Effects of X-rays and Water Content on Sugars in Barley Seeds

L. Ehrnberg and M. Jaarma

Institute of Organic Chemistry and Biochemistry, University, Stockholm, Sweden

A n investigation of the influence of ionizing radiations on biochemical systems demonstrated that the relative concentrations of simple sugars in growing Vicia faba plants were strongly affected by chronic γ-irradiation. When resting (i.e., ripe) barley seeds are irradiated, their radiosensitivity was found to decrease with increasing water content. Since the concentration of reducing sugars has been shown to increase with increasing moisture content, we found it important to investigate possible relations between sugar content and radiation sensitivity. Under certain conditions glucose may act as a protective agent.

Methods. Seeds of the two-rowed barley strain, Bonus, were treated for 6 days with streaming air of the relative humidities 0 % and 90 %. This treatment gave samples containing 7.5 % and 17 % H₂O, respectively. The seeds were irradiated with 175 kV unfiltered X-rays at an intensity of 4 000 r min⁻¹. Analysis of reducing sugars was made 15 hours after irradiation, and again after 2—4 weeks' storage at a constant water content and at 20°C.

For the analysis the material was ground twice in a Wiley mill, using first a 20-mesh, then a 40-mesh sieve. The grist was boiled for 3 min. in 80% ethanol, and thereafter extracted, with the same solvent, for 3 hours in a micro-Soxhlet apparatus. (Using 96% ethanol instead, only about two thirds of the sugars were extracted by the same procedure.) After deproteoinizing, reducing sugars were titrated, with an accuracy of 2 %, according to Somogyi. The maximum variation between individual extractions amounted to 5 %.

Results. It was demonstrated (Table 1) that in the unirradiated material the in-
Table 1. Content of reducing sugars (mg glucose/g dry weight) after irradiation and storage at different water contents.

<table>
<thead>
<tr>
<th>Water content</th>
<th>Analysis after</th>
<th>Seeds irradiated with, r</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5</td>
<td>15 hours</td>
<td>0.5 x 10^6</td>
</tr>
<tr>
<td></td>
<td>4 weeks</td>
<td>1.51</td>
</tr>
<tr>
<td>17</td>
<td>15 hours</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>4 weeks</td>
<td>1.92</td>
</tr>
<tr>
<td>17 *</td>
<td>2 weeks</td>
<td>1.98</td>
</tr>
</tbody>
</table>

* Experiment not simultaneous with those above.

crease of the water content first caused a fall in reducing sugars, possibly a consequence of the increased respiration.* During 3-4 weeks storage, at unchanged water content, the value increases, possibly becoming slightly higher at the higher water content.

Irradiation with 5 x 10^4 r increases the content of reducing sugars, especially at the higher water content. (10 x 10^4 r gives a somewhat lesser chemical change. After treatment with this high dose, a fraction of the seeds do not germinate; and death of seeds might therefore be responsible for any disturbed values.) As this increase is already observed immediately after irradiation, it is probably not an effect of a changed metabolic rate (e.g., decrease of respiration rate*). It might be ascribed to a radiation induced disintegration of, e.g., starch. If this is so, intermediates originating from cellular constituents other than carbohydrates and water, obviously play a role, as the disintegration of starch, irradiated at 8-23 % H_2O, was only measurable as viscosity decrease.

It can be concluded that irradiation causes a greater chemical change in sugars when the seeds have a higher moisture content, and consequently are protected against biological damage. The significance of this result, for the interpretation of the mechanism of action of radiations, will be discussed elsewhere.*


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The States I of Trivalent Prasodymium and Thulium
CHR. KLIQBULL JORGENSEN
Chemistry Department A. Technical University of Denmark, Copenhagen, Denmark

The identification by Spedding¹ of the states of Pr³⁺ has for many years been assumed to be complete. But the proposal of Ellis² that the band in the orange is due to a transition to ¹D, rather than to ¹S, was recently supported by the crystal field studies of Hellwege³. The Condon-Shortley theory⁴ was applied to this F²-system by Treffitz⁵. This author calculated the electrostatic interaction parameters F₁, F₄, and F₆ for a hydrogen-like 4f-wave function with an effective charge Zₑ = 9.48 (this seems very reasonable, because the ionization energy of Co³⁺ corresponds to Zₑ = 6.58). However, the value of F₆ calculated by Treffitz is 48 times too small due to a misinterpretation of Condon and Shortley's decimal point as a multiplication operator. This led Treffitz to accept Spedding's very small value of F₆.

In the author's opinion⁶, F₆ is not necessarily negligible⁷-⁸. The position of ¹D, relatively to ³P, can easily be accounted for by the set of ratios F₄ = 0.2 F₆ and F₆ =

* Note added in proof: Judd¹¹ has recently drawn the same conclusion from Eu²⁺. The present author must here correct the highest value among the three diagonal elements of energy of the ¹D-states to 9E⁵ = 11E⁵ rather than 9E¹ + 7E³, given in Ref. 8, p. 19.

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