Biodegradable IDHA chelates

High quality fertilizers for foliar application and fertigation:
- environmentally friendly
- fully biodegradable
- unique microgranule formulation

- Fe IDHA
- Mn IDHA
- Zn IDHA
- Cu IDHA
- IDHA compounds
- IDHA blends
Chelating agents are used in a variety of applications including detergents, agricultural nutrients, industrial cleaners, paper industry and photography. In agriculture chelated micronutrients prevent, correct and minimize deficiencies, thus increase yield and efficiency. Well known standard EDTA is a complexing agent able to maintain Fe and other micronutrients in solution so it is usually applied in agronomic conditions where iron and other micronutrients are expected to reduce significantly production.

However the concern on the use of EDTA as a recalcitrant chemical is rising. Commonly used chelating agents such as EDTA or DTPA are poorly biodegradable, accumulate in the environment and have been detected in the surface waters of rivers, lakes, soils and in water treatment processes. That is the reason why the new biodegradable chelating agent IDHA (imino-disuccinate) have been developed.

**Introduction**

**IDHA – readily biodegradable chelates, a new, environmentally friendly alternative to classic chelating agents**

ADOB company in cooperation with Bayer AG has developed a process to produce readily biodegradable chelates (IDHA-brand) that are applied in agriculture and horticulture as foliar sprays, in soil application as well as in hydroponics and fertigation.

From the chemical point of view IDHA (also known as IDS Na-salt) is D,L-Aspartic acid N-(1,2-dicarboxyethyl) tetratosodium salt – a pentadentate ligand, which forms octahedral structure with metal ions as presented (Figure 1).

This agent is a non-toxic, and non-polluting alternative to other chelating agents and there are no gaseous or waste products that can pollute water or the atmosphere.

![Figure 1. D,L-Aspartic acid, N-(1,2-dicarboxyethyl) tetratosodium salt iron (III) complex](image-url)
The reaction between the D,L-Aspartic acid, N-(1,2-dicarboxyethyl) tetrasodium salt anion IDHA\(^{m-}\) and a metal cation Me\(^{n+}\) is a reversible one and forms 1:1 complex acc. to the equation:

\[
\text{IDHA}^{m-} + \text{Me}^{n+} = \text{IDHA} \text{Me}^{(m-n)-}
\]

The stability constant for this complex is given by:

\[
K_{\text{IDHAME}} = \frac{[\text{IDHA Me}^{(m-n)-}]}{[\text{IDHA}^m] [\text{Me}^n]}
\]

IDHA is able to complex iron and other micronutrient presenting five bonds with the metal, so the stability of the complexes is lower than the one formed with EDTA. The pH values show that IDHA complexes are of moderate strength (table 1), however, enabling the application of micronutrients to the plants in the most available form.

<table>
<thead>
<tr>
<th>chelate</th>
<th>molecular weight</th>
<th>stability constant</th>
<th>biodegradation</th>
<th>pH range of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDHA</td>
<td>249</td>
<td>(10^{-16})</td>
<td>yes</td>
<td>moderate</td>
</tr>
<tr>
<td>EDTA</td>
<td>292</td>
<td>(10^{-25})</td>
<td>no</td>
<td>moderate</td>
</tr>
<tr>
<td>DTPA</td>
<td>393</td>
<td>(10^{-29})</td>
<td>no</td>
<td>moderate</td>
</tr>
<tr>
<td>EDDHA</td>
<td>394</td>
<td>(10^{-33})</td>
<td>no</td>
<td>wide</td>
</tr>
</tbody>
</table>

**Biodegradation of micronutrient chelates**

EDTA and other commonly used complexing agents accumulate in the environment simply because they are resistant to decomposition by bacteria. Biodegradation tests were carried out acc. to OECD directive 301E, using different commercial iron chelates (EDTA, DTPA, EDDHA), which are applied in agriculture. The degree of biodegradation was calculated by means of comparison with the concentration initially present. Figure 2 shows the biodegradation of different chelating agents and indicates that Fe IDHA chelate is the only one which is biodegradable.

**Figure 2. Biodegradation (%) of Fe IDHA chelate in comparison with other iron chelates**
## Products

### Table 2. IDHA biodegradable chelates in solid form

<table>
<thead>
<tr>
<th></th>
<th>Fe IDHA</th>
<th>Mn IDHA</th>
<th>Zn IDHA</th>
<th>Cu IDHA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration</td>
<td>9%</td>
<td>9%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>N-NO₃</td>
<td>3.5%</td>
<td>4.5%</td>
<td>4.5%</td>
<td>4.5%</td>
</tr>
<tr>
<td>pH of 1% water solution</td>
<td>6.0</td>
<td>9.5</td>
<td>8.0</td>
<td>9.0</td>
</tr>
<tr>
<td>pH of 0.1% water solution</td>
<td>6.5</td>
<td>9.0</td>
<td>8.5</td>
<td>9.5</td>
</tr>
<tr>
<td>Conductivity of 1% water sol. at 20°C</td>
<td>6.1 mS/cm</td>
<td>6.2 mS/cm</td>
<td>5.9 mS/cm</td>
<td>6.4 mS/cm</td>
</tr>
<tr>
<td>Conductivity of 0.1% water sol. at 20°C</td>
<td>0.73 mS/cm</td>
<td>0.75 mS/cm</td>
<td>0.70 mS/cm</td>
<td>0.75 mS/cm</td>
</tr>
</tbody>
</table>

PACKING OPTIONS: 1 kg, 3 kg, 15 kg, 25 kg bags and 1000 kg big bags

### Table 3. IDHA biodegradable chelates in liquid form

<table>
<thead>
<tr>
<th></th>
<th>Fe IDHA</th>
<th>Zn IDHA</th>
<th>Cu IDHA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration v/v</td>
<td>5%</td>
<td>6%</td>
<td>6.0%</td>
</tr>
<tr>
<td>N-NO₃</td>
<td>1.6%</td>
<td>2.5%</td>
<td>2.7%</td>
</tr>
<tr>
<td>pH</td>
<td>6.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Conductivity of 1% water sol. at 20°C</td>
<td>3.9 mS/cm</td>
<td>4.0 mS/cm</td>
<td>4.0 mS/cm</td>
</tr>
<tr>
<td>Conductivity of 0.1% water sol. at 20°C</td>
<td>0.43 mS/cm</td>
<td>0.44 mS/cm</td>
<td>0.46 mS/cm</td>
</tr>
<tr>
<td>Density</td>
<td>1.30 g/cm³</td>
<td>1.33 g/cm³</td>
<td>1.33 g/cm³</td>
</tr>
</tbody>
</table>

PACKING OPTIONS: 10 L, 20 L jerry cans and 1000 L IBC
Other products within the IDHA range

Apart from single microelements both in the solid and liquid forms, our offer includes also tailor-made physical blends and chemically produced compounds based on IDHA chelates. Both of them can be prepared according to a customer’s requirements and can also contain molybdenum, boron, magnesium or sulphur if required.

Table 4. Examples of IDHA blends and compounds

<table>
<thead>
<tr>
<th>micronutrient concentration</th>
<th>micro blend 1</th>
<th>micro blend 2</th>
<th>micro compound 1</th>
<th>micro compound 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe – 5.3%</td>
<td>Fe – 3.2%</td>
<td>Fe – 5.0%</td>
<td>Fe – 4.0%</td>
<td></td>
</tr>
<tr>
<td>Mn – 2.5%</td>
<td>Mn – 2.2%</td>
<td>Mn – 1.7%</td>
<td>Mn – 3.0%</td>
<td></td>
</tr>
<tr>
<td>Zn – 0.5%</td>
<td>Zn – 2.1%</td>
<td>Zn – 1.7%</td>
<td>Zn – 1.5%</td>
<td></td>
</tr>
<tr>
<td>Cu – 0.2%</td>
<td>Cu – 0.2%</td>
<td>Cu – 0.8%</td>
<td>Cu – 0.5%</td>
<td></td>
</tr>
<tr>
<td>Mo – 0.22%</td>
<td>B – 1.0%</td>
<td>Mo – 0.08%</td>
<td>Mo – 0.13%</td>
<td></td>
</tr>
<tr>
<td>B – 0.45%</td>
<td>MgO – 2.1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S – 2.7%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| N-NO₃                        | 3.7%          | 3.4%          | 2.0%            | 2.4%            |
| pH of 1% water solution      | 7.0           | 7.0           | 5.5             | 5.5             |
| pH of 0.1% water solution    | 7.0           | 7.0           | 5.5             | 5.5             |
| bulk density                 | 0.85 g/cm³    | 0.85 g/cm³    | 0.85 g/cm³      | 0.85 g/cm³      |
| conductivity of 0.1% sol. at 20°C | 0.7 mS/cm   | 0.7 mS/cm    | 0.73 mS/cm      | 0.72 mS/cm      |

PACKING OPTIONS: 1 kg, 3 kg, 5 kg and 25 kg bags as well as 1000 kg big bags.
The efficiency of IDHA in comparison to EDTA chelates was tested on several crops grown in greenhouse and open field conditions. Generally, the results of studies and trials showed a very good response of all plants to IDHA application. The use of IDHA resulted not only in high Fe concentration in leaves, (as shown in Figure 3, 4 and 5 for cucumber, soybean and tomato) but also in better plant biomass productivity (Figure 5 and 6). An application of highly efficient IDHA provides micronutrient to plants on optimum level, according to plants’ needs.

Therefore, the yield harvested from IDHA treated plants could be as high as from the EDTA ones (Figure 8) or significantly higher, as ashown for soybean (Figure 9). Additionally, plants treated with EDTA chelate are usually more susceptible to injuries resulting from stress conditions (fungus infections, warm weather) than those treated with IDHA (Figure 10).

**Figure 3. Effect of Fe-chelate application on Fe concentration in cucumber (Cucumis sativus L.) leaves.**

**Figure 4. Effect of Fe-chelate application on Fe concentration in soybean (Glycine max L. Merr) leaves.**

**Figure 5. Effect of micronutrient chelate application on Fe concentration in tomato (Lycopersicon esculentum L.) leaves.**

**Figure 6. Effect of Fe-chelate application on cucumber (Cucumis sativus L.) plant fresh weight.**
on soybean \((Glycine\ max\ L.\ Merr)\) plant fresh weight.

Figure 8. Effect of micronutrient chelate application on tomato \((Lycopersicon\ esculentum\ L.)\) total yield.

Figure 9. Relative effect of IDHA treatment on green bean \((Phaseolus\ vulgaris\ L.)\) yield parameters compared to EDTA application (100%).

IDHA chelate application by foliar spraying or/and fertigation supplies plants with micronutrients the level which fulfills plant requirements. This results in high yield of excellent quality and good condition of the crop. Therefore, IDHA chelates are a valuable alternative to other chelates available on the market.

Figure 7. Effect of Fe-chelate application on soybean \((Glycine\ max\ L.\ Merr)\) plant fresh weight.

Figure 10. Green bean plants treated with IDHA are more resistant to stress conditions then those treated with EDTA chelate.
Fertilizers offered by ADOB

### STRAIGHT SOLUBLE GRADE FERTILIZERS

**CALCIUM NITRATE AND DERIVATIVES**
- Calcium nitrate
- Calmag
- Calmag Fe
- Calmag Zn
- Calciplus
- Calcibor

**MAGNESIUM NITRATE AND DERIVATIVES**
- Magnesium nitrate
- Magboron
- Magzinc
- Magplus
- Magnesium sulphate

### MULTICOMPONENT MACROELEMENT FERTILIZERS WITH MICROELEMENTS

**LIQUID**
- **FOLIAR APPLIED**
  - Azosol® 36 Extra
  - Azosol® 34
  - Azosol® 6-12-6
  - Azosol® 12-4-6+S+amino

- **FOR ROW PLACEMENT**
  - ADOB® SB-2
  - ADOB® MA
  - ADOB® PO
  - ADOB® OR

**CRISTALLINE**
- **WATER SOLUBLE NPKs WITH MICRO**
  - FOR FOLIAR APPLICATION AND FERTIGATION
    - NPK Foliar 18+18+18+micro
    - NPK Foliar 4+12+38+micro
    - NPK Foliar 10+40+8+micro
    - NPK Foliar 4+12+38+micro

### MICROELEMENT FERTILIZERS

**STANDARD EDTA CHELATES**
- Fe EDTA
- Mn EDTA
- Zn EDTA
- Cu EDTA
- EDTA compounds and blends

**BIODEGRADABLE IDHA CHELATES**
- Fe IDHA
- Mn IDHA
- Zn IDHA
- Cu IDHA
- IDHA compounds and blends

**DTPA CHELATES**
- Fe DTPA

**HBED CHELATES**
- Fe HBED

**OTHER MICROELEMENT FERTILIZERS**
- ADOB® Mn
- ADOB® Zn
- ADOB® Mo
- ADOB® B
- ADOB® Cu
- ADOB® Fe