Calcium Fortified Beverages

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Type of beverage determines which Calcium salts can be used

<table>
<thead>
<tr>
<th>Opaque</th>
<th>Clear</th>
</tr>
</thead>
</table>
| Insoluble salts are used if:  
- small particle size  
- suspended using stabilizers  
- "shake well before using" | Soluble;  
no precipitation during long term storage.  
Soluble;  
delayed precipitation is acceptable. |

- RTD  
Dry mix
% Calcium levels vary widely

Calciuminum Carbonate 40
Tricalcium Phosphate 39
Calcium Chloride Dihydrate 27
Calcium Sulfate Dihydrate 23
Tricalcium Citrate Tetrahydrate 21
Calcium Fumarate Trihydrate 19
Calcium Lactate Pentahydrate 13
Calcium Lactate Gluconate 11
Calcium Gluconate Monohydrate 9
Calcium fortified milk

High levels of fortification: 0.13 - 0.15% w/v of added Calcium

Proteins + soluble Calcium + heat = coagulation

Use insoluble Calcium salts + suspension aid

Nestle & P&G have active patents for Calcium fortified milk using soluble, complexed Calcium salts
Calcium fortified orange juice

High levels of fortification: 0.13 -0.15% w/v of added Calcium

Both soluble and insoluble Calcium salts used

Currently used in North America:
- Tricalcium Citrate
- TCP & Calcium Lactate (Coca-Cola patent)
- Calcium Citrate Malate (P&G FruitCal patent)
- TCP & Calcium Fumarate
Calcium fortified clear RTD beverages

Low levels of fortification: 0.01-0.06% w/v of Ca

Soluble Calcium salts used in clear beverages:
- Calcium Chloride (bitter taste)
- Calcium Fumarate
- Calcium Lactate
- Calcium Lactate Gluconate
- Calcium Gluconate
Calcium fortified beverage dry mixes

Various levels of fortification: 0.01-0.13% w/v of Ca

Both soluble and insoluble Calcium salts used

In situ formation of Calcium Citrate and/or Malate: U.S. Patent 6,833,146 (Unilab)
Calcium-fortified beverages are prone to calcium salt precipitation
Calcium salt precipitation is influenced by:

- Calcium level
- pH
- Which acids are present?
- Calcium source
- Other ionic species
SOL-U-CAL - a new form of Calcium Fumarate Trihydrate

Manufactured using Bartek’s proprietary process

Classified as a dietary and nutritional additive (21CFR§172.350)

\[
\text{Ca}^{++} \cdot 3\text{H}_2\text{O}
\]
Achieve more natural fruit flavour with SOL-U-CAL

With Calcium Lactate

With SOL-U-CAL
Undissociated acids mask fruit flavours

![Graph showing the molar concentration of undissociated acids versus pH](image)

- **Lactic Acid** (from 0.31% w/v Calcium Lactate Pentahydrate)
- **Gluconic Acid** (from 0.45% w/v Calcium Gluconate)
- **Fumaric Acid** (from 0.22% w/v SOL-U-CAL)

$I = 0.05$
SOL-U-CAL results in a lower pH than other Calcium salts

<table>
<thead>
<tr>
<th></th>
<th>Cranberry Juice Cocktail</th>
<th>Grapefruit Juice Cocktail</th>
<th>Apple Juice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium Lactate</td>
<td>2.96</td>
<td>3.22</td>
<td>3.66</td>
</tr>
<tr>
<td>Pentahydrate 0.31% w/v</td>
<td>2.86</td>
<td>3.16</td>
<td>3.61</td>
</tr>
<tr>
<td>SOL-U-CAL 0.22% w/v</td>
<td>2.58</td>
<td>2.98</td>
<td>3.53</td>
</tr>
<tr>
<td>Control</td>
<td></td>
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</tr>
</tbody>
</table>
SOL-U-CAL contains more Calcium than other soluble Calcium salts

- Calcium Fumarate Trihydrate 19
- Calcium Lactate Pentahydrate 13
- Calcium Lactate Gluconate 11
- Calcium Gluconate Monohydrate 9
Calculate level of Calcium salt to yield required Calcium level

What level of Calcium is required?

Divide by % Calcium to determine the salt level

Divide by 0.19 to determine the SOL-U-CAL level

Example: Need 0.042% w/v Calcium

0.042 ÷ 0.19 = 0.22% w/v SOL-U-CAL
Use less SOL-U-CAL to obtain the same Calcium level

<table>
<thead>
<tr>
<th>Calcium Compounds</th>
<th>to yield 0.021% w/v of Calcium</th>
<th>to yield 0.042% w/v of Calcium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium Gluconate Monohydrate</td>
<td>0.24% w/v</td>
<td>0.47% w/v</td>
</tr>
<tr>
<td>Calcium Lactate Gluconate</td>
<td>0.20% w/v</td>
<td>0.40% w/v</td>
</tr>
<tr>
<td>Calcium L Lactate Pentahydrate</td>
<td>0.16% w/v</td>
<td>0.32% w/v</td>
</tr>
<tr>
<td>SOL-U-CAL</td>
<td>0.11% w/v</td>
<td>0.22% w/v</td>
</tr>
</tbody>
</table>
Bioavailability comparable to other Calcium salts

Calcium Gluconate  Calcium Fumarate  Calcium Carbonate  Calcium Citrate  Calcium Citrate Malate

A  {no difference in sera levels; p<0.05}
B  {no difference in bone absorption; p<0.05}


B: Weaver et al. 2002. Absorption of Calcium Fumarate salts is equivalent to other Calcium salts when measured in the rat model. *J. Agr. Food Chem.* 50:4974
Accelerate SOL-U-CAL dissolution at pHs less than 4.0
Malic Acid increases solubility and rate of dissolution of SOL-U-CAL

SOL-U-CAL solubility at 21-22°C (% w/v)

- Citric
- 90/10 Citric/Malic
- Malic
SOL-U-CAL is stable in combination with Citric Acid

1+5 syrup (56°Brix) - stable for 2 years:

Water: 26.71% w/w

Citric Acid: 0.78% w/w

SOL-U-CAL: 1.05% w/w

HFCS 55: 71.46% w/w
Calcium fortified energy drink: 0.021% Ca

water, high fructose corn syrup, citric acid, sodium citrate, calcium lactate, natural flavors, black carrot extract magnesium lactate, ascorbic acid, vitamin E acetate, niacinamide, pantothenic acid, pyridoxine HCL, riboflavin, thiamin HCL, cyanocobalamin
Dry opaque beverage mix: 0.033% Ca in recon. drink

sugar, citric acid, malic acid, artificial flavors, xanthan gum, cellulose, calcium fumarate, tricalcium phosphate, titanium dioxide, sodium citrate, aspartame, acesulfame-K, ascorbic acid, artificial colors, caramel color, vitamin A palmitate
Calcium fortified carbonated soft drink: 0.042% Ca

carbonated water, apple juice from concentrate, calcium gluconate, calcium lactate, ascorbic acid, natural flavors, sucralose, acesulfame potassium, fruit and vegetable juices (for color), malic acid, potassium sorbate, sodium hexametaphosphate and calcium disodium edta
“Bubbles with benefits”

"With 7 UP PLUS you have ‘bubbles with benefits,’ including a delicious taste, a good source of calcium and vitamin C, as well as real fruit juice.”

L.L. Stern,
Cadbury Schweppes Americas Beverages,
August 2004 press release
Calcium fortified clear juice drink:
0.042% Ca

Filtered water, cranberry juice, high fructose corn syrup, calcium fumarate, ascorbic acid, calcium chloride
Dry clear beverage mix:
0.084% Ca in recon. drink

calcium fumarate,
citric acid,
maltodextrin,
aspartame, beta
carotene, natural and artificial flavor, sodium citrate, magnesium oxide, acesulfame-K,
Yellow 5, Red 40
Save time by using Bartek’s web site:  www.bartek.ca