

QUALITY AND NUTRITIONAL ASPECTS OF CHOLINE CHLORIDE

KAKVOĆA I HRANIDBENA VRIJEDNOST KOLIN KLORIDA

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Choline chloride is a well known vitamin in animal feed. As a matter of fact it was isolated for the first time in 1849 from ox bile. The Greek name for "bile" is "chole". Choline itself is an alkaline product. Therefore it has to be neutralized before it can be used in feed or food. For feed, the usual form is choline chloride. For human application the usual form is choline bitartrate. Both products are produced and marketed by Akzo Nobel Functional Chemicals NL-Amersfoort.

In the current EU feed additive directive 70/524 and the new 1831/2003, choline chloride is listed as a vitamin. There are no restrictions in use, neither for the amount in the feed, nor related to the animal.

This is an introduction into the

1. quality, related to current and coming EU directives and
2. nutritional aspects, based on function, need, feed conversion etc.

QUALITY OF CHOLINE CHLORIDE, LIQUID OR ON CARRIER

Items which are important for the market are:

- a) assay of the product: do you get what you asked for?

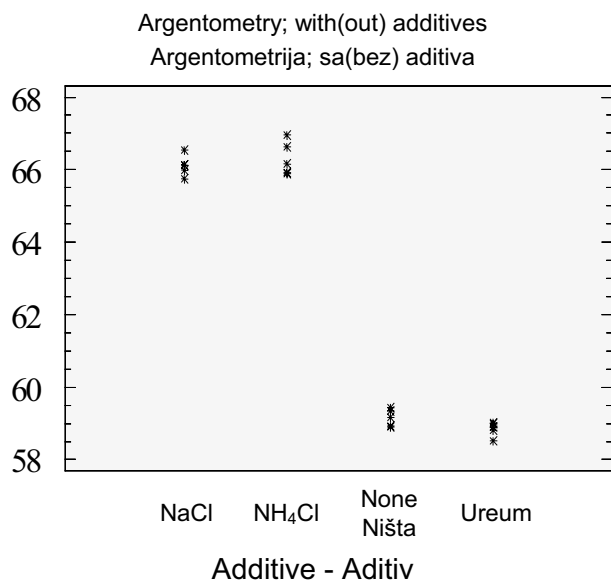
- b) contamination: is it free of residues or undesirable substances?
- c) Is it easy to handle, in other words: does it remain free-flowing?

Ad a) assay.

To estimate the contents of choline chloride you have the choice to estimate the "choline" content or the "chloride" content. Reason for that is, that by dissolving choline chloride in water, the choline chloride splits up in equal parts "choline" and "chloride". The "chloride" method (also known as "argentometry") is fast, reliable and cheap. So it is obvious that both the producer and the buyer of choline chloride will use this method. But for a couple of years there has been fraudulent choline chloride on the market. What happened? Some producers added chloride-containing products like table salt to the choline chloride to "enrich" the "chloride" content. By using argentometry, the method of analysis can not distinguish the source of the chloride. All chloride will be calculated as choline chloride in this case.

This table shows the results if some salts are added

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The conclusion: if ammonium chloride or sodium chloride is added, there will be a 'virtual' increase of choline chloride content. Other chloride salts will act the same.

To avoid this problem, the method of **Reinecke** is usually used. This method is more specific for choline. But not exclusive. So fraud is also possible.

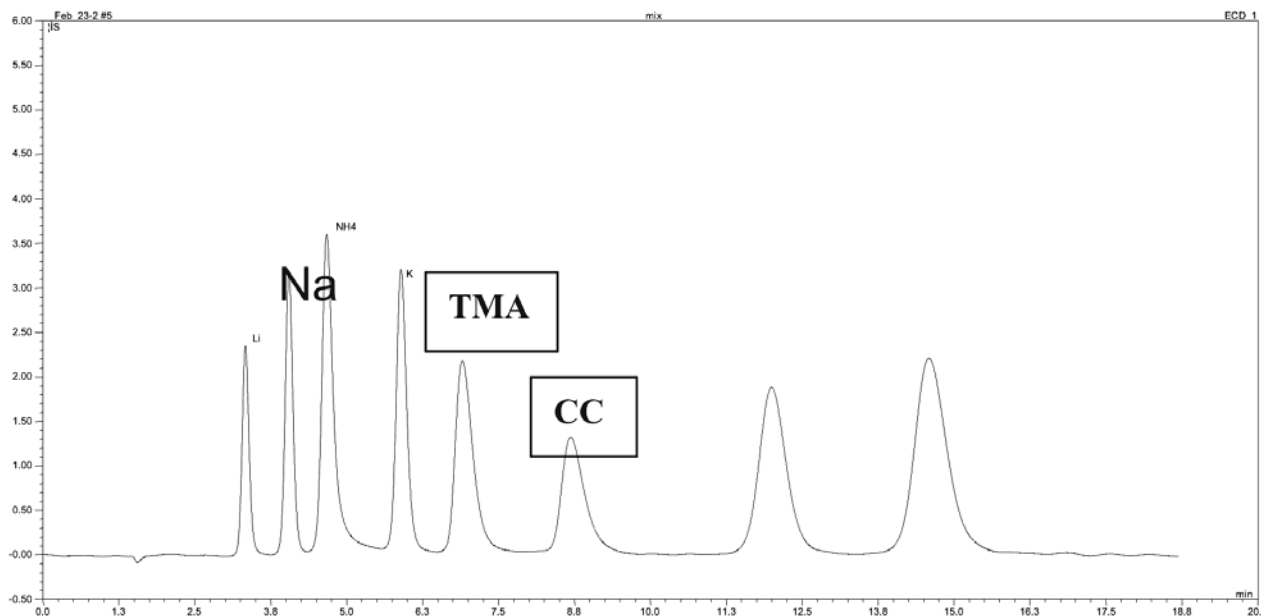
A sample, estimated by both the chloride method and the Reinecke method showed the following results:

	Result Rezultat	-	Expected Očekivano	-
Argentometrie (Chloride)	66.4		60.0	
Reinecke (Choline)	40.9		60.0	

Based on these results, one can see that the sample was not the expected and promised choline chloride 60% as stated on the bag, but:

40% CHOLINE CHLORIDE plus 10% TABLE SALT!

For these reasons and also to detect in one run other ions, coming from added salts we developed a so-called IC (Ion Chromatography) method. This will show not only the choline chloride content, but also the other ions, coming from salt, remaining trimethylamine etc. The graph below will show you that.



Every "peak" can be identified as an ion. - Svaki "vrh" može se označiti kao ion.

Ad b) contamination

How a product can look like has published by the Chinese (!) government: they checked quite a lot of samples from Chinese producers and found every figure between 0 (zero) and 50% in products, sold as choline chloride 50% on carrier. By using the IC technique, you can also see how many impurities are present:

	Chloride	Reinecke	Other ions in ppm - Ostali ioni u ppm (mg/kg)					
			Na	NH ₄ ⁺	K	TMA	Ca	Mg
1	52.20	51.30	50	-	1760	370	600	180
2	49.20	46.90	-	-	-	17135	-	285
3	52.20	16.90	5400	28800	2700	22000	650	147
4	56.80	5.80	48000	10	2800	-	17000	6500
5	54.70	6.90	16900	-	-	7500	7300	700
6	58.40	24.50	41500	200	-	370	5300	-

Some heavy metals / some GMO - Nešto teških metala / nešto GMO-a

Contamination of feed additives in general, but also by choline chloride on carrier of unknown producers can and will happen. In the overview just above, you see that some choline chloride will have a **high TMA content**. This will result in a fish-like odor of feed or premix.

Undesirable substances, mentioned in EU Directive 2002/32, like lead, arsenic and mercury have been detected.

Dioxin (EU Directive 2001/102) has been detected in some products. Probably this is because of the drying system. If direct drying with open flame is used, high dioxin content is unavoidable. This has been known for years. The well known laboratory of LUFÄ in D-Speyer published an article on the drying process for grass. The grass was heavily contaminated with dioxin.

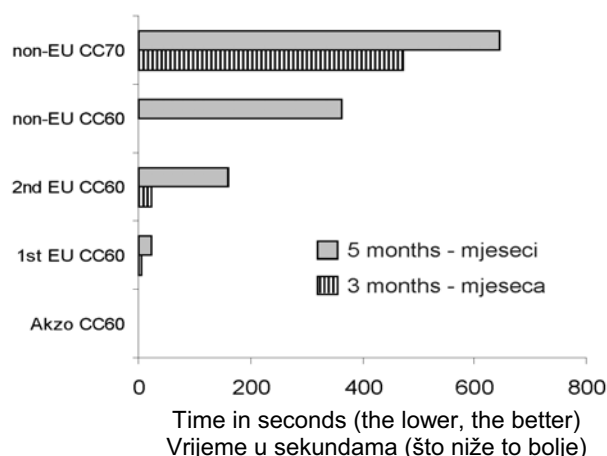
If an additive contains a **GMO**, labeling is compulsory according to EU 1829/2003 and 1830/2003.

Akzo Nobel Functional Chemicals has made purchasing contracts with their suppliers to avoid such contamination. We also random send samples to an external lab to check these items.

HANDLING AND PROCESSING CHOLINE CHLORIDE ON CARRIER.

Handling is easy when the product is *and* remains free flowing. To be sure that choline chloride on vegetable carrier remains free-flowing, also after a short period in contact with the open air, we add a flow-additive. How the Akzo Nobel Functional Chemicals product behaves after 3 or 5 months storage at 40°C and 50% relative humidity, you will find in the graph below.

Degree of caking of CC60/CC70 (storage at 40 °C and 50% rH)
Stupanj stvrdnjavanja CC60/CC70 (spremanje na 40 °C and 50% rH)



Test conditions are the following: after storage of a complete bag, the bag is opened. If there is a lump, this lump will be put on a sieve. *Then the sieve is shaken until the lump has disappeared.* In Akzo Nobel Functional Chemicals product no lumps were found. In the "1st EU producer CC60" only small lumps were found. But in CC70 of a 'non-EU' producer, hard and big lumps were found in the bag.

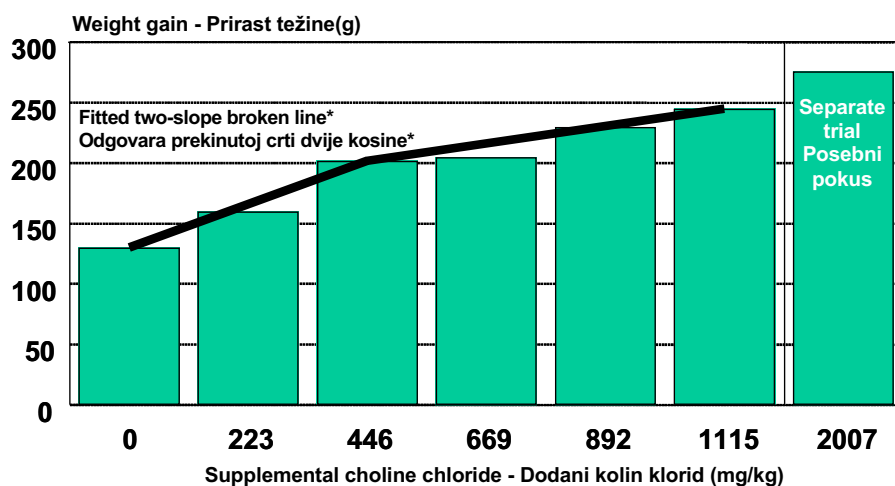
NUTRITIONAL ASPECTS OF CHOLINE CHLORIDE.

Choline chloride has different functions. It should be added if the natural content is not sufficient to fulfil the requirements. The well known NRC-tables will give you an idea of the choline content in raw materials. But the real content is not always like that.

This is because of

- the country of origin,
- the harvest of that year,
- how old the product is and last but not least,
- how bio-available it is.

A study by INRA-France showed quite different results in natural contents compared with the NRC tables. And bio-availability could be as low as 25%. Such calculation, based on NRC-tables only, will result in a too low choline chloride content.



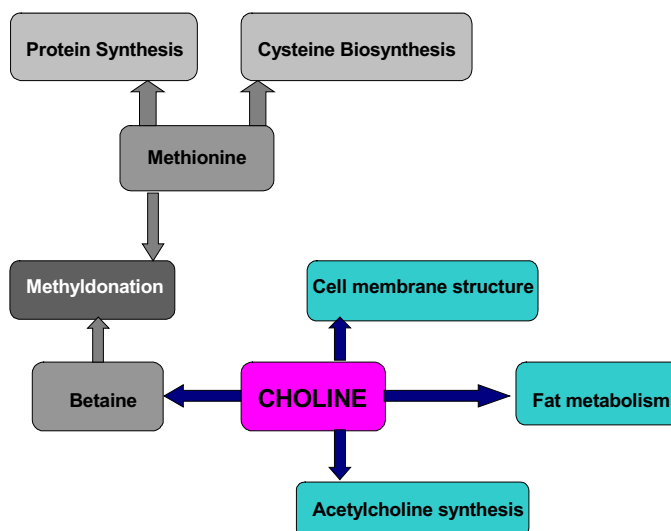
Essential functions of choline chloride (not possible to be replaced by other additives) are;

- in building and maintaining cell structures
- in fat metabolism of the liver
- in formation of acetylcholine

Non-essential function of choline chloride is

- methyl-group donor via betaine

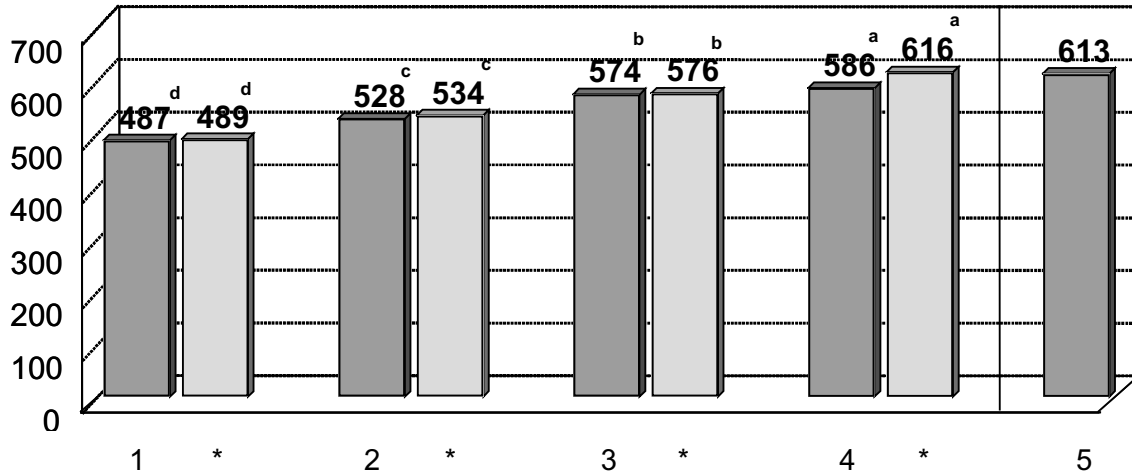
This is shown in the next graph (always look in the direction of the arrow, the reverse is not possible)



According to tests at INRA-France, but also in the USA and even in Taiwan, it was concluded that adding higher amounts of choline chloride to poultry is beneficial. An amount of 800 ppm choline (equal to 1500 ppm choline chloride 60%) added to feed will reduce the feed conversion rate. For 1000 kg weight gain of the broilers it was shown that adding 2.2 kg of CC60%, 50kg of feed could be saved.

More choline chloride in the diet results in more weight gain. Optimum is 800 ppm as choline chloride 100%. Based on economic savings.

Gain: feed** (Figures give weight gain in gram for 1000 gram of feed consumption)
 Prirast: hrana (Brojke pokazuju prirast težine za 1000 grama potrošene hrane)



1 Basal diet - Osnovni obrok

2 Basal + 223 mg/kg choline chloride - Osnovni + 223 mg/kg kolin klorida

3 Basal + 446 mg/kg choline chloride - Osnovni + 446 mg/kg kolin klorida

4 Basal + 669 mg/kg choline chloride - Osnovni + 669 mg/kg kolin klorida

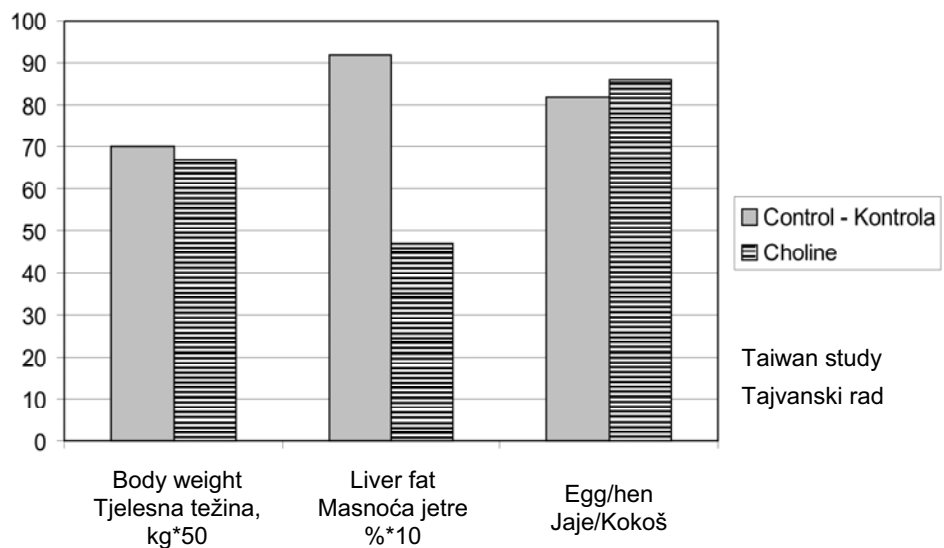
5 Separate trial - Posebni pokus: Basal + 2007 mg/kg choline chloride - Osnovni + 2007 mg/kg kolin klorida

* Betaine add. 500 mg/kg - Dodano Betaine 500 mg/kg

If betaine is added to a diet with not enough essential choline chloride, there is no result. First the essential need for choline chloride should be fulfilled.

In ducks, the liver fat was reduced and there was a slight increase of eggs production. And as already stated; although these results are based on a study in Taiwan, with a non-European diet, the conclusion of this study was the same as the INRA-study: ~800 ppm added choline is beneficial

Ducks diet - Obrok pataka
 Liver fat and eggs - Masnoća jetre i jaja



CONCLUSIONS

1. choline chloride is an essential vitamin for poultry
2. high doses in poultry feed are beneficial
3. "listed" figures of choline content should be verified. (And still the bio-availability is questionable)
4. high quality choline chloride will result in high quality meat
5. high quality choline chloride on carrier will be easier to process

References:

On request by the author