.

The infrared spectra were obtained in KBr discs in the range 4000-400cm^{-1} by using a FTIR BOMEM apparatus model MB 102. The X-ray diffraction patterns (powder method) were obtained on a Phillips PW 1710 apparatus by using CuKa radiation. The obtained diffraction patterns were compared with standard ones[3].

RESULTS AND DISCUSSION

The obtained infrared spectra, X-ray diffraction patterns, TG and DSC curves are shown in Figures 1-4, respectively.

The obtained X-ray diffraction patterns for both, ascorbic acid standard samples and ascorbic acid tablets

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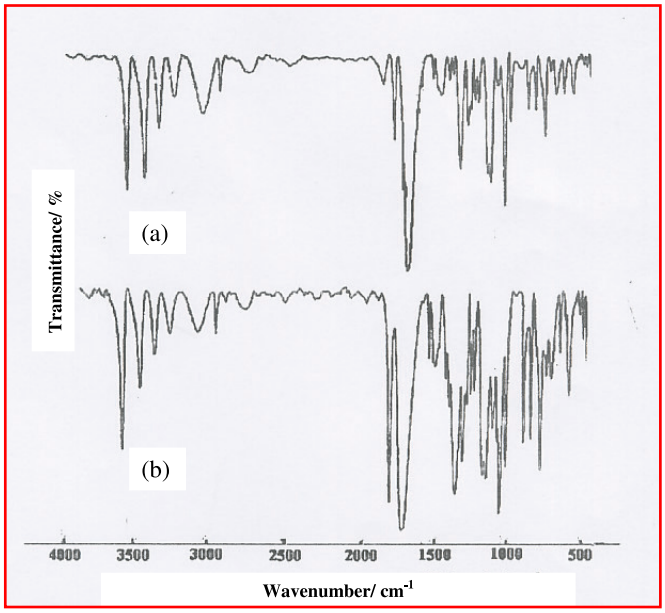

FIG. 1 - Infrared spectra for standard ascorbic acid sample (a) and ascorbic acid tablet (b).

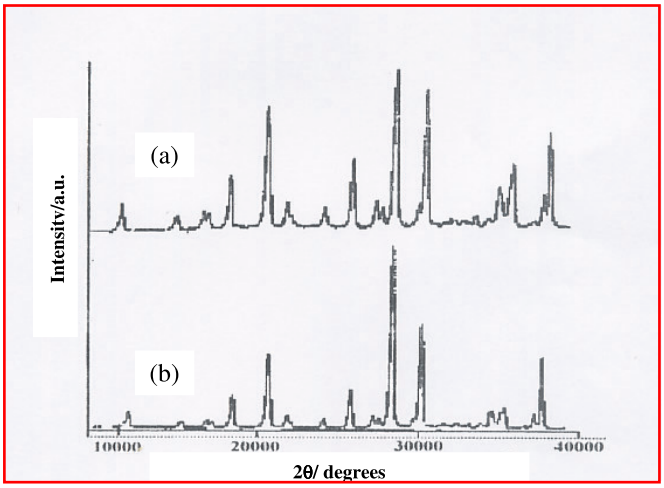

FIG. 2 - X-ray diffraction patterns for ascorbic acid sample (a) and ascorbic acid tablet (b).

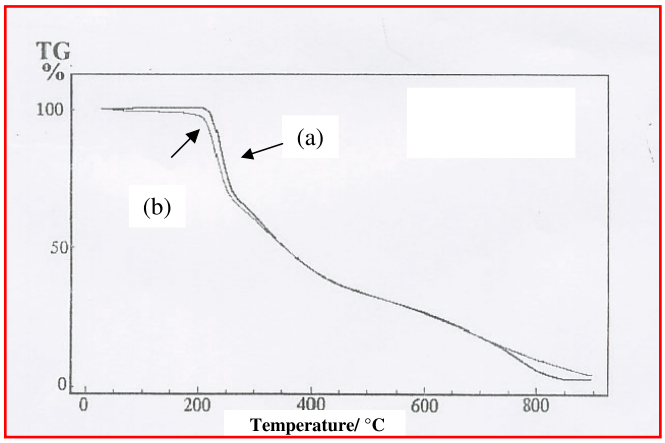

FIG. 3 - TG curves for ascorbic acid sample (a) and ascorbic acid tablet (b).

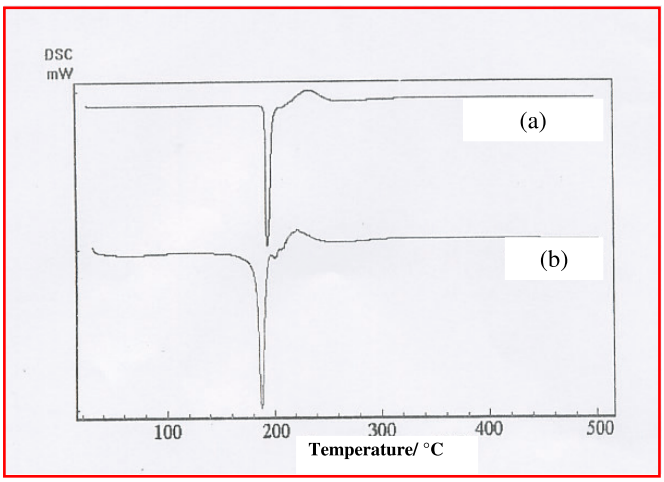

FIG. 4 - DSC curves for ascorbic acid sample (a) and ascorbic acid tablet (b).

are in agree with standard data for ascorbic acid[3]. In the X-ray pattern of the tablet only diffraction peaks due to ascorbic acid are observed. So, for the ascorbic acid tablet sample must be mentioned that the excipients used by Shering are aerosil (silicon dioxide, SiO_2) and talc (magnesium trisilicate, $2MgO.3SiO_2.xH_2O$). Aerosil is an amorphous substance and talc a crystalline one, as verified by inspection of the obtained X-ray patterns for those compounds (not shown). So, could be concluded that talc is present in such amount that its diffraction peaks are "lost" in the signal-to-noise ratio of the obtained diffraction patterns. So, can be concluded that X-ray diffractometry is not able to detect the presence the excipients in the tablets and so could not be employed neither for qualitative nor for quantitative determinations.

In the infrared spectrum of the ascorbic acid tablet an intense peak around $1050cm^{-1}$ associated with the n Si- O vibration mode is observed. Obviously, such peak is absent of the standard ascorbic acids sample. Since Si-O bonds are present in both, aerosil and talc, the presence of excipients was certainly detected. However, a quantitative deter mination based only on the intensity of the Si-O band is not reliable.

Comparing the TG and DSC curves obtained for the standard ascorbic acid and ascorbic acid tablets samples, can be verified that the excipients have decreased the melting point (from 193°C to 188°C, the first endothermic peak in the DSC curves) as well as the thermal stability (the second peak, an exothermic one, is associated with the thermal degradation) of

TABLE I
Thermogravimetric data for the degradation of standard ascorbic acid and ascorbic acid tablets. T_1, T_2 and T_p are the initial, final and "peak" temperatures for the thermal degradation process, respectively. Dm is the observed mass loss.

	T_1	T_2	T_p	/ %
Standard	220	262	240	33.8
	274	461	323	33.2
	466	845	772	33.0
Tablets	213	1000	231	35.5
			324	31.0
			704	27.4

ascorbic acid. Since the variation in the melting point is most easily perceived (the melting point of a pure substance is very sensitive to the presence of even very small amount of impurities) than the mass loss variation, DSC can be used to indicate the presence or absence of another substances in the ascorbic acid sample.

The TG data are summarized in Table I. As can be verified, for the standard sample a 100% mass loss is observed, whereas for the tablets 93.9 % mass loss is detected. The calculated difference, i.e. 6.1% can be attributed to the excipients. Hence, a quantitative determination can be performed.

CONCLUSION

The obtained experimental results show that thermogravimetry and differential scanning calorimetry can be successfully employed in the pharmaceutical industry as a routine technique to detect quantitatively the presence of excipients in ascorbic acid formulations. DSC is very sensitive to the presence of excipients, and TG is suitable for the quantitative determination, based on the final residues masses.

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