Extemporaneous Isoniazid Mixture: Stability Implications

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Published
2005

Journal Title
Journal of Pharmacy Practice and Research

DOI

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ABSTRACT

Background: Isoniazid mixtures are compounded in Australia using commercially available isoniazid tablets.

Aim: To determine the stability of isoniazid 10 mg/mL mixture compounded from commercially available isoniazid tablets.

Method: The stability of the compounded isoniazid mixture stored at a range of temperatures (4–60 ºC) was assessed with high-performance liquid chromatography. Differential scanning calorimetry was used to investigate the compatibility of isoniazid with the excipient, lactose.

Results: The compounded isoniazid mixture exhibited significant degradation (>10% after 3 days at 4 and 25 ºC), whereas the control (using isoniazid powder) retained desired stability (>90% at 30 days) under identical conditions. A replicate control formulation, spiked with lactose, produced statistically similar degradation profiles to that of the compounded isoniazid mixture (p > 0.05), indicating lactose to be responsible for the degradation of isoniazid. The thermoanalytical studies demonstrated an incompatibility between isoniazid and lactose (broadening and shifting of melting endotherm of isoniazid at 171.46 ºC).

Conclusion: The British Pharmaceutical Codex specifies the use of isoniazid powder for compounding isoniazid mixture. This study highlights the importance for stability evaluations on all modified extemporaneous preparations in order to ensure that quality pharmaceuticals are delivered to patients.

METHOD

Isoniazid (isonicotinic acid hydrazide) is an antimicrobial used for the treatment of tuberculosis in Australia.1 An isoniazid mixture is a useful formulation for children and in situations where tablets are unsuitable. Due to the unavailability of commercial isoniazid liquid formulations, a mixture is commonly prepared in pharmacy practice from tablets, more conveniently acquired than the raw material (powder). The British Pharmaceutical Codex recommends isoniazid powder for compounding isoniazid mixture.2 Although the incompatibility of isoniazid and lactose is well documented, the compounded isoniazid mixture (from commercially available tablets) has been prepared without considering the possible presence of lactose as an excipient in the tablets.3

Isoniazid is susceptible to hydrolysis and oxidation and interacts with excipients, particularly reducing sugars, to form hydrazones.4 The hydrazone formed by the reaction of isoniazid with lactose (pH 1.0–6.0) is 1-isonicotinoyl-2-lactosylhydrazine.2,3 There are also reported incompatibilities between lactose and other drugs containing a primary or secondary amine functional group, as is the case with isoniazid.4

Differential scanning calorimetry is a powerful tool in preformulation and stability studies for the rapid evaluation of the compatibility of active ingredients and excipients used in solid dosage forms.5 It is possible to derive information about potential physicochemical incompatibilities between active ingredients and tablet excipients. Differential scanning calorimetry can distinguish between excipients that are unlikely to cause problems and those that may cause problems in the formulation. It is valuable for its sensitivity and rapid response to identify incompatibilities in a very short time.6 However, to substantiate differential scanning calorimetry findings, other more direct and conclusive techniques have to be used.7

The aim of this study was to determine the stability of isoniazid 10 mg/mL mixture compounded from commercially available isoniazid tablets.

INTRODUCTION

Isoniazid (isonicotinic acid hydrazide) is an antimicrobial used for the treatment of tuberculosis in Australia.1 An isoniazid mixture is a useful formulation for children and in situations where tablets are unsuitable. Due to the unavailability of commercial isoniazid liquid formulations, a mixture is commonly prepared in pharmacy practice from tablets, more conveniently acquired than the raw material (powder). The British Pharmaceutical Codex recommends isoniazid powder for compounding isoniazid mixture.2 Although the incompatibility of isoniazid and lactose is well documented, the compounded isoniazid mixture (from commercially available tablets) has been prepared without considering the possible presence of lactose as an excipient in the tablets.3

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Standard error of means and percentage relative standard deviations were determined for representation of accuracy in the measurement. Statistical Package for Social Sciences was used for ANOVA analysis to determine the level of significance (p < 0.05) of results obtained. The time taken for the concentration of isoniazid to be reduced to 90% of the initial concentration was determined using a linear regression analysis.

RESULTS
A retention time of 1.5 ± 0.1 minutes was obtained and confirmed for isoniazid (method validated). Accuracy expressed as a per cent recovery of isoniazid was 99%, while precision was expressed as per cent coefficient of variation of the method which was 2.9% (n = 6). Linearity was confirmed over the concentration range used and was r² = 0.9998. Isoniazid peak purity was determined was confirmed over the concentration range used and was r² = 0.9998. Isoniazid peak purity was determined through spectral library comparison and peak purity determinations of the respective samples and standard solutions. The absence of co-eluting degradants and excipients was verified using a photodiode array detector; spectral similarities of above 0.999 for the pure and sample isoniazid peaks were achieved. Concentrations of samples were determined from respective peak areas in relation to constructed standard curves and then converted to a percentage of the initial isoniazid concentration. The expiration date was based on the time at which the 95% confidence interval intersects the line for 10% decomposition of isoniazid.

An increase in temperature did not result in a corresponding increase in the degradation of the compounded isoniazid mixture, with ≥ 10% degradation occurring at all temperatures after three days. Table 1 shows the percentage of isoniazid remaining in the mixtures stored at room temperature. The isoniazid mixture prepared from tablets exhibited significant degradation (71% remaining after 7 days). The control mixture, prepared from isoniazid powder, retained desired stability (over 90% remaining), substantiating the British Pharmaceutical Codex claim for the stability of this formulation. The replicate control mixture, spiked with lactose, produced statistically similar degradation profiles to that of the mixture made from isoniazid tablets (p > 0.05).

Table 1. Stability of isoniazid mixtures at room temperature

<table>
<thead>
<tr>
<th>Isoniazid mixture</th>
<th>Isoniazid remaining (%)</th>
<th>(10 μg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day 0</td>
<td>Day 3</td>
</tr>
<tr>
<td>Prepared from tablets</td>
<td>100</td>
<td>78</td>
</tr>
<tr>
<td>Prepared from powder</td>
<td>100</td>
<td>84</td>
</tr>
<tr>
<td>Prepared from powder 1: lactose powder</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Prepared from powder 2: lactose powder</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

*values reported as the mean (n = 6); variability around the mean < 5% relative standard deviation

The thermal behaviour of lactose shows the water content of lactose monohydrate to evolve at temperatures up to 160 ºC (an endothermic event corresponding to the dehydration reaction at 148 ºC), a small exothermic event due to crystalline transition in the range 171–181 ºC, and an endothermic peak corresponding to the melting point at 217.9 ºC followed by thermal decomposition. The differential scanning calorimetry curves of isoniazid and the isoniazid/lactose mixtures showed a broadening and shifting of the isoniazid melting endotherm from 171.46 ºC for pure isoniazid to 165.39–169.17 ºC demonstrating a concentration-dependent incompatibility between isoniazid and lactose. A smaller endothermic event (142–148 ºC) was observed in the isoniazid/lactose mixtures, corresponding to the dehydroxylation reaction of lactose.

Additional thermoanalytical studies were performed with binary mixtures (90:10) of isoniazid and the excipients, glucose, sucrose, lactose and microcrystalline cellulose (MCC) respectively. A similar broadening and shifting of the isoniazid melting endotherm at 171.46 ºC was seen for the sugars (glucose, sucrose, lactose). The isoniazid/MCC mixture showed no broadening and shifting of the characteristic endothermic event for isoniazid (171.09 ºC). MCC has shown to be a comparatively inert excipient and compatible with many drugs. 4,9,10–12 These results demonstrated that the incompatibility with lactose is not merely due to the accelerated nature of the test.

DISCUSSION
The British Pharmaceutical Codex formula for isoniazid mixture recommends isoniazid powder, however, due to ease of use and availability, isoniazid tablets have been used in practice. Isoniazid is unstable in the presence of sugars and degrades to hydrazine (a carcinogen) in liquid formulations at ambient temperatures. 4,5,7 A stability indicating HPLC assay was able to quantify isoniazid in the presence of its degradants and formulation excipients. Degradation of isoniazid in the compounded mixture proved to be ≥ 10% after three days of storage at 4 and 25 ºC, whereas the control mixture retained acceptable stability for up to 30 days suggesting an incompatibility with formulation excipients, also demonstrated in the solid state by the differential scanning calorimetry studies. This study highlights the importance for stability evaluations on all modified compounded preparations so that quality pharmaceuticals are delivered to patients.

Competing interests: None declared.

References

Submitted: December 2004
Accepted after external peer review: August 2005