Extemporaneous Isoniazid Mixture: Stability Implications

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Extemporaneous Isoniazid Mixture: Stability Implications
Alison Haywood, Martina Mangan, Gary Grant, Beverley Glass

ABSTRACT

Background: Isoniazid mixtures are compounded in Australia using commercially available isoniazid tablets. Isoniazid is susceptible to hydrolysis and oxidation and interacts with excipients, particularly reducing sugars, 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. 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.

Isoniazid is susceptible to hydrolysis and oxidation and interacts with excipients, particularly reducing sugars, to form hydrzones. The hydrazone formed by the reaction of isoniazid with lactose (pH 1.0–6.0) is 1-isonicotinoyl-2-lactosylhydrazine.2 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

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. 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.

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METHOD

Isoniazid 10 mg/mL mixtures were compounded according to the following formula: 20 x 100 mg tablets (Isoniazid BP, Fawns & McAllan Pty Ltd), 0.5 g citric acid, 2.4 g sodium citrate, 80 mL glycerol, 2 mL Compound Hydroxybenzoate Solution APF, purified water BP to 200 mL (chemicals from David Craig Galenicals). The control mixtures were compounded in a similar manner using isoniazid powder (Sigma Chemicals). A replicate control isoniazid mixture spiked with lactose (David Craig Galenicals) was also prepared. All samples were inspected for uniformity and colour prior to storage. Sample bottles (in duplicate) were stored, protected from light at 4 ± 1 °C, 25 ± 1 °C, 40 ± 1 °C, 50 ± 1 °C and 60 ± 1 °C. At the time of sampling, samples were shaken to allow for uniform distribution of the ingredients and 0.5 mL of sample and control solutions were analysed daily in triplicate for the isoniazid concentration from days 0 to 7.

A stability indicating high performance liquid chromatography (HPLC) assay was developed and validated (linearity, accuracy, precision, specificity) to quantify isoniazid in the presence of its degradants and formulation excipients. The HPLC system consisted of a ProStar 240 Solvent Delivery Module, ProStar 210 AutoSampler, ProStar 330 Photodiode Array Detector and Varian Star Chromatography Workstation software. A Varian C18 (5 mm, 150 x 4.60 mm) reverse-phase column with sodium acetate (Sigma Chemicals) buffer (pH 3.6) methanol (Sigma Chemicals) (50:50) as mobile phase and a detection wavelength of 260 nm was used. The flow rate was 1 ± 0.1 mL/min and the injection volume was 50 mL.

Binary mixtures of isoniazid and lactose were prepared by mechanical shaking to produce isoniazid-lactose mixtures in the ratios of 90:10, 80:20 and 70:30. Samples (5–10 mg) of isoniazid and lactose individually, as well as the respective isoniazid-lactose mixtures, were weighed and sealed in 40 mL aluminium crucibles with a pierced aluminium lid. Differential scanning calorimetry thermograms were obtained using a Mettler-Toledo STAR system and the DSC 822/700/1089 module (calibrated with indium). A constant heating rate of 10 °C/min was applied over a temperature range of 100–200 °C under dynamic nitrogen atmosphere (50 mL/min).
Standard error of means and percentage relative standard deviations were determined for representation of accuracy in the measurement. Statistical Package for the 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 \( r = 0.9998 \). Isoniazid peak purity was determined though 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% lower 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 (%) ( \pm % \text{SD} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day 0</td>
</tr>
<tr>
<td>Prepared from tablets</td>
<td>100</td>
</tr>
<tr>
<td>Prepared from powder</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 171.46 ºC followed by thermal decomposition.\(^4\)\(^5\)

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 dehydrogenation 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.\(^6\)\(^-\)\(^8\)\(^-\)\(^12\) 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.\(^2\)\(^-\)\(^3\)\(^,\)\(^13\) 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

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