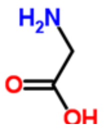
RSC | Advancing the Chemical Sciences

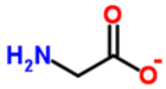
Reckitt Benckiser

Synthesis of *cis*- and *trans*-copper(II) aminoethanoate

Student worksheet



Glycine (aminoethanoic acid)



Glycinate ion (aminoethanoate ion

Soluble copper(II) salts dissolve in water to give a solution of hexaaquacopper(II) ions, $[Cu(H_2O)_6]^{2+}$.

Glycine (systematic name: aminoethanoic acid) has the molecular formula $C_2H_5O_2$ and structural formula H_2CH_2COO.

When dissolved in an alkali such as sodium hydroxide, the carboxylic acid group ionises to give an ion with a single negative charge. It is called a glycinate ion (systematic name: aminoethanoate, $H_2CH_2COO^-$).

The copper(II) complex of glycine can be made by adding a hot aqueous glycine solution to a hot solution of copper ethanoate in a water-ethanol mixture.

Equipment and materials for both preparations

- Hot water bath or electric heating mantle
- 25 cm^3 measuring cylinder
- 2 x 100 cm^3 conical flasks
- 2 x 250 cm^3 conical flasks
- Water bath
- −10 – 110 °C thermometer
- Filter funnel and fluted filter paper
- Watch glass (2)
- 50 cm^3 round-bottom flask (Quickfit)
- Condenser (Quickfit) to fit the 50 cm^3 round-bottom flask
- Bunsen Burner, tripod and gauze
- Sample tube (2)
- Ethanol
- Copper(II) ethanoate-1-water
- Glycine
- Ice

Synthesis of *cis*-$Cu(H_2CH_2COO)_2.H_2O$

Method

Care: Wear eye protection. Copper(II) ethanoate-1-water is harmful and an irritant. Ethanol is flammable. Work away from naked flames. As industrial denatured alcohol or ethanol formulated with methanol (IDA/IMS – industrial methylated spirits) is being used, there may be toxicity issues from methanol (or other adulterants) so work in a well-ventilated lab.

1. Using a measuring cylinder, measure out 25 cm^3 of ethanol into a 100 cm^3 conical flask and place the flask in a hot water bath at 65 °C.
2. Using a measuring cylinder, measure 25 cm^3 of water into a 250 cm^3 conical flask. Weigh out 2.0 g (0.01 mol) of copper(II) ethanoate-1-water and add to the flask. Place the flask in the water bath and stir the mixture until the solid dissolves. When the solution reaches 65 °C pour the warm ethanol into the copper(II) ethanoate solution.
3. Using a measuring cylinder, measure 25 cm^3 of water into a 100 cm^3 conical flask. Weigh out 1.5 g (0.02 mol) of glycine and add to the flask. Place the flask in the water bath. Stir the mixture until the solid dissolves. When the solution reaches 65 °C pour it into the flask containing the copper(II) ethanoate solution.

4. Cool the mixture in an ice bath. Light blue needles should crystallise. Filter the cold mixture through a fluted filter paper. Collect the filtrate in clean 250 cm^3 conical flask and keep it for the synthesis of *trans*-$Cu(H_2NCH_2COO)_2.H_2O$.
5. Open up the filter paper and lay it on a watch glass. Cover the crystals with a piece of clean filter paper and leave it to dry in a fume cupboard at room temperature.
6. Label a sample tube with the name of the product, your name and the date. Weigh the labelled sample tube and record its mass.
7. Scrape the dried crystals into the weighed sample tube. Weigh the tube again. Record its mass.

Calculations

Calculate the theoretical yield and the percentage yield.

Synthesis of *trans*-$Cu(H_2CH_2COO)_2.H_2O$

Method

1. Weigh about 1.5 g of *cis*-$Cu(H_2NCH_2COO)_2.H_2O$ and 1 g of glycine into a 50 cm^3 round-bottom flask.
2. Use a measuring cylinder to pour 10 cm^3 of the filtrate from the synthesis of *cis*-$Cu(H_2NCH_2COO)_2.H_2O$ into the flask, fit a condenser and reflux the mixture for one hour (use a hot water bath or electric heating mantle).
3. Filter the hot mixture through a fluted filter paper to obtain blue-violet platelets of *trans*-$Cu(H_2NCH_2COO)_2.H_2O$.

   Note that if the mixture all dissolves during the reflux, then the *cis*-product will re-precipitate not the *trans* isomer.
4. Open up the filter paper and lay it on a watch glass. Cover the crystals with a piece of clean filter paper and leave it to dry in a fume cupboard at room temperature.
5. Label a sample tube with the name of the product, your name and the date.
6. Scrape the dried crystals into the weighed sample tube.

   It is not possible to get a meaningful value for the percentage yield as the exact quantity of *cis*-$Cu(H_2NCH_2COO)_2.H_2O$ is not known.

Finally

Why does the structure change from the *cis* isomer to the *trans* isomer? The initial reaction mixture contains both *cis* and *trans* isomers in equilibrium, but the *cis* isomer crystallises faster. However the *trans* isomer is thermodynamically more stable and less soluble, so on continued heating, the only product is the *trans* isomer.

- Make molecular models and draw structures for the two geometrical isomers of copper(I) aminoethanoate.
- Do you think there are any benefits of using one isomer rather than the other as a source of the micronutrient copper?