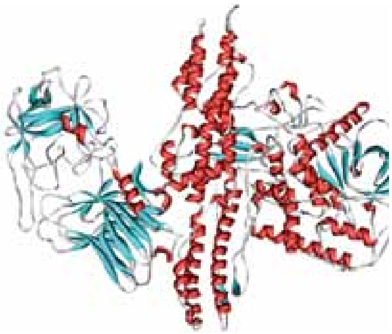
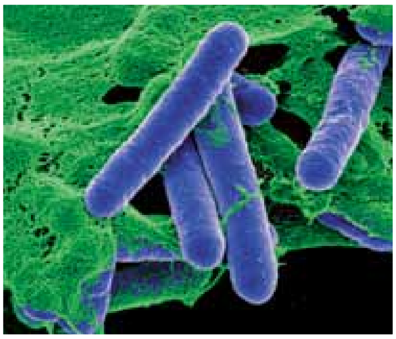
Chronic Botulism

How much is cow health preservation worth?



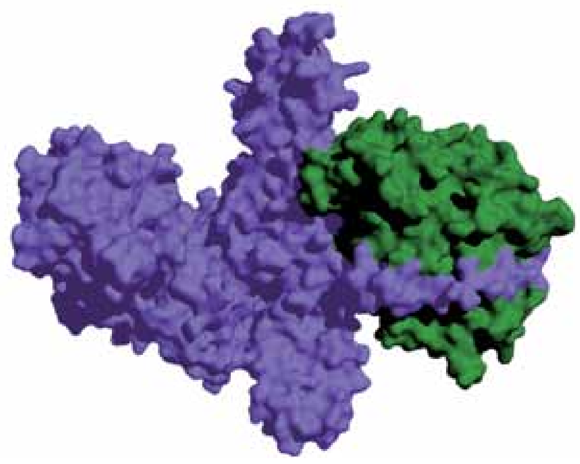
by Prof. Dr. Friedrich Weißbach

Botulism

There has been no end of scary reports in recent past. For 10 years now dairy cows have been suffering from a new kind of herd disease. This disease proceeds insidiously and usually results in devastating animal losses and thus existential needs for afflicted farmers. At the same time this ailment is not recognized as a notifiable disease. In consequence no payments are covered by the Animal Health Fund. Farms affected by this disease are nowadays found in most of all regions of Germany.

The name of this disease is „chronic botulism". A two-day seminar attended by 170 participants regarding this topic took place in September 2010 at the Agricultural and Veterinary Academy (AVA) in Horstmar-Leer. During the seminar farmer Heinrich Strohsahl from Hohenaspe (Schleswig-Holstein) gave a harrowing account of the „controlled perishment" of his entire stock of 450 dairy cows (as well as their progeny). A few months earlier the Stuttgarter Zeitung had already published an article with the heading „Death Awaits in Famer Schiele's Stable". The article recounted the plight of a farm in Gerpfenhausen (Baden-Württemberg), which lost 99 cows and 25 calves in short succession. Furthermore, a more recent case was reported in the paper „Free Press". It concerns the family Kuder of Thossfell (Vogtland), which lost nearly 600 animals in a mere few years. Veterinary treatment of the disease is difficult and rarely successful. In consequence one wonders what more must happen before people develop an awareness of this threat and start to seriously invest in disease prevention.

For a long time only acute poisoning by an extremely powerful bacterial toxin (formed by the bacterium Clostridium botulinum) was regarded as „classical" botulism. This botulinum toxin (Botulinumtoxin-surface see down below) is formed under specific conditions during the decomposition of dead animal tissue (i.e. outside the body). It can lead to fatal poisoning within a few days after intake.



The so-called botulism acquired its greatest significance as an immensely dangerous form of meat poisoning for humans. This risk has been common knowledge for more than 100 years and is nowadays contained under control by the regular use of sodium nitrite (as part of curing salt). In many countries sodium nitrite is permitted as a preservative for meat products. Attempts to ban its use due to health concerns were tried and subsequently abandoned. Evidently, the risk to consumers through botulism is obviously much larger than that from sodium nitrite.

In contrast to classical botulism experts assume that in case of the chronic form clostridia settle and multiply in cows' digestive tracts. Triggered by specific conditions these clostridia then produce the poison and thereby sicken the animals via a chronic process leading to their eventual death. The pathogenesis of this disease is not completely understood yet and is still controversially debated by vets. This is primarily due to the fact that the purported pathogen clostridia (including the type *Cl. botulinum*) is widespread in the environment. Obviously, several additional factors in conjunction to the presence of specific pathogens thus trigger the disease. There are many indicators that it is an entire range of deficiencies in hygiene and the feeding of livestock that work together to cause the outbreak of this disease finally. In order to prevent disease outbreak these defects should be diligently searched for and corrected as best as possible. This includes an as low as possible intake of clostridial spores via fodder.

The main source of clostridial spores in cattle fodder is poor grass silage. For a long time it has been known that poor silage can make cows sick.

In Table 1 results are presented derived from systematic herd checks of dairy farms exclusively using grass silage as basic fodder. Besides silage fermentation quality testing feces samples (of at least 10 cows per herd) were repeatedly examined regarding the presence of clostridial spores (during an interval of several months). These spores are durable forms of clostridia that survive in the digestive tract unharmed and are eventually excreted in the feces. Via feces, the spores get into the slurry and thus on the fodder areas. Because they are distributed much more uniformly in feces than in silage the animals' contamination level can best be determined by examination of the feces..

Table 1: **Results from farm monitorings on feed hygiene program**

Farm	Butyric acid content of grass silage (% dry matter)	Clostridial spores in faeces of cows (MPN/g) *
Winter feeding, grass silage		
A	**0.2**	**5,000**
B	**0.7**	**6,800**
C	**0.7**	**23,000**
D	**1.2**	**163,000**
E	**1.5**	**224,000**
Summer feeding, grass silage		**66,000**
Summer feeding, pasture		
I		**150**
II		**220**

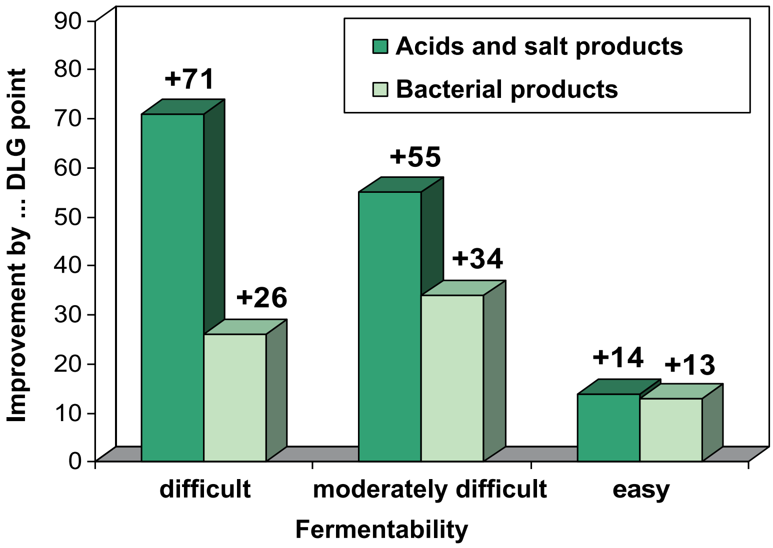
Reference: Kalzendorf, 1996; *MPN = most probable number

As can be seen, there are huge differences regarding spore contamination between the herds and their respective feeding periods. If silage is employed during summer stall feeding (zero grazing) spore numbers remain on the same high level as in the winter. In the case of exclusive pasture grazing they fall to a mere few hundred per gram, which once again confirms that silage is the main source of contamination. But even during winter feeding significant differences occur. These indicate a clear link to the butyric acid content of silage seeing as some clostridial species produce butyric acid. If butyric acid fermentation was allowed during ensiling, the multiplication of clostridia can be traced back to it. Therefore, every possible means has to be undertaken to prevent this kind of noxious fermentation.

This is the purpose of using chemical silage additives. These "classical silage appliances" have been increasingly replaced by lactic acid bacteria preparations in the past 2-3 decades. There were several reasons for this development. One reason was that after the advent of wilted silage many farmers believed silage appliances in order to counter butyric acid fermentation were no longer necessary. In truth, since wilted silage inception as standard procedure the percentage of poor, foul-smelling grass silage has been strongly reduced compared to the past. However, many farmers believe their grass silage fermentation quality to be far better than it actually is because at high dry matter levels butyric acid is less discernable. Moreover, since studies regarding fermentation acids are expensive they are consequently only rarely conducted. The second reason for the decline of classical silage appliance use is the fact that treatment costs per ton of silage material with bacterial preparations are much lower. Anyone believing that his grass silage is adequate even without any additions will be satisfied with lactic acid bacteria preparations that "make good silage better" (as oftentimes exclaimed in past advertisements). If that was all there was to it the logical conclusion would of course be to save these costs. Nowadays, bacterial preparations for the improvement of silages are consequently advertised with new, additional effects. In reality however, convincing evidence for these effects is usually lacking.

Bacterial preparations have a much less significant effect than proven chemical silage additives when it comes to improving fermentation quality (a crucial aspect of feeding hygiene). This has been proven time and again by the evaluation of test results for silage additives available at DLG (see chart).

The effect of silage additives on the fermentation quality
(Reference: Honig and Thaysen, 2002)



Data collection has shown in practice that the fermentation quality and thus the hygienic status of many grass silages are in need of improvement. It was revealed that one of the reasons for butyric acid fermentation (in the case of silage that was, apparently, sufficiently wilted) was the absence of nitrate found in forage. It was subsequently exposed that a certain minimum content of nitrate is prerequisite for the success of wilt silage.

Bacteria, which are always present in sufficient quantities, reduce nitrate of the forage to nitrite within the first hours or days after ensiling. Nitrite is a very potent inhibitor against clostridia. It suppresses noxious fermentation due to clostridia until the pH value has fallen far enough. With reduced fertilization intensity nitrate levels in grass are often very low. The experimental results in Table 2 show that in this case - in spite of good silage fermentability - butyric acid fermentation nonetheless takes place.

Added lactic acid bacteria can counteract this unwanted development by accelerating acidification. However, only a sodium nitrite-containing silage additive reliably suppresses butyric acid fermentation. Hereby, the added nitrite supplants the effect usually originating from nitrate in the grass. Above all, these experiments have shown that in such case forage wilting cannot substitute the use of silage additives. Thus, both measures must be combined to produce hygienically impeccable silage.

Table 2: **Effect of silage additives in low nitrate grass**

Fermentability	Fermentability Coefficient (FC)	Control	Lactic acid bacteria products	Nitrite-containing additive
heavy	< 35 (slight wilted)	**2.0**	**1.3**	**0.1**
moderately	35 .. 45 (moderate wilted)	**2.2**	**1.4**	**0.1**
easy	> 45 (heavy wilted)	**1.5**	**0.9**	**0.2**

Reference: Kaiser, 2000

A further important effect of additives containing nitrite is the destruction of clostridial spores already present on the grass. The silage may already be heavily contaminated by previous manure fertilization or by dirt during harvest. Even without butyric acid fermentation and growth of clostridia in the silo silages can pose a hygiene risk. The nitrite is capable to eliminate these clostridial spores too, and is therefore interrupting the potential infection cycle: animal - slurry tank - forage area - silo - animal. Table 3 shows this effect on a test result under practical conditions.

Table 3: **Clostridia spores in butyric acid-free grass silage**

Treatment		Butyric acid content (% fresh matter)	Clostridia spores (MPN/g FM)*
Control (without additive)	Mean Range	**0.13** (0.08 ... 0.23)	**51,600** 3,200 ... 100,000
Nitrite-containing silage additive	Mean Range	**0.02** (0.01 ... 0.02)	**1,100** (250 ... 2,500)

(Reference: Reuter and Kwella, 1991) *MPN = most probable number

Although both silages were virtually free of butyric acid, the untreated variant contained large numbers of clostridial spores. To what extent these spores were due to grass contamination or multiplication of species originating from the silo (which themselves do not form butyric acid) cannot be clearly exposed at this point. The nitrite additive in any event significantly reduced spore contamination.

Another reason for the oftentimes unnoticed deficiencies in the hygienic quality of grass silage is the inevitable wilting degree fluctuation during ensiling. Whether clostridia can grow in the silo does not depend on the average DM content of silage from, but rather on the minimum dry matter content (which is necessary for the suppression of butyric acid fermentation) being maintained throughout the process. Strictly speaking, the wettest silage portion (that entered the silo together with the rest) defines the hygienic status of the whole silo content, for a subsequent separation is not possible. On the contrary, while the cows formerly left poor silage shares lying in the manger, they are nowadays forced to consume them via feeding by means of the mobile feed mixer.

Studies have shown that the DM content substantially varies even with the most diligent efforts towards regularity, and these fluctuations considerably increase with the desired level of average wilting degree (see Table 4).

Table 4: **Variation in DM content at ensiling of wilted grass; two examples from practice**

Wilting degree and filling time	Numer of samples per silo	Dry matter content %		
		Mean	Standard deviation	Range from ... to
slight, (ensiled for one day)	24	**29.7**	4.5	22.8 ... 40.4
heavy, (ensiled for two day)	25	**46.6**	9.7	25.7 ... 58.1

(Reference: Von Borstel and Sommer, 2000)

For all practical purposes of silage preparation this means the required wilting degree and silage dosage has to be constantly “sustained” in order to stay on the safe side. In this case however, even grass portions that do not require silage additives at all (or at this amount) are saturated with it. Until recently, there was no escape from this dilemma. The only remaining options were either compromises to the detriment of the safety of the desired fermentation quality or high silage appliance costs. At this point, a practice-ready technical solution to this problem is available. It consist of measuring the DM content online during chopping and controlling the dosage containing nitrite silage salt solutions pursuant to a predefined program as required. This method allows minimizing the average required silage appliance dosage of the silo while maintaining full effectiveness. Table 5 uses a model calculation to indicate the significantly reduced application rate which has to be factored in despite the use of a highly effective nitrite-containing silage additive.

In the case of a wilting degree of 35% of DM on average, the application rate and accordingly the silage appliance costs per ton of silage are halved compared with the contemporary application recommendation. The costs are then at the same level or slightly higher than those applied in the use of expensive bacterial preparations of certain suppliers.

Table 5: **DM dependent Silage additive application rate per t fresh grass**

Wilting degree	DM content (%)			Mean silage additive* dosage in the silo (l/t FM**)	Expenses of silage additives (€/t FM**)
	on average over the entire silo	Range			
		from ... to	Difference		
fresh	**18**	16 ... 20	4	3.0	4.05
very slight	**25**	20 ... 30	10	2.5	3.38
slight	**30**	22 ... 35	13	1.8	2.43
moderate	**35**	25 ... 45	20	1.2	1.62
heavy	**40**	28 ... 58	30	1.0	1.35

* Active ingredients: sodium nitrite und hexamine; Price = 1,35 €/Litre
** FM: fresh matter

A significant improvement of the hygienic quality of grass silage at a reasonable costs is thus possible. Hence it follows that chronic botulism in dairy cows can be effectively prevented. The knowledge and technical means to do so are available. Especially in areas where the disease has already occurred, sodium nitrite-containing silage additives should be used during grass silage preparation. Of course this cannot be done without additional effort. But this investment is money well spent when comparing it with the possibly dire economic consequences of herd disease affliction (addressed earlier). The maintenance of our cows' health should be worth these additional costs.

By the way, in the case of intensive dairy farming in warmer countries (such as in Israel or South Africa) the animals are regularly vaccinated against botulism. This of course also costs money, and there must be good reasons why these farmers are willing to pay for it.

In conclusion, I would like to address issues regarding the meat industry. In the production of different varieties of dry sausage the use lactic acid bacteria has also become common practice to speed up the ripening process and simultaneously safeguard against the development of undesirable microflora. The addition of nitrite curing salt to prevent the growth of *clostridium botulinum* was, however, nonetheless maintained. Safety first!

Why don't we also apply this wise guideline to dairy farming?

Prof. Dr. F. Weißbach, 05/2011