

Is the Choline Chloride you purchased the Choline Chloride you received?

All choline chloride is the same on a molecular level. Yet significant differences can and do exist among choline chloride products and manufacturing practices.

Why? The reasons vary. Some companies have poor manufacturing processes and poor overall quality control; others are known to cheapen their products to reduce manufacturing costs. In these situations, clever substitutions allow adulterated products to pass established industry tests for quality. Unfortunately, whether through poor production techniques or deliberate manipulation, customers end up suffering and animal performance ends up compromised.

Unintentional Quality Problems

Choline is a fairly simple molecule, yet important considerations go into making a high-quality product. *Specific manufacturing considerations include:*

- **Ingredient quality** – Carefully choosing the right ingredients is a very important step both for the production of liquid choline and for making dry choline from liquid. Ingredient selection is the single most important step for the prevention of dioxin problems with choline.

Quality Varies Among Choline Chloride Samples

sample#	Ccgrade	Choline content		TMA	Salts				
		IC	CC	TMA	NH4	Ca	K	Na	Mg
Test Method		IC	CI	IC	IC	IC	IC	IC	IC
		%	%	mg/kg	%	%	%	%	%
Specification		59 -61	59 -61	< 400	< 0.05	< 0.5	< 0.3	< 0.3	< 0.3
EU leg. 2002/32									
C-01	CC60	35.00	80.00		16				
C-02	CC60	50.20	59.20	< 25	< 0.05	0.80	< 0.3	< 0.3	< 0.3
C-03	CC60	52.10	60.10	65	< 0.05	< 0.3	0.41	< 0.3	< 0.3
C-04	CC60	52.50	59.90	85	< 0.05	< 0.3	0.46	< 0.3	< 0.3
C-05	CC60	28.50	64.60	2110	< 0.05	0.76	7.8	1.3	< 0.3
C-06	CC60	54.30	61.00	125	< 0.05	0.75	0.41	< 0.3	< 0.3
C-07	CC60	55.40	60.40	131	< 0.05	0.80	0.39	< 0.3	< 0.3
C-08	CC60	23.70	72.10	< 25	3.5-3.9	1.57	< 0.3	< 0.3	< 0.3
C-09	CC50	46.60	53.40	13450	0.29	< 0.3	0.41	< 0.3	< 0.3
C-10	CC50	45.70	52.90	13400	0.31	< 0.3	0.43	< 0.3	< 0.3
C-11	CC50	17.50	47.00	7675	< 0.05	0.45	0.31	5.4	< 0.3
C-12	CC50 (??)	54.00	51.60	275	< 0.05	< 0.3	0.24	< 0.3	< 0.3
C-13	CC50	50.40	50.30	60	< 0.05	0.38	0.65	< 0.3	< 0.3
C-14	CC50	48.60	47.90	< 25	0.36	< 0.3	< 0.3	< 0.3	< 0.3
C-15	CC50 (??)	58.60	58.90	50	< 0.05	< 0.3	2.37	< 0.3	< 0.3
C-16	CC50	19.30	52.60	3040	0.12	4.1	0.43	1.3	< 0.3
C-17	CC50	50.20	50.30	110	< 0.05	< 0.3	0.22	< 0.3	< 0.3
C-18	CC50	45.60	47.10	< 25	< 0.05	< 0.3	0.5	< 0.3	< 0.3
C-19	CC50	50.90	50.20	420	0.23	< 0.3	< 0.3	< 0.3	< 0.3
C-20	CC50	47.10	48.80	21	< 0.05	< 0.3	0.37	< 0.3	< 0.3
C-21	CC60	57.70	59.00	59	< 0.05	< 0.3	< 0.3	< 0.3	< 0.3
C-22	CC60	58.50	60.70	61	< 0.05	< 0.3	< 0.3	< 0.3	< 0.3
C-23	CC60	57.90	59.60	< 25	nd	nd	nd	nd	nd
C-24	CC60	54.40	59.40	615	nd	nd	nd	nd	nd
C-25	CC60	57.80	58.80	< 25	nd	nd	nd	nd	nd
O-03	CC60	18.7	88.5	1745	4.6-4.1	< 0.3	< 0.3	< 0.3	< 0.3

- **Production conditions**

- The synthesis of liquid choline chloride needs to be carefully controlled to produce a finished product that is clear choline chloride, low in odor and stable for long durations. If the synthesis is not carefully controlled, a very “fishy” smelling choline product may result that is yellow in color and quite unstable during storage. In addition, it may not contain the proper amount of choline chloride.
- The drying of choline chloride to generate a dry product must be carefully controlled, as poor quality ingredients plus improper drying conditions can yield issues with dioxin formation. A poorly regulated dry choline production process can yield a product that is quite variable in finished choline content.

Deliberate Quality Problems

The deliberate adulteration of choline chloride products began being discovered in 2002, and it continues today. A common test for choline chloride content is to titrate the chloride ion. It has become all too common to simulate a higher choline chloride content by adding chloride salts to a choline chloride product, such as KCl, MgCl₂, NH₄Cl, etc.

For instance, a company might combine 35% choline chloride with a chloride salt, such as ammonium chloride (NH₄Cl) and sell the resulting product as 60% choline chloride on carrier. The adulterated product readily passes the perchloric acid test which measures chloride content, but not choline content. It tests as 61% choline chloride on a chloride basis. Yet, the same product fails the cation exchange chromatography test. With the cation exchange chromatography test, the choline content is determined. In this case, the test showed that the adulterated choline chloride contained 35% choline rather than the expected 60% choline.

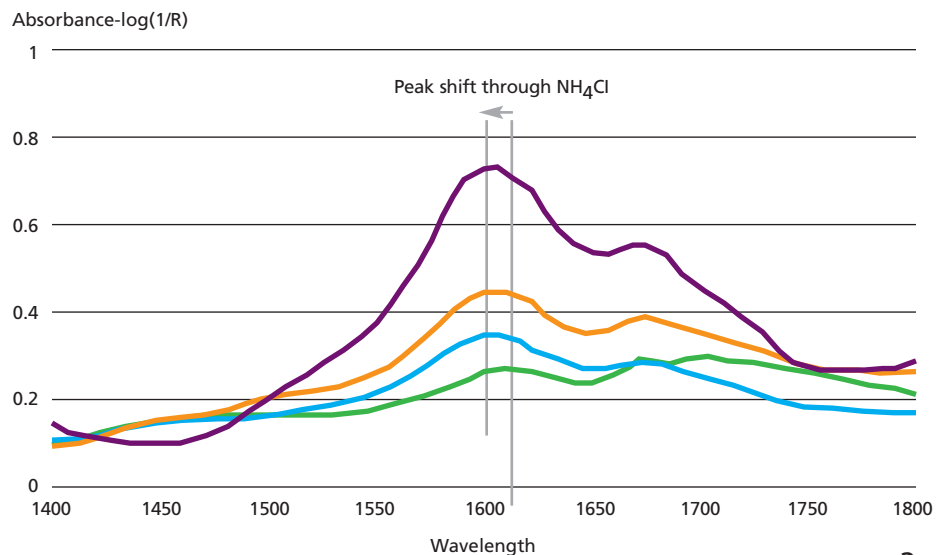
Tests to Confirm Product Quality

Four tests are available to confirm choline chloride content:

1. **Mohr/Volhardt** – measures chloride through AgNO₃ titration
2. **Perchloric acid** – measures chloride through HClO₄ titration
3. **Reinecke color comparison** – measures choline through salt color comparison and is highly selective for choline chloride
4. **Ion chromatography** – measures all positively charged ions, including choline, but can be influenced by the presence of some cations in the product such as K⁺ and NH₄⁺

Benchmarking Choline on Carrier Detection of “Fraud Product” with Near Infra-red Spectroscopy

- NH₄Cl
- Product A
- Product B
- Product C



Until recently, the industry heavily relied upon tests which measured chloride content as a means to confirm a product's choline chloride content. These tests cost less than tests for choline, but they are susceptible to fraud through the addition of chloride salts.

The two tests for choline cost more, but are harder to fraud. The Reinecke method is more difficult. Ion chromatography detects all ions and consistently reveals possible fraud.

The United States National Feed Ingredients Association (NFIA) has set the Reinecke color comparison method as the standard for choline determination in premix products. In China it also serves as the national standard for testing choline content in feed premixes. Due to high variation, however, it works best for confirming low choline content, ppm, rather than high concentrations such as 50-75%.

Recommendations

The Mohr/Volhardt test is reliable and fast, provided the product does not fraudulently contain salts such as sodium chloride and calcium chloride. The test measures choline and assumes a 1:1 ratio between choline content and chloride content.

For further confirmation of choline chloride content, the Reinecke salt test is often recommended with ion chromatography as a final confirmation. Both offer high levels of accuracy and precisely identify any product adulteration.

How can a purchaser be confident in their choline chloride purchases?

- 1. Choose a reputable company**
- 2. Ask for plant quality certifications**
- 3. Be informed of differences among quality tests**
- 4. Carefully choose the test(s) to confirm product quality**
- 5. Be aware that the lowest cost product may not offer high quality**

With a few informed precautions, purchasers can avoid:

- 1. Over paying for Choline Chloride**
- 2. Higher feed consumption rate (FCR) due to under delivery of Choline Chloride**
- 3. Neglected metabolic functions caused by a lack of choline which can affect cell structures, fat metabolism in the liver, and the formation of acetylcholine**

Highest Industry Standards

Balchem currently sets the highest industry standards for choline chloride products. The choline chloride content indicated on the label is the content delivered, and its plants proudly maintain industry quality certifications.

As the industry leader, Balchem offers consistent, high-quality choline chloride products through:

1. A wide product portfolio
2. Total product chain control
3. Moisture content below 2.5% (0.5% is typical)
4. High choline chloride density
5. The proprietary ability to spray choline chloride onto a carrier
6. Dust free products due to particle size distribution
7. No caking for good free flowing properties
8. Very low residual total trimethylamines-ammonium (TMA) content. High TMA content results in a fish-like odor
9. Dioxin free
10. GMO free product availability
11. Minimal undesirable substances (low values)
12. Nutritional value in carrier
13. Durable bags with polyethylene liner
14. Short lead time
15. Certifications: FAMI-Qs, HACCP, ISO 9002, 14001 and others

Minimal Moisture

The low moisture content in Balchem Choline Chloride and premixes helps prevent the decomposition of vitamins. As water migrates into premixes, it contributes to vitamin instability, instability that also relates to the type of vitamin, temperature, light, etc. Water migration is largely caused by the hygroscopic effect of choline chloride.

Dioxin Free

In November 2001, the EU directive 2001/102/EC set the maximum allowed dioxin concentration at 0.75 ng per kg for feed materials with increases to 6 ng per kg for fish oil, as expressed in WHO-PCDD/F-TEQ.

Balchem addressed dioxin concerns by demanding that suppliers guarantee raw materials and by randomly testing raw materials. It uses the highest quality HCL, and Balchem also uses an indirect heating process to dry the choline chloride on the carrier.

GMO Free

No more than 0.9% GMO is allowed in human food or in animal feed in the European Union. When customers require GMO free, Balchem assures the highest quality by using a European carrier, requiring supplier guarantees and agreements, conducting external random tests, and committing one manufacturing site to the production of Balchem GMO-free Choline Chloride.

Certifications

Balchem conscientiously maintains all the appropriate certifications and registrations. Each site has a registration according to EU 95/69 legislation as noted by the number on the product specification sheet and bags. In addition, manufacturing sites have FAMI-QS certification. Balchem is an active member of Fefana, and Balchem Choline Chloride is being registered via a Vitac subgroup.

Purchasing agents can have complete confidence in Balchem Choline Chloride products.

Balchem – Integrated production chain of Choline Chloride

