tablets made from the 71 $\mu$m material, from 3 MN $m^{-2}$ at 100 MN $m^{-2}$ compaction pressure to 7·6 at 800 MN $m^{-2}$, subsequently falling to 6·9 at 1000 MN $m^{-2}$. Thicker tablets, weighing 1·0 g of the same material, had lower tensile strengths. So also did tablets made from the larger particle size material.

It thus seems that at about 110 $\mu$m particle size, the initial crystal size is such that intergranular scattering and flaw scattering are minimized over the whole pressure range at the 13 mm die diameter used here.

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## A stable free radical for the investigation of hydrogen abstraction reactions in aqueous solution

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A large number of biological and pharmaceutical reactions involve the abstraction of hydrogen, often as a primary step in the reaction sequence. An established method of examining hydrogen abstraction reactions is by use of a hydrogen-deficient, stable free radical, such as $\alpha,\alpha$-diphenyl-$\beta$-picrylhydrazyl (DPPH) (Dearden, 1971). However, the characteristics that bestow stability on a free radical generally tend also to bestow water-insolubility; whilst certain of the nitroxides are reasonably soluble in water, they are poor hydrogen abstractors.

In a search for a stable water-soluble free radical, we examined a number of ionic derivatives of DPPH, and found that the potassium salt of $\alpha,\alpha$-diphenyl-$\beta$-2,4-dinitro-6-sulphophenylhydrazyl (DDSH), first prepared by Ikrina & Matevosyan (1962), is reasonably stable in aqueous solution, and abstracts hydrogen readily from –OH, $-NH_2$ and >NH groups, but not in general from –COOH. We prepared the radical by sulphonation and subsequent nitration of *p*-chloronitrobenzene, followed by reaction with 2,2-diphenylhydrazine; treatment with lead dioxide then gave the free radical, which is deep purple in solution. The stability of DDSH in Clark and Lubs phosphate buffer is as follows:

| pH | % decrease in absorbance (525 nm) in 1 h |
|---|---|
| 5·6 | 0·7 |
| 6·5 | 0·6 |
| 7·4 | 0·8 |
| 8·6 | 1·1 |
| 9·8 | 1·9 |

These stabilities can be increased appreciably by de-gassing. The radical appears to be stable indefinitely in the solid form. The kinetics of hydrogen abstraction may be followed by either u.v. or e.s.r. spectroscopy. In the former case, a correction must be applied for absorption by the corresponding hydrazine formed as hydrogen abstraction proceeds, and a computer program has been written for this purpose.

We have so far investigated hydrogen abstraction from amino-acids and dipeptides in Clark and Lubs phosphate buffer (pH 7·4), and have obtained the following results: Glycine, $k = 0{\cdot}0048$ l $mol^{-1}s^{-1}$; L-alanine, $k = 0{\cdot}0025$ l $mol^{-1}s^{-1}$; L-proline, $k = 0{\cdot}015$ l $mol^{-1}s^{-1}$; glycylglycine, $k = 0{\cdot}031$ $l^2$ $mol^{-2}s^{-1}$; L-alanylglycine, $k = 0{\cdot}011$ $l^2$ $mol^{-2}s^{-1}$; glycyl-L-alanine, $k = 0{\cdot}024$ $l^2$ $mol^{-2}s^{-1}$; glycyl-L-proline, 0·023 l.$mol^{-1}s^{-1}$; L-alanyl-L-proline, 0·013 l $mol^{-1}s^{-1}$. The rate constants are clearly sensitive to changes in molecular structure, and may thus be explained in terms of electronic and steric effects within a molecule. In addition to its role in studies of reaction mechanisms, DDSH can also be used in quantitative analysis of pharmaceuticals (Papariello & Janish, 1965).

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