



# FRUIT STARCH SUGAR

The natural upgrade



 **ActiBeet**® – natural betaine for efficient livestock production

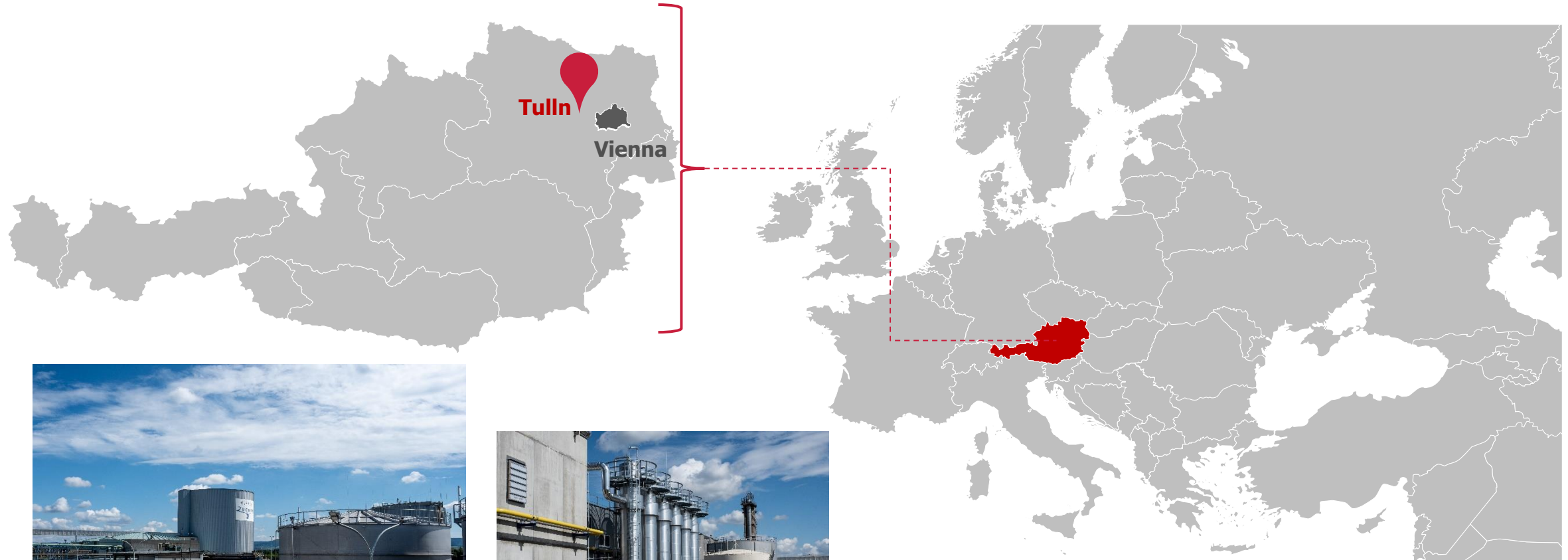


# AGENDA

- 1 ActiBeet® - Natural Betaine
- 2 AGRANA R&D Activities and Trials
- 3 Strategies & Dosage Recommendations
- 4 Natural versus Synthetic Betaine
- 5 Challenges and New Perspectives



# PRODUCTION SITE





## PRODUCTION SITE IN TULLN





NATURAL BETAINÉ

ACTIBEET®

ActiBeet®





## WHAT IS ACTIBEET® ?



- ✓ a natural source of Betaine
- ✓ a GMO-free product, obtained from sugar beets
- ✓ certified: ISO9001:2015, GMP+ and GMO- free

### COMMISSION IMPLEMENTING REGULATION (EU) 2019/2164 of 17 December 2019

**'betaine anhydrous'** for monogastric animals **and only from natural or organic origin comply** with the **objectives and principles of organic production"**.



## WHAT IS ACTIBEET® ?



- min. 96% Betaine activity
- Betaine anhydrous
- Crystalline
- Free - flowing





## OUR PRODUCTS?



### ActiBeet® 96

- 96% betaine content
- Betaine anhydrous (3a920)
- Anticaking agent: Calcium stearate
- Labeled as PREMIXTURE

### ActiBeet® 97

- 97% betaine content
- Betaine anhydrous (3a920)
- Pure, no anticaking agent
- Labeled as feed additive

Package size: 20 kg PE bags + Big Bags

Certified: ISO9001:2015, GMP+ and GMO-free





## ACTIBEET PRODUCTS

# CERTIFICATES AND STATEMENTS



- ✓ ISO 9001 Certificate
- ✓ GMP+ FSA assured Certificate
- ✓ GMO – free Certificate
- ✓ Halal
- ✓ Kosher
- ✓ Free Sale Certificate
- ✓ Health Certificate
- ✓ Non-Animal Origin Certificate
  
- ✓ Declaration of non irradiation, non ionization, non solvent
- ✓ Statement of organic authorization for ActiBeet 97
- ✓ Statement of absence of nanoparticles
- ✓ Statement of absence TSE/BSE risk





NATURAL BETAINÉ

**ACTIBEET** ®

 **ActiBeet** ®



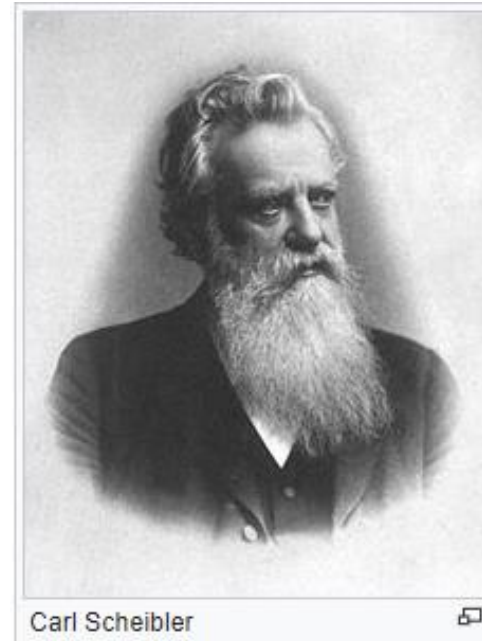


ACTIBEET® – NATURAL SOURCE OF BETAINE

## INTRODUCTION

### Betaine or trimethylglycine (TMG)

- First discovered in the juice of sugar beets (*Beta vulgaris*) -19<sup>th</sup> century
- Present also in other plants, animals and microorganisms



0,2 - 0,3 %

**Betaine**



# ACTIBEET® – NATURAL SOURCE OF BETAINE

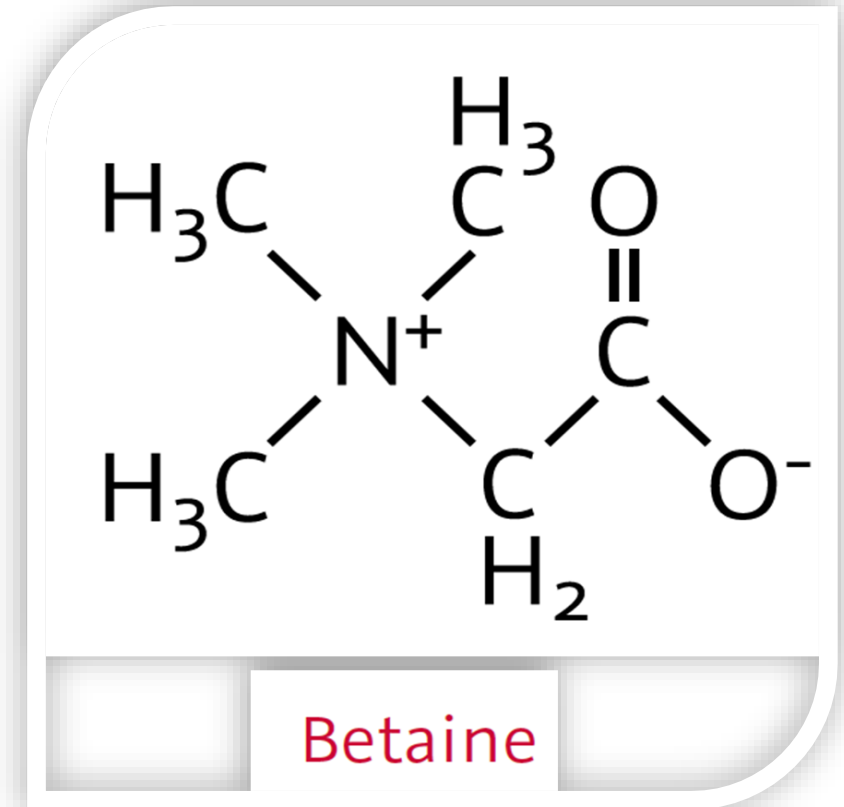
Betaine or trimethylglycine (TMG)



... has two main physiological functions:

**1 Methyl group donor**

**2 Organic osmolyte**





# ACTIBEET® – NATURAL SOURCE OF BETAINE

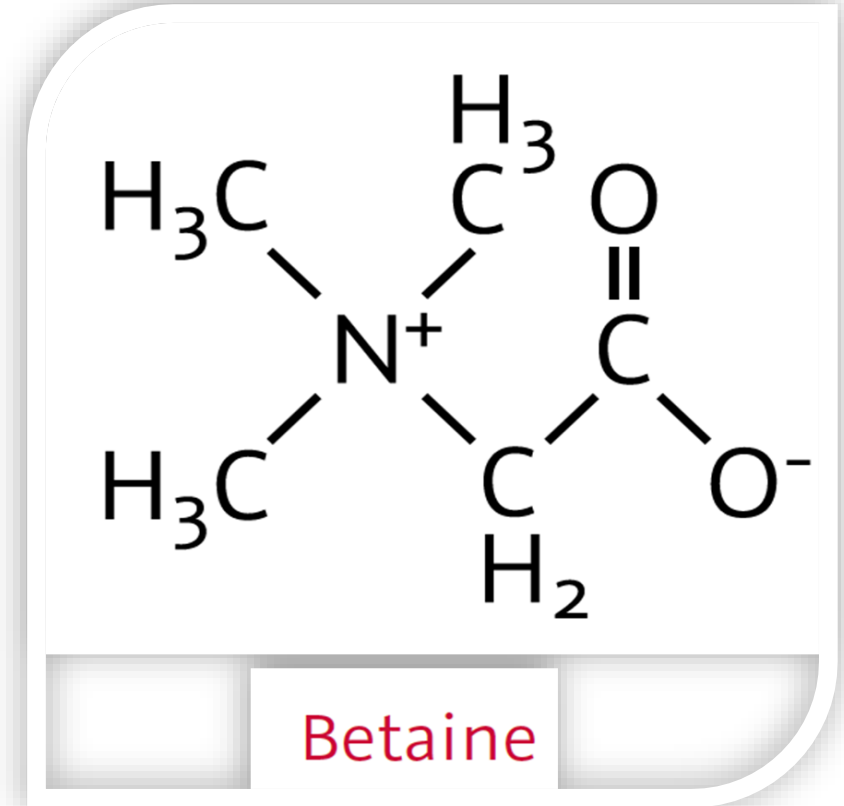
Betaine or trimethylglycine (TMG)



... has two main physiological functions:

**1 Methyl group donor**

**2 Organic osmolyte**





BETAINE OR TRIMETHYLGLICINE

## ACTIBEET® – METHYL GROUP DONOR

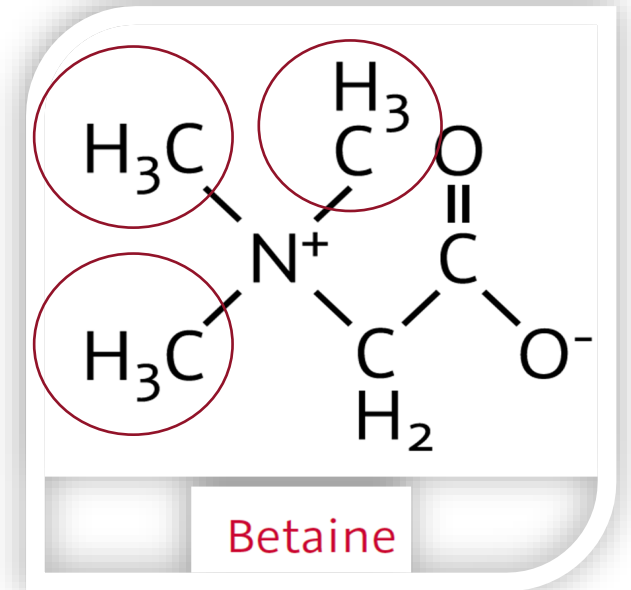
**1. Betaine as an efficient methyl group donor:** is a catabolic source of methyl groups via transmethylation, for use in many biochemical pathways:

➤ in the homocysteine - methionine cycle

➤ supports the synthesis of metabolically active substances

➤ works as a lipotropic agent

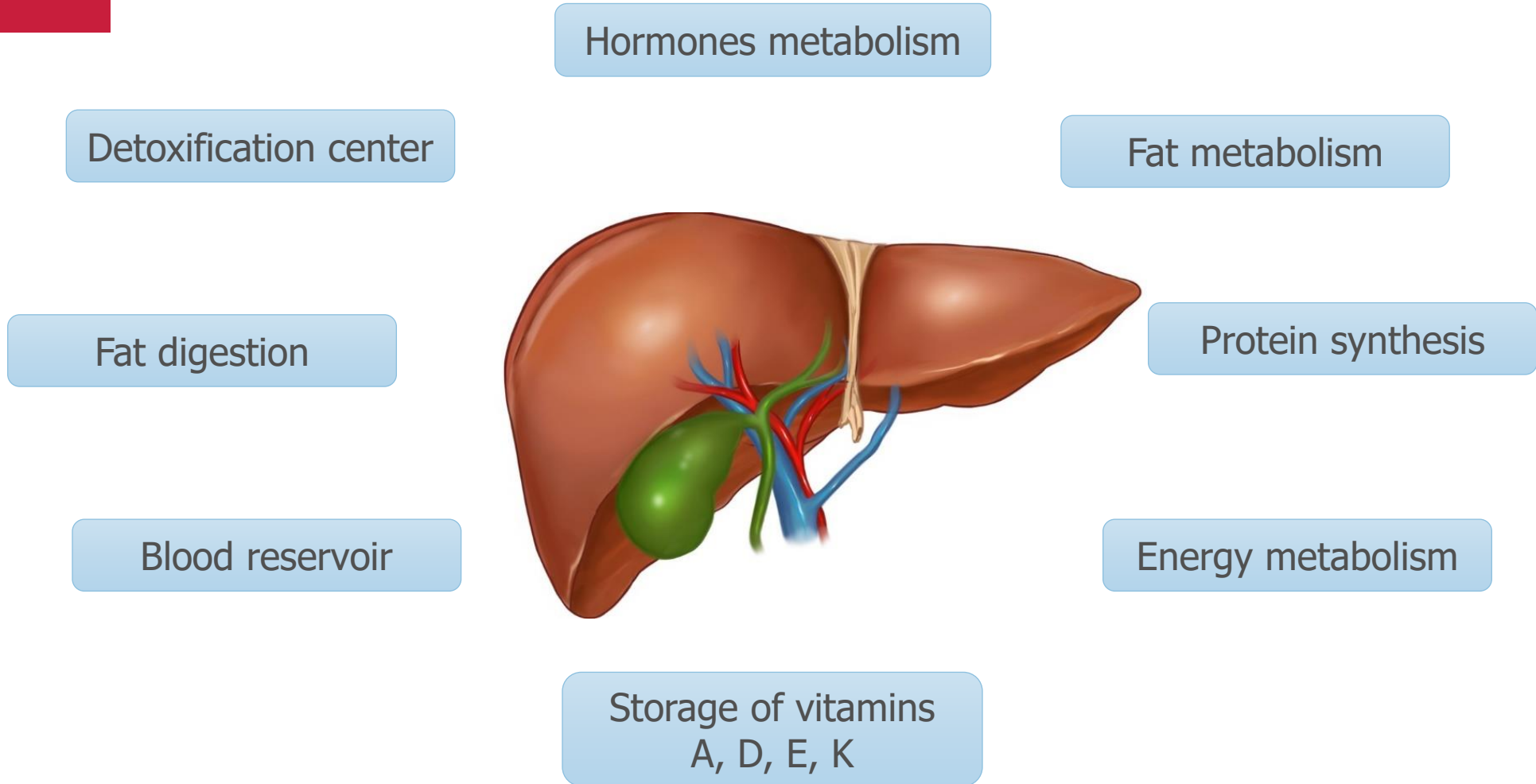
➤ source of glycine- relevant in N- reduced feeding



*- glycine, is one of the amino acids present in the bile salts. One of its functions is to produce uric acid to eliminate the excess of nitrogen from the body via the urine*

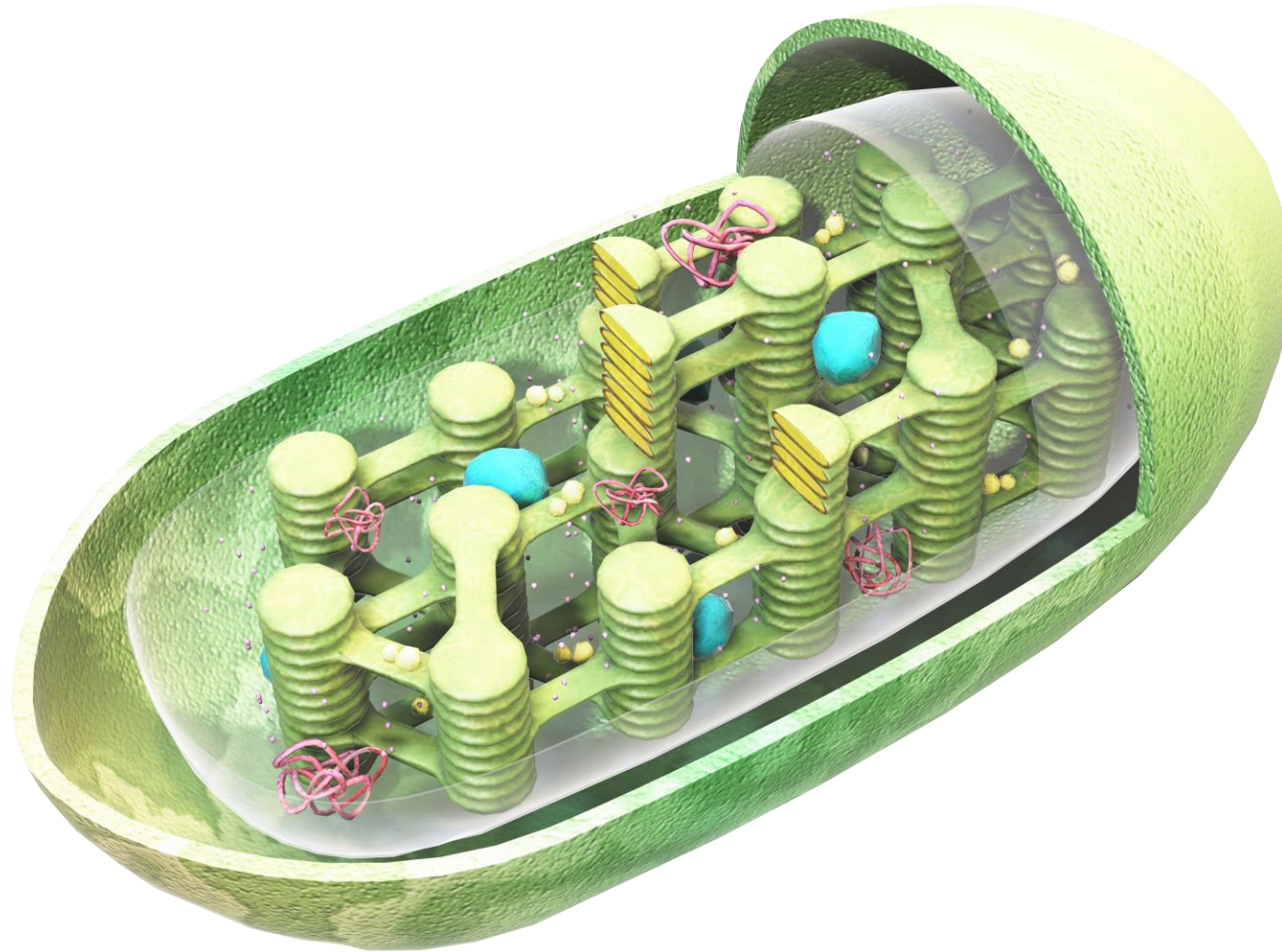


# FUNCTIONS OF LIVER





# FUNCTIONS OF LIVER- MITOCHONDRIA

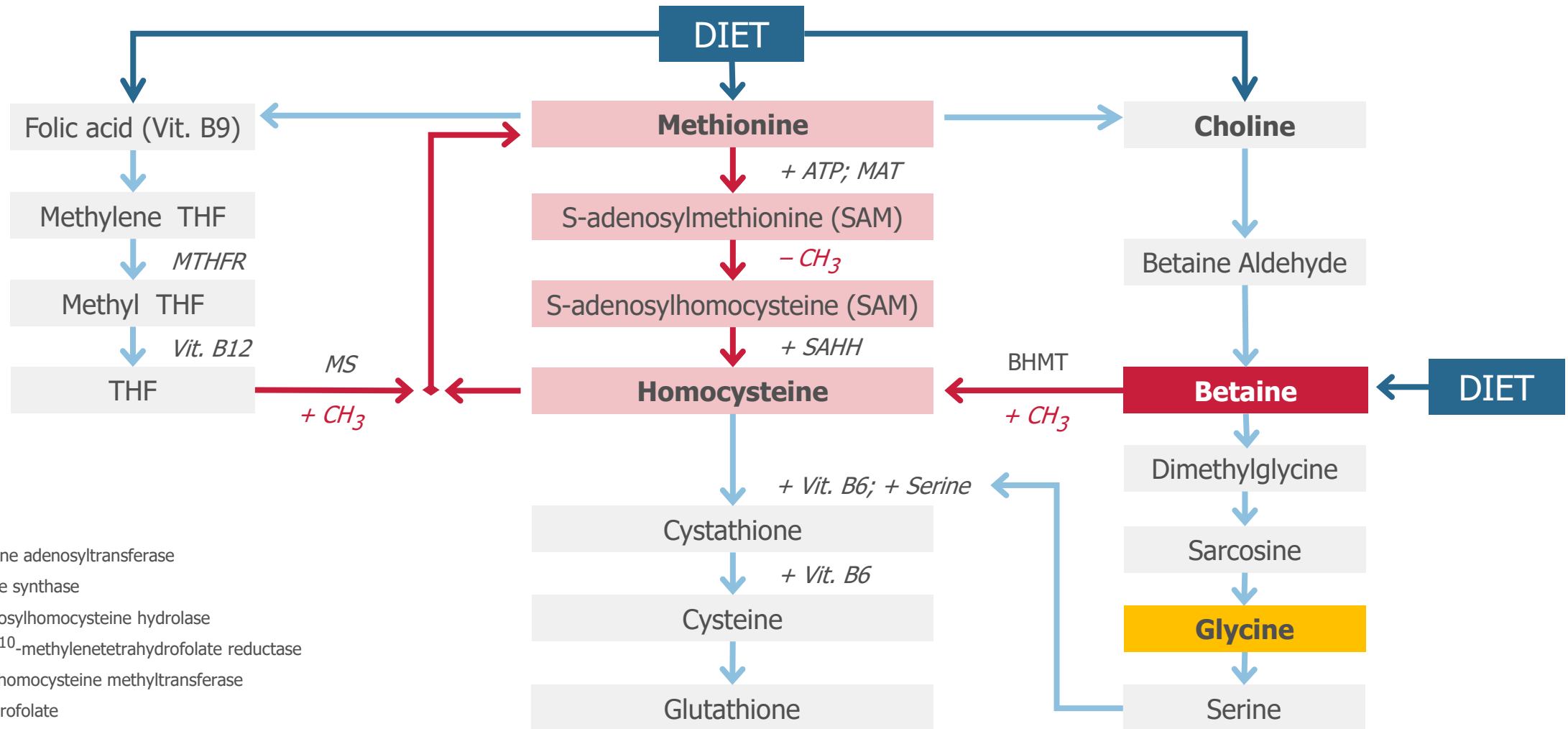






ACTIBEET® – NATURAL SOURCE OF BETAINE

# THE ROLE OF BETAINE AS A METHYL GROUP DONOR



MAT – Methionine adenosyltransferase  
MS – Methionine synthase  
SAHH – S-adenosylhomocysteine hydrolase  
MTHFR – N<sup>5</sup>, N<sup>10</sup>-methylene tetrahydrofolate reductase  
BHMT – Betainehomocysteine methyltransferase  
THF – Tetrahydrofolate



ACTIBEET® – NATURAL SOURCE OF BETAINE

# THE ROLE OF BETAINE AS A METHYL GROUP DONOR

**Methionine**

**Protein biosynthesis**



ACTIBEET® – NATURAL SOURCE OF BETAINE

# THE ROLE OF BETAINE AS A METHYL DONOR

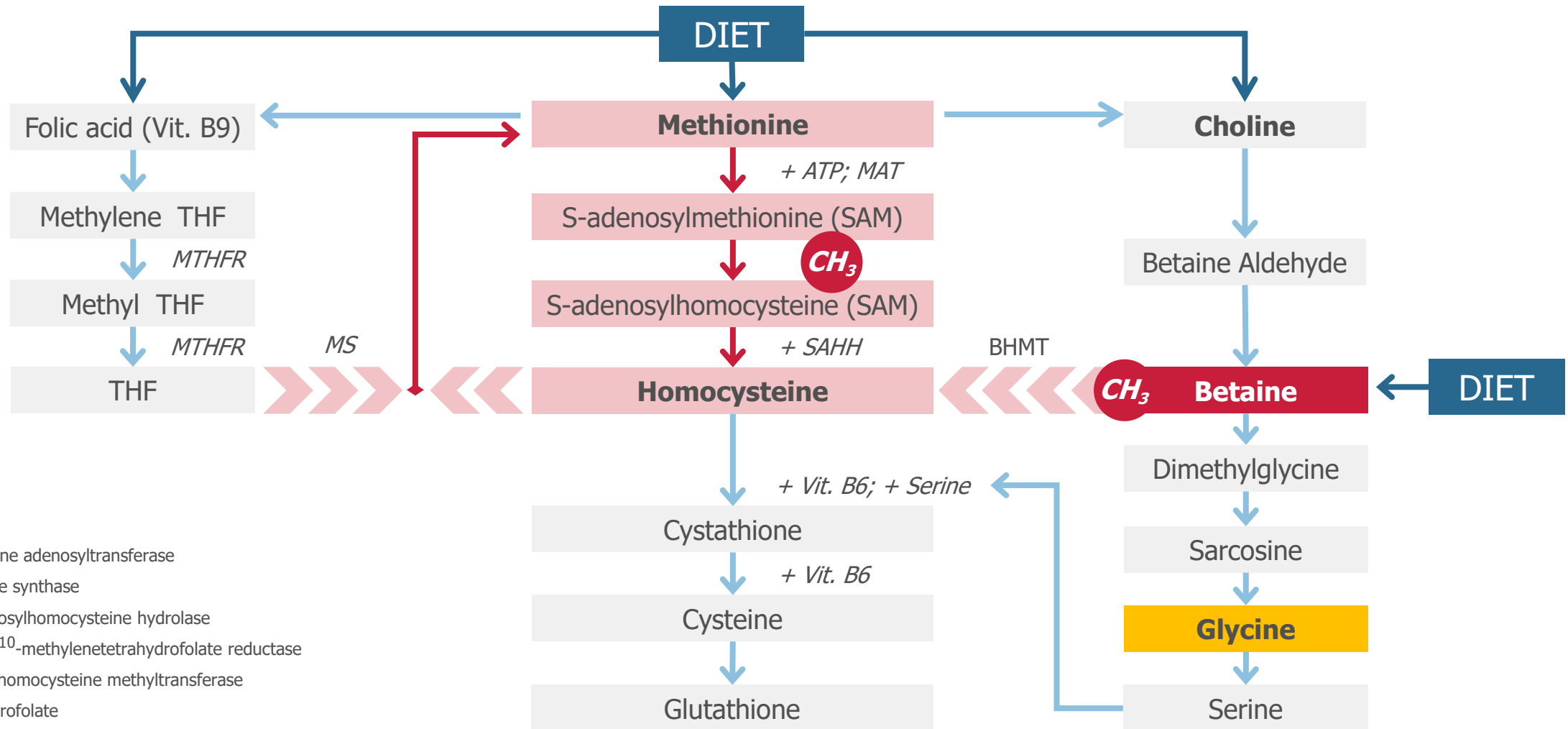
Choline

**Acetylcholine-  
Neurotransmission**



ACTIBEET® – NATURAL SOURCE OF BETAINE

# THE ROLE OF BETAINE AS A METHYL GROUP DONOR



MAT – Methionine adenosyltransferase  
MS – Methionine synthase  
SAHH – S-adenosylhomocysteine hydrolase  
MTHFR – N<sup>5</sup>, N<sup>10</sup>-methylenetetrahydrofolate reductase  
BHMT – Betainehomocysteine methyltransferase  
THF – Tetrahydrofolate



Diet



# ACTIBEET® – NATURAL SOURCE OF BETAININE

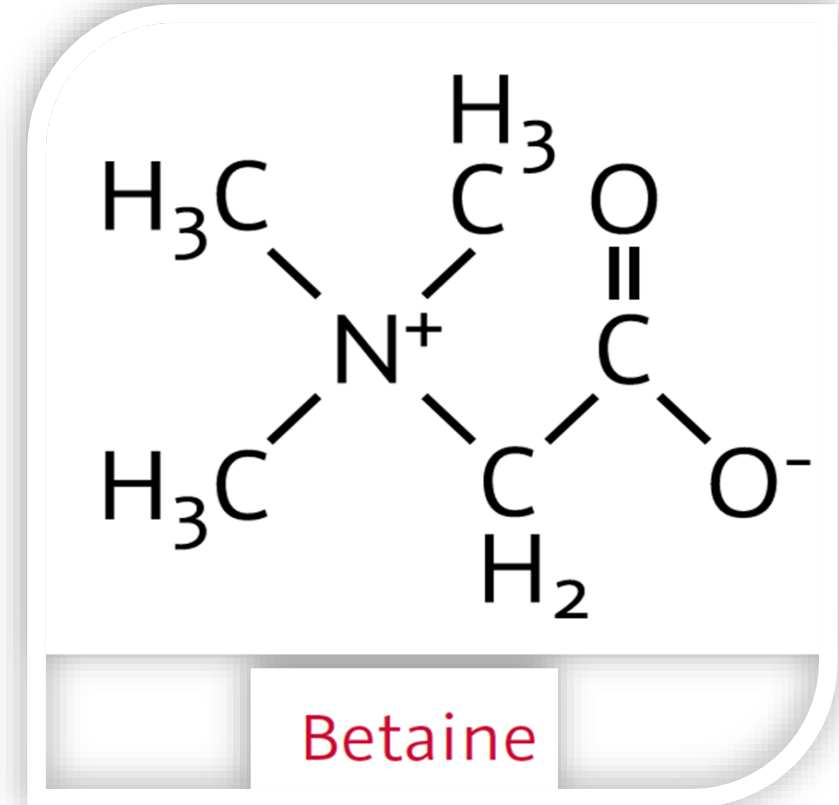
Betaine or trimethylglycine (TMG)



... has two main physiological functions:

**1** Methyl group donor

**2** Organic osmolyte





BETAINE OR TRIMETHYLGICINE

## ACTIBEET® – ORGANIC OSMOLYTE

### **Osmoregulation:**

The ability of a cell to maintain its structure and function by regulating movement of water in and out of the cell

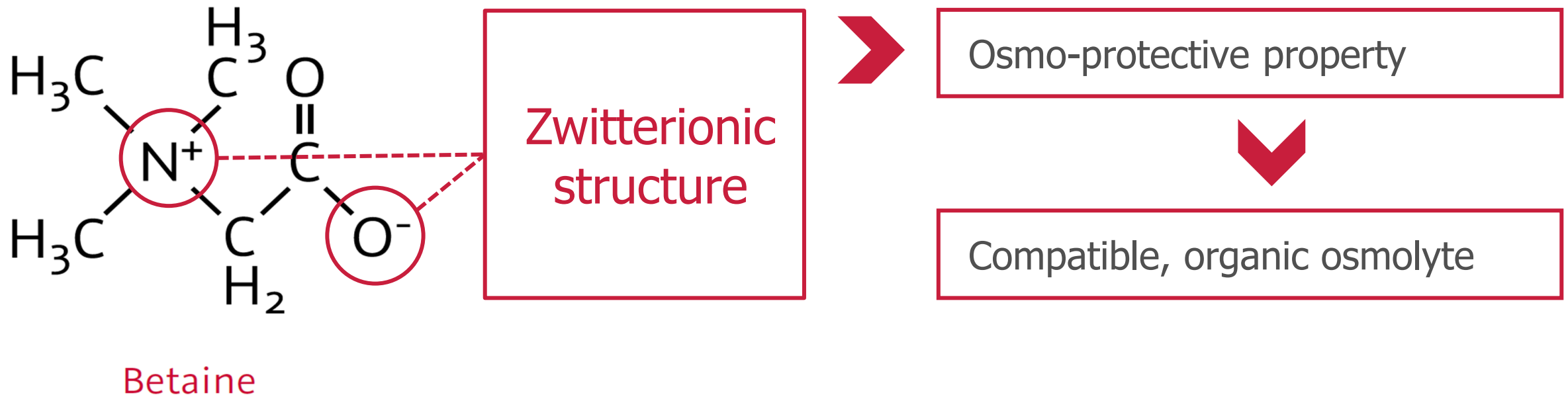




BETAINE OR TRIMETHYLGLICINE

# ACTIBEET® – ORGANIC OSMOLYTE

Betaine as an osmoprotectant in the osmoregulation:



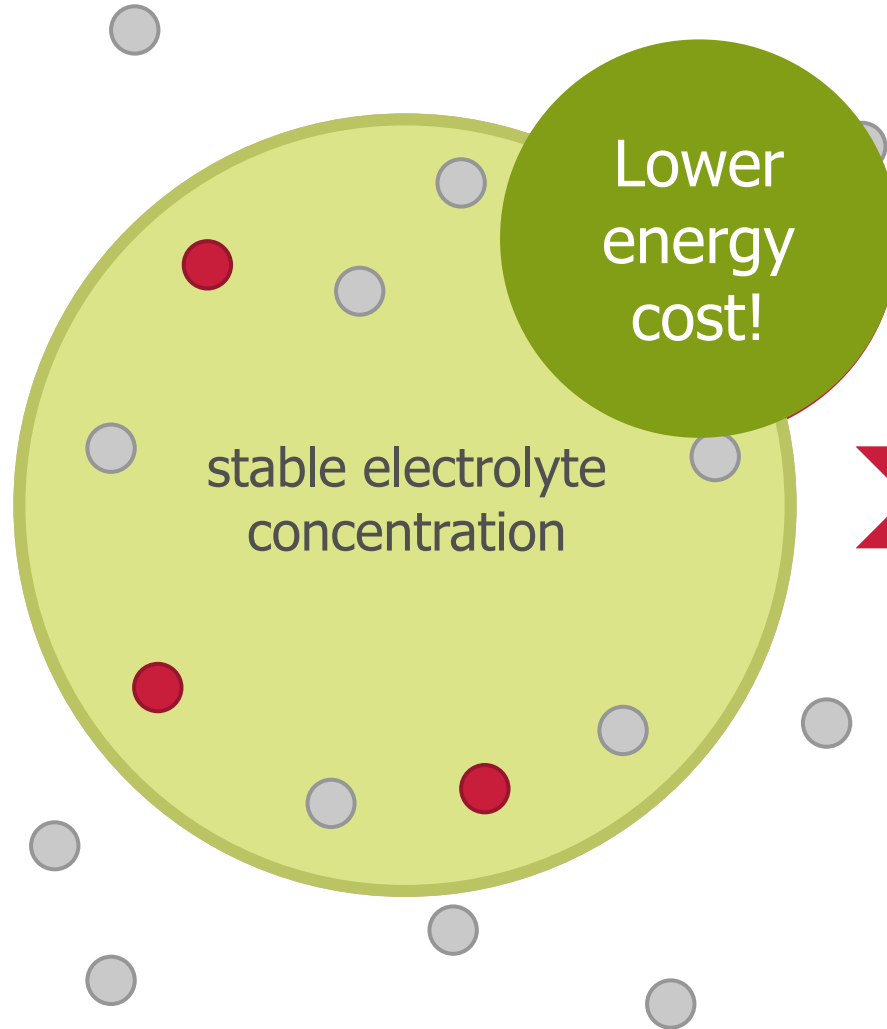




ACTIBEET® – NATURAL SOURCE OF BETAINE

# CHALLENGES OF HYPEROSMOTIC STRESS

**Increased**  
**ActiBeet®**  
**in the cell**



Perturbing inorganic ions are replaced by betaine as organic osmolyte  
**Depressed flux of metabolites of the cell**

**Water balance** maintained

**Cell volume restored and maintained**

ELECTROLYTE



BETAINE OR TRIMETHYLGLICINE

## ACTIBEET® – NATURAL SOURCE OF BETAINE

### 2. **Organic osmolyte** - osmoprotector

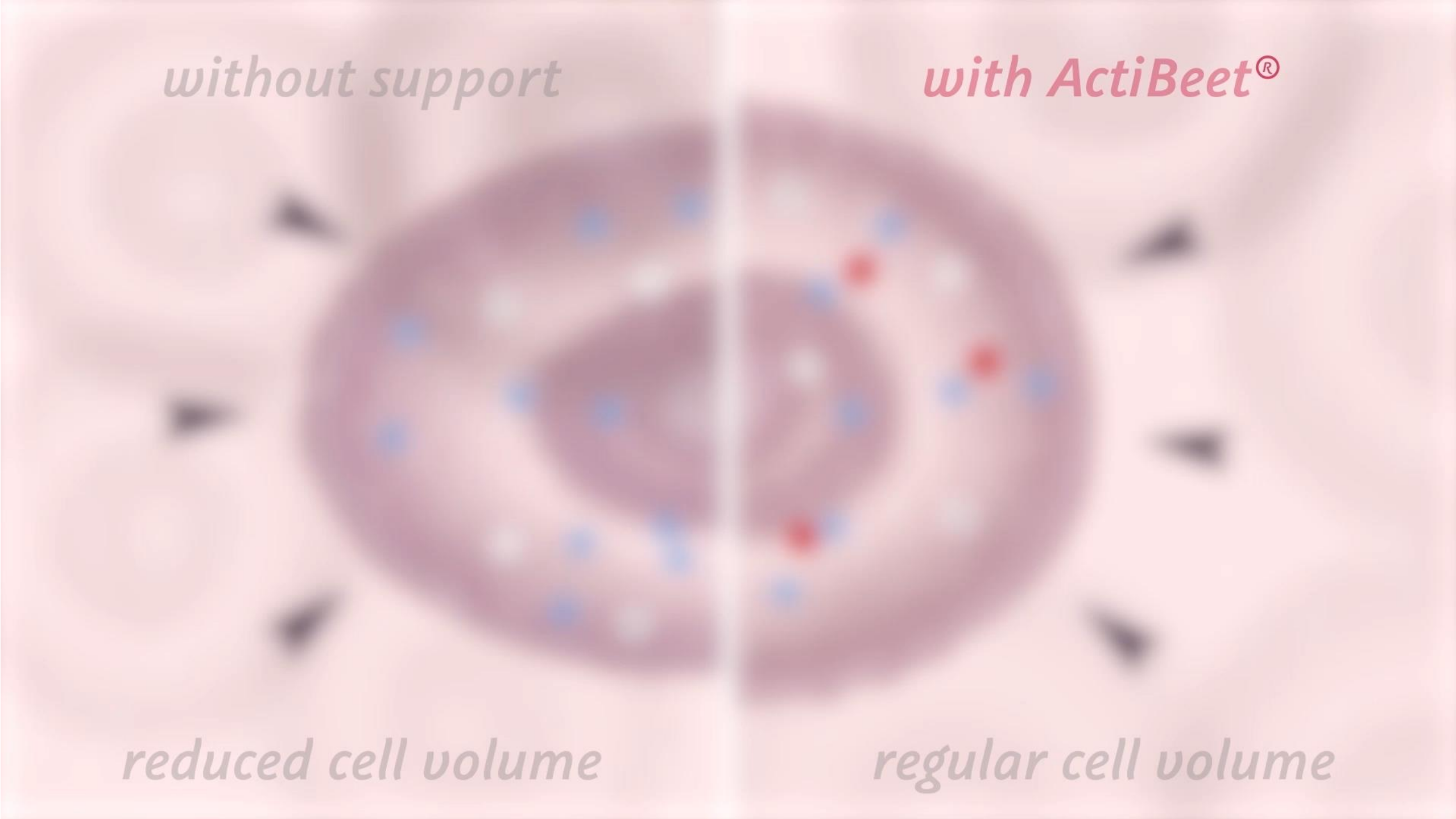
- Sustains the mineral and water balance, helps to maintain cell volume without disrupting normal functions, prevents dehydration (*Klasing et al., 2002*)
- Betaine increases the surface for nutrient absorption
- Highly compatible with cellular enzyme function, protects cellular enzymes and membranes against osmotic inactivation
- Promotes energy efficient osmoregulation

*without support*

*with ActiBeet<sup>®</sup>*

*reduced cell volume*

*regular cell volume*



*without support*



*intestinal villi*

*with ActiBeet<sup>®</sup>*



*intestinal villi*



BETAINE OR TRIMETHYLGLICINE

## ACTIBEET® – NATURAL SOURCE OF BETAINE

### **1. Methyl group donor & 2. Organic osmolyte**

- ***Supports animals in challenging conditions:***  
*heat stress, temperature stress, coccidial challenge...*
- ***It helps to increase performance and carcass quality, as well the efficiency for producers***



NATURAL BETAINE  
**TRIALS**





NATURAL BETAINE

## OVERVIEW TRIALS

### (1) Schothorst Feed Research 2014-2015

“The effect of four betaine products on replacing methionine and choline supplementation on growth performance in broiler chickens from 10 to 28 days of age”

### (2) NKP FARM 2016, Thailand

“Comparing the effects of different methyl group donors on the carcass quality of broilers in challenged conditions and the effect on the litter quality, from 0 to 38 days of age”

### (3) Schothorst Feed Research 2016

“The effect of betaine and crude protein level on performance responses of broiler chickens, from 0 to 21 days of age”



NATURAL BETAINE

## OVERVIEW TRIALS

### (1) Schothorst Feed Research 2014-2015

“The effect of four betaine products on replacing methionine and choline supplementation on growth performance in broiler chickens from 10 to 28 days of age”

### (2) NKP FARM 2016

“Comparing the effects of different methyl group donors on the carcass quality of broilers in challenged conditions and the effect on the litter quality, from 0 to 38 days of age”

### (3) Schothorst Feed Research 2016

“The effect of betaine and crude protein level on performance responses of broiler chickens, from 0 to 21 days of age”





R & D - TRIALS

## SCHOTHORST FEED RESEARCH (SFR)

### Research title:

**“The effect of four betaine products on replacing methionine and choline supplementation on growth performance in broiler chickens from 10 to 28 days of age”**

### Conducted by:

- P. Agostini, PhD-Schothorst Feed Research B.V.,
- DI Barbara Auer-Agrana Stärke GmbH,
- W. van Hofstraeten-Schothorst Feed Research B.V.,
- L. de Lange, MSc -Schothorst Feed Research B.V





## OBJECTIVES

1. What is the effect of BET in diets deficient in methionine and choline on productive performance of broilers during the grower phase (d 10–28)?
2. Can the quality of AGRANA BET products compete with other BET products?





# TEST PRODUCTS

<i>Test products</i>	<b>AGRANA natural Betaine dry product</b>	<b>AGRANA natural Betaine liquid product</b>	<b>Crystallized natural Betaine product</b>	<b>Crystallized synthetic Betaine product</b>
<i>Producer</i>	AGRANA Zucker	AGRANA Zucker		
<i>Active ingredients</i>	<b>Product A</b> Dry Natural Betaine - ActiBeet® VC	<b>Product B</b> Betaine liquid- ActiBeet® L	<b>Product C</b> Betaine anhydrous	<b>Product D</b> Betaine hydrochloride
<i>% of active ingredients</i>	<b>40%</b>	<b>40%</b>	<b>96%</b>	<b>70,7%</b>



# MATERIAL AND METHODS

## Animal and housing

- 840 Ross 308 broilers
- Males and females (split sexes)
- 42 pens (2 m<sup>2</sup>)
- 7 treatments \* 3 replications x 2 sexes \* 20 broilers \*
- Broilers arrival date > December 30<sup>th</sup>, 2014





## MATERIAL AND METHODS

- T1:** no added MET and CHOL  
→ d. M+C/d. Lys ratio = 0.63 (-10% of standard)
- T2:** T1 + 0.7 g/kg of MET from DL-MET  
→ d. M+C/d. Lys ratio = 0.70 (at standard)
- T3:** T1 + 0.7 g/kg CHOL from choline chloride – synthetic
- T4:** T1 + 0.7 g/kg BET from ActiBeet® VC – natural dry product
- T5:** T1 + 0.7 g/kg BET from ActiBeet® L – natural liquid
- T6:** T1 + 0.7 g/kg BET from Product C – natural crystallized
- T7:** T1 + 0.7 g/kg BET from Product D – synthetic crystallized





# RESULTS

Description	d. M+C (g/kg)	d. Lys (g/kg)	d.M+C/ d. Lys ratio	d 10-28			
				BWG (g)	FI (g)	FCR (g/g)	
<b>Treatment effect</b>							
NC	6.72	10.73	0.63	1303	<i>A</i>	1867	1.433 <i>c</i>
NC + MET (DL-Methionine)	7.42	10.73	0.70	1353	<i>B</i>	1884	1.393 <i>a</i>
NC + CHOL (choline chloride)	6.72	10.73	0.63	1308	<i>A</i>	1856	1.419 <i>bc</i>
NC + BET (ActiBeet® VC)	6.72	10.73	0.63	1342	<i>AB</i>	1865	1.390 <i>a</i>
NC + BET (ActiBeet® L)	6.72	10.73	0.63	1363	<i>B</i>	1905	1.399 <i>ab</i>
NC + BET (Product C)	6.72	10.73	0.63	1351	<i>B</i>	1889	1.398 <i>ab</i>
NC + BET (Product D)	6.72	10.73	0.63	1336	<i>AB</i>	1885	1.412 <i>abc</i>
<i>Lsd</i>				42		48	0.025
<i>P-value</i>				0.07		0.47	0.02
<b>Sex effect</b>							
Females				1254	<i>a</i>	1763	<i>a</i> 1.407
Males				1419	<i>b</i>	1994	<i>b</i> 1.406
<i>Lsd</i>				40		45	0.023
<i>P-value</i>				< 0.001		< 0.001	0.34

Lsd: least significant difference.

<sup>a-c</sup> Values without a common superscript within a column differ significantly ( $P \leq 0.05$ ).

<sup>A-B</sup> Values without a common superscript within a column tend to differ significantly ( $0.05 \leq P < 0.10$ ).



## CONCLUSION

- ✓ The negative control diet was limiting in methionine supply
- ✓ The addition of **700 ppm betaine** from ActiBeet<sup>®</sup> VC, ActiBeet<sup>®</sup> L or Product C- natural betaine **were able to fully replace equal amount of added methionine in the grower broiler diet** (d 10-28) when its d. M+C / d. Lys ratio was decreased by 10%, from 0,7 (d. M+C = 7.42 g/kg and d. Lys = 10.73 g/kg) to 0,63 (d. M+C = 6.72 g/kg and d. Lys = 10.73 g/kg).
- ✓ The addition of 700 ppm choline in a methionine deficient grower diet was not able to replace equal amount of added methionine.



NATURAL BETAINE

## OVERVIEW TRIALS

(1) Schothorst Feed Research 2014

“The effect of four betaine products on replacing methionine and choline supplementation on growth performance in broiler chickens from 10 to 28 days of age”

(2) NKP FARM 2016, Thailand

“Comparing the effects of different methyl group donors on the carcass quality of broilers in challenged conditions and the effect on the litter quality, from 0 to 38 days of age”

(3) Schothorst Feed Research 2016

“The effect of betaine and crude protein level on performance responses of broiler chickens, from 0 to 21 days of age”





R & D - TRIALS

## TRIAL CONDUCTED AT NKP FARM, THAILAND

Research title:

**“Comparing the effects of different methyl group donors on the carcass quality of broilers in challenged conditions and the effect on the litter quality, from 0 to 38 days of age”**

Conducted by:

- Saksit Srinongkote, Animal research consultant,
- Barbara Auer, Agrana Stärke GmbH,
- Ana Gavráu, Agrana Stärke GmbH,





TRIAL CONDUCTED AT NKP FARM, THAILAND

## OBJECTIVES

1. To compare the effects of two betaine products vs. choline chloride, in broilers fed low energy diet from newly hatched to 38 days of age in challenged heat stress condition
2. What is the effect of test products on the litter quality?
3. Can the AGRANA product compete with the test products?





TRIAL CONDUCTED AT NKP FARM, THAILAND

## MATERIAL AND METHODS

### Animal and housing

- 400 Ross 308 broilers
- newly hatched males
- 40 pens (1 m<sup>2</sup>)
- 5 treatments \* 8 replications \* 10 broilers
- Trial period (MAR 2 – APR 9, 2016)





TRIAL CONDUCTED AT NKP FARM, THAILAND

## TEST PRODUCTS

<i>Test products</i>	<b>AGRANA natural Betaine liquid product</b>	<b>Crystallized natural Betaine product</b>	<b>Crystallized synthetic Choline chloride product</b>
<i>Producer</i>	AGRANA Zucker		
<i>Active ingredients</i>	<b>Test product BET1</b> Betaine liquid-ActiBeet® L	<b>Test product BET2</b> Betaine anhydrous	<b>Test product CHOL3</b> Choline chloride
<i>% of active ingredients</i>	<b>40%</b>	<b>96%</b>	<b>50%</b>



TRIAL CONDUCTED AT NKP FARM, THAILAND

## MATERIAL AND METHODS

**Diet 1:** Positive control (PC) practical corn-SBM diet, according to Ross 308 nutritional guideline,

**Diet 2:** Negative control (NC) as diet 1, but with lower ME by 100 kcal/kg,

**Diet 3:** NC + Test betaine product 1 BET1 – ActiBeet® L 40% (liquid, natural source of betaine- AGRANA)

**Diet 4:** NC + Test betaine product 2 BET2 – crystallised, natural betaine product 96%,

**Diet 5:** NC + Test product 3 CHOL3 – choline chloride 50%, synthetic product.





## TRIAL CONDUCTED AT NKP FARM, THAILAND





TRIAL CONDUCTED AT NKP FARM, THAILAND

## RESULTS

**Table 1. Effect of different methyl donor products on carcass traits of broilers (38 day of age)**

<b>Treatment group</b>	<b>Breast meat (%)</b>	<b>Thigh (%)</b>	<b>Drum stick (%)</b>	<b>Abdominal fat (%)</b>
T1 : PC diet	27.12	16.47	13.25	2.49
T2 : NC diet (-100 kcal ME/ kg)	26.43	16.90	13.83	2.45
T3 : NC + BET1	27.74	16.15	13.38	2.44
T4 : NC + BET2	27.12	16.44	13.49	2.46
T5 : NC + CHOL3	27.09	17.00	13.29	2.58
<i>P-value</i>	<i>0.5359</i>	<i>0.2536</i>	<i>0.1236</i>	<i>0.9948</i>
<i>Pooled SEM</i>	<i>0.520</i>	<i>0.295</i>	<i>0.163</i>	<i>0.046</i>
<i>C.V.%</i>	<i>5.42</i>	<i>5.03</i>	<i>3.42</i>	<i>7.04</i>



TRIAL CONDUCTED AT NKP FARM, THAILAND

## RESULTS

**Table 2. Effect of different methyl donor products on litter of broilers (38 days of age)**

<b>Treatment group</b>	<b>Litter Score<sup>1</sup> (score)</b>	<b>Litter DM (%)</b>	<b>Litter Moisture (%)</b>
T1 : PC diet	1.75	74.70	25.30
T2 : NC diet (-100 kcal ME/ kg)	1.69	74.93	25.07
T3 : NC + BET1	1.44	78.36	21.64
T4 : NC + BET2	1.38	78.07	21.93
T5 : NC + CHOL3	1.56	76.84	23.16
<i>P-value</i>	<i>0.5339</i>	<i>0.5115</i>	<i>0.5175</i>
<i>Pooled SEM</i>	<i>0.178</i>	<i>1.874</i>	<i>1.871</i>
<i>C.V.%</i>	<i>32.20</i>	<i>6.92</i>	<i>22.57</i>

<sup>1</sup> Litter samples collected from the middle of the pen using a 20 cm diameter sampling ring. Visual scoring on the scale of 1-3, where 1 = Good (light brown color and quite dry), 2 = Fair (brown color and quite wet) and 3 = Poor (dark brown color and wet)





TRIAL CONDUCTED AT NKP FARM, THAILAND

## RESULTS

Why is litter quality of importance?



- Gut health and litter quality are directly linked
- Wet litter can lead to further complications
- Relevant to bird welfare



TRIAL CONDUCTED AT NKP FARM, THAILAND

## RESULTS

Why is litter quality of importance?



- Dry litter



- Wet litter



TRIAL CONDUCTED AT NKP FARM, THAILAND

## CONCLUSION

- ✓ Despite lower ME, improvement in breast meat yield and lower abdominal fat content were observed by supplementing natural betaine products (table 1).
- ✓ All methyl donor products could improve litter quality by reducing the score of visual litter assessment and litter's moisture content; better results were achieved with ActiBeet® L - showing the lowest moisture content in the litter!



NATURAL BETAINE

## OVERVIEW TRIALS

### (1) Schothorst Feed Research 2014

“The effect of four betaine products on replacing methionine and choline supplementation on growth performance in broiler chickens from 10 to 28 days of age”

### (2) NKP FARM 2016

“Comparing the effects of different methyl group donors on the carcass quality of broilers in challenged conditions and the effect on the litter quality, from 0 to 38 days of age”

### (3) Schothorst Feed Research 2016

“The effect of betaine and crude protein level on performance responses of broiler chickens, from 0 to 21 days of age”



R & D - TRIALS

# SCHOTHORST FEED RESEARCH (SFR)

Research title:

**“The effect of betaine and crude protein level on performance responses of broiler chickens, from 0 to 21 days of age”**

Conducted by:

- P. Agostini, PhD, Schothorst Feed Research B.V.,
- DI Barbara Auer, AGRANA Stärke GmbH,
- Ana Gavráu (MSc), AGRANA Stärke GmbH,



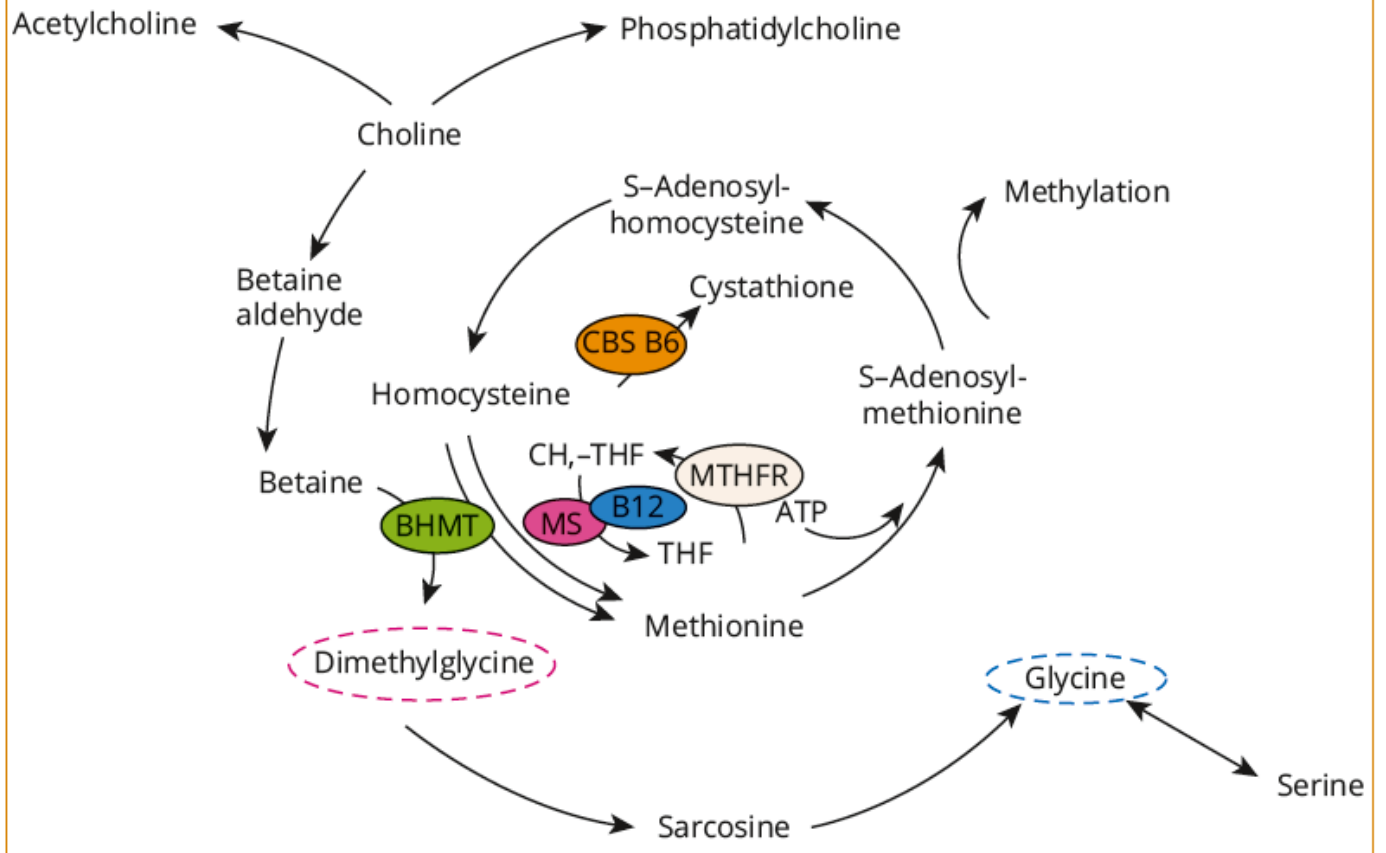


# SCHOTHORST FEED RESEARCH (SFR)

## Non-essential, but important!

Even though glycine is considered a non-essential amino acid (NEAA), it became an important issue in the last years due to the reduction of crude protein (CP) content in diets for monogastric animals. When CP is reduced more than 3%, glycine and serine levels can decrease drastically which can result in lower performance responses (Ospinas-Rojas *et al.* 2013).

Figure 1 - Simplified v, choline and betaine (adapted from Craig, 2004).





R & D - TRIALS

# SCHOTHORST FEED RESEARCH (SFR)

Glycine multi-functionalities in nitrogen, amino acid and energy metabolism (adapted from Akinde, 2004):

As precursors and co-substrates	End products/biosynthetic pathways
<b>1) Nitrogen and energy metabolism</b>	
<b>Glycine</b>	An inhibitory transmitter within the amino acidergic neurotransmitter system
<b>Glycine, serine and methionine</b>	Methyl group trafficking
<b>Glycine in hormonal syntheses</b>	Synthesis of steroids- e.g. cortisone-like, androgenic and estrogenic hormones
<b>Glycine</b>	Sarcosine
<b>Glycine, glutamine and aspartate</b>	Uric acid (a purine)
<b>Glycine</b>	Glucogenic amino acid, feeding into the citric acid cycle via serine and then pyruvate
<b>Glycine, arginine, methionine/betaine</b>	Creatine
<b>Glycine and taurine</b>	Bile acids
<b>Glycine, cysteine and glutamate</b>	Glutathione
<b>Glycine, glutamate &amp; aspartate</b>	Nucleic acid bases (DNA, RNA) and purines
<b>2) Amino acid metabolism</b>	
<b>Glycine</b>	Collagen, keratin, elastin
<b>Glycine</b>	Serine
<b>Glycine</b>	Threonine catabolism
<b>Glycine and serine</b>	Methionine & cysteine biosynthesis
<b>Glycine, serine and threonine</b>	Glycosylated proteins in mucins



## OBJECTIVES

- The trial aimed to determine the effect of BET supplementation in diets with mid-low CP and glycine levels, on productive performance of broiler chickens from day 0-21 of age.







# TEST PRODUCTS

<i>Test products</i>	<b>AGRANA- natural Betaine liquid product</b>	<b>AGRANA- natural Betaine dry product</b>	<b>AGRANA- natural Betaine dry product</b>
<i>Producer</i>	AGRANA Zucker	AGRANA Zucker/ ARIC	AGRANA Zucker/ ARIC
<i>Active ingredients</i>	<b>ActiBeet® L</b> liquid	<b>ActiBeet® VC</b> complementary feed	<b>ActiBeet® SD</b> spraydried
<i>% of active ingredients</i>	<b>40%</b>	<b>40%</b>	<b>50%</b>



# MATERIAL AND METHODS

## Animal and housing

- 480 one-d-old Ross 308
- male broilers
- 24 pens (2 m<sup>2</sup>)
- 4 treatments \* 6 replications \* 20 broilers
- Broilers arrival date: May 9<sup>th</sup>, 2016





# MATERIAL AND METHODS

## Experimental treatments:

Starter phase (day 0-7)						
Treatment	N Crude protein <sup>1</sup> (%)	ML Crude protein (%)	d. M+C/ d. Lys	N d. G+S <sup>2</sup>	ML d. G+S <sup>2</sup>	Betaine <sup>3</sup> - 700 ppm/ kg
				(g/kg)	(g/kg)	
<b>1</b>	22.3	21	0.7	17.23	15.90	No (Control)
<b>2</b>	22.3	21	0.7	17.23	15.90	ActiBeet L
<b>3</b>	22.3	21	0.7	17.23	15.90	ActiBeet VC
<b>4</b>	22.3	21	0.7	17.23	15.90	ActiBeet SD
Grower phase (day 7-21)						
Treatment	N Crude protein <sup>1</sup> (%)	ML Crude protein (%)	d. M+C/ d. Lys	N d. G+S <sup>2</sup>	d. G+S <sup>2</sup>	Betaine <sup>3</sup> - 600 ppm/ kg
				(g/kg)	(g/kg)	
<b>1</b>	21.5	20.2	0.7	16.64	15.28	No (Control)
<b>2</b>	21.5	20.2	0.7	16.64	15.28	ActiBeet L
<b>3</b>	21.5	20.2	0.7	16.64	15.28	ActiBeet VC
<b>4</b>	21.5	20.2	0.7	16.64	15.28	ActiBeet SD

<sup>1</sup> Crude protein level was reduced by around 5-6%, keeping the essential amino acids at normal levels; **d.M+C/ d.Lysin ratio** was the same in both **0,7**

<sup>2</sup> Digestible glycine + serine level was reduced by around 7-8%;

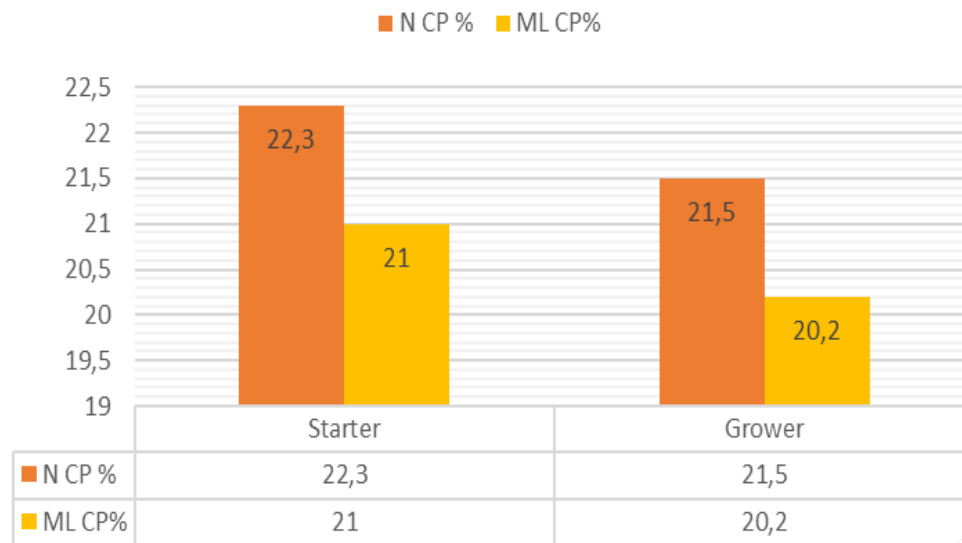
<sup>3</sup> 700 and 600 ppm of active betaine was added in the starter and grower diets, respectively.



# MATERIAL AND METHODS

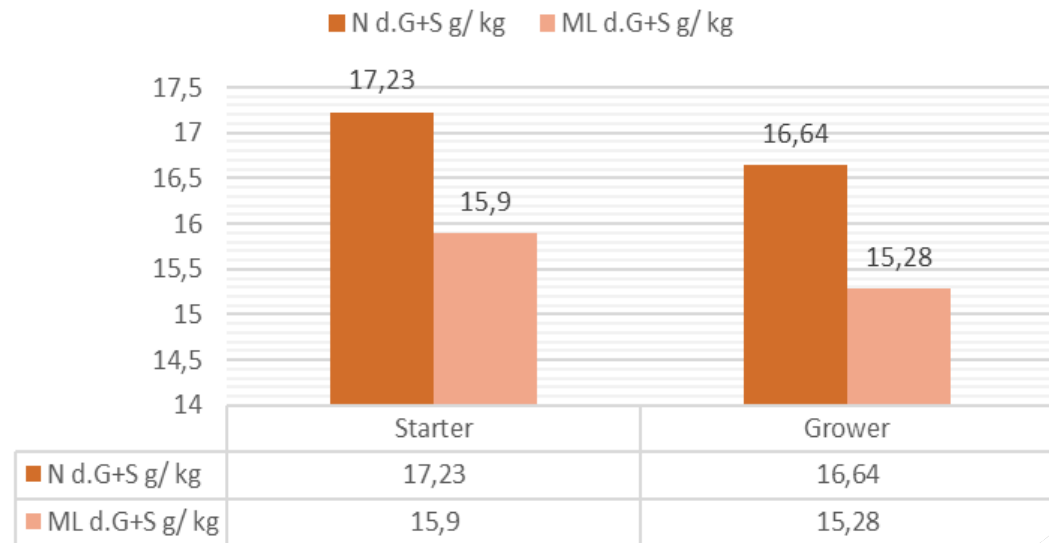
## Experimental treatments:

### CP Levels lowered by 5-6%



N CP – normal crude protein levels  
ML CP – mid-low crude protein levels

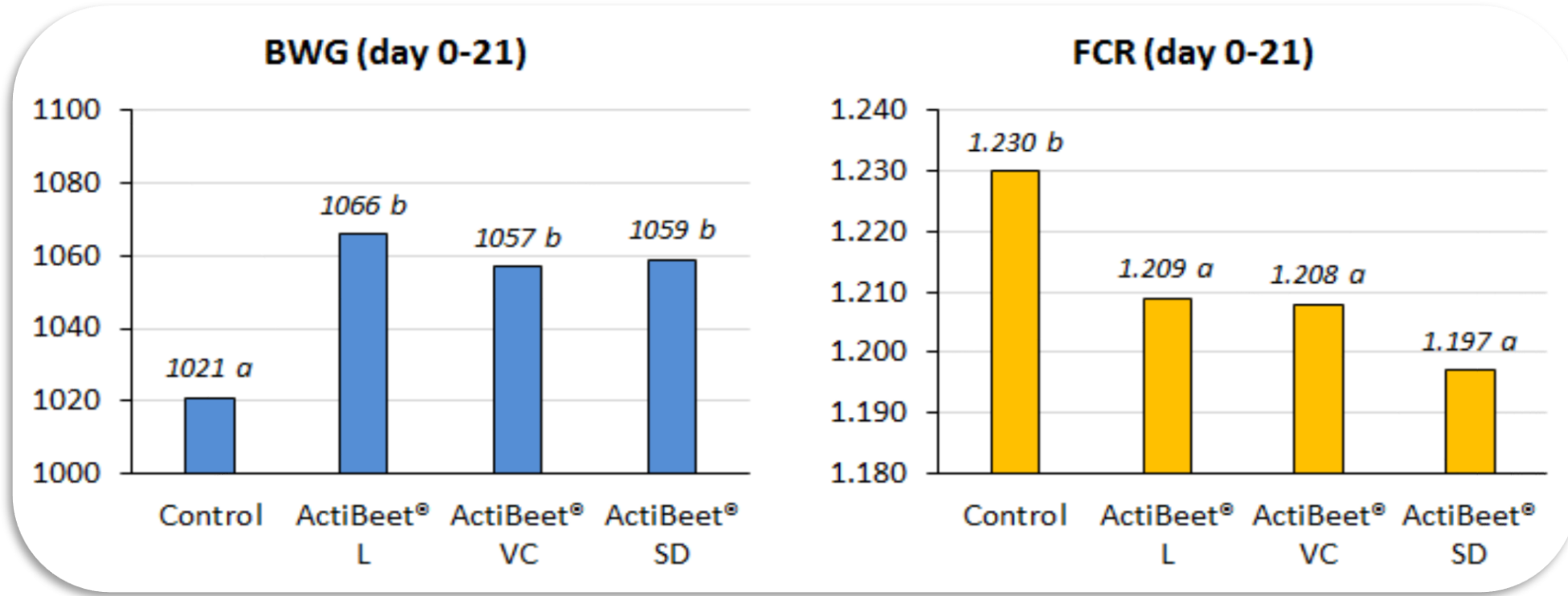
### d.G+S Levels 7-8%



Digestible glycine + serine levels  
in the starter and grower phase



# RESULTS



**Figure 1.** Body weight gain (BWG) of broilers from day 0-21 of age fed diets low in crude protein with different betaine products.

**Figure 2.** Feed conversion ratio (FCR) of broilers from day 0-21 of age fed diets low in crude protein with different betaine products.



## CONCLUSION

- ✓ A significant effect for BWG and FCR was observed from day 0-21 of age. Diets containing either ActiBeet L, ActiBeet VC or ActiBeet SD resulted in higher BWG and better FCR compared with the diet without BET.

### **The use of betaine in diets with:**

- mid-low CP and lower glycine plus serine levels,
- low levels of choline and
- with normal levels of essential amino acids,

**can improve performance of broilers up to day 21 of age.**



# DOSAGE RECOMMENDATION





## DOSAGE RECOMMENDATION



**STANDARD DOSAGE RECOMMENDATION: 1 kg/t (0,1 %) of finished feed**

### STRATEGIC DOSAGE RECOMMENDATION:



**For hot climate, heat stress or other challenging conditions:\***

**Inclusion rate  
in kg/t of finished feed**

**Nutritional value of betaine  
in mg/kg of finished feed**

ActiBeet®

1-1.5

1000-1400

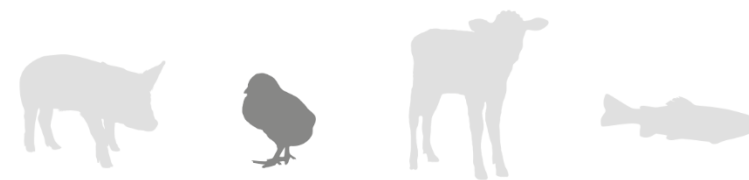
*\*\*) as reference please see AGRANA Trial conducted in Thailand. For detailed information, please contact AGRANA.*





## DOSAGE RECOMMENDATION

# POULTRY



### STRATEGIC DOSAGE RECOMMENDATION:

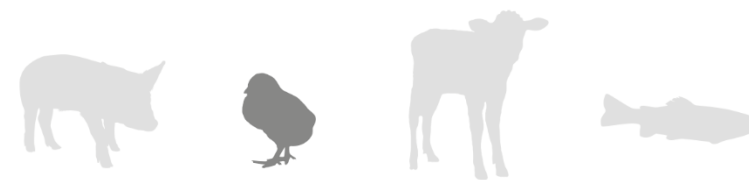
<b>For choline replacement (from choline chloride)</b> <i>For removal of total added choline chloride:**</i>		<b>Inclusion rate</b> <i>in kg/t of finished feed</i>	<b>Nutritional value of betaine</b> <i>in mg/kg of finished feed</i>
<b>Broiler starter</b>	ActiBeet®	0.50	480
<b>Broiler grower</b>	ActiBeet®	0.35	330
<b>Broiler finisher</b>	ActiBeet®	0.25	240
<b>Broiler breeder</b>	ActiBeet®	0.25–0.50	240–480
<b>Layer breeder</b>	ActiBeet®	0.25–0.35	240–330
<b>Commercial Layer</b>	ActiBeet®	0.25	240
<b>Turkey</b>	ActiBeet®	0.55	530
<b>Turkey breeder</b>	ActiBeet®	0.65–0,85	620–810

*\*) For detailed information, please contact AGRANA.*



## DOSAGE RECOMMENDATION

# POULTRY



For cholinechloride replacement	Replacement of Cholinechloride by ActiBeet®	Inclusion rate in kg/t of finished feed	Nutritional value of betaine in mg/kg of finished feed
<b>ActiBeet® 96%</b>	ActiBeet: Choline chloride	1.00	960
<b>Cholinechloride 50%</b>	0,36 : 1,50 (1:4)	0,36	347
<b>Cholinechloride 60%</b>	0,36 : 1.25 (1:3.5)	0,36	347
<b>Cholinechloride 75%</b>	0,36 : 1.00 (1:2,77)	0,36	347

### Coefficient of equivalence:

**1 mg Betaine = 2,16 mg Choline;** for e.g. 347 mg Betaine = 749,52 mg Choline

		Dosage / 100kg	Dosage / 1000kg		Dosage / 1000kg	
Choline chloride	50	0,150	1,50	750	1,20	600
Choline chloride	60	0,125	1,25	750	1,00	600
Choline chloride	75	0,100	1,00	750	0,80	600
<b>ActiBeet®</b>	<b>96</b>	<b>0,036</b>	<b>0,36</b>	<b>347</b>	<b>0,29</b>	<b>278</b>



DOSAGE RECOMMENDATION

## POULTRY



### Coefficient of equivalence:

**1 mg Betaine = 2,16 mg Choline;** for e.g. 347 mg Betaine = 749,52 mg Choline

### Why?

**Chemical equivalence between choline chloride and betaine:**

$$139.6 / 117.15 = 1.1916$$

**Correction considering the bioeffectiveness of choline compared to betaine is approx. 55%;** (*Result of the study of Saarinen et al. 2001: "dietary betaine is nearly twice as efficient as the same mole equivalent level of choline for increasing liver betaine levels"*)

$$1.1916 / 0.55 = 2.167$$



## DOSAGE RECOMMENDATION

# POULTRY



### Total Choline level in the feed according to the ROSS 308 nutritional guide:

MINIMUM SPECIFICATION				
Choline per kg	mg	1700	1600	1550
Linoleic Acid	%	1.25	1.20	1.00

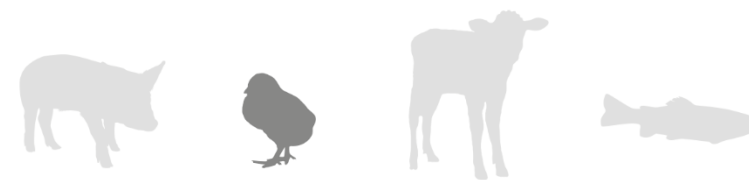
### Vitamin Bioavailability (source DSM):

„Bioavailability of choline, niacin and vitamin B6 is adequate in some feeds but limited or variable in others. For example, bioavailability of choline is 100% in corn but varies from 60 to 75% in soybean meal“.



## DOSAGE RECOMMENDATION

# POULTRY



### Analysis results\* on native Choline level in raw materials:

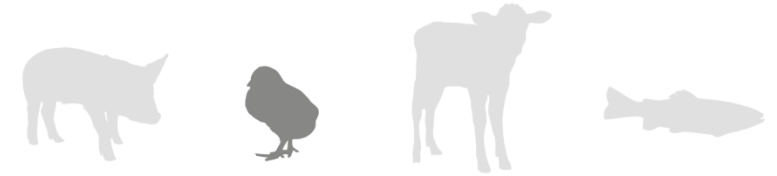
Feed materials	native Choline content expected in mg/ kg	native Choline content analysed in mg/ kg	Bioavailability 50% (average)	Feed composition e.g.	total native choline in mg/ kg	Min. total bioavailable native choline in mg/ kg
Rapeseed meal_404427	6500	5280	2640	9,5	501,6	250,8
Sunflower meal_401842	3500	2390	1195	8	191,2	95,6
DDGS_404466	2500	3780	1890	10	378	189
SBM_404743	2600	2640	1320	22	580,8	290,4
Wheat_404791	1000	1320	660	10	132	66
Corn_404037	500	632	316	40	252,8	126,4
				99,5	<b>2036,4</b>	<b>1018,2</b>
			Premix 0,5%	0,5		
				100		

\* LUFA Nord-West - Institut für Futtermittel - Jägerstraße 23-27 - 26121 Oldenburg



## DOSAGE RECOMMENDATION

# POULTRY



**For methionine sparing effect:\*\*\***

**Inclusion rate  
in kg/t of finished feed**

**Nutritional value of betaine  
in mg/kg of finished feed**

ActiBeet®

0.75

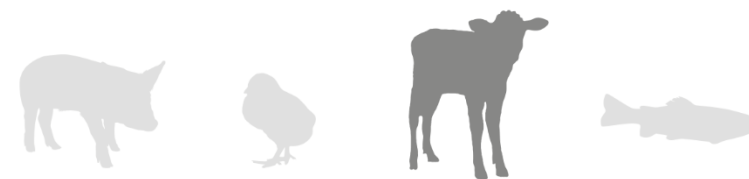
720

- *as refererence please see AGRANA Trial in Schothorst; for detailed information please contact AGRANA;*
- *please consider that a min. of 6.5 g/kg feed, the level of digestible M+C, should be ensured; only in good conditions a partial replacement of the total methionine is a recommended and safe strategy.*



## DOSAGE RECOMMENDATION

# RUMINANTS



### DOSAGE RECOMMENDATION IN THERMONEUTRAL CONDITIONS (UP TO 21°C):

		Dosage recommendation in g/head/day	Nutritional value of betaine in g/head/day
<b>Dairy cattle</b> – moderate milk yield < 35 kg milk/day	ActiBeet®	20.8–41	20–40
<b>Dairy cattle</b> – high milk yield > 35 kg milk/day	ActiBeet®	41–62.5	40–60
<b>Beef cattle</b>	ActiBeet®	20.8–32	20–30
<b>Small ruminants</b> – sheep and goats	ActiBeet®	4.2	4

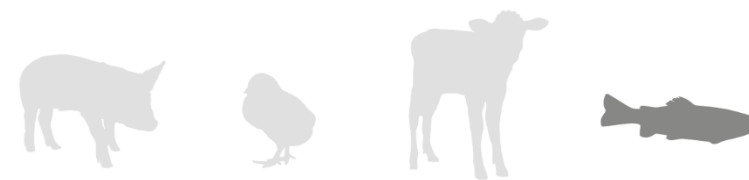
### DOSAGE RECOMMENDATION FOR HOT CLIMATE – HEAT STRESS CONDITIONS:

		Dosage recommendation in g/head/day	Nutritional value of betaine in g/head/day
<b>Dairy cattle</b> – moderate milk yield < 35 kg milk/day	ActiBeet®	10.5–20.8	10–20
<b>Dairy cattle</b> – high milk yield > 35 kg milk/day	ActiBeet®	26–37.5	25–36
<b>Beef cattle</b>	ActiBeet®	10.5–20.8	10–20
<b>Small ruminants</b> – sheep and goats	ActiBeet®	2.1	2



## DOSAGE RECOMMENDATION

# AQUACULTURE



		Inclusion rate in kg/t of finished feed	Nutritional value of betaine in mg/kg of finished feed
<b>Aquaculture</b>	ActiBeet®	2 – 10	2000-10.000

➤ **Major Aqua Species:** rainbow trout respectively salmon, tilapia and shrimps;







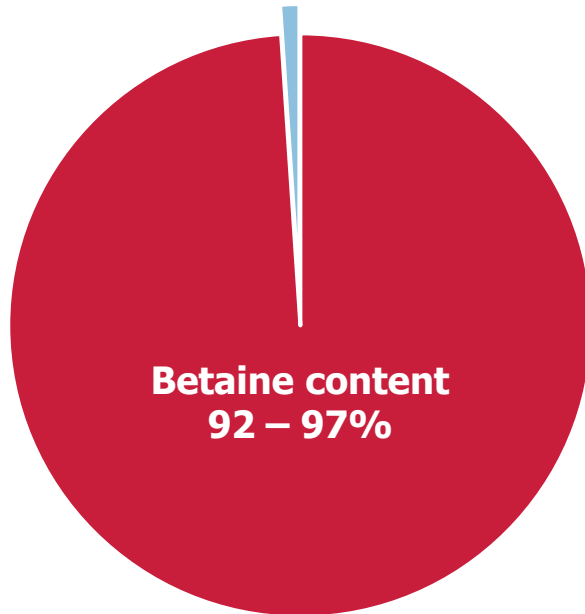
# NATURAL BETAININE VS SYNTHETIC BETAININE



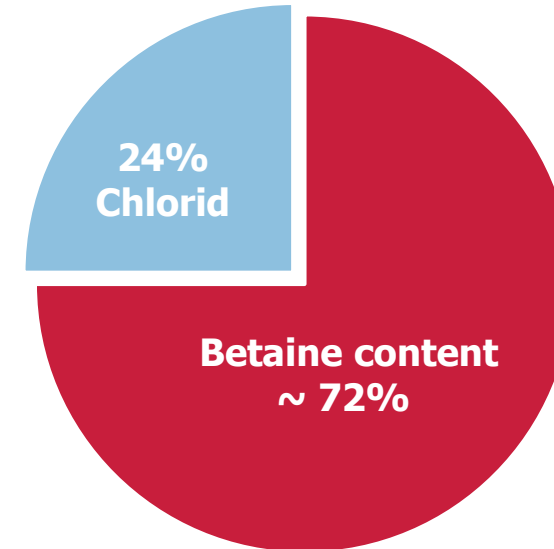
## BETAINE CONTENT

# NATURAL BETAINE vs. SYNTHETIC BETAINE HCL

### Natural Betaine



### Synthetic Betaine HCl declared with 96% Betaine content



- Betaine HCL on the market consists only of approx. 72% betaine content



## TMA CONTENT

# NATURAL BETAINE, BETAINE HCL AND CHOLINE CHLORIDE

**Trimethylamines (TMA)** - natural products contain very low TMA

- TMA content in synthetic products > 200 ppm than permitted
- show differences between products & batches
- are highly corrosive in nature
- can cause toxicity in birds
- it causes sloughing of the intestinal mucosa
- malabsorption - reduced nutrient utilization
- creates discomfort to the respiratory tract
- restricted feeding
- reduced production performance

*Source: Engormix*



## TMA CONTENT

# NATURAL BETAINE, BETAINE HCL AND CHOLINE CHLORIDE

### Quality varies among Choline Chloride samples

- 18 samples from 25 are not achieve the declared choline level
- 7 samples from 25 are showing high or very high TMA levels: **13450 mg/ kg**

sample#	Ccgrade	Choline content		TMA	Salts				
		CC	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



# NATURAL BETAINE, BETAINE HCL AND CHOLINE CHLORIDE

**EFSA Journal 2012-** the “Scientific Opinion on the safety and efficacy of aliphatic and aromatic amines: 3-methylbutylamine, trimethylamine and its salt”:

The compounds under application are well **recognised as being corrosive** to the **eye** and **strongly irritant** or corrosiv to the **skin** and known irritant to the respiratory tract.

For trimethylamine and its salt the proposed high use level (5 mg/kg feed) is safe for all animal species with a margin of safety ranging between 3 and 15.



## TMA CONTENT

# NATURAL BETAININE, BETAININE HCL AND CHOLINE CHLORIDE

### Prüfbericht

Seite 1 von 1

Kunden-Nr.:	849503	Eingangsdatum:	12.01.2016
Analysen-Nr.:	31 16 000881	Ende der Prüfung:	26.01.2016
Beginn der Prüfung:	12.01.2016		
Befindlich in:	Glas		
Probenart:	Sonstige Proben		
Bezeichnung:	Cholinchlorid		

#### Ergebnis in der Originalsubstanz

**Trimethylamin**

**649 mg/kg**

Methode: §64 LFGB L 10.00-4; #5





## TMA CONTENT

# NATURAL BETAINE, BETAINE HCL AND CHOLINE CHLORIDE

### Prüfbericht

AGRANA  
RESEARCH & INNOVATION CENTER GMBH

Oldenburg, 06.09.2016

Seite 1 von 1

Berichts-Version: 1

Kunden-Nr.:	50160337	Probeneingang:	26.08.2016
Auftrags-Nr.:	398489	Untersuchungsbeginn:	26.08.2016
<b>Proben-Nr.:</b>	<b>16FU007667</b>	Untersuchungsende:	06.09.2016
Probenart:	Vitamine und Provitamine		
Befindlich in:	Polyflasche		
Bezeichnung:	Probe 1: Cholinchlorid - flüssig		
Probenehmer:	durch Auftraggeber		

### Ergebnis in der Originalsubstanz

<b>Trimethylamin</b> <i>Methode: ASU L 10.00-4; 1988-12; #5; #6</i>	1011 mg/kg
<b>Schwefel (S)</b> <i>Methode: BVL F 0096; 2013-04</i>	<0,02 %

Im Auftrag

  
Dr. Michael Egert  
Institutsleiter





## TMA CONTENT

# NATURAL BETAINE, BETAINE HCL AND CHOLINE CHLORIDE

### Zusammenfassung

Oldenburg, 06.09.2016

Seite 1 von 1

Berichts-Version: 1

Kunden-Nr.:	50160337	Probeneingang:	26.08.2016
Auftrags-Nr.:	398489	Untersuchungsbeginn:	26.08.2016
<b>Proben-Nr.:</b>	<b>16FU007668</b>	Untersuchungsende:	06.09.2016
Probenart:	sonstige Zusatzstoffe		
Befindlich in:	Röhrchen		
Bezeichnung:	Probe 2: Betain HCL - kristallin		
Probenehmer:	durch Auftraggeber		

### Ergebnis in der Originalsubstanz

<b>Trimethylamin</b>	1732 mg/kg
<i>Methode: ASU L 10.00-4; 1988-12; #5; #6</i>	
<b>Schwefel (S)</b>	<0,05 %
<i>Methode: BVL F 0096; 2013-04</i>	

Im Auftrag

  
Dr. Michael Egert  
Institutsleiter







## TMA CONTENT

# NATURAL BETAINE, BETAINE HCL AND CHOLINE CHLORIDE

### Prüfbericht

Seite 1 von 1

Kunden-Nr.:	849503	Eingangsdatum:	12.01.2016
Analysen-Nr.:	31 16 000878	Ende der Prüfung:	26.01.2016
Beginn der Prüfung:	12.01.2016		
Befindlich in:	Dose		
Probenart:	Melasse		
Bezeichnung:	Betainmelasse - Muster 2		

#### Ergebnis in der Originalsubstanz

#### Trimethylamin

20,2 mg/kg

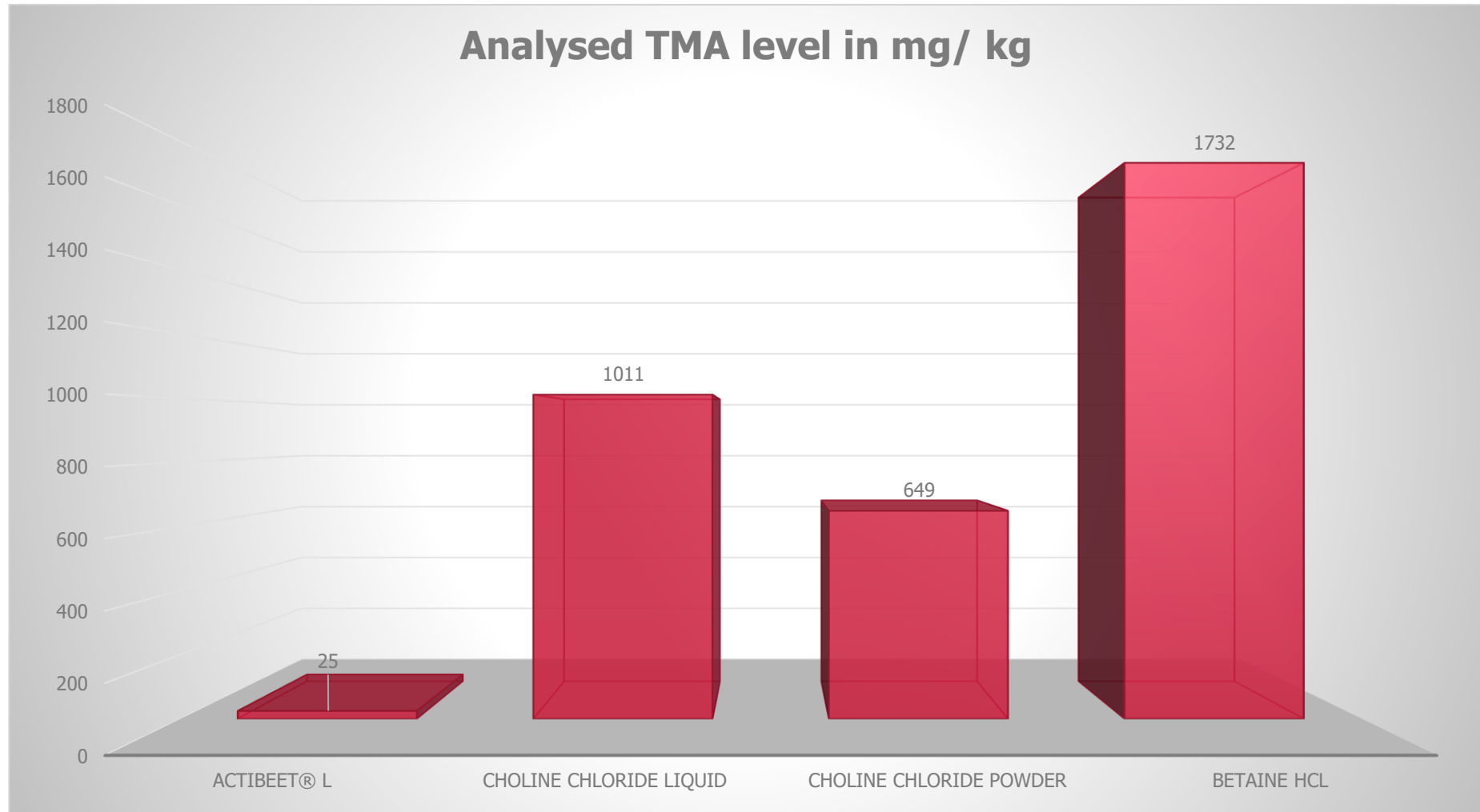
Methode: §64 LFGB L 10.00-4; #5





## TMA CONTENT

# NATURAL BETAINE, BETAINE HCL AND CHOLINE CHLORIDE






ACTIBEET

# NATURAL vs. SYNTHETIC BETAINE

	ActiBeet®	Betaine hydrochloride (HCl)/Cholinechloride
<b>Production process</b>	Natural from sugar beet	Synthetic chemical
<b>Residues</b>	↓	↑
<b>Trimethylamines (TMA) content</b>	20 – 25 mg/kg	> 200 – 1730 mg/kg
<b>Chloride content and pH level=&gt; Corrosivity</b>	0.03 %; pH 6,7-10=> no corrosivity	> 14.5 %; pH 1-5=> high corrosivity
<b>Water solubility</b>	↑	↓
<b>Osmoprotection</b>	↑	↓



## WHY ADDING ACTIBEET® ?

- 
- ✓ Natural product – not chemically synthesised
  - ✓ Labeling "NATURAL" is possible
  - ✓ Suitable for organic feed production
  - ✓ Multi-species applications
  - ✓ Non- aggressive, non- corrosive
  - ✓ Heat stable

 **ActiBeet®**





ACTIBEET® – NATURAL SOURCE OF BETAINE



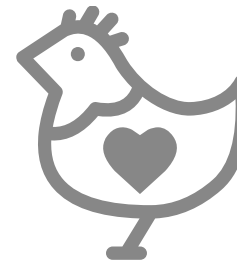
**High performance**



**High quality end-products**



**Healthy gut**



**Healthier livestock**



**High production efficiency**



 **ActiBeet®**



# FRUIT STARCH SUGAR

The natural upgrade



**THANK YOU FOR YOUR ATTENTION!**