

Saltpeter: A Concise History and the Discovery of Dr. Ed Polenske

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The Noord Nieuwland in Table Bay 1762; The VOC was created, in part, to facilitate the trade in saltpeter.

## Overview

Many years ago people used saltpeter to cure meat. It was discovered that saltpeter or potassium nitrate do not directly contribute to meat curing. Denitrifying bacteria remove one oxygen atom from the nitrogen compound, nitrate, and nitrite is created. Nitrite turns into nitric oxide and it is this molecule that is responsible for curing. I wondered how the composition of saltpeter was discovered and who was the first to identify the change of nitrate to nitrite in old curing brines which paved the way for the development of the modern curing industry which uses nitrite directly, thus shortening the curing cycle considerably. This is the story.

## Background

Bacon curing was described in 1876 by Edward Smith as the process whereby pork is “**preserved by salt and saltpeter.**” (Smith, 1876: 64). Curing gives bacon its characteristic pinkish/ reddish colour, a nice flavour, and it lasts a long time before it tastes “off”. The curing agent was saltpeter.

A typical curing mix used during the late 1800’s to the middle of the 1900’s for dry cured bacon was a mix of 10 pounds salt, 3 pounds of brown sugar, 6 ounces of black pepper and 3 ounces of saltpeter. They used 10 pounds of this mixture per 100 pounds of meat. (1, 2)

## Dr. Eduard Reinhold Polenske (3)

Below are the cover of the original journal, the title page and the first page of the actual article.



**Arbeiten**  
aus dem  
**Kaiserlichen Gesundheitsamte.**

(Beiträge zu den Versuchsergebnissen des Kaiserlichen Gesundheitsamtes.)

Siebenter Band.

Dr. E. Polenske,  
Technischer Hüttenarbeiter im Kaiserlichen Gesundheitsamte.

Mit 22 Zeichnungen und 10 Tafeln nach den Zeichnungen von F. Springer.

Berlin.  
Verlag von Julius Springer.  
1891.

+ 3770.66  
97

eitungen aus dem chemischen Laboratorium des Kaiserlichen Gesundheitsamtes.  
(Vorstand: Geh. Reg.-Rath Professor Dr. Zell.)

ber den Verlust, welchen das Rindfleisch an Nährwert durch  
ölsalz erleidet, sowie über die Veränderungen Salpeter-haltiger  
Pökelfäden.

Von  
Dr. E. Polenske,  
Technischer Hüttenarbeiter im Kaiserlichen Gesundheitsamte.

lag in der Absicht, zunächst festzustellen, in welche Weise der Nährwert des durch die Pökelfäden, während der Aufbewahrungszeit von verschiedener Dauer, ist wird. Zu diesem Ende waren 3 Gefäße mit je 1 Stück Rindfleisch und einer ebeicht wurden, welche nach dem Verhältnis von 6 K. Wasser, 1½ K. Koch- g. Kalifalpeter und 120 g. Zucker hergestellt worden war. r Füllung, welche von anderer Seite aus festgestellt hatte, waren verwendet

Gefäß I	905 g	rohes Rindfleisch	1941 g. Zafe.
" II	1035 "	"	1659 "
" III	1060 "	"	1648 "

e zur Unterscheidung verwendeten Mengen Fleisch und Zafe wurden den gut en Gefäßen entnommen:

I	nach 3 monatlicher Aufbewahrung,
II	" 3 monatlicher "
III	" 6 "

r Feststellung des Nährwerts konnte mit Sicherheit nur die Stoff- und die Phosphorsäure herangezogen werden, während von einer genauen ung der Kalifalte, aus früher erhaltlichen Gedanken, Abstand genommen werden

ber die äußere Beschaffenheit der Unterfangungsobjekte an den betreffenden n, läßt sich berichten, daß die Zafe I noch hellrot, rot klar und leicht filterbar heind die Zafe II und III mehr gelb, trübe und schwerer filterbar waren,

Dr. Ed Polenske (1849-1911), as friends called him, was a chemist at the Imperial Health Office in Berlin, Germany. He was born in Ratzebuhr, Neustettin, Pommern, Germany on 27 Aug 1849 to Samuel G Polenski and Rosina Schultz. He married Möller and passed away in 1911 in Berlin, Germany. (Ancestry. Polenske)

The Imperial Health Office where he worked was established on 16 July 1876 in Berlin, focusing on the medical and veterinary industry. At first, it was a division of the Reich Chancellery and from 1879, fell under the Ministry of the Interior. In 1879, the “Law concerning the marketing of food, luxury foods, and commodities” was adopted, and the Imperial Health Office was tasked with the responsible for monitoring compliance with it. Established in 1900, the Reichsgesundheitsrat supported the Imperial Health Office in its tasks. (Wikipedia. Kaiserliches Gesundheitsamt)

Dr. Polenske was a prolific food scientist who made valuable contributions to the examination of food preservatives in the 1880 and 1890's. The subject of preservatives in meat and whether they are safe to use has been one of the subjects he studied. The Wichita Daily Eagle (Whichita, Kansas) reports in an 1890 article on a convention of chemists at Speyer, Bavaria, which took place on 10 September 1888, where preservatives in meat were discussed. A conclusion of the conference was that boric acid, as a food preservative, was to be “regarded with caution.” (The Wichita Daily Eagle, 1890)

It notes that Dr. E. Polenske made an examination of 10 different “commercial preservatives intended for meat.” “Three of the 10 contained sulphurous acid or sulphites; two contained borax, and five boric acid; one each contained alum, arsenious oxide, salicylicacid and free phosphoric acid; two contained glycerine, and two boroglycerine; three contained niter, and six common salt.” (The Wichita Daily Eagle, 1890) The niter is saltpeter.

Three years following the conference (1891), Dr. Polenske published findings on a remarkable discovery that the niter commonly used in meat curing in the form of saltpeter changes into nitrite (4). *This was probably the first scientific paper by any scholar on the subject of meat curing where nitrite and meat curing was linked. In a real sense, one can say that he is the father of what became the modern meat curing with sodium nitrite and therefore the modern meat curing industry.*

The years following 1891 saw this knowledge being harnessed by industry and advanced upon by science as they worked out that it is indeed the nitrite doing the curing work (through NO) and developed methods of accessing nitrite directly in curing brines. This sped up curing from 21 days to curing in 24 hours. On farms, long curing is less of a problem, but for a commercial curing operation, it means that you keep large stocks of bacon that are in the process of curing.

Dr. Polenske's goal with the 1891 article was not to unlock the chemistry of curing but "to determine to what extent the nutritional value of beef was affected by brine over different periods of time." He set up the experiment using three jars of beef with brine. (Polenske, E. 1891)

The containers were sealed for 3 weeks, 3 months and 6 months respectively, before they were opened and the content analysed. The nutritional value was determined by measuring the nitrogen (stickstoffsubstanz) and the phosphoric acid (Phosphorssaeure) components. The brine was a mixture of salt, saltpeter and sugar. (Polenske, E. 1891)

When testing the brine, he found that nitric acid (Salpetersaeure; HNO<sub>3</sub>) was reduced through "the microorganisms induced reduction" to nitrous acid (Salpetriger Saeure; HNO<sub>2</sub>) and ammonial (ammonia). (Polenske, E. 1891) (5) Note the presence of nitrite in nitrous acid (NO<sub>2</sub>).

I approached the South African meat scientist, Dr. Francois Melette, for comment on the nature of the experiment. He observes that "the way the experiment was set up meant it was not possible for Dr. Polenske to determine if the nitrites were released from the proteins. He did the chemical analysis on the cover brine and the meat at the end of the period." In the end, Dr. Polenske's experimental design made it difficult to draw conclusions. (private correspondence with Dr. Melette, 2017).

Dr. Polenske postulated that nitric acid, which forms when saltpeter dissolves, dissociates into potassium and nitrate ions and the nitrate ions react with hydrogen ions from the water to form nitric acid; that bacterial reduction change the nitric acid into nitrous acid and ammonia. There is, however, another possible source for the nitrites namely from the meat proteins itself. Dr. Melette explains that "the protein that are broken down yields NH<sub>3</sub>/NH<sub>4</sub> and free PO<sub>4</sub> from ATP/ADP and IMP. Traditional Spanish and certain Italian products made with salt only, also cures. This is due to the break down of amino groups from the protein to NH<sub>3</sub>/NH<sub>4</sub>, that are aerobically changed into NO<sub>2</sub> and then NO<sub>3</sub>. The microbiological NO reduced product from meat origin reacts with the myoglobin meat pigment to yield the cured colour." (6) (private correspondence with Dr. Melette, 2017) The time that it takes for this to happen means that in Dr. Polenske's experiment it would not have played a role, but the possibility did not form part of the experimental design.

The interesting question that now comes up is if bacterial reduction of nitrates to nitrites was something that Dr. Polenske speculated about, or was this process generally known by 1891.

It was indeed well known by 1891. Gayon and Dupetit introduced the term denitrification 1883 and in 1886, managed the isolation in pure culture of two strains of denitrifying bacteria. The discovery followed on the discovery of Jean-Jacques-Theophile Schloesing (1824-1919) and Charles-Achille Müntz (1846-1917), when they correctly identified nitrifying bacteria in 1877 in the soil and the importance of identifying denitrifying bacteria, as in the case of nitrifying bacteria, was firstly in terms of its application in agriculture. (Payne, 1986)

W. J. Payne from the Department of *Microbiology*, University of Georgia, tracked the fascinating historical record of this discovery in a brilliant review article entitled, [1986-centenary-of-the-isolation-of-denitrifying-bacteria](#). (Click on the title to access the full article. I recommend reading this most fascinating chronology of discovery by a rich cast of characters.) Dr. Polenske undoubtedly drew on this knowledge when he wrote that the formation of nitrites and ammonia from saltpeter is achieved through a “microorganisms induced reduction.”

He immediately saw the controversial nature of his discovery and wrote that “*since the same decomposition products* (in particular nitrous acid; HNO<sub>2</sub>) *are also found in the cured meat it is likely that this subject matter will receive sharp comment.*” He referred to the fact that the presence of nitrite in drinking water was a matter of great concern in the 1890’s and was even reported on in weekly newspapers. The same is true today, but it is kept so well under control that nitrite levels in drinking water are no longer a point of public consideration. He clearly recognised the controversial nature of his discovery that, what was perceived as a poison, was found in cured meat and curing brines. (Polenske, E. 1891)

He further observed that “*values indicate that the ammoniac (Ammoniak) and nitrous acid (Salpetriger Saeure; HNO<sub>2</sub>) content of the brine increases with age.*” (Polenske, E. 1891) As we noted, he could not have known if this was from the saltpeter of the proteins, but his observed that nitrites was present in the brine and meat, makes this 1891 article the first step to a full understanding of the curing reaction which resulted in our modern method of bacon production.

## Unlocking the secrets of Saltpeter

We are so far removed from the time when saltpeter was used that it is useful to briefly look at what it was and how its chemical composition was unraveled. I relied heavily on a few authoritative works on the subject, but freely quotes from a brilliant and detailed review article, written by Richard P. Aulie, [boussingault-and-the-nitrogen-cycle](#) outlining the chronology of the discovery of the nitrogen cycle by focusing on the work of the prolific French chemist, Boussingault, published in the Proceedings of the American Philosophical Society, Vol. 114, No. 6 in 1970. (The entire article is accessed by the link and readers are encouraged to take the time to study this article thoroughly).

For many years we did not know what saltpeter is composed off. We knew what one could do with it. It is a salt that is used for explosives, meat curing, to fertilize crops, cool beverages and by the late 1800's, even as a treatment for blood pressure. In many regards, saltpeter was the subject of an arms race between nations in the middle ages as they jostled for superiority in matters pertaining to ammunition and agriculture. Saltpeter was the key ingredient in both these.

By far the largest natural deposits were found in India (potassium nitrate) and the East Indian Companies of England and Holland were in large created to facilitate its acquisition and transport. Later, massive deposits of sodium nitrite were discovered in the Atacama Desert of Chili and Peru and became known as Chilean Saltpeter.

At a few places, some peoples of the ancient world cured their meat with saltpeter and enjoyed its reddening effect, it's preserving power and the amazing taste that it gave. It was, however, not widely used until the 1700's when it became more commonly used and by 1750, its use was probably universal in curing mixes.

These ancients could not tell if saltpeter occurred naturally or was it something that had to be nourished or cultivated by humans. Both occurred. It was found naturally and the technology of producing it became common knowledge among farmers in Germany. Generally, when the ancients managed to get hold of it, they wondered how to take the impurities out of the salt which gave inconsistent results in curing meat, fertilising fields and in the quality of gunpowder produced from it.

People were baffled by its power. Almost every great civilization used it in one way or the other. Romans used it to cure meat as early as 160 BCE. The Chinese and Italians used it to make gunpowder. There is a record of gunpowder being used in India as early as 1300 BCE, probably introduced by the Mongols. It was used since ancient times as medicine and as fertilizer. (Cressy, David, 2013: 12) Saltpeter was used in ancient Asia and in Europe from the 1500's to cool beverages and to ice foods. (Reasbeck, M: 4) The first reported references to the characteristic flavor of cured meat produced by the addition of saltpeter during meat preservation and curing were made as early as 1835. (Drs. Keeton, et al; 2009) Some speculated that it contained the ***Spiritus Mundi***, the 'nitrous universal spirit' that could unlock the nature of the universe! (Cressy, David, 2013: 12)

Peter Whitehorney, the Elizabethan theorist who wrote in 1500's, said about saltpeter, "I cannot tell how to be resolved, to say what thing properly it is except it seemeth it hath the sovereignty and quality of every element". Paracelsus, the founder of toxicology who lived in the late 1400's and early 1500's said that "saltpeter is a mythical as well as chemical substance with occult, as well as material connections." The people of his day saw "a vital generative principle in saltpetre, 'a notable mystery the which, albeit it be taken from the earth, yet it may lift up our eyes to heaven'" (Cressy, David, 2013: 12)

From the 1400's to the late 1800's scientific writers probed the properties of this magical compound. "Saltpeter encompassed the "*miraculum mundi*", the "*material universalis*" through which 'our very lives and spirits were preserved. Its threefold nature evoked 'that incomprehensible mystery of ... the divine trinity,' quoting Thomas Timme who wrote in 1605, in his translation of the Paracelsian Joseph Duchesne. "Francis Bacon, Lord Chancellor and Privy Councillor under James I, described saltpeter as the energizing "spirit of the earth.'" (Cressy, David, 2013: 14)

From as early as the mid-1600's, important observations started to emerge about saltpeter but without any real experimental basis. Some of these conclusions were based purely on speculation but were remarkably accurate. Johan Rudolph Glauber (1604-1670) detected it in plants, animals, and soil in 1658 . He speculated on the chemical relationships that bind them together. Despite the fact that he did not do many experiments on plants, he suggested the efficacy of saltpeter in plant nutrition. He called it "the Universal Menstruum," since by it, "he wrote. . . every pure Sand destitute of all fatness is quickly so fatted . . . we affirm that the Salt-

Petre was of necessity in the Herbs, & Grass, afore the Beasts feeding on them ...." (Aulie, R. P.; 1970: 440)

In 1676 Edme Mariotte (1620-1684) quite brilliantly speculated about the role of the atmosphere in plant nutrition, despite not having any experimental basis for his speculation. He correctly stated that "*these volatile salts, etc., are mixed in the air with aqueous vapors, etc., and fall again with the rain formed with these vapors onto the surface of the ground. There they penetrate together as far as the roots of plants, where they enter with some particles of soil...*" (Aulie, R. P.; 1970: 440)

From the earliest times, the study of saltpeter was done concurrently with a study in fertilisers and explosives. Beginning with the work of John Woodward (1665 – 1728) of the Royal College of Physicians, the speculation on saltpeter and fertilisers of the 17th century ended and made way in England for a much more practical approach to agriculture. The French chemists, like Boussingault, took up the challenge of rigorous scientific research on the subject.

Another French Chemist, Louis Lemery (1677-1743), "showed for the first time that saltpeter is of organic origin and that it cannot be considered a mineral. In his 1717 paper, "On the Origin of Nitre," he described its slow production in the superficial layers of the soil. He also recognized the reciprocal relationships that characterize plants, animals, and the soil, while denying the previous "nitro-aerial matter." (Aulie, R. P.; 1970)

There is an interesting reason behind the changes in focus between the English and the French. England gained access to the saltpeter fields in India reducing the national priority of understanding it in order to manufacture it. The French, on the other hand, never had access to natural saltpeter and it had to find better ways of producing it in order to satisfy the demand of its enormous military and, I am sure, their farmers.

The practical approach of the English to fertilizers became an important backdrop of the future work of the brilliant French chemist Jean-Baptiste Joseph Dieudonné Boussingault (1 February 1801 – 11 May 1887). Boussingault would become one of the most prolific scientists in terms of the research on nitrogen and is rightly credited for laying the foundation for the discovery of the nitrogen cycle. (Aulie, R. P.; 1970)

The next major milestone on the road to the full realization of the role of nitrogen in nutrition was the identification of "nitrogen as a gas in the atmosphere, and as a constituent of both animal

and plant tissues". These occurred in the last quarter of the eighteenth century as a combined achievement of English and French chemistry. (Aulie, R. P.; 1970)

"By 1772 the English pneumatic chemists had isolated "mephitic air," but they had not yet established its elemental nature. The French quickly saw the importance of the English gas studies and, beginning with Antoine Laurent Lavoisier (1743-1794), rapidly incorporated them into their own work. They invented the names azote and nitrogen for the new gas, established its elemental nature, determined its quantitative percentages in nitric acid, ammonia, and saltpeter, and began to detect les azotates de potasse in many plants, all before the close of the eighteenth century." (Aulie, R. P.; 1970)

The chemical elements of potassium, nitrogen, and oxygen as constituents of saltpeter were identified even though there remained uncertainty about the exact ratio of atoms. The value of nitrogen in plant and animal nutrition was elucidated by scientists, particularly by Boussingault. His work laid the foundation for the discovery of the role of microorganisms in fixation of nitrogen as well as the reduction of nitrates to nitrite and ammonia.

The next few years saw scientists and in particular, Boussingault, starting to understand the value of nitrogen in plant and animal nutrition. A key question that had to be answered was the source of the nitrogen. One of the possible sources that was still being looked at with great interest was atmospheric nitrogen. Another, more obvious source, at this time, due to the long and well documented use of saltpeter, was nitrates.

Boussingault turned his attention in 1855 to conducted research on nitrates as a source of plant nitrogen. This naturally led him to inquire how they are formed in the soil. He asked the question "if nitrates and ammonium salts are interchangeable in the soil, and which is the more efficacious; is one or the other actually the form in which nitrogen is absorbed by plants? Furthermore, did nitrates act essentially like alkali salts because of their sodium or potassium content, or like ammoniacal salts?" (Aulie, R. P.; 1970)

"Beginning with Boussingault in 1855, various workers attempted to settle these questions with the view of determining how plants get their nitrogen. These essentially chemical attempts continued until the late 1870's, when the modern biochemical interpretation began to emerge. Kuhlmann thought that nitrates were formed by the oxidation of ammonia in the soil. As a corollary to this view, he also maintained that the utility of nitrates was due to their deoxidation into ammonium compounds in the soil. Noting the constant association of organic

materials with nitrification, although, to be sure, missing the importance of microorganisms, he went on to assert that putrid fermentation was a necessary condition for this nitrification." (Aulie, R. P.; 1970)

"In the spring and summer of 1855, Boussingault examined this hypothesis by investigating the influence of potassium on *Helianthus argophyllus*, or the sunflower. He wished first to test whether putrescible organic material in the soil was absolutely indispensable for the absorption of the nitrogen of nitrates, and second, to determine whether there was a prior transformation into ammonium compounds." (Aulie, R. P.; 1970)

"The first part of this hypothesis was easy to test, which he did, by using an artificial soil free of all organic materials. In his first experiment, he reported to the Academie that his sunflowers flourished in a soil composed of calcined sand and ash, when watered with a solution containing 1.11 grams of potassium nitrate (saltpeter)." (Aulie, R. P.; 1970)

"He showed that all the nitrogen could be accounted for by the potassium nitrate (saltpeter). Although Boussingault could not then test for the nitrate "ion," the contemporary ideas of "equivalents" allowed him to determine the relative proportions of nitrogen and potassium both in the soil and in his experimental plants. At the time he began his nitrate work, there was still confusion about the number of atoms that would combine to make a compound. But chemical equivalents were directly measurable, and this concept Boussingault readily used to good advantage, as did many chemists of his day. Dictionaries and texts gave the composition of potassium nitrate as  $KO_3AzO_5.146$ ." (Aulie, R. P.; 1970)

Boussingault reasoned that by determining the ratio of alkali to nitrogen in his test plants, and comparing this figure with the known value for niter, he would be able to draw a conclusion with respect to its possible prior transformation in the soil. The data show that the action of potassium nitrate was manifest in the absence of decomposing organic material. But did the nitrogen enter as a nitrate or as ammonia? The answer to this question depended on the ratio of potassium to nitrogen in the soil." (Aulie, R. P.; 1970)

"Boussingault considered his figures close enough to warrant the conclusion that potassium nitrate was absorbed as such by each equivalent of potassium, at least in this experiment, without prior transformation in the soil. Transformation into an ammonium salt prior to absorption would have resulted presumably in different analytical results, owing to the escape of

volatile ammonia. His control plant languished in the absence of potassium nitrate; a slight increase in nitrogen he attributed to a visible cryptogamic contamination." (Aulie, R. P.; 1970)

"From the beginning of his career, Boussingault was aware that nitrogen was far from the only useful element in plant nutrition. As early as 1841 he was "certain that many calcium and mineral salts are indispensable for the development of plants." His work on nitrates in the late 1850's was an experimental confirmation of his earlier views. Having demonstrated qualitatively in 1855 with Helianthus the pronounced growth that results with a regimen of potassium nitrate (saltpeter), Boussingault in 1857 then went on to demonstrate the quantitative effects produced in this plant by both mineral and nitrogen components of fertilizer on the elaboration of organic materials." (Aulie, R. P.; 1970)

Saltpeter, nitrogen and its role in plant and animal, including human nutrition, the nitrogen cycle, nitrifying and denitrifying bacteria are all integrally connected fields of study. It encompasses chemistry, biochemistry, bacteriology, nutrition, medicine and meat science and even today the various complex mechanisms associated with its efficacy as fertiliser and curing agent is not fully understood by science.

Another interesting link between Polenske and Boussingault is the way in which Polenske sought to determine the nutritional value of cured beef. He looked at amongst other, the nitrogen content. This had its origin in work done by Boussingault and Magendie.

"Franqois Magendie (1783-1855) reported in a classic study in 1816 that dogs could not survive on a diet of non-nitrogenous food alone. He wrote that "*It would be of fundamental importance in the history of nutrition, if the source could be determined of the nitrogen which is found in such great abundance in the animal body*". It was this study of Magendie that gave Boussingault the "clue on which he promptly acted in his first research work. This clue was the identification of nitrogen as an important ingredient in animal diet." It was on the basis of this work that Dr. Polenske wrote his 1891 article, examining the nutritional value of cured beef by focussing on its nitrogen content. The obvious loss of nitrogen in the curing process caused him to view cured meat as inferior to fresh meat. (Aulie, R. P.; 1970) Even today, it is a recognised fact that nitrogen is an important ingredient in a healthy diet.

## **Conclusion**

Saltpeter's mysterious composition was unlocked by Lavoisier and his contemporaries. This, together with discoveries in the 1880's about the conversion of nitrite to nitrate and nitrate to nitrite by ground and water bacteria lead to Dr. Polenske's remarks that nitrite is created through bacterial action from saltpeter (potassium nitrate) in curing brines and cured meat. This simple discovery later precipitated an avalanche of academic discoveries about nitrate, nitrite, nitric oxide and the mechanisms behind curing.

Indian Saltpeter was widely used in brine mixes around the world by the second half of the 1800's. One such recipe from an American newspaper gives the make-up of a popular brine mix as fifteen pounds of salt, two and one-half ounces of crude East Indian Saltpeter and ten gallons of water with three-quarters of molasses. The meat is emerged in this mix and cures in between forty to forty-five days, ready for smoking. (Shenango Valley News (Greenville, Pennsylvania), 26 January 1883, page 3)

Butchers are very observant people and I am convinced that they were aware of the change of nitrate to nitrite and the probability that it was nitrite doing the curing, even before Polenske published and before the curing agent was identified as nitrite in the last decade of the 19th century. There are many examples of butchers through the ages being not only knowledgeable of chemical reactions in their trade but also careful students of the latest scientific work associated with anything remotely associated with meat and blood. Dr. Polenske's work is indeed the first important scientific work that resulted in our modern way of curing meat by the use of sodium nitrite.

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## Notes:

(1) A survey was done in the US in the 1950's to determine the most common brine mix used for curing bacon at the time. Even though it is 60 years after this letter was presumably written, I include it since methods and formulations in those days seemed to have a longevity that easily would have remained all those years later. The survey was also done among farmers, in an environment where innovation are notoriously slow. (Dunker and Hankins, 1951: 6)

(2) How salty was this bacon in reality? The recipe is used by most US farmers by the 1950's was 10 lb (4.54kg) salt, 3 lb (1.36kg) of brown sugar, 6 ounces (170g) of black pepper and 3 ounces (85g) of saltpeter. 10 pounds (4.54kg) of this mixture per 100 pounds (45.36kg) of meat.

The total weight of dry spices is therefore 6.07kg of which salt is 74% or 3.4kg. This was applied at a ratio of 3.4kg salt per 45kg of meat or 1 kg salt per 13 kg of meat. Not all salt was absorbed into the meat, but the meat was regularly re-salted during then curing time which means that this ratio would be applied many times over before curing was complete. Compare this with the salt ratio targeted by us in 2016 of 25g per 1kg final product, this means that the bacon made with this recipe would be extremely salty, irrespective of the use of sugar to reduce the salty taste. The bacon would have to be soaked in water first to draw out some of the excess salt, before consumed.

(3) Spelling of his surname varies between Polenski and Polenske. His fathers name was spelled "Polenski."

(4) Dr Ed Polenske's findings has been published in "Arbeiten aus dem Kaiserlichen Gesundheitsamte , 7. Band, Springer, Berlin 1891, S. 471–474"  
[http://books.google.co.za/books?id=R\\_YAAAAAYAAJ&pg=PA471&redir\\_esc=y](http://books.google.co.za/books?id=R_YAAAAAYAAJ&pg=PA471&redir_esc=y)

(5) Qualitative and quantitative techniques for measuring nitrite and nitrates in food has been developed in the late 1800's. (Deacon, M; Rice, T; Summerhayes, C, 2001: 235, 236). The earliest test for nitrites is probably the Griess test. This is a chemical analysis test which detects the presence of organic nitrite compounds. The Griess reagent relies on a diazotization reaction which was first described in 1858 by Peter Griess.

Schaus and others put the year of the discovery by Griess as 1879. According to him, Griess, a German Chemist used sulfanilic acid as a reagent together with  $\alpha$ -naphthylamine in dilute

sulfuric acid. In his first publication, Griess reported the occurrence of a positive nitrite reaction with human saliva, whereas negative reactions were consistently obtained with freshly voided urine specimen from normal individuals. (Schaus, R; M.D. 1956: 528)

(6) “The typical aroma, texture and taste of these products are denatured and deaminated protein skeletons, and some oxidised fat (some of which are very pleasant and called in German “genuss saeure”, “enjoyable” acids, or food acids.” (private correspondence with Dr. Melette, 2017)

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