Ferrous bisglycinate
Also known as ferrous glycinate, ferrous bisglycinate chelate, bis-glycino iron II, and bisglycino-iron (II)chelate. (R. Anton et al 2006)

1. Clinical trials referenced for bioavailability and side effects

STUDIES SHOWING BIOAVAILABILITY LESS THAN SULFATE

(Patil 2013) - study outlined in carbonyl section

My summary
Bisglycinate showed about the same effectiveness as carbonyl but slightly less than ferrous fumarate (Hb the same but ferritin down at about 87% of fumarate). Side effects were better than fumarate and about the same as carbonyl. Not sure what food was affecting it.

STUDIES SHOWING BIOAVAILABILITY SAME AS SULFATE

(Duque-Lopez et al. 2014)
A double blind study of 200 children with low iron but not anemic were given either ferrous sulfate or bisglycinate chelate iron (30 mg of elemental iron plus 100μg of folic acid) every day for 12 weeks. Hb and ferritin measured a week after and 6 months later. They all ate similar foods as they were boarding school students at the same school.

Result
Iron levels and hemoglobin were the same in both, however ferritin concentration was better with bisglycinate after 6 months. They conclude that they are both equally good.

![Graph showing ferritin concentration over time with data points for ferrous sulfate and bisglycinate chelate.]

There was no statistical difference of side effects between sulfate and bisglycinate.

My summary
Quite a detailed study. Showed that both forms were about the same. Bisglycinate did have a notable increase in ferritin at 6 months which is an important indicator. Not much side effects for either supplements, though. As noted by the author, probably due to the low dose of 30mg.
(Milman et al. 2013)
I couldn’t access the full study of this one but from abstract: 80 pregnant women given either 25 mg bisglycinate or 50mg sulfate /day. Usual markers were taken a couple of times throughout pregnancy

results
No significant difference between the two despite the half dose of bisglycinate. Gastro side effects were lower in bisglycinate but not mentioned by how much.

my summary
Bisglycinate was as effective as sulfate, could be considered more effective seeing as it was half dose. No mention of food it was taken with.

(Olivares et al. 1997)
The study involved two groups of 14 women testing the absorption of bisglycinate or ferrous ascorbate. Used a double-isotopic method and given either in a water solution or milk solution, or with milk and ascorb. Small doses of 3mg iron and no other food given within 4 hours either side.

results
The absorption of each wasn’t statistically different (34.6% bisglycinate and 29.9% ferrous ascorbate). The absorption of bisglycinate was reduced to 8.3% when taken with milk, and 10.7% with milk and ascorbic acid. Standardised against ferrous ascorbate being 40% (which they say is the bioavailability of ascorbate for anemic patients), then bisglycinate comes out at 46.3% with water, 11.1% with milk, and with 15.4% with ascorbic acid and milk. They didn’t test ferrous ascorbate with milk but they reference another study (Stekel et al. 1986) and claim their result of bisglycinate with milk was 2 to 2.5-fold higher than the Stekat one of 4% bioavailability of cow’s milk fortified with ferrous sulfate.

my summary
Good in the it clearly separated the supplement from any food they weren’t testing. From this study it seems that bisglycinate has the same bioavailability as ferrous ascorbate. A fairly high bioavailability of 34.6% in anemic patients. It was given in soluble form and in quite small doses. Ferrous ascorbate is a ferrous salt with ascorbic acid, so it should be more bioavailable than just sulfate, so hard to say hour FeBS stacks up against sulfate. Somewhere between the same and better.
Milk is a big inhibitor and ascorbic an enhancer. Possibly inhibited by milk less than sulfate but not conclusive.

(Fox, Eagles, and Fairweather-Tait 1998)
Infants were given meals with isotope labeled iron given as either bisglycinate iron or sulfate both. The sulfate dose was also give with ascorbic acid.

results
no difference in the efficiency of either forms both in a vegetable puree (around 9% for both) or a high-phytate cereal (5.2% for iron glycine and 3.8% for ferrous sulfate. not statistically significant).
Iron glycine used - so a different amino acid chelate to FeBC but pretty similar. Because it is only bonded with one glycine though, maybe it doesn’t stop the inhibitors as well as FeBC.

The sulfate had some ascorbic added to it during the preparation which could have given it an advantage. The study indicates that bisglycinate has the same bioavailability as sulfate. Slightly less affected by inhibitors but not statistically significant.

**STUDIES SHOWING BIOAVAILABILITY MORE THAN SULFATE**

*(Sc et al. 2001)*

145 pregnant women were given either 15mg Bis-glycinate or 40mg Sulfate per day. No mention of what it was taken with except they say sulfate recommended to be taken alone and that bis-glycinate can be taken with food. A big drop out of patients in the sulfate group so sample size for that one ended a lot less.

**Results**

<table>
<thead>
<tr>
<th>Gestational age</th>
<th>Hemoglobin, g/dL</th>
<th>Serum ferritin in g/L</th>
<th>Transferrin saturation %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FeSO₄</td>
<td>FeAAC</td>
<td>FeSO₄</td>
</tr>
<tr>
<td>&lt;20 weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean ± s.d</td>
<td>12.3 ± 1.09</td>
<td>12.6±1.00 b</td>
<td>41.7±34.20</td>
</tr>
<tr>
<td>(N)</td>
<td>(23)</td>
<td>(14)</td>
<td>(21)</td>
</tr>
<tr>
<td>20-29 weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean ± s.d</td>
<td>11.4 ± 0.73 ad</td>
<td>11.9±0.70 b</td>
<td>17.7±10.50</td>
</tr>
<tr>
<td>(N)</td>
<td>(40)</td>
<td>(14)</td>
<td>(22)</td>
</tr>
<tr>
<td>30 weeks or</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean ± s.d</td>
<td>11.6 ± 1.27</td>
<td>12.2±1.02</td>
<td>10.7±8.14</td>
</tr>
<tr>
<td>(N)</td>
<td>(23)</td>
<td>(14)</td>
<td>(17)</td>
</tr>
<tr>
<td>More</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean ± s.d</td>
<td>11.1 ± 1.27</td>
<td>12.1±1.02</td>
<td>10.6±8.14</td>
</tr>
<tr>
<td>(N)</td>
<td>(23)</td>
<td>(14)</td>
<td>(17)</td>
</tr>
</tbody>
</table>
*FeAAC = Ferrochel
Despite the lower dose, transferrin saturation was better with ferrochel, and while serrum ferritin dropped for both (due to pregnancy), it dropped less with ferrochel.
"Iron depletion found in 30.8% of women on Ferrochel and 54.5% of women on Sulfate"

side effects

![Table 3]

Double the amount of people stopped treatment in the sulfate group to gastro side effects.

My summary

A big drop off in patients during the trial, and they also mention lots of results getting lost at the lab. From their results it appears **Ferrochel was more effective** despite the smaller dose. Hard to say by how much or how much food influenced the result, but it was a much smaller dose of Ferrochel. For side effects, Ferrochel seemed to have **half** but they only reported drop out rates not incidents and there are other factors involved in a dropout decision.

*(Bovell-Benjamin, Viteri, and Allen 2000)*

Contains a few studies, but the one that is of interest involves 10 non anemic or iron deficient men. Labeled bisglycinate and sulfate taken with maize porridge was compared in the same person.

results

"the average iron absorption from bisglycinate was 4.7 times greater than that from ferrous sulfate (6.4 and 1.3%, respectively; P < 0.05)."
My summary

A small sample size, but they labeled the iron. They weren’t iron deficient subjects, so low bioavailability all round. Shows that bisglycinate is **less affected by maize porridge** (phytate + milk) than sulfate - by about 4.7x. Their conclusion about bisglycinate not exchanging with iron from maize or ferrous sulfate in the intestinal pool I’m not sure about. I read in another study that this conclusion can’t be drawn from this study.

(Ma W.Q et al. 2013)

Study compares iron glycine chelate (Fe-Gly) with ferrous sulfate in Caco-2 cells.

My summary

Fe-Gly tested not FeBC though they seem similar. Seems to look at permeability and transport rates rather than bioavailability so hard to compare. Fe-Gly had better of both though, which they imply has effects on bioavailability

SIDE EFFECT STUDIES

(Coplin et al. 1991) – only accessed the abstract
Study of 38 women given 50mg of either bisglycinate or sulfate every morning before breakfast for two weeks. Just studied side effects.
Moderate-to-severe side effects: 37% sulfate, 21% bisglycinate

(Melamed et al. 2007)
453 pregnant women were surveyed on the side effects of their supplement in the 2nd and 3rd trimester.

<table>
<thead>
<tr>
<th>Preparation</th>
<th>N</th>
<th>Abdominal pain</th>
<th>Vomiting</th>
<th>Constipation</th>
<th>Diarrhea</th>
<th>Dyspepsia</th>
<th>Any</th>
<th>Discontinued</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrous fumarate</td>
<td>56</td>
<td>5 (8.9)</td>
<td>2 (3.6)</td>
<td>2 (3.6)</td>
<td>16 (28.6)</td>
<td>3 (5.4)</td>
<td>1 (1.8)</td>
<td>22 (39.3)</td>
</tr>
<tr>
<td>Ferrous sulfate (IR)</td>
<td>174</td>
<td>38.4*</td>
<td>6 (3.4)</td>
<td>57 (32.8%)</td>
<td>14 (8.0)</td>
<td>10 (5.7)</td>
<td>98 (56.3)</td>
<td>34 (19.5)</td>
</tr>
<tr>
<td>Ferrous sulfate (SR)</td>
<td>54</td>
<td>9 (17.2)</td>
<td>2 (3.7)</td>
<td>13 (24.1)</td>
<td>4 (7.0)</td>
<td>6 (11.1)</td>
<td>6 (11.1)</td>
<td>12 (22.2)</td>
</tr>
<tr>
<td>Multivitamin with ferrous fumarate</td>
<td>38</td>
<td>8.4</td>
<td>2 (5.3)</td>
<td>1 (2.6)</td>
<td>1 (2.6)</td>
<td>1 (2.6)</td>
<td>9 (23.7)</td>
<td>4 (10.5)**</td>
</tr>
<tr>
<td>Ferrous bisglycinate</td>
<td>33</td>
<td>7.3</td>
<td>2 (6.1)</td>
<td>6 (18.2)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>7 (21.2)</td>
<td>3 (9.1)**</td>
</tr>
<tr>
<td>Ferrous sulfate (SR)</td>
<td>90</td>
<td>19.9</td>
<td>9 (10.0)</td>
<td>4 (4.4)</td>
<td>2 (2.2)</td>
<td>27 (30.0)</td>
<td>7 (7.8)</td>
<td>1 (1.1)</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>1.8</td>
<td></td>
<td></td>
<td>1 (2.6)</td>
<td>1 (2.6)</td>
<td>9 (23.7)</td>
<td>4 (10.5)**</td>
</tr>
<tr>
<td>Total</td>
<td>453</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Taken from table: % with any side effects
Ferrous fumarate - 56%
Ferrous sulfate immediate release - 53%
Ferrous sulfate slow release - 43%
Ferrous bisglycinate - 21%

Things to note:
- Pregnant so some attributes could be down to pregnancy
- Dose plays a large role, and amount of iron in each isn’t mentioned. Only mention is that the multivitamin had 60 mg of elemental iron and the fumarate alone had 100 mg. Because of this, these results need to be taken with caution.

1.1. Info and sources regarding its inhibitors and enhancers

(Hertrampf and Olivares 2004)
FeBC is the most studied and used form. Iron absorption from FeBC (Ferrous bis-glycine chelate) is affected by enhancers and inhibitors of iron absorption, but to a lesser extent than ferrous sulfate. Its absorption is regulated by iron stores. FeBC is better absorbed from milk, wheat, whole maize flour, and precooked corn flour than is ferrous sulfate.

(Layrisse et al. 2000)
A confusing set of studies, so i’m going with the summary that (Allen 2002) gives of it.
"Layrisse et al. studied iron bioavailability from breakfasts enriched with ferrous bisglycinate to which phytates and polyphenols (iron absorption inhibitors) were added. Five different experiments were conducted in a total of 74 subjects. When ferrous bisglycinate and ferrous sulfate were given together or in different meals (in breads made from corn flour or white wheat flour, with cheese and margarine) the iron absorption from the bisglycinate was twice
that from the sulfate although it was slightly less than iron absorption from iron EDTA. The efficiency of iron absorption from the fortified corn flour was 5.1% from ferrous sulfate and 10.1% (significantly higher) from the ferrous bisglycinate"

"However, the addition of phytase to the bisglycinate fortified corn bread did increase iron absorption by approximately 30%, indicating that there was some inhibition of absorption of the bisglycinate iron by phytate. The polyphenols in espresso coffee and tea reduced iron absorption from the ferrous bisglycinate by 50% but there was no ferrous sulfate control for comparison."

My summary
FeBC is inhibited by the usual inhibitors, however it seems to be inhibited less than sulfate (about half as much)

(Pizarro et al. 2002)
"The iron from iron bis-glycine chelate delivered at the level of the stomach or duodenum becomes part of the nonheme-iron pool and is absorbed as such."

(Allen 2002)
The study talks about how FeBC is inhibited by milk and enhanced by ascorbic, but to a lesser extent than sulfate:
“Ferrochel iron was less well absorbed from the milk (11%) than from the water (46%). Also, adding ascorbic acid increased the absorption of Ferrochel iron from milk by 38%, to 15%. These results suggest that inhibitors and enhancers can affect the absorption of the bisglycinate iron. The authors commented that there was a much larger (approximately 250%) increase in iron absorption, however, when ascorbic acid was added to ferrous sulfate in a previous experiment. Another limitation of this study was that there was no assessment of the absorption of ferrous sulfate iron from milk; the authors reported that in a previous study they found this to be only 4%, which would mean approximately three times more ferrous bisglycinate iron than ferrous sulfate iron is absorbed from milk."

1.2. Sources for general information

(R. Anton et al 2006)
"ferrous bisglycinate is highly soluble at physiological pH"
Lists lots of other field trials where Ferrous bisglycinate has been used in fortification. Seems to be a popular newish iron for fortification, especially with milk and wheat. States that FeBC is regulated normally by iron status.

(Fidler 2003)
Talking about ferrochel -"The exact composition along with the manufacturing process are however closely guarded secrets. Thus, there is a lack of independent evaluations of this compound."

(Jeppsen 2001)
Talks quite a bit about the structure of bisglycinate
(Allen 2002)

“Ferrous bisglycinate (sold commercially as Ferrochel by Albion Laboratories, Clearfield, UT) consists of 2:1 molecule of ferrous iron attached to two molecules of glycine. The iron is bound to the carboxyl group of glycine in an anionic bond, and to the amino group in a coordinated, covalent bond, to form two heterocyclic rings. This structure may protect iron from interactions with dietary inhibitors of iron absorption”

1.3. References used in this section


Milman, Nils, Lisbeth Jønsson, Pernille Dyre, Palle Lyngsie Pedersen, and Lise Grupe Larsen. 2013. ‘Ferrous Bisglycinate 25 Mg Iron Is as Effective as Ferrous Sulfate 50 Mg Iron in the

Notes and references document for ferrous bisglycinate
www.medium.com/@learnigirl


Sc, Szarfarc, de Cassana Lm, Fujimori E, Guerra-Shinohara Em, and de Oliveira Im. 2001. ‘Relative Effectiveness of Iron Bis-Glycinate Chelate (Ferrochel) and Ferrous Sulfate in the Control of Iron Deficiency in Pregnant Women.’ *Archivos Latinoamericanos de Nutricion* 51 (1 Suppl 1): 42–47.