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Short Communication

Development of a quantitative FT-IR assay for the determination of a tackifier within the adhesive mass of a hydrocolloid patch*

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Introduction

Hydrocolloid adhesive dressings developed by Convatec have a wide range of applications in the management and treatment of ostomates and in patients with wounds and skin disorders. Hydrocolloid dressings are self-adhesive patches containing hydrophobic compounds such as an elastomer, an adhesive, a plasticizer and a tackifier in addition to the hydrophilic hydrocolloids gelatin, pectin and sodium carboxymethylcellulose (NaCMC) [1]. The hydrophobic components give the patch its adhesive and cohesive nature whereas the hydrocolloids provide the product with good water absorption properties.

In order to gain a clearer idea of the interactions, movement and stability of both the hydrophobic and hydrophilic components of the patch, a series of methods were developed. The hydrophilic components were assayed by conventional means such as chromatography or titration. However, assay of the hydrophobic components proved difficult by standard chromatographic or spectroscopic techniques. Fourier Transform-Infra Red (FT-IR) spectroscopy has become a routine technique in the Quality Control and Analytical laboratory for the identification of compounds [2]. More recently, this technique has been employed in the quantitative assay of a number of molecules in a variety of matrices [3–5], both alone and in combination with chromatographic techniques [6].

In the present study, a quantitative assay was developed for the analysis of the tackifier present in the Convatec hydrocolloid patch. The assay was subsequently employed in a stability study in order to assess any movement or degradation of the tackifier following storage under stressed temperature conditions.

Materials and Methods

Chemical and formulations

The solvents used were hexane (Fisons), methanol (Fisons) and deionized water. The standards employed in the study were tackfier (Convatec Ltd, Deeside, UK), degradation product 1 (acid) (Sigma, St Louis, MO), and degradation product 2 (alcohol) (Sigma). The formulations used were hydrocolloid adhesive patches (Convatec Ltd).

Instrumentation

Infra-red spectra were obtained with a Nicolet 5ZDX FT-IR instrument with Advantage software. Attenuated Total Reflectance (ATR) accessories included a trough base plate (45°) zinc selenide crystal (Specac) and a flat top assembly (45°) zinc selenide crystal (Specac). Scans were routinely performed from 4000–600 cm^{-1} at a scan rate of 100 min^{-1} (total number of scans = 10).

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Extraction of tackifier from hydrocolloid adhesive matrix

Extraction of the tackifier from the hydrocolloid adhesive matrix was performed as follows: the silicone release paper (SRP) was removed from a 4 × 4 cm sample and the matrix was weighed in a 30-ml scintillation vial. Hexane (10 ml) was added to disperse the adhesive matrix and the sample was sonicated for 30 min enabling recovery of the polyethylene backing material. The sample was subsequently centrifuged at 3000 rpm for 10 min and the resulting supernatant (2 ml) was analysed on the trough ATR with hexane as the background. The area of the peak corresponding to the β-keto ester linkage of the tackifier at 1735 cm^{-1} was quantitated employing Advantage software in the quantitative analysis mode and was integrated from 1746.6 to 1721.2 cm^{-1} with the baseline.

Analysis of the hydrocolloid patch

Direct analysis of the tackifier in the hydrocolloid adhesive matrix was achieved through the use of a flat top ATR system. The SRP was removed from a sample of adhesive (8 × 2 cm) and the patch was placed, adhesive side down, onto the zinc selenide crystal and subsequently analysed.

Results

Method validation

All quantitative analyses were performed on the peak in the spectrum at 1735 cm^{-1} that corresponded to the β-keto ester linkage of the tackifier. Quantitation was achieved by integrating the peak area between 1746.6 and 1721.1 cm^{-1} (Fig. 1).

Linearity. Samples for the linearity study were prepared in hexane at concentrations of 5–350 mg ml^{-1} tackifier and analysed on the trough ATR system. The assay exhibited good linearity with a correlation coefficient (r) = 0.9998 (Fig. 2).

Recovery. Recovery of the tackifier from the adhesive matrix was performed by spiking a patch of known weight which did not contain tackifier with the nominal amount of tackifier. Samples were subsequently extracted as described above and analysed on the trough ATR accessory. Mean recovery of the tackifier

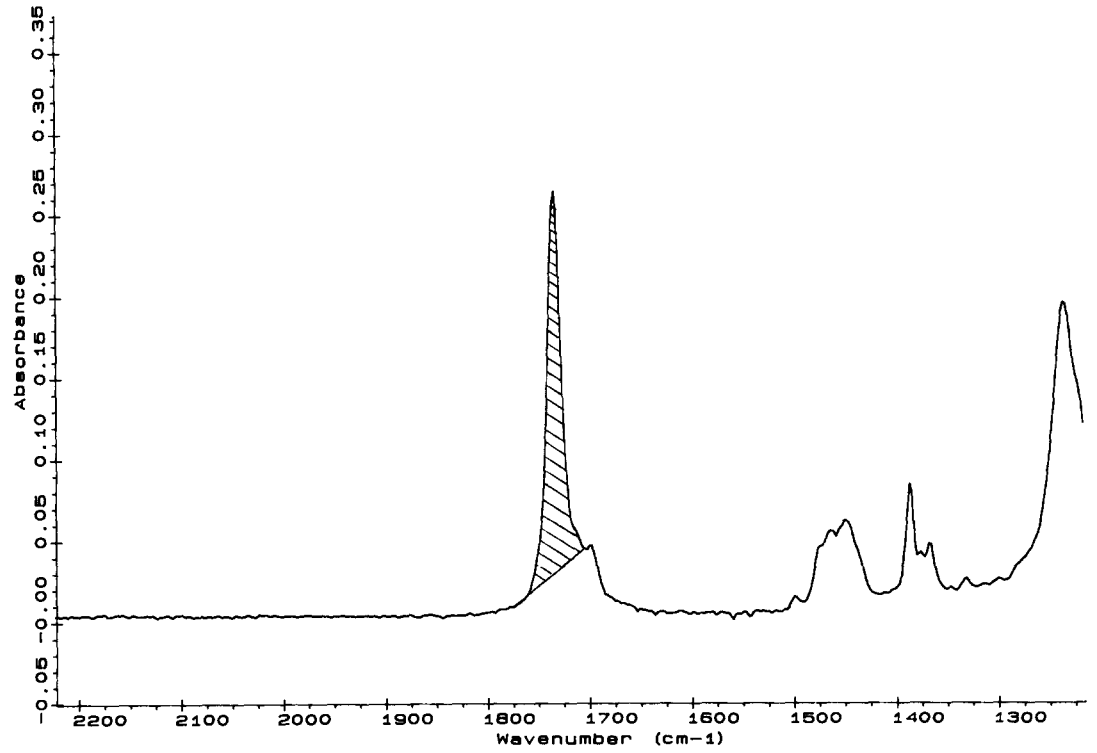

Figure 1
Quantitation of peak corresponding to the β-keto ester linkage of the tackifier. Hatched area indicates integration of the peak area from 1746.6 to 1721.1 cm^{-1}.

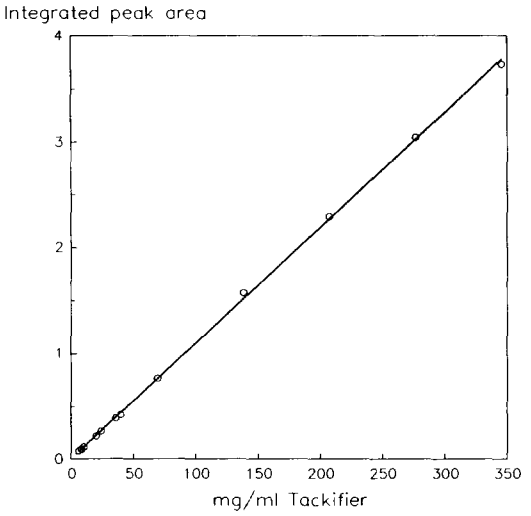

Figure 2
Linearity plot of the tackifier peak area vs concentration; correlation coefficient (r) = 0.9998.

from the adhesive matrix was 102.6% with an RSD of 1.23% (n = 9).

Precision. Precision of the assay was determined on 'real' samples of hydrocolloid dressings using the trough ATR system. Intra-patch and inter-patch precisions were calculated for ten samples and the RSD values were 2.46 and 4.42%, respectively (Table 1).

Specificity. Forced degradation studies were performed to assess the stability of the tackifier standard and to identify its main degradation products. Samples of the tackifier standard were subjected to heat, acid, base, light and oxidation, and samples were subsequently analysed by FT-IR. Two main degradation products (DP) were formed which corresponded to DP1, an acid, and DP2, an alcohol, obtained by forced degradation with light, base or oxidation. Both main degradation products were insoluble in hexane; DP1 was soluble in methanol and DP2 was soluble in aqueous solutions.

FT-IR analysis of the degradation products was achieved by dissolving part of the insoluble material in methanol, followed by analysis of a known volume of the methanolic sample using a KBr disk, and then dissolving the remaining insoluble material in water followed by analysis of a KBr disk. (Solvents and water were removed from KBr by heating to 100°C for 5 min.) Figure 3 shows the spectra obtained from the analysis of (A) the sample solvent, hexane; (B) DP1 (peak at 1703 cm^{-1} corresponding to the acid group); (C) DP2 (peak at 1014 cm^{-1} corresponding to the alcohol group); and (D) the tackifier standard. These spectra demonstrate that the method was specific for the tackifier with no interference from the possible contaminants. In addition, there was no interference from the other excipients in the hydrocolloid patch, as a blank patch (i.e. containing no tackifier) exhibited no peak at 1735 cm^{-1} (Fig. 4).

Table 1
Precision of assay
Intra-patch assay

Sample number	Response
1	0.2690
2	0.2599
3	0.2707
4	0.2733
5	0.2794
6	0.2683
7	0.2712
8	0.2639
9	0.2635
10	0.2804

SD = 6.6376×10^{-3}.
Mean = 0.2699.
RSD = 2.46%.
Precision of assay expressed as RSD of 10 'real' samples from a patch.
Response = integrated peak area divided by sample weight (g).

Inter-patch assay

Sample number	Response
1	0.2293
2	0.2276
3	0.2326
4	0.2252
5	0.2261
6	0.2251
7	0.2272
8	0.2444
9	0.2440
10	0.2495

SD = 0.0104.
Mean = 0.2351.
RSD = 4.42%.
Precision of assay expressed as RSD of 10 'real' samples.
Response = integrated peak area divided by sample weight (g).

Determination of movement of the tackifier on storage

Following validation, the method was employed in the analysis of hydrocolloid patches

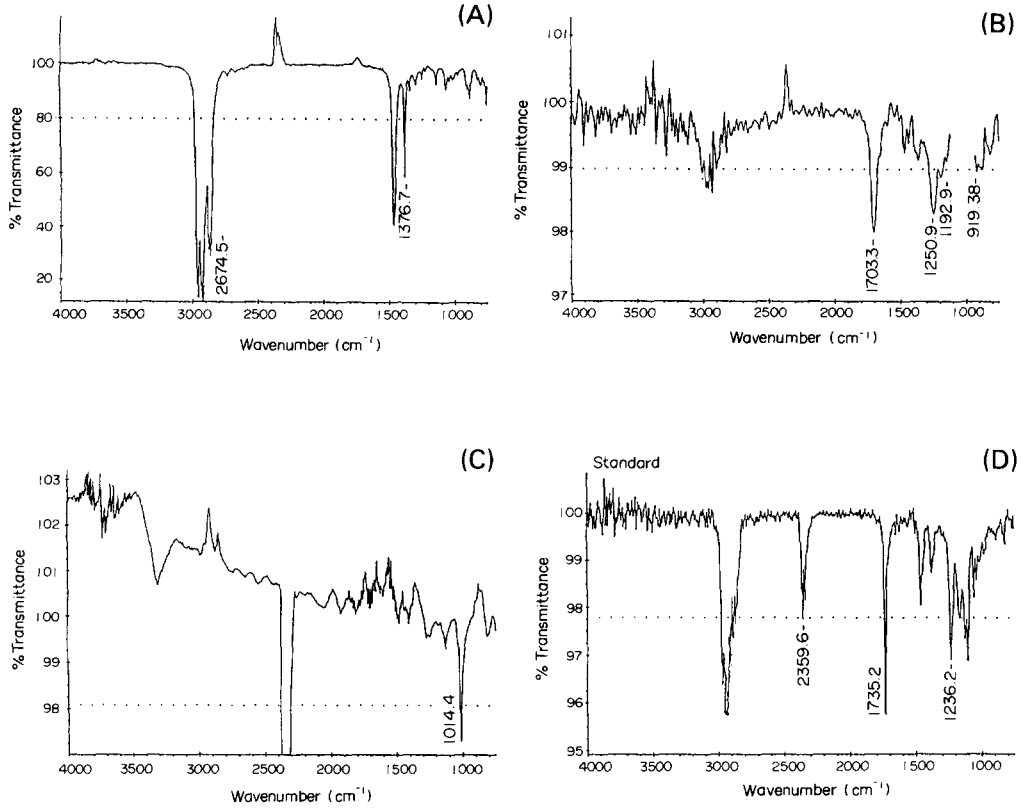

Figure 3
FT–IR spectra of (A) hexane (Trough ATR), (B) degradation product 1 (KBr disk), (C) degradation product 2 (KBr disk) and (D) tackifier (Trough ATR), demonstrating the assay to be specific with respect to possible degradation products or contaminants.

that had been stored under a variety of conditions. Table 2 shows the results of a study to investigate the effect of temperature and irradiation on the movement of tackifier within the adhesive matrix of a number of batches of hydrocolloid patches. As the flat-top ATR system beam penetrated the patch to a certain depth, assessment of any movement of the tackifier to the surface of the patch was possible.

These results showed that there was an increase in the peak area (1735 cm^{-1}) with increasing temperature and increasing irradiation level, suggesting in both cases a movement of tackifier to the surface of the patch. However, these results, in addition to physical tests, all remained within the initial specifications, indicating a slight but not significant change in the nature of the adhesive mass.

Table 2
Assay of tackifier in hydrocolloid patches demonstrating movement of tackifier on storage with increasing temperature and irradiation levels

Storage conditions	Integrated peak area
5°C	1.527
25°C	2.0731
32°C	2.2627
40°C	2.5491
40°C/75% RH	2.7856
Non-irradiated	2.5583
Irrad. at 2.5 Mrad	2.8916
Irrad. at 5 Mrad	2.9459

RH = relative humidity.

Conclusion

This report describes methodology that may be employed in the quantitative assay of a hydrophobic tackifier present in a hydrocolloid adhesive dressing. The assay was successfully validated and shown to be of use in the assessment of movement of the tackifier in the adhesive matrix. In the future, it may be employed as a test of tackifier stability upon storage.

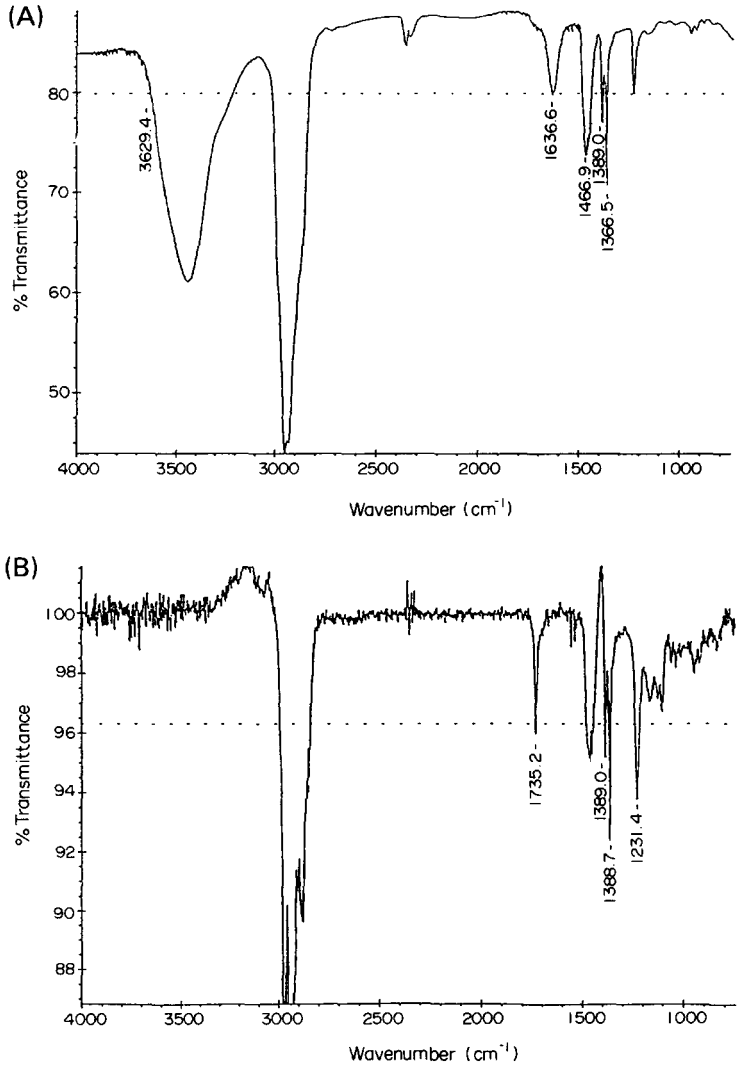

Figure 4
FT-IR spectra of (A) hydrocolloid patch blank containing no tackifier and (B) hydrocolloid patch, demonstrating no interferences from patch excipients (measurements achieved by flat-top ATR).

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